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COMPARATIVE PHYSICAL EDUCATION – SOME METHODOLOGICAL CONSIDERATIONS FROM SOCIAL SCIENCE PERSPECTIVE

Petr Vlček
Faculty of Education, Masaryk University, Brno, Czech Republic

Abstract

The study deals with some chosen problems of the comparative physical education and sport methodology. The goal of the text is to contribute to the quality methodological discourse in physical education and sport sciences. The author also attempts to show some possible approaches to the process of the comparative research in physical education and sport based on the problem approach methodology.

Apart from the brief theoretical and historical issues of the comparative research in chosen social sciences which stand for the basis of the authors further considerations the text presents some principles of comparative research valid also for the research in physical education and sport. The principles are based on the methodology used in chosen social sciences which use the scientific comparative method.

The text presents particular steps of the comparative method in physical education and sport research.

The final paragraphs deal with some considerations about the role of descriptive and case oriented studies in the physical education and sport research mainly from the problem oriented scientific approach.

Keywords: *physical education and sport, social sciences, comparative research, methodology, comparative method, problem approach*

Introduction

Our lives are full of comparison. Children want compare their results at school, they like to show and being seen as stronger, faster or more skilful than the others on a playground or in any places they play around. And also all of us adults compare. We compare our career, financial well-being, health (our muscles at first, our middle age spread later). As Brandel-Bredenbeck (2005) states, comparing oneself with others is a core element of identity development. We compare more or less deliberately as comparing is a general cognitive medium of our knowledge.

In science, comparing is used as a scientific method which is also used in physical education and sport. Based on scientific comparison there can be found various disciplines and sub-disciplines and special fields of research (Vlček, 2009,

2015) including physical education and sport (Howell et al., 1979). As some authors point out (Vlček, 2015; Walterová, 2014; Manzon, 2011; Noah & Eckstein, 1969), comparative researchers stating the use of scientific comparative method in some social sciences[1] often present texts which are descriptive, insufficiently verified and tendentious. The examined data are often randomly collected, the texts are narrative in their character and lack explicit method, explanations and search for solutions (Vlček, 2015; Walterová, 2014; see also Manzon, 2011; Noah & Eckstein, 1969).

As the domain of[2] comparative physical education and sport as an area of study can draw from number of comparative disciplines (Kudlorz, 1989, Hardman, 2000) and hence, is seen to be multi- and inter-disciplinary in nature and scope, we in the presented text undertake an examination of comparative fields in some chosen social sciences. We want to look at what is essential to them concerning the field of their study. This would help put the debate on the position of comparative physical education within the framework of the educational sciences in a wider perspective (Howell at al. 1979) but also focus more precisely on some issues concerning methodology.

Comparative politics

We examined the field of comparative politics and two of its subfields: comparative public administration and comparative policy studies. The discourses about their nature are useful in enlightening the issue of the nature of Comparative physical education and sport. Roberts (1972, see also Říhová, 2005) defines comparative politics as "the study of the relationship of theories and concepts to the universe of political systems, past and present, and necessarily employing comparison as a means of explanation". Roberts highlights the scientific comparative approach as a necessary element of the study.

Comparative law

Bogdan (1994, see also Štefanovič, 1996) describes that in the discipline of law, the systematic ordering of legal subjects and fields of research usually mirrors the common way of dividing the legal system. For example, penal law is concerned with the rules prescribing the punishment of criminal act. Yet, some fields of legal science deal with problems of a general nature which effect the entire, or almost the entire, legal system. To this category belong theoretical subjects such as legal history, sociology of law, and comparative law. He defines comparative law as the subject that encompasses: the comparing of different legal systems with the purpose of ascertain their similarities and differences ascertained, for instance explaining their origin, evaluating the solutions utilised in the different legal system, grouping of legal

[1] In the field of Comparative physical education and sport it concerns especially qualitative research in Sport pedagogy...
[2] not only

systems into families of law, or searching for the common core of the legal systems (theoretical purposes); and the treatment of the methodological problems which arise in connection with these tasks, including methodological problems connected to the study of foreign law.

Comparative literature

Aldridge (1969) defines comparative literature as "the study of any literary phenomenon from the perspective of more than one national literature or in conjunction with another intellectual discipline or even several". He distinguishes comparative literature from general literature by highlighting that this comparative field focuses on "the relations between one particular literature and others", where such relations may take the form of "affinity, tradition, or influence".

Comparative education

Manzon (2011, see also Walterová, 2006, 2014) defines comparative education as "an interdisciplinary subfield of education studies that systematically examines the similarities and differences between educational systems in two or more national or cultural context, and their interactions with intra- and extra-educational environments. Its specific object is educational systems examined from a cross-cultural (or cross-national, cross-regional) perspective through the systematic use of the comparative method, for the advancement of theoretical understanding and theory building".

Methods

Summarising the results of the above definitions, we might try to define academic comparative physical education. Nevertheless, we suggest concentrate at the historical consequences first.

Comparative physical education and sport is a relatively young area of study in a formal sense (compared e.g. to comparative law) although the quest for knowledge about practices and systems has been in evidence since Prussian Count Leopold Berchtold included physical education and sport in 400th page questionnaire for travellers in 1789 (Hardman, 2000). The pioneering work of Berchtold was developed by another Frenchman, Marc Antoine Jullien, when in 1817, he published a series of questions on public education, including physical education in European countries. Thus, as Hardman (2000, 2001) states, the field of Comparative physical education and sport has travelled a similar road to that of comparative education (but also to the other comparative disciplines), from which it has adopted various methodological approaches in comparative study and research.

According to Noah and Eckstein (1969, see also Halls, 1990; Průcha, 2006; Váňová, 1998; Walterová, 2006; etc.) development of comparative education has

been marked by five identifiable stages, each characterized by a different motive for comparative study and each producing a different genre of work. The earliest stage, the period of travellers‘ tales, was promoted by simple curiosity. Second came a period of educational borrowing, when the desire to learn useful lessons from foreign practices was the major motivation. In the third stage, international education cooperation was stressed in the interests of world harmony and mutual improvement among nations. Since the beginning of the twentieth century, two more stages have appeared, both concerned with seeking explanations for the wide variety of educational and social phenomena observed around the globe. The first of these attempted to identify the forces and factors shaping national educational systems. The second, and the latest, may be termed the stage of social science explanation, which uses the empirical methods various social sciences e.g. economics, political science, and sociology to clarify relationships between education and society.

In agreement with the specification of the latest stage the International Society for Comparative Physical Education and Sport (ISCPES) defines current comparative study as a field in which two or more units (countries, cultures, ideologies, regions, states, systems, institutions, populations [3]) are compared mostly occurring in different geographical settings. Examples of phenomena to be compared include school systems (or elements of physical education and sport models in a macro or micro context). Usually the phenomena associated with such units are universal, but cross-culturally and cross nationally, they may differ in focus and substance. Comparativists study how and why they differ (Hardman, 2000).

Summarising the facts from the above definitions we can define four fundamental principles of comparative research as follows: there has to be more studied objects, they have to be comparable and systematically and scientifically explained in the global context. On that account the fundamental principles of comparative research are (Vlček, 2015 see also Knapp, 1991):

- plurality,
- comparability,
- contextuality,
- scientific approach.

In other words the principles mean that a prerequisite for any comparative study is to establish the parameters for initial comparability of chosen units of analysis (more than one). In general, comparative analysis can be carried out when the units for comparison have some parameters in common to make analysis of their differences meaningful (Holmes, 1984; Váňová, 1998). Thus, rather than mechanical identification

[3] For detailed structure of the levels of comparison see Bray & Thomas (1995).

of similarities and differences between two or more places, it is suggested that attention should be paid to the underlying context of these commonalities and differences (Noah & Eckstein, 1969, p. 97; see also Knapp, 1991; Liu, 2008), and to their causal relevance to the exactly defined phenomenon (Walterová, 2006, p. 21; Noah & Eckstein, 1969) being examined. This attitude in the social sciences is inseparably bound up with the research strategy which is "systematic, controlled, empirical and critical" (Almond & Verba, 1963). Here it has been accepted to distinguish two approaches in comparative research. The first, the problem approach, as Bereday (1964) states, enables the researcher to survey comparative evidence in small segments. The second, the total approach, exposes the whole panorama.[4]

The problem approach as a fundamental step involves the selection of one theme (one topic). As Noah and Eckstein (1969, see also Holmes,1981; Manzon, 2007) stress, without a specific topic there is no way to decide what data are relevant in the early stages of the investigation, when data gathering may cease, and what countries [5] ought to be included in the sample.

In Bereday's (1964) classic book Comparative Method in Education the author introduces his four-step method of comparative analysis (Figure 1), consisting of description, interpretation, juxtaposition, and simultaneous comparison.

[4] There is no comparative researcher who can attempt the total comparative approach without a life-long, full time preparation for the task. Hence the justification for the problem approach (Bereday, 1964)...
[5] For detailed structure of the levels of comparison see Bray & Thomas (1995).

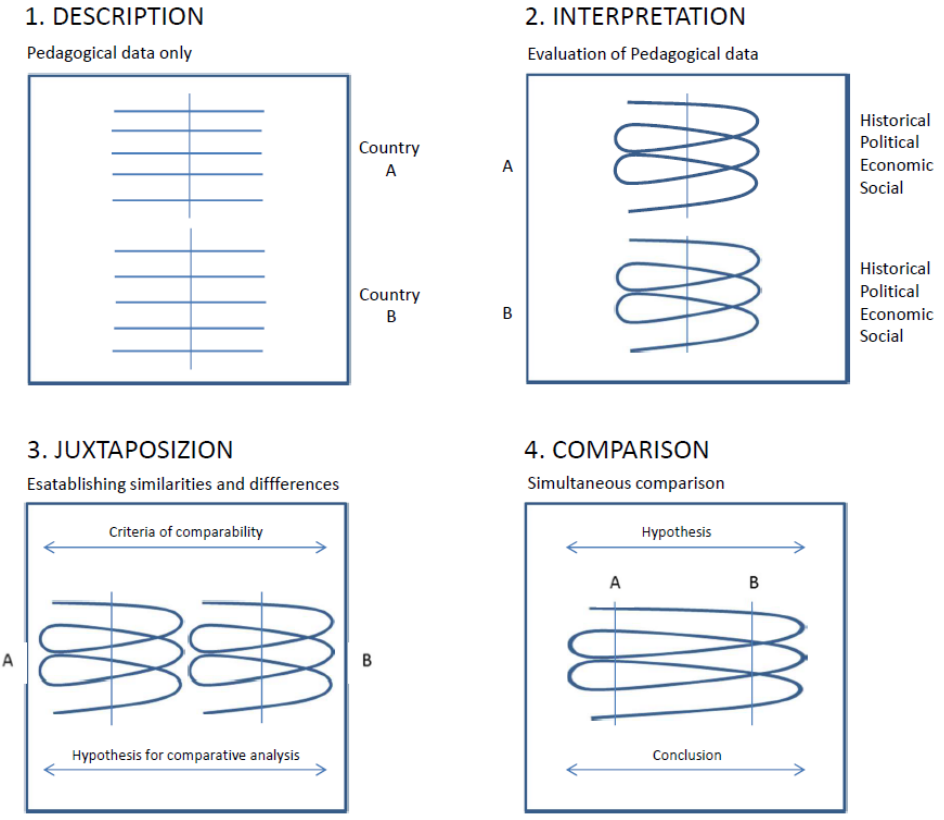

Fig. 1: Bereday's Model for Undertaking Comparative Studies

Description – collection of pedagogical facts, interpretation – the analysis of facts by the methods of different social sciences, juxtaposition – the preliminary comparison of facts, comparison – the final fusion of the facts with similarly assembled data from other countries[6] *for the purpose of comparison (Bereday, 1964).*

Results and Discussion

It is important to stress once again that the fundamental question in the problem oriented comparative research is the definition of one theme, one topic and one or

[6] …or other levels (Bray & Thomas, 1995).

more precisely described problems. Yet, there can be found both monographs and paper texts describing e.g. physical education in various countries without focusing on certain questions. It must be emphasized that even a single case study cannot be looked at as successful from the comparative methodology point of view without an explicitly stated problem, rigorously defined concepts and variables (Ishikawa, 1968). As Noah and Eckstein (1969) highlighted, case studies that neglect these basic features of scientific work risk remaining isolated fragments of the phenomena they deal with. A series of separate country-by-country studies (a tapeworm studies) are hardly a substitute for a study that is comparative which means that deals with a certain problem cross-nationally. Thus, a pure enunciation of facts about foreign countries is in the light of presented analysis not a comparative treatment.

Most important, perhaps, the criteria by which one accepts or rejects statements about social life are of a special nature. The ultimate criterion is the method by which they are gathered. The method should be relatively systematic and relatively reliable. And it ought to be amenable to replication, so that some other researcher looking at the same body of material would come up with roughly the same facts (Almond & Verba, 1963). All this implies that the method should be public and explicit.

Utilizing the specific approach of Holmes (1981, 1984) and adding a few words, as Howel et al. (1979) did, comparative (physical education as a theoretical generalizing social science consists of those theories, hypotheses, models and laws which facilitate our understanding of the processes of (physical) education. The aim of a comparative (physical) educationist interested in this aspect of his subject is to build up a pattern of testable hypotheses and develop conceptual models which will enable complex data to be classified and functional relationships examined. The theoretical scientist moreover is interested in putting his hypotheses to the test of experience. In comparative physical education a body of knowledge is slowly emerging.

Conclusion

As we have experienced ourselves[7], the potential of the Comparative physical education and sport can be seen in various directions:

- in the promise of extending the generality of propositions beyond the borders of one single society,
- in the provision of and arena where propositions (which can be tested only in a cross-national context) can be investigated,
- it can serve as a field for interdisciplinary work,
- and, it can serve as an instrument for planners and policy makers.

[7]…or other levels (Bray & Thomas, 1995).

In this text our goal was to show and explain the need for scientific treatment in the field of Comparative physical education and sport in which the use of rigorous methodology plays crucial role. Thus, we would like to conclude the paper revising the most urgent thoughts we tried to present.

A central advantage of using the rigorous scientific method in comparative research is that it offers a consistent way of dealing with problems of bias and tendentiousness. And as Bereday (1957) stresses, no method is comparative unless it is preceded by a formulation of an abstract scheme which serves as a guiding hypothesis for the collection and the presentation of comparative data. We can add in a figurative way, it is only a game "find 10 differences in a photo" without knowing why and what for. Concluding in a similar metaphorical way, it is not only inefficient and uneconomical to collect some data without defining a problem as the researcher cannot determine their relevance, but as Karlinger (1965 in Noah & Eckstein, 1969) outlines, the preliminary problem definition is similar to playing a game of chance. The rules of the game are set up in advance. One cannot change the rules after an outcome, nor can one change one´s bets after making them. That would not be fair. One cannot throw the dice first and then bet. Similarly, if one gathers data first and then selects a datum and comes to a conclusion on the basis of the datum, one has violated the rules of the scientific game.

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PRELIMINARY CZECH-AUSTRIAN PROJECT OUTCOMES OF THE INTERGENERATIONAL CONTEXT BETWEEN SENIOR AND CHILDREN GENERATION FROM THE CZECH PERSPECTIVE

Dagmar Heiland Trávníková, Milena Strachová
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Background and Purpose: According to the latest demographic data, contemporary population is facing progressive process of ageing. Recently conducted studies have shown that intergenerational relation and common activities among seniors and their children or grandchildren present a significant factor in both physical and mental fitness of the seniors (World Health Organisation [WHO], 2011; Hoff, 2007; Uhlenberg and Hammill, 1998). This paper presents preliminary results of a qualitative study, conducted within the international Czech-Austrian AKTION project, delivered at the Faculty of Sports Studies, Masaryk University (Febr.2015 – June2016), which deals with the intergenerational context between grandparents and grandchildren, especially in the area of physical activities. The goal of the study is to study the mutual influence between the senior and grandchildren generation in the area of daily physical activity and routine as well as the geographical, political and other factors in the two included countries. *Methods:* For the purpose of the study with seniors we use a semi-structured interview conducted with total amount of 50 Czech and Austrian seniors – grandparents (n = 50), in order to monitor their childhood memories of common activities with their grandparents as well as their contemporary situation of performing common activities with their own grandchildren. The semi-structured interviews have been progressed by general data analysis firstly (such as age, sex, nationality, number of children and grandchildren and possible occurrence of a child/ grandchild with disability). The second part of the analysis consists of qualitative data progression by means of interview transcript analysis and matching particular key words to significant domains. For the purpose of the study with the grandchildren qualitative projective method of an essay will be used. Final results of both age groups will be compared in both countries subsequently. *Results*: The so far analysed interview transcriptions show that many study respondents follow similar pattern of activities in their childhood, such as commuting to school by bike, helping with the work at home or in the field as many families were dependent on farming. Unsurprisingly, mutual historical life paths have been found in the interrogated Czech and Austrian seniors. The key theme domains in the context of the intergenerational relationships have been stated as relation to parents, emotional situations, events and experiences in the childhood, relation and activities with grandparents and relation and activities

with grandchildren. The whole set and subsequent comparison of domains, as referred to by Czech and Austrian senior respondents, is to be completed. *Conclusions*: Preliminary project outcomes show that different levels of grandparent involvement in their grandchildren education and personal development exist. However, positive relationship and certain way of grandparent participation on physical activities and meaningfully spent leisure time is positively accepted by both generations. Furthermore, typical repeated family patterns in the area of communication, emotions and relationships may be seen.

Keywords: *Aktion, seniors, children, intergenerational context, historical-cultural background, Czech Republic, Austria*

Introduction

According to the latest demographic data, contemporary population is facing progressive process of ageing. Recently conducted studies have shown that intergenerational relation and common activities among seniors and their children or grandchildren present a significant factor in both physical and mental fitness of the seniors (World Health Organisation [WHO], 2011; Di Gessa et al, 2015; Hoff, 2007; Uhlenberg and Hammill, 1998). Suitable physical activities slow down the ageing processes of human organism and thus, improve the quality of life in seniors. Moreover, it has been proved that the grandparent–grandchild relationship is very important during grandchild's childhood (Harper, 2005). Grandparents can influence their grandchildren in many ways. Grandparents may have a direct influence on grandchildren through their interactions with them. They can serve as role models for their grandchildren, discussing appropriate behaviour, encouraging academic or other success, helping with homework, and providing advice and emotional support (Dunifon, 2013).

Therefore we assume that active involvement of grandparents in their grandchildren education, meaningfully spent leisure time and personal development is a mutually beneficial societal phenomenon. Involved grandparents may work with parents to enforce consistent norms and monitor children's activities (Coleman, 1988). This paper presents the Czech-Austrian cooperation project AKTION and a qualitative study, the key objectives of which are to describe the coexistence of two different generations of grandparents and grandchildren, to study how they perceive each other and how physical activities and games are included within this context. Partial goal of the project is relevant to a comparative study of Czech and Austrian historical-social context of specific periods (before 1900, during WW II period and nowadays), especially in the area of daily activities and physical activities or sport of grandparents

and grandchildren. It is necessary to take into consideration social, economic and political situation during the above mentioned historic periods and consequently, the status and level of physical education or sport activities that differed fundamentally. The nature of grandparents' role has also changed, with grandparents reporting more warmth toward their grandchildren than existed in previous generations (Cherlin and Furstenberg, 1992).

Historical background of physical activities and sport in the Czech context

After the publication of the October diploma in 1860, by means of which the monarchy renounced the model of absolutism and due to the complex releasing atmosphere in the society, federative life has started. Voluntary gymnastic federations were founded. Foundation of the Sokol gymnastic federation (in1962), the goal of which was, among other, to increase physical and moral fitness of the Czech nation, has become a crucial historical moment. In the past decade of 19th century blue-collar and catholic gymnastic federations were founded as well (Federation of blue-collar gymnastic federations, Orel). Development of sport, tourism as well as scout movement was typical for this period (Grexa and Strachová, 2011). Rowing, skating, cycling and athletic were first sports disciplines that were developed in Czech lands. On the edge of 19th and 20th centuries football became highly popular not only in the Czech lands, but also in middle Europe (Schůtová and Wajc, 2003). Activity of the sports federations was paralysed by WWI. Majority of the federations were dissolved, however, particular associations continued its activity, as permitted by war conditions. Establishment of Czechoslovakia in 1918 became an important landmark in the modern development of Czechs and Slovaks. Creating an independent state enabled faster development of sports environment as well. In the new state a wide range of gymnastic, sports, touristic and scout organisation arose. They were often related to political parties. Sokol has become the most powerful and well-structured one again. Other federations (Orel, blue-collar gymnastic federation, etc.) also renewed their activities. New associations, such as Young Men's Christian Association a Young Women's Christian Association were founded. In the associations focus was put on bodily exercises and public presentations. Touristic and scout movements, dealing with camping, outdoor life in nature, tracking or combat social games and sport (handball, football, athletics, water sports, etc.) were developed as well (Grexa and Strachová, 2011). Progression of sport was visible in sports clubs and in most cases took place on the level of amateurism. Due to its rising popularity it penetrated into wider layers of mostly city population. During the WWII period (1939-1945) Czech and Slovak members of sports associations actively participated in local and external anti-fascist resistance movement, not important whether civic or communistic (Prošek, 1979). Strong anti-fascist attitude of sports and scout association led to their dissolving

during the occupation period. The only sports organisation, that was tolerated by the occupants, was the Association of blue-collar sports associations. Sports associations as apolitical ones were tolerated, however international isolation of Czech sport was implemented (Grexa and Strachová, 2011). In the protectorate period the further steps and progress of Czech physical education and sport were no longer in the Czech hands (Uhlíř and Waic, 2001). Grandparents of senior participants of the presented study lived on the edge of 19-20 centuries, whereas the respondents themselves experienced WWII (1939-1945) during their childhood. Therefore, the interview answers relate to the above stated historical context adequately. Many respondents mention the Sokol and Orel federations as well as being included in various touristic and scout movements. As the Czech-Austrian history has a very close cultural-historical linkage, we expect many points of intersection in the significant historical moments (Austria-Hungary monarchy, etc.) Historical background of the Austrian part is being under the procession of the Austrian project team currently.

Methods

Objectives of the study

Objective of the study is to ascertain the mutual influence between the senior and grandchildren generation in the area of daily physical activities and routine as well as the geographical, political and other factors in the two included countries. The theoretical concept of the project study is based on the following four pillars:

1) family and social relations;
2) generational transmission;
3) active life-style and
4) cross-cultural comparison.

Partial specific target group is represented by grandchildren with special needs as this has become a world-wide thoroughly discussed topic and much attention is paid to physical activities of children with disabilities, their inclusion to a common daily life and their "as normal as possible" functioning within social groups, they are members of (family, class, school, leisure time groups, etc.).

In the study attention is paid to frequency, contents or quality of the time grandparents and children used to spend in the past and spend nowadays together and how these criteria changed over the lapse of time. Qualitative research is conducted in Czech Republic and Austria, two geographically neighbouring countries with common historical and cultural background and aim to stress similar and significantly different aspects in the context of intergeneration context. According to Uhlenberg and Hammill (1998), the six crucial aspects of frequent or infrequent contact between grandparents and grandchildren are represented by geographic distance, quality of

relationship, gender of grandparent, lineage of the grandchild, and marital status of the grandparent. Living near grandchildren creates opportunities for grandparents to become involved with grandchildren, and close geographic proximity to grandchildren has been consistently related to more grandparent involvement (Smith and Drew, 2002; Uhlenberg and Hammill, 1998). When taking the gender aspect into consideration, increased grandmother involvement, especially by maternal grandmothers, may stem from greater involvement of family relations women in the socialization of children and the maintenance of kinship relations (Bates, 2009).

The AKTION project team, dealing with the presented study, includes academic workers, young student researchers and students of the Faculty of Sports Studies, Masaryk University in Brno and Institute of Sport Science, University of Vienna.

Respondents

Fifty respondents (n=50) from the Czech Republic and Austria participated in the study. Criteria of a participant selection were age 65+, mental and health status enabling participation in the semi-structured interview and temporal/local availability in order to implement the interview.

Research strategy

Semi-structured interview has been used for the purpose of the study, in order to ascertain the senior´s childhood memories of common activities with their grandparents as well as their contemporary situation of performing common activities with their own grandchildren. Research participants underwent an interview session with a Czech / Austrian researcher on the basis of a semi-structured interview manual in Czech or German language. This type of interviewing comprises specific areas and themes, whereas their order and formulation may vary. Additional questions are asked, if needed. When using the semi-structured qualitative interview, it is necessary to create an interview manual, conduct the interview, fill in the necessary data and eventually, to process the acquired data. According to Berg (2001), four types of questions shall be included in the semi-structured interview manual: 1) Essential questions (focus on the main research topic); 2) Extra questions (are equal to the essential questions, they may be re-formulations of the original questions, not fully understood by the interviewee); 3) Throw-away questions (used to create positive and trustworthy atmosphere at the beginning of the interview, they may play crucial role in the whole interview process); 4) Probing questions (their goal is to acquire more information from the interview on a particular questions, "Can you tell me more about that?"). The semi-structured interview of our study was divided into four following areas:

a) biographical data (sex, age, nationality, education, family status, living situation and healthy status)
b) childhood personal memories (locality, activities of daily life)

c) respondent´s grandparents (connection to grandparents and common activities)

d) interviewee himself/herself as a grandparent (relationship to grandchildren, frequency of contact, common activities) A recording of each interview was stored for review and future analysis checking purposes. Transcriptions of interviews were completed simultaneously with follow-up data completion on the basis of the voice recordings, in cases important data were missing in the transcription. All implemented interviews followed the effective ethical guidelines of qualitative research.

Interviews were informal and participants were encouraged to talk openly about their experience.

Results

Interviews have been progressed by biographical data analysis firstly (such as age, sex, nationality, number of children and grandchildren, possible occurrence of a child/grandchild with disability and a selected grandparent of the interviewee), as demonstrated in Table 1.

Tab. 1 Example of biographical data analysis by various criteria

Code	*Nationality*	*Sex*	*Age*	*Education*	*Number of children / grandchildren*	*Selected grandparent*
CZ3	Czech	F	70	secondary	3/6	father of mother
A11	Austrian	M	73	primary	3 (1 disabled) /3	father of father

The second part of the analysis consists of qualitative data progression by means of interview transcript analysis and matching particular key words to significant domains. Presently, transcriptions are being analysed according to the following steps of qualitative evaluation in both countries (CZ/AT):

1) on the basis of the interview transcription, a short biography of the respondent and a family tree (with the indication of close relationship to a particular grandparent/ grandchild) is created

2) key sentences are indicated in the transcription and transferred to a table in the home language; key sentences are subsequently transferred into associated key words in the home language; key sentences and key words are translated into English (Table 2)

Tab. 2 Example of a key sentence and key word, based on the interview transcription

Key sentences in the interview transcript	*Associated key words*
A1 “I loved my grandparents”. (line 36)	A1 positive emotional relationship to grandparents

3) key words are analysed and corresponding theme domains arise (e.g. relation to grandparents, activities with grandparents)

4) comparison of the acquired key sentences, key words and domains between the Czech and Austrian participants.

The second part of the senior interview analysis is to be finished by the end of 2015. For the purpose of the subsequent study (Nov. 2015 - April 2016) with the contemporary grandchildren the following criteria of respondents selection (n=20) were set: age 10, at least one grandparent and mental and health status enabling participation in the interview. Qualitative projective method of an essay, focusing on a selected grandparent, in relation to activities they perform together will be used. Similarly to the senior interviews, the children essays will be processed by qualitative analysis. Final results of both age groups will be compared in both countries subsequently.

Discussion

The so far analysed interview transcriptions show that many study respondents follow similar pattern of activities in their childhood. They commuted to school by bike or on foot, after school they helped with the work at home or in the field as many families were dependent on farming. Many seniors also remember their grandparents mostly through working together and stress the formal relationship and respectful attitude towards them. Unsurprisingly, mutual historical life paths have been found in the interrogated Czech and Austrian seniors. Some of them come originally from the other country and their family moved out only later out of various reasons (war, better living conditions, work in Vienna, etc.). New questions also arose, such as "What accident, that made the whole German speaking family move from the Silesia border areas to Vienna, happened in 1930"? These and many other questions within the historical contexts are to be analysed. Some respondents point out the influence of technical progress on communication frequency with their grandchildren, both in positive (grandparents are able to work with modern communication technologies) and negative ways (grandparents are not able to keep up with the newest communication devices). We can also see high importance of an emotional experience that the grandparents experienced during their childhood and that they have remembered for sixty years (connection to nature, war experience, family event, etc.). Regional influence on performed physical activities of grandparents during their childhood is obvious – those who lived in the mountain areas of Czechoslovakia stress skiing and other snow sports, whereas those who lived in cities mention performing athletics or gymnastic disciplines under various sports associations. Furthermore, many seniors think that they directly or indirectly influence their grandchildren by the life style or activities they do together. As has been deduced from the so far

analysed interview transcriptions, the main theme domains in the context of the intergenerational relationships are relation to parents (although not primarily included in the semi-structured interview manual), emotional situations, events and experiences in the childhood, relation to grandparents, activities with grandparents, relation to grandchildren and activities with grandchildren. The whole set and subsequent comparison of domains, as referred to by Czech and Austrian senior respondents, is to be completed.

Conclusion

Interview transcripts and their subsequent analysis show that different levels of grandparent involvement in their grandchildren education and personal development exist.

This aspect is influenced by many factors, the crucial of them being geographical distance or frequency of contact. Family tradition, social connection and a senior´s life style are important. Many interviewed seniors admit they would prefer having more social contact and interaction with their grandparents as they feel they have much experience to transmit. However, positive relationship and certain way of grandparent participation on physical activities and meaningfully spent leisure time is positively accepted by both generations, as the seniors state. We can also see a typical repetition of some family pattern in a few senior respondents. The way their grandparents dealt with them in childhood is now transmitted into the family situation with their grandchildren subsequently. The relation and attitude of grandchildren to grandparents will follow in order to cover the research theme in a complex way.

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Team members: Dagmar Heiland Travnikova, Hana Valkova, Gabriela Janikova and Milena Strachová (all FSpS), Maria Dinold, Martin Kolb, Jenny Lischka (all University of Vienna).

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THE INSTRUMENTAL REDUCTION AS A "NON-PHANTOM MENACE" FOR MODERN SPORTS

Emanuel Hurych
College of Polytechnics Jihlava, Czech Republic

Abstract

Instrumentality can be examined from different viewpoints. Martin Heidegger sees instrumentality as a symptom of the inauthentic way of being. The loss of authenticity accompanied by instrumental approaches constitutes a very serious problem of modern competitive sports. That is why kinanthropologists should pay their attention on the possibilities how to decrease the growth of instrumentalism in sport. The paper is written as a theoretical study which comes from the perspective of the philosophical kinanthropology. For this reason the used approach is firstly philosophical. The main applied method here is the phenomenological reduction, according to Edmund Husserl. Three steps of this method – the epoché, the transcendental reduction and the eidetic reduction are used here just in a constructive way. Then a proposal for the construct of the instrumental reduction is laid out. Finally, both the methods of reduction are compared and interpreted.

Some sports and sport disciplines are very instrumental in principle. Hegel´s logical laws of transitions from quantity to quality can explain the rules of the instrumentalization process in sport. Some instrumental features of this process are self-evident and unavailable. The problem comes when the essence is losing. Within this paper the phenomenological reduction is used to explain the problem more concretely. Applying three steps of the phenomenological reduction brings an eidetic invariant. Then the principles of the instrumental reduction are explained and applied. Finally, in one selected case of 100 meters run we can get two different outputs - one after the phenomenological reduction, the other after the instrumental reduction. The instrumental reduction is connected with the unilateral focus on the output. The positivistic approaches lead to the idea that everything important can be expressed in figures. Majority of everyday situations needs some kind of reduction. The instrumental reduction is one of the most frequent and easiest approaches in sport. The phenomenological reduction can help us to understand that there are more possibilities how to make reduction. The simplest way may not be the best one in each case. We should be cautious and not to accept the most common and frequent approaches fully and automatically.

Keywords: *Authenticity, instrumentality, phenomenological reduction, run*

Introduction

The term of "instrumentality" can be understood from a lot of different viewpoints. Within Martin Heidegger´s concept of the authentic and inauthentic modes of being instrumentality presents the process of falling into the Das Man (Empire). Instrumentality means a way how to fall into the time in which we concern ourselves (within-time-ness). Heidegger (2008) considers instrumentality as a symptom of the inauthentic way of being. Nowadays a loss of authenticity constitutes a very serious problem of modern competitive (esp. elite) sports. Some instrumental approaches to sports evince perhaps the most visible and examinable symptoms of this deficit. That is the legitimate reason why kinanthropologists should pay their attention on the possibilities how to decrease, or limit the rise of instrumentalism in sport.

The title of this paper contains the adjective "non-phantom" which is sometimes used in physical cosmology, especially concerning transfers of energy from the non-phantom phase to the phantom one. The adjective *non-phantom* in this context means *quintessence* as an attribute related to something essential. The whole term "non-phantom menace" sends reminders to the first volume of Star Wars saga (Lucas, 1999), quite an interesting and voluminous cultural product of the U.S. filmography (Star Wars: Epizode I – The Phantom Menace).

This word construction should support the message of this paper that instrumentality is naturally (and essentially) contained in sport activities but at the same time there is a real and significant danger that too strong dependence on instrumental approaches can harm or destroy both the intrinsic and extrinsic values of sport.

Method

The paper is written as a theoretical study. It comes from the perspective of the philosophical kinanthropology. For this reason the used approach is firstly philosophical. The applied methods come from the concept of fundamental ontology which was introduced and examined by Martin Heidegger and his followers. Heidegger (2008) differentiates between the ontologic and the ontic and builds his (phenomenological-hermeneutical) discourse via existentiales – the specific ontological characteristic. He introduced a specific term of Dasein which became a base for a very influential direction of many phenomenological studies in the ontological discourse.

There are two methods of reduction used. The first one comes from the concept of phenomenology. Concretely, it is the phenomenological reduction, according to Edmund Husserl. Three steps of this method – the epoché, the transcendental reduction and the eidetic reduction (Husserl, 1998) are used here just in a constructive (and perhaps rather symbolic) way, as an example how some problems in sport can be seen in the perspective of the selected concrete case.

The focus on kinanthropology in this paper is the proper reason why the used approach cannot be just philosophical in its pure form. The ontological frame of being brings a very sophisticated line of human thinking (especially in the case of Martin Heidegger) on one hand but, on the other hand, this discourse could be too abstract for any practical usage. Searching for some perspective which can be acceptable by kinanthropologists, the author decided to transfer some ontological characteristics of being towards the ontic understanding where the concrete sport settings can be observed in a more applicable way.

There is a logical gap between studying the authentic and inauthentic modes on the ontological level on one hand and between the possibilities how to interpret and explain some concrete situations in sport practice on the other hand. This is the reason why, in general, the applications of some philosophical abstract ideas (on the ontological level) can be presented mainly in the form of universal principles within the frame of the theoretical recommendations.

The other used method of reduction is called instrumental reduction. Within this paper we examine a selected case when the instrumental approach can become too unilateral and insufficient and may lead to the loss of the original nature of sport. The method of instrumental reduction cannot be described as a scientific instrument yet, it presents just a principle which criticizes using some exact instrumental methods in the selected cases. Definitely, the method of phenomenological reduction (in Husserl´s conception) presents a very sophisticated and abstract process which cannot be properly developed within this paper in detail. For these reasons it is necessary to admit that we cannot speak about methods in a scientific understanding but about some main principles which can help us to realize that a lot of trends in sport are not as requisite as they seem to be.

Results

Authenticity and instrumentality in sport

Authenticity has become a significant topic for some authors focused on kinanthropology since 1980s. The perspectives were quite diverse – philosophical, sociological, psychological, or religious (Kluck, 2009; Lawrence, 1989; Mandelbaum, 2004; Thompson & Matheson, 2007, etc.).

Some Czech authors, as well, studied this problem from different perspectives. Jirásek (2005) considers authentic possibilities of being in his conception of philosophical kinanthropology. Bednář (2009) examines Heidegger´s existentiales including authenticity within the archetype of *homo movens*. Authenticity itself, as a phenomenon of human being, presents too broad topic for the purposes of this paper. Our focus should be aimed more narrowly towards instrumentality, as a symptom

of inauthenticity. We tried to select some studies about the loss of authenticity in sport which are concentrated on instrumentality as the most concrete aspect of the inauthentic mode of being.

Oborný (2004) emphasises some negative aspects of instrumentalism and he examines authenticity in sport in the bipolar mode. Martínková (2013) speaks about two kinds of instrumentality in sport – the extrinsic and the intrinsic ones. She takes into account competitive nature of sports and considers the presence of instrumentality in sports as unavailable. Primarily, she focuses on the intrinsic values of sport and their relations to instrumentality. Hogenová (2005) speaks about some risks related to the accent on the performance in the sphere of competitive sports and she offers different values than just the measurable results instead. These values come from the more authentic approaches to human being based on aletheia and reconciliation.

Some concrete negative impacts of the instrumental approach on sportsmen/women can be described more or less exactly in the understandable way, as Oborný notices: some phenomena of body are taken as components (a segment understanding of human body), a temporal understanding of personality prevails (a body is a temporal, provisional value), the commercial evaluation of a person dominates to the humanistic one (a sportsman can be sold), there is supported the alienation of a human being in both the phylogenetic and ontogenetic context (Oborný, 2004, 137).

The call for decreasing negative aspects of instrumentality in sport is urgent. Hurych (2015) summarises and comments some possibilities how to face with the loss of authenticity in sport. The main important proposals are: to return to the Olympic tradition (or to other roots), to obey and develop the Fair Play Principle, to create some new sports and disciplines not so closely tied with business and commerce, to search some other dimensions of sport (aesthetic, art, experiential) than the result-focused one, to distinguish between some specific concepts (sport versus game, sport versus movement, the competitive mode versus the recreational one etc.), to build a better educational systems (PE lessons, families, sport clubs) and to support healthy forms of an active human movement.

Instrumentality represents quite a general aspect of inauthenticity which can be observed and studied from different viewpoints. Instrumentalism is related to using instruments. Modern technologies play important role in the contemporary society. This growth of technical progress is unavailable. There is no alternative expectation which could be considered, or applied. The situation in sport corresponds with the development of human society at all. The process of instrumentalization of sport is not just unavailable, it is more, it is essential. This note is important because it displays that the eidos of the problem is hidden deep in the principle of competitive sport (and perhaps explains the title of this paper).

The instrumental reductionism is a term which was used, for instance, by Falk (1984) in the context of human genetics. In general, it presents an approach in which instrumental (and formal) criteria are determining for a process and for a result despite an original content.

The point of this paper is not to focus on overusing of some technological developments in sport. We argue that a problem of instrumental approaches in sport is more general. This process can be studied and followed. *The instrumental reduction* in sport is a result of this study. It is a theoretical construct which can be explained here via an example from the sport settings. This example is intentionally simple and plain. It is related to the activities which require no specific technical development. Using this example could help us to develop the idea that a strong expansion of technologies (instruments in principle) is primarily a symptom (and a result) of the instrumental reduction. It is not a purpose. The roots of the instrumental reduction in sport are connected with the competitive nature of sports. Using some instruments just reinforces this process.

Where instrumentalism in sport begins?

Some typical attributes of competitive sports are essentially instrumental because these are based on the comparative approach. According to Lipiec (1999) we can consider two main motives for sport effort – rivalization and perfectionalism. Both of these motives lead to instrumentality if they are developed to an extreme position in which the result is the only important thing (according to the rule "the winner takes it all").

However, via these motives we can display how transmitting the focus from rivalization to perfectionism can strengthen instrumentality in sport. As an example we can introduce the situation when two runners decide to compare who of them is faster. There are not many things which are needed for this race. We need just two people and some space where we can establish a track. It is necessary to decide about the distance, to choose the terrain and profile and to define the way of motion (run, walk, jump etc.). The situation changes at the moment when these runners want to improve their performance. One way how to do it is to run against each other again and again, any time we want to compete. It seems not to be very practical. Any time when our rival is not disponible, we have to wait, or to find somebody else. Much more practical is to objectivize the rules and transmit from (the direct) rivalization to (developing) perfectionism. However, this process needs a great number of the instrumental steps. We have to establish and then to measure the exact distance. We have to select comparable conditions (the terrain and profile), sometimes very exactly – 100 m race (track), sometimes just approximately – marathon races. Then we apply the instrumental reduction more and more because it is very practical. We need to

produce as exact kind of measurements as possible (hand stopwatches give way to some electronic devices). Together with the development of many sport disciplines the differences between the results of sportsmen/women are smaller and smaller. That is why we need more and more exact ways how to measure them. This situation can be followed in swimming, athletics, speed-skating, cycling and many other measurable sports.

We can see this problem via the perspective of evolution ontology as the conflict between the nature and culture (Šmajs, 2009). Within this conflict the growth of technological influences can presents a trend of necessary development in the frame of cultural changes. The significance of these changes is related to the transition from quality to quantity, according to Hegel´s logical laws. Hegel constitutes the specific relevance of *measure* which can be regarded as the specific conceptual tool for overcoming the categorical impasse (Ferrini, 1988). Some authors underline the meaning of *Essence* which is revealed to be a totality that contains both itself and other – measure, or appearance (Carlson, 2007).

Modern technological developments cause distinctive qualitative and quantitative changes in the development of human society. It also pays in the field of sport. New materials enabled, in distant or recent history, the appearance of new sport disciplines (carving skis, mountain bikes, paragliding etc.), or strongly changed the nature of the existing ones (ice-hockey helmets, composite tennis racquets, LZR swimsuits etc.). Some sports and sport disciplines are very instrumental in principle because they need some specific instruments (balls, sticks, bets) to be carried on. Speaking about instrumentality in sport, we would like to pay attention on the measure, as a key point determining the quantitative and qualitative transitions. These transitions are not harming themselves. The problem comes when the essence is losing. Nevertheless, how can we examine a loss of something as abstract as the essence is? For this reason we can use the phenomenological reduction to explain this problem more concretely.

Discussion

The principles of the phenomenological reduction applied in sports

How can be the rules of phenomenological reduction applied to the sphere of sport? Firstly, it is necessary to stress that we have to be very cautious in the interpretation. Our goal is not to work with the phenomenological reduction, as a tool, but just to use some major principles of it to get better understandings of the situation. Therefore, we have follow the ontic level and "reduce" the process of phenomenological reduction up to its leading ideas only.

The first step of this process is "epoché". It is described by Husserl as "the exclusion of the pure Ego" (Husserl, 1998, 132–3). It means that we have to become observers

instead of participants and set aside all our previous experience and prejudice. The second step is based on the transcendental reduction. That means to step in the pure immanence and exclude all transcendent, including God (ibid, 133–4). The last (third) step is the eidetic reduction and it consists of exclusion of pure logic as *mathesis universalis* (ibid, 135–6). After making these three operations we can get the pure eidos, it means the *eidetic invariant* which cannot be divided into smaller particles. The relation between understandings of essence and eidetic invariant constitutes a difficult philosophical theme which entirely transcends the frame of this paper. However, via using the simplified operations of phenomenological reduction we can receive a platform for developing ideas about the transitions of quantity to quality, or even about the loss of essence.

Concerning the sport settings we can remember the former example of runners. A concrete case can be presented here by 100 meters run (a sprint race in track and field competitions). First of all, we can reduce our personal approach. It means all of our active and passive experience. We should become just a neutral observer. Then we should forget everything transcendental which is usually connected with this race (a heritage of the Olympic history, the mythological backgrounds, religious thanksgiving of the winners etc.). Then we should exclude all the logical structures. This step is very difficult to be made in practice. However, we can exclude (at least) the athletic rules and adjustments (distance, profile, surface, limited wind speed) from our thinking.

There can be some objections against this way of reduction. It is necessary to admit that it could be made in many different ways. This mentioned scheme is just an illustrative example, not a manual or a set of recommendations.

Finally, after this (symbolic and simplified) reduction we get *run* (the process of running) as an eidetic invariant. No matter how fast, no matter how long, no matter where it is "run". It cannot be divided into the chain of steps in this context (in a biomechanical analysis). It is not directly connected with athletics, it is not related to the final time or to the distance. The key quest here is whether we can still speak about 100 meters race if we have no distance and no settings determined. It seems to be very paradoxical at first sight. However, some explanation can be offered here.

The instrumental reduction versus the phenomenological reduction

There are a lot of concrete examples of instrumental reduction in sport which can be mentioned. Within the ethic frame we can find some concrete results of instrumentality on the elite level (doping cases of Ben Johnson, Johann Müehlegg, or Lance Armstrong; Alexander Ovechkin´s hit on Jaromír Jágr in the Olympic Vancouver 2010; or Thierry Henry´s goal achieved with a hand in the match of France against Ireland in 2009 etc.). However, here we would like to focus on our previous case where instrumentality is not as strongly presented and visible via using technologies.

If we take our example (100 metres run) and compare it with the case of 200 metres run, we can find that a lot of characteristics are very similar. The speed is comparable here, the style of run is perhaps the same, similar types of sprinters can be successful in both the races. There is a major difference just in the distance (and surely some other smaller differences). We could find quite a good number of kinanthropologists who would agree that 100 and 200 metres races have got a lot of significant features in common. However, 400 metres race is much more different than 100 metres run concerning the demands on runners. And, 5000 metres race is a completely different event from the perspective of sport biomechanics. It is also different race for runners, spectators, or for coaches. All these viewpoints are proper and true. Nevertheless, they are primarily instrumental.

Let us back to our previous findings that the eidetic invariant is *run*. The phenomenon of run means a complex activity, not just the physical one. It is developed in the mental, social and spiritual way, as well (Hurych, 2013a, 92–3). Running thus presents a continuous movement activity, and an essential part of some people´s lifestyle. It can be understood as a poem, a picture, or a song (Hurych, 2013b). This presents a completely different approach to running then the case of the athletic race. However, it is not completely different, in fact. The most successful athletes often say that the point of their success is not hidden in their legs but in their brain.

We hereby delimited two different approaches to the same race – 100 metres run. The first one is very technical and instrumental. It is based on specific training methods, special equipment and administrative delimitation of the discipline. The other is holistic and takes "run" as a complex activity. Both of these approaches can be (and in fact they often are) applied in the case of the 100 metres race.

Within the holistic understanding it is not universally important that the concrete case is represented just by the 100 metres race. On the other hand, that does not mean that this concrete race cannot become an object of this understanding. This object is thus seen from a different perspective. The instrumental concept is close to "techné athletiké" focused on measurable and comparable results in which a body is particularly taken as an instrument serving to reach winning. The holistic one is much closer to "techné gymnastiké" (a harmonic ideal of "kalokagathia") in the ancient Greek tradition (Jirásek, 2005, 292).

It is quite a clear thing that the 100 metres race on the elite level will always be understood as an important sport event. The fights between the best sprinters (Asafa Powell versus Tyson Gay, Usain Bolt versus Justin Gatlin) will be recorded in sport history once forever. And every story which will be told builds a wall against mechanical and instrumental approaches to sport. The point of the previous lines is to display that we can accept one concrete case (100 metres race) in more ways and from different perspectives. This approach can help us to break the routine belief that just one way is possible.

Conclusions

To summarize the previous ideas we can say that the instrumental reduction in sport is presented by the focus just on some selected aspects of a sport event. It would be an output of the race. It would be presented by the effort to express everything connected with the followed activity in measurable way. In the case of run we can examine the final time, lap times, average speed, maximal speed, heart rate, pace, wind speed and a lot of other factors. Thanks to modern technologies we have got an opportunity to measure all of it more and more exactly. Instrumentality is not caused by developments of technologies yet, the instrumental reduction is connected with unilateral focus on the output and wit an idea that everything important can be expressed in figures. The phenomenological reduction is also a kind of reduction. That is why it can help us to understand that each of us has to solve a lot of difficult situations where some form of reduction is necessary. It is very difficult to watch a level of measure of the reducing processes. The instrumental reduction is one of the most frequent and easiest ways. However, there are many reasons why we should be cautious and should not accept all the aspects of this process automatically. We argue that instrumentality can present an ambigeuos menace for contemporary sport. It is partly phantom (hidden, or ignored), partly non-phantom (real and essential). It looks that the proper time to face both these kinds of menace has already come.

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PHYSICAL ACTIVITY IN SOCIOLOGICAL PERSPCTIVE: SEDENTARY WAY OF LIFE VERSUS ACTIVE WAYS OF TRANSPORTATION

Aleš Sekot
Faculty of Sports Studies, Masaryk university, Czech Republic

Abstract

The purpose of the contribution is related to the fundamental feature of sedentary consumerist society strongly diminishing role and importance of physical activity in everyday life. At the same time sportive physical activity is also very important factor in the process of officiating of the level of healthy and active life style, quality of life and health in general. Method to study position of physical activity in sedentary society is based on discussion of relevent concepts and consequent presentation of most typical conclusions of sociological research relating to levels of physical activity (inactivity) of Czech inhabitants. Sedentary society is confronted with great decline of physical activity at work, households and in transportation. Active transportation, as an indispensable part of healthy active way of life refers to the most reasonable human-powered transportation – walking and cycling. Results of the great emprical research "Physical activity of Czech population" concluded that most respondents prefer „inactive ways of transportation" (cars, public transportation system); only less that one quarter of respondents use active ways of transportation (walking, biking). Men are more interested in biking, women in walking. In the Czech cultural setting changing attitude to physical activity as an integral part of everyday active life style is resulting from the changing social structure, in particular the newly establishing middle-class as well from prevalent cultural changes.

Keywords: *Physical activity, sport, active way of life, individual transportation.*

Introduction

The position of physical and sportive activity is globaly affected with essential features of sedentary society: general decreasing of physical activities in most professions, in households and in personal transpor. There is no doubt that even in this context one can say that *sport reflects the culture of given society.* As the individual widely stretched levels of sport, a performance-oriented and success-focused post modern society puts stress particularly on performance, victory, records and material gain.

The levels of physical activity (PA) and sedentary behaviour are significant indicators of health behaviour and their monitoring in the context of way of life in

„sedentary society“ loosing fundamental demands and requests for hard physical work and physical activities. *Physical activities* in general in our cultural settings are *fading away* from most *professions*, in keeping our *households* and in *individual ways of transportation* too. Walking and biking as typical healthy outdoor activities save money, provide mobility choices, free up road space, reduce pollution and promote economic vitality. In other words, for communities to thrive, trails and other safe walking and bicycling opportunities are absolutely *essential* (Buis 2000).

Phenomenon of physical activity is many-sidedly affair connected with the concept of *healthy life style.* Decision about whether to adopt a healthy lifestyle reflects personal attitudes and value preference and thereby includes an aspect of *personal choice.* But factual personal choice has many preconditions with social position and cultural quality of people and with the access to resources of full range of choices regarding sportive activities. We can conclude: The healthy lifestyles are patterns of voluntary behaviours based on choices from options that are available to people according to their life situations (Cockerham, Rutten & Abel, 1997; Vanreusel & Meulders 2007).

Conceptual discussion

To discuss properly the topic of growing importance, state and condition of physical activity in context of active ways of transportation, requires conceptual delimination of relevant key concepts as life style, quality of life, active health, physical activity, exercise, sport, physical fitness and active ways of transportation. The concept of *life style* is highly complicated phenomenon, which could be approached from various perspectives. On the ground of sociology is very closely connected with relevant concepts as way of life (reflecting characteristic nature and features of given society), style of life (descripting individual personal attitude to his/her life), or quality of life (Dufková 2007, Valejt 2012). From strictly academic perspective the concept of the life style reflects structured system of habits, customs, traditions and norms in an interaction with relevant material surroundings (Velký sociologický slovník, 1996, p. 1246).

From our point of view we speak about such side of life style, which, beside active approach to professional, family and societal obligations and duties, includes also regular long-life sportive physical activities and correct and regular eating habits as an integral part of all-out developed individual (Krejčík, 2006; Cooper 1996). And just in such context a utilizing and application of active way of personal transportation corresponds and is in accord with such attitude to life.

Exercise: Any structured and/or repetitive physical activity performed or practiced where the main intention is to achieve improved physical fitness (Pink 2008, p. 3).

Sport: An activity involving physical exertion, skill/or eye-hand coordination as the primary focus of the activity, with elements of competition where rules and patterns of behaviour governing the activity exist formally though organizations. "It is institutionalized physical activity motivated with improving individual shape, personal experience or performance, results and reward objectives"(Sekot 2008, p. 10).

The relevant concept of *physical fitness* is a complex phenomenon that is difficult to define in the context of health. It can be conceived as a set of attributes that people have or achieve and that relate to the *ability to perform physical activity* (Casperson et al., 1985). From another perspective it is a set of health (i.e. cardiorespiratory endurance, muscle strength, flexibility) and performance related (i.e. skill, speed, dexterity, mental concentration) attributes that people have in relation to their ability to perform physical activity (Pink 2008, p. 5).

This defined, the physical fitness includes discrete components such as aerobic (or cardio respiratory) fitness, muscle strength, muscle power, flexibility, agility, balance, reaction time and body composition. The physical fitness component usually associated with fitness is aerobic fitness and other components are related to it (Krejčík 2006).

Highly topical and up-to date concept relating to physical activity and active lifestyle is theoretical concept *"active health"* constructed up to the theory and its practical impacts known as "*aerobic programme for active health"* (Cooper 1986). It is mostly in the USA known complex of recommendations for regular physical exercise, healthy eating habits and psychical and mental wellbeing. As first step for to such objective figures regular intensive aerobic physical activities, second step is rooted in suitable nutrition and third prerequisite for active health is proper sleeping regime and reasonable active ways of leisure. The jogging, walking, swimming, countryside skiing and biking is highly recommended in this context. It is evident that active way of style grants to personal life the proper sense improves the quality of life and decreases respective medical expense of healthy complications and subsequent social care (Pratt 2010, p. 23). Another benefit of an active way of life is better digestion, healthy sleep and mental appeasement (Slepičková, 2001) as an integral part of harmonic state between physical and psychological side of individual (Dufková 2007).

Afterwards we defined *active lifestyle* as a system of important activities and relations and associated practices focused on reaching undepreciated and harmonic state between physical and mental aspect of human being. *The sedentary behavior* compared with active lifestyle is classified according to time per day sitting at the desk, sitting with friends, travelling by car, using public transportation on the bus, train as well as fading, playing games (cards etc.) or watching television, including the time spent for sleeping (Hamřík et al, 2013).

Active transportation refers to any form of human-powered transportation – walking, cycling, and using a wheelchair, in-line skating or skateboarding. There are many ways to engage in active transportation, whether it is walking to the bus stop, or cycling to school/work. Active way of transportation are integral way of active way of life as basic attitude to acquiring healthy way of life (Cooper, 1996; Jansa 2005; Kováč 2001; Litman 2002) in comparasion with effect of physical inactivity as an agent of major non-communicable diseases worldwide (Lee et al, 2012).

Walking and biking – natural way to develop and sustain physical fitness

Active transportation (also called *non-motorized*, *human-powered* or *walk/bike* transport) includes travel modes such as walking, cycling, skating, skiing, and manual wheelchairs.

Active transportation can provide a variety of benefits to individuals, businesses and governments, particularly when it substitutes for motorized travel: More active transport improves physical fitness, and provides additional benefits when it reduces motor vehicle traffic. To discuss the topic of active ways of transportation means to speak above all about walking a biking (Sekot, 2015, p. 111 – 119).

Walking is the natural form of getting about and the commonest and secure exercise (Sutherland et al., 1993, p. 23). Walking is one of the few feasible exercise regiments in the treatment of overweight individual, gains in fitness are particularly valuable for the elderly and can be proportionately as large as those at younger ages. Walking is ideal as a gentle start-up for the sedentary, including the inactive, immobile elderly, bringing a bonus of independence and social well-being (Selensminde 2002).

Walking is *the most natural activity* and the only sustained dynamic aerobic exercise that is common to everyone except for the seriously disabled or very frail. No special skills or equipments are required. Walking is convenient and may be accommodated in occupational and domestic routines. It is self regulated in intensity, duration and frequency, and, having a low ground impact, is inherently safe. Alternatively, walking can be suggested as very effective means for personal motivation, clinical practice, and public health (Rzewnicky, 2003; Morris & Hardman, 1997; Litman, 2002).

Walking as an individual *way of transportation* is supported with diversity of the landscape scenery and closeness of acceptable, comfortable and secure opportunities for walking in everyday rituals to transfer to work as well as to walk for shopping or for amusement and recreation. Attractivity of walking is supported namely in attainability of walking opportunities at maximum distance of 5-10 minutes from our places of residence. World Health Organization focuses on children and older people presenting walking as a form of active life through everyday transport. (WHO 2003, Nelson et al. 2007; Neuls 2010).

In our cultural settings the *growing popularity* of *cycling* is reflected mostly as a form of active leisure physical activity; not preferably as an individual way of transportation. In the Czech Republic driving the bike is mostly popular as a pleasure sportive activity, unlike in many West European countries, prefering the bike as an economical and ecological way of individual transportation to work, to school, for to visit friends, for shopping. In this context it is inevitable to take in an account that general comfort of cycling routes and paths is improved with growing standards of security for broad spectrum of their users (Janežič et al., 2010, p. 49). In some countries (Denmark, Netherlands, Germany, England) growing tendency to use the biking as an active way of individual transportation to work and to school is mentioned (Cahil, N. et al. (2010).

In the context of motivation to active way of life and to active physical activity mass free access to cycle paths and cyclo-tourism in general is supported (Kahn et al., 2002; Schwarzhoffová, 2010, p. 39). The general system of traffic transportation in Czech Republic still does not absorbed in sufficient ways an effective conception supporting walking and biking as an integral part of individual ways of transportation. In this context we can remind the fact that nearly all agree that basic infrastructure like roads, water, sewer systems are integral pieces of effective functioning of active transportation, Also to built up the safe places for people to walk and bike are more universally understood to be *necessary* for a successful 21st century community. In other words, for communities to thrive, trails and other safe walking and bicycling opportunities are absolutely *essential.* (Jackson & Kochtitzky, 2001; Littman 2002, 2002a; Buis 2000). There are many ways to engage in active transportation, whether it is walking to the bus stop, or cycling to school/work. There are numerous usual and customary benefits from active transportation: opportunity to be regularly physically active, to be involved in positive social interactions, to enjoy economic and ecological way of transportation in natural settings.

Active transportation *declined o*ver much of the last century, but in recent years this decline leveled off and is *reversing* in many communities. There appears to be significant latent demand for active transport, that is, people would walk and cycle more if they have suitable facilities and support. This suggests that improving conditions for non-motorized travel can increase active transportation, and benefit individuals and communities overall. Various transport and land use factors affect the amount of active transportation that occurs in a community. These tend to have synergistic effects (their total impacts are greater than the sum of their individual impacts), so an integrated program that combines several strategies tends to be more effective at increasing active transportation than implementing just one or two of these strategies (Jackson & Kochtitzky 2001; Litman 2002).

Active ways of transportation in Czech perspective: Methodology and research results

The crucial topic "walking and biking in the Czech sociological perspective" means also to present some important facts on physical and sportive activities of Czech population. At this context we also have to remind the fact, that the existing *whirlwind of changes* associated with way of life and standard of living regarding working activities, nutrition, housing, environment, transport, leisure, travelling etc. have with no doubt strong impact at a physically active lifestyle. We live in the cultural setting adoring youth, beauty, healthy and sexy body and top physical performance. Unfortunately, images of fit and healthy attractive personalities and widely circulated health messages have not translated effectively into increased physical activity for most Czech people. Sportive activities are more less rather the manifestation of "up-to-date" style of life, then as an integral part of everyday life. It is for more and more financially prospering people in good social position the expression of the prosperity and the ability to freely spend and choose independently their leisure (Rychtecký 2007; Hamrík et al. 2012; Hamrík et al. 2013; etc.).

The research „*Physical activity (inactivity) of Czech inhabitants"*organized during the period 2012 – 2013 by Masaryk university, Brno; main criterions for to classify the physical activity were the intensity and frequency of different levels of physical activities, as well as walking and biking (Sebera, 2014, p. 50 – 52).

The significant indicator of frequency and intensity of physical activities is also existence of *individual ways of transfer to work.* The discussed research in this context found that respondents in given alternatives (public transportation, car, walking, biking) prefer „inactive ways of transportation": public transportation and car, only one quarter or respondents prefer walking or biking (Sekot & Sebera 2014, p. 56 - 60): Particular data of presented research supported hypothesis on growing popularity of leisure physical activities of more educated people, high level of preference of walking in senior age groups and general tendency to sedentary occupations and professions (Sekot and Sebera 2014, p. 82 – 83).

Tab. 1 Regarding gender the research results offer following data:

Gender	Walking	Biking	Public transportation	Car	No	Total
Women	545	169	1122	683	507	3026
%	56.71%	35.88%	60.26%	38.59%	62,90%	
Men	416.	302	740	1087	299	2844
%	43.29%	64.12%	39.74%	61.41%	37,10%	
TOTAL	961	471	1862	1770	806	5870

From the perspective of active ways of transfer to work women prefer more walking, men are more enthusiastic with biking**.** Detailed data revealed the fact that women in 37% prefer public transportation (men 26%); men prefer individual transportation by car (61%). From the perspective of active ways of transportation women prefer walking (57%), men are more active in biking (65%). Men in general are more enthusiastic about individual transportation (car, bike), women prefer public transportation and walking.

Conclusion

In the Czech cultural setting two groups of factors impact on development trends of sports and physical activities in the context of changing people's lifestyles: One group are factors resulting from the changing social structure, in particular the newly establishing middle-class (broader impact of the latest economic development, tendencies in education, affluence, employment structure, changing character of labour, etc.), while factors in the other group stem mainly from cultural changes (prevalent system of values, dominant ideals, behavioural patterns, social control, public opinion, cultural pressure, strong impact of mass media, etc.).

The phenomenon of physical activity and sports is closely related to urbanisation of sports facilities. Rapid housing and industrial development has resulted in numerous urban-architectural and sociological issues as well. Sports facilities planning, design, development and operation should be considered to be one of the strategic points in public administration on both the local and national levels. The sole fact of sedentary nature of contemporary society makes physical/sports activities to be the most critical policy area: The very high prestige of sports and sport activities in Czech society is incompatible with the relatively low level of practical regular physical or sport activities.

People prefer, in general, *passive form of leisure*, watching sport rather than doing sport. In such situation we are more and more confronted with pressing questions: "Why do people who know they should be more physically active still fail do so?

What form the obstacles to achieving a more physically active lifestyle" (Sekot, 2008)? Also the public policy makers have *not sufficient attention to* public and health preventive medicine and *healthy lifestyles*. Our chance to achieve a physical active society as an integral part of healthy life style could be improved if we can accept the challenges of truly healthy lifestyles available to all members of society, or at least for most part of society (McElroy, 2002; Krejčík, 2006).

The existence of sedentary way of life detracts general level of physical/sportive activities in everyday life of mass of people; growing importance of active way of life and an imperative of responsibility for individual health improves phenomenon of human wellbeing. People responsible for his/her physical and psychical good shape expect from regular physical activities an indispensable source of wellbeing, respect of their surroundings, and – the last and not least – his/her self-respect.

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FOOTBALL FAN BEHAVIOR OF TWO MOST SUCCESSFUL FOOTBALL TEAMS IN THE CZECH REPUBLIC

Petr Scholz
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Football is a phenomenon of the last decades and also due to fans it could become the most popular sport in the world throughout its history. In this context, we realize that the rapid development of sport itself has brought problems and complicated relationships, especially at the professional level. Football fan behavior has been for many years a major cause for concern, not only in the United Kingdom but also throughout Europe, including the Czech Republic. Violent supporter behavior has been identified as football hooliganism and is sometimes referred to as the English disease. The aim of this paper is to identify speeches of fans on the issue which are attending football matches in the Czech Republic.

A survey was performed in 2015 year, with data collected from fans (n = 78) aged 23.5 ± 5.6 years old. The paper used quantitative research, methods of analysis, mathematical and statistical methods.

The survey shows that classical fans find a biggest problem with physical aggression, firing of pyrotechnics, vulgar chants etc. The survey also confirms that football supporters and hooligans do not find a problem with the firing of pyrotechnics, vulgar chants, whistling etc. Triggers for their behavior are mostly alcohol or other addictive substances, referee´s mistake and aggression from police or security. On the other hand classical fans find the above-mentioned fans´ expressions considerably problematic.

Football clubs and organizers look at the classical fan and football supporter primarily as an economic factor. It is important to realize that they are responsible for work with football fans. It is evident that the media play a very significant role in the public´s view of football hooliganism. In our opinion football clubs and media should focus on educational broadcasting, promoting fair play and critically evaluating acts of violence.

Keywords: *aggression, behavior, fans, football, football hooliganism*

Introduction

Sport in the form of active sport as a passive spectator consumption is one of the most important social phenomena that extends to politics, economy, but also affects the arts and education. We can say that it is one of the most important means of mass entertainment worldwide and leisure fills a large part of the population regardless of national borders or socio-cultural formation (Slepička et al., 2010). Sports spectatorship is currently considered an important social phenomenon that is linked to other areas of human activity. Football spectatorship is an integral part of sport spectatorship, and thanks to the frequency of audience and phenomena associated with football spectatorship is thus the subject of numerous sociological, psychological, socio-psychological and demographic researches.

Particularly sports spectatorship became a mass consumption character and corresponds to the state where the vast majority of the population is actively any sport and its contact with the sport has audience form. For sports fans and spectators can participate passively sport, it was also necessary to fund the expansion of leisure time. In the past, approximately 1900, people worked 10.5 hours per day almost 300 days a year. It has changed after World War 2. In 1950, workers had 12 days of holidays. Currently, it deals with 29.5 days, which represents approximately 6 weeks. The prognosis for 2020 represents a preponderance of leisure time over working hours (Freyer, 2006).

Sekot (2013) states that people are coming to the stadiums and other sports as diverse blend that can be distinguished by age, ethnicity, gender, education, social status, professional status, etc. Sports spectatorship is a social phenomenon that can be analyzed from several different perspectives. Social and psychological aspects of this phenomenon have noted primarily by motivation of spectator attendance, spectator experience, connections with relations spectators to clubs. They also pay attention of the spectators´ responses of the selected game situations and ways of prevention of negative audience expressions (Sekot, 2010).

Given the long history of spectator sports events consumption it is not surprising fact that there were also serious manifestations of spectator aggression. Coakley (1998) defines aggression as behavior that intends to destroy property or injure another person. It is also grounded in a total disregard for the well-being of self and others. The spectators´ aggression is displayed in various forms. There are a lot of different scientific studies about explanation of aggressive behavior. The best known study is by Wann & Branscombe (1993). He used the self-esteem maintenance model which describes the strong commitment that fans have with their football team. When the team wins, the fans are inclined to have higher self-esteem and their social identity

is enhanced. This is more characteristic for the fans that have stronger relations with their team. The spectators that have low identification with the team, simply need to cut themselves off from the team if the team is not successful, thus maintaining a positive self-image. This is very difficult thing to do for sport spectators that have a high level of identification with their team. Self-esteem tends to decrease with the team´s failures, which can lead spectators or fans to the derogation processes. This is their attempt to restore the damage done to their self-esteem (Slepička, Slepičková 2007; Slepička et al., 2012).

Frosdick and Marsh (2005) state that football fan behavior has been for many years a major cause for concern throughout Europe, especially in Germany, Netherlands, Italy and Belgium, as well as in the United Kingdom. Substantial disturbances at football matches have also been witnessed in the Czech Republic, Greece, Denmark, Austria and other countries in Eastern Europe. Violent and anti-social behavior amongst football fans is referred to as football hooliganism, or sometimes as the British disease or English disease. These populist terms have been used by the media and by politicians to label deviant behaviors. But these labels are based on three popular mistakes: that the violence is something relatively new; that it is found at football matches only; and that it is an English phenomenon. None of these statements stands up to scrutiny. In recent years, the issue of football hooliganism has become the subject of intense media, political and academic interest.

Czech football has no history of widespread of serious violence, but there have been some reports of incidents during the 1980s and early 1990s, mainly involving Sparta Prague fans. Incidents have occurred within the stadium and involved attacks on opposing players, although fans of Sparta Prague have also caused damage to trains towards to away-matches and been involved in street fighting after matches with Slavia Prague (Duke, 1990).

In the new millennium there were interrupted several matches due to the ravages of hooligans in the auditorium e. g. between Baník Ostrava and Sparta Prague (2014); fight fans at the derby between Slavia Prague and Sparta Prague (2008) with police and riot police. Nevertheless, the matches were played without any termination as they had been planned. Conversely, in the semifinals of the domestic cup between Slavia Prague and Sigma Olomouc (2011), Slavia fans penetrated during the half time break on the grass. They were subsequently adjusted by riot police, the match was interrupted and the game won due to the forfeit of the opponent.

In the former UEFA Cup (now European league), hooligans caused considerable damage at the stadium and in the city center during the match between Sparta Prague and Spartak Moscow (2007). Furthermore, in revenge match of the European League between Slovan Bratislava and Sparta Prague (2014) game was interrupted several times due to riots hooligans in the stands. Unfortunately, oftentimes ignorance and

misunderstanding of football hooliganism determines preview on it. It is important to distinguish hooligans from other people who are interested only in football and watch football matches.

In this context, it is possible to identify three major groups: football spectators, football fans and football hooligans (Table 1; Mareš et al., 2004). But the most used division is the division according to Smolík (2008) that divides the various kinds of audience at football stadiums into four groups: inactive spectators, classical fans, hooligans and ultras.

Tab. 1 Distinction between spectators, fans, and hooligans

Criterion	Spectators	Fans	Hooligans
Stability of group	low	high	high
Integration of group	low	high	high
Cohesion	low	medium	high
Attractiveness of group	low	high	high
Stability of group	low	medium	high
Autonomy of group	low	medium	high
Size of group	large	medium	small
Degree of intimacy in group	low	medium	high
Accessibility of group	high	medium	low
Homogeneity/heterogeneity	heterogeneous	homogeneous	homogeneous
Focus of group	low	medium	high
Focus on values	low	medium	high
Degree of satisfaction	low	medium	high
Degree of attractiveness	low	medium	high
Degree of control	low	medium	high
Violent behavior	low	medium	high
Displays of nationalism	low	high	high
Expressions of xenophobia and racism	non-existent	infrequent	frequent
Degree of ideological focus	non-existent	non-existent	high
Judgment of game	objective	subjective	subjective
Club chauvinism	low	high	low

Source: processed under Mareš et al, 2004.

Methods

The aim of this paper is to analyze the speeches of football fans that relate to behavior and violence at football stadiums in the Czech Republic. Following the aim we set research question:

Which speeches are considered by football fans at football stadiums the most serious? We used primary data that had been collected by a questionnaire survey at the Eden stadium and Letná stadium in 2015. The pilot study is focused on the two most successful football clubs in the Czech Republic, so we chose Sparta Prague and Slavia Prague and their fans. A total of 78 respondents participated in this pilot study, of

which 65 were men and 13 women. All of the respondents enjoy the football matches in a home team´s supporters stand. The questionnaire included seventeen questions; most of them were scalable, where respondents rated on Likert scale individual speeches from the least serious to the most serious. This paper uses quantitative research, methods of analysis, mathematical and statistical methods.

Results

Over 3/4 of the respondents (77 %) own a season ticket of their favorite club for home matches. Also, 77 % of the respondents prefer supporting their club in a group, 8 % of the respondents favor individual chanting, and 15 % of the respondents do not support anymore, they are interested in a football match only and they visit this sector for active fans due to the cheapest ticket for a game.

Respondents evaluated the speeches which can be found at the football stadiums in the Czech Republic. The evaluation was using a Likert scale (1-10) and speech that appeared to be the least serious, was rated 1, the most significant speech received the highest grade, i.e. 10.

The firing of pyrotechnics evaluated more than a half of the respondents (52 %) as very serious activity, and more than 1/4 of the respondents (26 %) even identified this activity as the most serious activity. Regarding vulgar chanting of the stand or vulgar individual expression, we recorded a corresponding response. 23 % of the respondents said that vulgar individual expression is not a serious problem. Physical aggression against rival fans at the stadium found nearly 2/3 of the respondents (62 %) as the most serious activity, and other respondents (20 %) called it as a very significant problem. Only 4 % of the respondents considered this activity for the least serious. Similar results (52 % and 8 %) were noted in the physical aggression against the police or riot police.

Arranged hooligan fight outside the stadium evaluated almost 1/3 of the respondents (27 %) as the most serious activity, another 19 % of the respondents identified this activity as a major problem. Nearly 1/5 of the respondents (19 %) believe that throwing objects onto the pitch is also the most significant activity, as confirmed by 23 % of the respondents, who called it serious activity, too. The most frequently situations are during the wrong verdict of side referee or the opposing players celebrate a goal in front of the home stand and the football pitch is often sprinkled with empty or full cups of beer, pennies or even lighters. We can conclude that referees´ negotiations in some cases can even become igniter of violent clashes, even when referees are acting contrary to the rules of football. In the better case it is perceived as improper behavior by sports fans in the stand, or in the worst case directly as a provocation.

Demolished stadium and other riots in it identified more than one half of the respondents (52 %) as the most serious activity, a further 15 % of the respondents said that it is very serious activity. However, there are some individuals who believe that the demolition of the stadium is not a serious problem. We expected that the percentage of the respondents will be higher (grade 10), especially for sports fans, who mostly supported their football club (Table 2).

Tab. 2 Activities during the football matches in percentage

activities during the football matches	1	2	3	4	5	6	7	8	9	10	Σ
firing of pyrotechnics	8	8	4	8	8	4	4	4	**26**	**26**	100
vulgar chants in the stand	16	12	12	2	8	0	12	12	**18**	8	100
individual vulgar expression	**23**	4	15	8	12	4	8	8	12	6	100
physical aggression against rival fans at the stadium	4	0	14	0	0	0	8	8	4	**62**	100
physical aggression against police and riot police	8	0	8	8	0	4	8	12	0	**52**	100
arranged hooligan fight outside the stadium	8	12	4	4	10	8	8	0	19	**27**	100
throw in the subject on the pitch	0	8	0	0	12	0	19	19	**23**	19	100
demolishing stadium and other riots	0	4	4	0	4	8	0	8	15	**57**	100
expressions of racism	8	0	0	0	12	12	4	4	19	**41**	100
whistles	**45**	12	15	8	12	4	0	4	0	0	100
penetration on the pitch	0	12	**16**	15	8	10	4	15	8	12	100

Source: Own elaboration, 2015.

Almost a half of the respondents (41 %) rated racism with the highest grade, another almost 1/5 of the respondents (19 %) found these statements against dark-skinned players as a major problem. Whistling at the football stadiums does not consider any of the respondents as the most important activity that should disappear from the stadiums. In contrast, almost one half of the respondents (45 %) believed that it is a minimal problem, and a further 27 % of the respondents are confident about it, too. Penetration on the pitch is considered by 12 % of the respondents as the most important activity, and almost another quarter of the respondents (23 %) said that it is a significant problem (Table 2).

Approximately the same results we noticed in the use of pyrotechnics. Nearly 1/4 of the respondents (23 %) met with pyrotechnics in the majority of matches, and 23 % of the respondents meet with firing of pyrotechnics every game. More than 1/3 of the respondents (35 %) met with vulgar chants in the stand in the majority of matches, with individual vulgar expressions there is more than one half of the respondents (54 %). With physical aggression against rival fans at the stadium had never more than 1/4 of the respondents (31 %) and more than 1/3 of the respondents (38 %) clashed with it in less than a half of the matches. Physical aggression against police and riot police achieved similar results, 46 % of the respondents had encountered with it in less than a half of the matches, and 31 % of the respondents did not meet with it anymore.

More than 1/3 of the respondents (38 %) have never met with an appointed hooligan fight. It is alarming but the value that 35 % of the respondents met with this conflict, even if it is less than one half of the matches. Also throwing objects onto the pitch saw almost one half of the respondents (49 %), similar results we noticed with demolishing stadium and other riots (53 %). These two mentioned activities happen in less than one half of the matches. Nearly 1/3 of the respondents (31%) reported that they met with racism, on the other hand 49 % of the respondents met with these abusive expressions in less than one half of the matches). Nearly 3/4 of the respondents (72 %) experienced with whistles at the stadium every match, further 12 % of the respondents met with whistles on the majority of the matches. Almost one half of the respondents (46 %) do not meet with penetration on the pitch (Table 3).

Tab. 3 Frequency of the activities during the matches in percentage

activities during the football matches	every football match	majority of the matches	1/2 matches	less than 1/2 matches	never	Σ
firing of pyrotechnics	**23**	**23**	18	**23**	13	100
vulgar chants in the stand	26	**31**	**31**	8	4	100
individual vulgar expression	23	**54**	4	15	4	100
physical aggression against rival fans at the stadium	4	12	15	**38**	31	100
physical aggression against police and riot police	4	4	15	**46**	**31**	100
arranged hooligan fight outside the stadium	12	4	12	35	**38**	100
throw in the subject on the pitch	8	12	23	**49**	8	100
demolishing stadium and other riots	4	4	8	**53**	31	100
expressions of racism	4	4	12	**49**	31	100
whistles	**72**	12	8	8	0	100
penetration on the pitch	4	0	15	35	**46**	100

Source: Own elaboration, 2015.

Discussion

Football clubs and organizers look at the classical fan and football supporter primarily as an economic factor. It is important to remember that they are also responsible for work with football fans. It is evident that the media play a very significant role in the public´s view of football hooliganism. In our opinion football clubs and media should focus on educational broadcasting, promoting fair play and critically evaluating acts of violence. The aim of this paper was to analyze the speeches of fans that relate to behavior and violence at football stadiums in the Czech Republic. In connection with the problem and following the aim we set research question:

Which speeches are considered by sports fans at football stadiums the most serious?

In our pilot study, we found that the most serious speech is physical aggression against rival fans in the stadium, which confirmed 62 % of the respondents.

Furthermore, more than one half of the respondents (57 %) found the most serious activity demolishing stadium and other disturbances, and only less than a third of the respondents (31 %) did not meet with the destruction of the stadium and other riots. Triggers for their behavior are mostly alcohol or other addictive substance or referee´s mistake. Physical aggression against police and riot police marked 52 % of the respondents.

Also, based on the results of the pilot study, we find that classical fans under 23 years old are more tolerant of negative social phenomena in the surroundings of the stadium, which confirms Slepička et al. (2010), who conducted research on the number of 5,629 spectators.

Conclusions

In order to encounter for increasingly less socially negative phenomena in the stands and around the stadiums it is more than desirable to utilize all existing preventive measures sufficiently. Currently, the stadiums only sell non-alcoholic beer during derby or other risky matches (e. g. Baník Ostrava), there are separate sectors or stands for fans who want to support their team. The sale of tickets for risky matches is possible with identity card only and personal inspection is more thorough, etc.

The Football Association of the Czech Republic considers the addressable ticketing and CCTV (closed circuit television) systems in the future.

We consider the social prevention to be the most important factor to avoid the football acts of violence. With this help it is possible to capture new incoming fans and hooligans. The intention is to direct these individuals to positively support football players and teams, i.e. without violence, individual and group vulgarities, racist insults etc.

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HISTORY OF PHYSICAL EDUCATION INSTRUCTION AT MASARYK UNIVERSITY – PE HISTORICAL DEVELOPMENT AS REFLECTION OF SOCIOHISTORICAL DEVELOPMENT OF SOCIETY

Zora Svobodová, Věra Večeřová, Renáta Vychodilová
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Physical Education instruction is included at all stages of the whole educational system in the Czech Republic as an important element for each individual to gain, develop and improve physical and locomotive competencies. The tertiary level of education is a specific area, where PE is entirely the responsibility of particular universities. The universities themselves decide about the form of their PE instruction, or whether any form of PE instruction will be provided to their students. Our contribution deals with the beginnings and history of PE instruction at MU from 1922 up to the present time. The study observes its development as a reflection of socio-historical status and values of our society.

The sources utilized to compose this study can be divided into two categories. First, the archival references at MU related primarily to teaching PE at the university, such as the instruction organization, teaching plans and goals, as well as to significant personalities and events that influenced the development processes significantly. The other category includes the non-fiction publications and studies referring to the construction of the gym Pod hradem, which is an integral part of the history of PE development at the university.

The analysis and comprehension of historical relations, attitudes and values can guide us to understand the presence. It can enlighten and clarify the consequences of the decisions and actions that influence and shape it. The assessment and understanding of the broader context, the formulation of our priorities enables us to decide better and more efficiently about the acts in the future. This work aims to describe the history of PE instruction at Masaryk University and to provide the outlook on this issue in a broader socio-historical context.

Keywords: *PE instruction, teaching plans, teaching goals and methods, sports fields, homeland defence*

Introduction

Masaryk University celebrated the 95th anniversary of its establishment last year. The act of opening was preceded by several long decades of discussions and disputes. The theme of opening an independent Moravian university reappeared for several centuries and employed more than three generations. In 1918 a newly established and independent state, the Czechoslovak republic inherited this aim from the Habsburg monarchy. The establishment of a university in the Moravian region seemed to be an indisputable and vital step (Fasora, Hanuš, 2015).

On the 15th November 1918 Alois Jirásek and Prof. Karel Engliš submitted the law proposal to establish the university at the parliament. The proposal was accepted and the university was established on 28th January 1919 in Brno. Four faculties were opened then: the Faculty of Law, Medicine, Arts and Science. At the same time the study programme of PE Training courses and later the Institute for Education of PE Teachers came into existence in Brno. The institute soon earned a good reputation and eminence of high quality of its teachers and graduates. After some time periods the institute was considered the best one in the whole country, especially when Babák, Hora, Volkr, Suk, Šmiřák, Matoušek, Majda, Tvarůžek, Krčma and Vojta worked there (Archive of MU).

How were the history and tradition of PE education of future PE teachers as well as the PE tutoring of all university students in Brno developed and built? Which personalities and historical events formed this education? Let´s take a brief look inside the process.

Under the supervision of Prof. Edward Babák, the following subjects for secondary school PE teachers were established in the academic year of 1924/25: Practical PE and Methodical Training, Games and PE, Fencing, Pedology and Anthropometry, Orthopaedics and Questions of Orthopaedics, Hygiene and Swimming. The instruction was gradually extended with some other subjects, such as Aesthetics of Exercising, Physiology of Exercising, PE Theory and Taxonomy, PE History and Literature, Anatomy, Science of Sports Aids, Gym and Playground Foundation, PE Regulations and First Aid. The lecturers teaching the subjects were members of the State Examining Board and also taught at the Faculty of Medicine and Science. We should mention at least some of them: Roček, Suk, Volker, Zahradníček. Furthermore some secondary school PE teachers from Brno participated in the teaching process: Javůrek, Matoušek, Majda, Pokora, Severa, Šmiřák (later a school inspector of PE for Moravia and Silesia) and Mr. Tvarůžek, a staff captain. In 1929 František Vojta became

a lecturer at Masaryk University and connected his pedagogical activities and scientific research with it for quite a long time. In 1929 the first woman, Koutníková Bohumila, became a member of the academic staff. Their offices were spread throughout the whole city of Brno, mainly at different secondary schools, at The Faculty of Medicine and Science and one of the lecturers had the office at the Faculty of Law.

In 1939 the university was closed for a certain period of time, and later on the programme of the lectures and seminars underwent various content changes. The list of subjects was extended with PE Methodology and the Courses of Defence, Scouting for Men and Skiing Courses in the academic year of 1937/38.

When the study programme of PE Training courses and the Institute for Education of PE Teachers were established, the need to provide the students at other universities in Brno with PE education appeared important and useful. This requirement appeared at all universities in Brno, at the University of Technology, Mendel University and the University of Veterinary Medicine.

The first record about the University Sports Club *("the only club that provides sports and PE for university students at all universities in Brno"*) appeared in 1927/28. František Vojta, whose office was located at the Faculty of Medicine, was in charge of its organization and programme. The instruction ran in the form of courses called PE, Sport and Games. Students had to apply for different courses, such as Preparatory Athletics Course, Winter Exercise Running, Swimming or PE which took place twice a week for four hours altogether. Later they could join the University Sports Club, which offered these sports courses: PE, Exercise Running in Forest, Athletics, Swimming, Tennis, Skiing, Volleyball, Rugby and Fencing (lectured staff captain Tvarůžek for long). Women could also participate in special swimming and rhythmic gymnastics courses. The fee was two to five Czech crowns for everybody.

The programme was offered without any changes until the Second World War. Later some attractive sports courses, such as Gliding, Horse Racing, Camping, Sailing, Climbing as well as Games and Athletics for Women were provided. The aim of these sports courses was to offer scientifically guided PE and sports courses whose purpose was to improve students´ health and character. At that time the University Sports Club was in difficulties. It fought the of lack of professional staff and technical facilities for the offered PE and sports courses, and the solution of some of them took quite a long time.

The records of requests to establish permanent job positions for PE lecturers by the university rector addressed to the Ministry of Education appeared repeatedly since 1929. Doctor Vojta was considered to become the first lecturer, but the Ministry constantly rejected the requests for financial reasons. We quote Vojta´s explanation of the request: *"I dare point out that the conditions under which we have to organise the university sport and PE education in Brno are quite hard"*. His request stressed that although the number of university students is growing constantly, the university lost the only playground where its sports courses took place as well as the low, but regular subventions. The problem of sports base was resolved after the WW II. In 1945 Vojta requested the allocation of the gym Pod hradem. The gym used to be the property of the German sports club Brünner Turnverein before the war (Švácha, et.al., 2012) and it was owned by the university since 1951. Until these days the gym has been serving its original purpose – practising PE and different types of sports. It represents a comfortable, pleasant and dignified sports environment and the building itself is on the list of the city cultural heritage.

As a counterreaction on the demonstrations against our German occupation held on 28th October and 15th November, the Nasties attacked the university colleges on 17th November. They killed 9 people involved in the organisation of the protests and about 1200 students were sent to concentration camps. All Czech universities were closed. Ten Czech universities, namely Charles university, Huss Theological University, Czech Technical University and the Academy of Fine Arts in Prague, Technical University in Příbram, Masaryk Universtity, the University of Technology, Mendel University and the University of Veterinary Medicine in Brno and Sts Cyril and Methodius Faculty of Theology in Olomouc, were shut down for three years and this violent regulation stayed valid until the end of our protectorate. Only the German universities stayed open, the German University in Prague and German technical universities in Prague and Brno. Although all universities were closed and occupied by SS troops first, gradually several exceptions were given. The theological Faculties and Mendel University renamed the University of Agriculture could provide education under a German supervision (Koura, 2005).

The damage which Masaryk University suffered during the World War II was enormous. The loss of many academic experts and other employees caused by the Nazi persecution was really serious. The number of teachers executed and tortured to death was egregiously high. The Faculty of Science lost one quarter of its professorial staff in consequence of the Nazi terror (https://www.muni.cz/history/summary). In 1942 the mass execution of teachers from Masaryk University was performed in Mauthausen (https://www.muni.cz/history/milestones).

When the WW II finished, Masaryk University as well as the Institute for Education of PE Teachers were reopened. The studies there took 7 semesters and the list of courses and lectures changed a lot then. The following sports courses and lectures were placed on the list: Practical PE in Gym for men and women, Gymnastics, Rhythmic Gymnastics and National Dances for women, Fencing, Swimming, Skiing, Anatomy, Kinesiology, Physiology, Basketball, Skating and new subjects, such as Methodology of PE curriculum in Secondary Schools, Art Dancing, Anthropology, Anthropometry, Aesthetics of Exercising, PE Directives and Legal Regulations.

The list of staff members also changed because of the above mentioned reasons. The director of the Institute became Prof. PhDr. et MUDr. Vojtěch Suk. He had already directed it before the war. Specific subjects, such as Anatomy, Physiology, First Aid and Hygiene were lectured by doctors and practical courses, such as Practical PE in Gym, Athletics, Volleyball and Gymnastics were lectured by PE teachers and lecturers.

The instruction of PE and Defence courses was compulsory in the first and second term of the studies for all students at all universities in Brno. The PE courses were provided by the PE University Institute based at the Faculty of Law. The curriculum was adapted to the then situation and focused on the defensiveness of the population mainly. There were two compulsory subjects, Basic PE and Teaching of State Defence. Students had to participate in two marches, the attendance of 60% was compulsory and the fitness test was obligatory. There were also optional courses offered to all university students, such as Athletics, Fitness Running, Swimming, Basketball and Volleyball. Some other kinds of sports were offered by the University Sports Club. 5 602 university students completed the compulsory PE curriculum at that time, and only the gym at Veveří Street was available for all sports classes.

The director of the University PE Institute became doctor Vojta, who managed to obtain the gym Pod hradem. He also opened the Canoeing Centre at Veslařská Street and Tyrš´s PE Institute in Brno. Vojta accompanied our sports representatives to the third Light Athletics Championship in Oslo. Mr. Vojta was awarded by a degree on general and systematic locomotory culture in 1946 and he left the Institute in 1947.

The revolution in February 1948 slowed down the succesfull development of the university. 5% of students from the Faculty of Education and 46% of students from the Faculty of Law were expelled from the university. The changes in teaching staff were lesser, except the Faculty of Law, where these crackdowns started the process of the cancellation of the faculty in 1950 (https://www.muni.cz/history/summary).

The majority of the best teaching staff at the PE Institute were illegally expelled too and the institute became a part of the Faculty of Education established in 1946, where it had to join the PE department for primary school teachers. Between 1953 – 1964, when the Faculty of Education was reorganized and became an independent school named High Pedagogical School, the institute was cancelled. The institute reappeared again at Palackého University in Olomouc thanks to their effort and interest and to the impassivity and unconcern of the PE department and the whole Masaryk University. The Centre for Distant PE Studies survived in Brno only.

The crisis of Masaryk University experienced its peak in 1960, when it only included three faculties. The University of Veterinary Medicine, the only facility of its type in Bohemia and Moravia, was cancelled too. Masaryk University was renamed, and called Jan Evangelista Purkyně University.

The 1960s finally became a more prosperous period in the history of the university. Next political changes brought more convenient conditions for research and pedagogical activities, in 1964 the Facutly of Education and in 1969 the Faculty of Law were reopened.

What about the situation of the PE Intitute and PE education in Brno? As mentioned above, the PE and Defence instructions were compulsory for all university students since 1945. According to the records in the archive, the defence instruction was very important. In 1946/47 students were obliged to attend two lessons of Basic PE and two lessons of Defence. They could also choose some other sports from the optional PE offer.

Since the winter term 1947 both the practical and theoretical defence instructions were obligatory for eight terms until the fourth grade and other sports were non-obligatory. Until 1952 the students under military service, female students older than 21, male students older than 22, students studying at the PE Institute and PE at the Faculty of Education, and handicapped students were exempt from these instructions only. Two PE departments were established at the university. One of them came under the rectorate, the director became doctor Čáp and it provided PE instructions for the Faculties of Education, Arts and Science. According to the records, the department suffered from the lack of sports facilities and lecturers. In 1952 it only had 7 employees, and the instruction was influenced by the Ministry of Education and university ideological and educational requierements, as well as the demand to cooperate with the Military department. The teachers had to organize different sports actions and events, and they also were expected to deepen and extend their

practical and theoretical knowledge, the study of Russian authors (Pavlov, Těplov, Makarenko and some others) was privileged. The teachers also had to participate in regular lessons and presentations every week. The other department, the PE and Sports Medicine Department, was established at the Faculty of Medicine, professor Polčák became its head and the heads of the office became Gajdošová and Dražil. The PE departments at the University of Technology, the Faculty of Civil Engineering, Electrical Engineering, Mechanical Engineering and at the University of Agriculture provided the PE instruction. In 1953 the PE instruction was unified for all these PE departments. Students in their first and second grades attended 2 lessons of PE a week, in their third and fourth grades one lesson a week was obligatory. They also had to complete one winter sports course during their studies. There were 270 sports courses and 2700 students participated in PE classes then.

The number of sports facilities was inconvenient and insufficient. There was no swimming pool available for PE instructions then. The record from 1956 emphasized: *"If possible, the PE instructions must be held for one hour twice a week. It is not desirable to teach PE as a two-hour class once in two weeks and it is vital to focuse on the correct posture because it is often neglected."* The conditions for the credit assessment were as follows: the PE credit is given to each first and second grade student who attends spring and autumn PE classes, as well as courses regularly. Students also had to complete the final fitness tests and participated in them actively.

In the academic year 1956/57, several PE offices were established under the rectorial department whose head was Mr. Hadaš. The PE department at the Faculty of Medicine divided into two parts and one of them joined the rectorial department. The other became an independent Deparment of Sports Medicine at the Faculty of Medicine. In 1963 independent PE departments were established at all faculties, but in 1966 they were joined together under the rectotial department again, the head became doctor Höhm.

The record from the meeting of the executive directors of the PE offices reveals that the PE classes were suggested to become compulsory in the form of two lessons twice a week from first to fourth grade. In first grade PE was provided as a basic PE course and later students could choose different sports classes plus had to participate in one obligatory winter ski course. One summer course was obligatory for women and male students who did not serve the military service. All these requests were supposed to be included in the new academic law. The directors also mentioned unsufficient sports facilities at the university, the lack of gyms, athletic fields and

swimming pools. All then available facilities were overburdened up to 180%. They agreed on the construction of new sports complexes for each university: Masaryk University in the district of Bohunice, The University of Technology under Palackého hill and the University of Agriculture on its premises. As stated in the record, the realization of the construction projects should not take more than 15 years. As PE classes were compulsory at the academic environment since 1930, the university managements were supposed to be responsible for the projects. Unfortunately, the project at Masaryk University was postponed for many years, it was realized much later and the sports facilities were not opened until 2009.

According to the record in 1967/68, there were 21 teachers at the PE Department who taught 18 PE lessons a week and there were 3718 participating students. Besides standard classes, different specific courses were also offered, such as courses for overweight university students and staff.

The record from 1981 says that 5182 students participated in PE classes and first grade students´ fitness corresponded to the national fitness average, but 15% of students could not swim properly. To redress the situation, swimming courses for non-swimmers were immediately opened. The work overload of all then PE teachers did not enable them to dedicate their working time to research.

The PE department was located under the Rectorate until 2001. Then it became part and parcel of a newly established sports faculty, the Faculty of Sports Studies. In the course of time it was renamed and it is one of the faculty departments called the University Sports Centre until today. University students have to complete two terms of PE education during their Bachelor studies, for which they are given credits. The departments provide the students with eighty different sports in many classes. 9000 students participated in the compulsory PE classes and 2000 in the optional classes which are also assessed by the credit system in the academic year 2014/15.

Concerning the history of PE teachers´ further education, training and research work, after the reorganization in the 1950s the research in sport and PE field was almost exclusively pursued by the Department of Sports Medicine at the Faculty of Medicine. In 1966 when the Faculty of Education rejoined the university, the PE Deparment was restored. It was named the Department of PE Theory and governed by docent Hadač. The department survived the collapse of the communist regime in 1989 without any serious difficulties and provided the education for future primary school PE teachers. The study involved two subjects, one of them was PE and the other one was either Geography or Mathematics or Biology or Civics. To teach older primary school students, the PE students had to extend their study for one more year. Despite

the effort to reesablish the study programme for secondary school PE teachers, which used to be offered and had a high standard in the past here, this attempt was not fruitful. The roceords show that many discussions and negotiations were held, but none of them was accepted by representants of the Ministry of Education and of the universities in Prague and Olomouc for long. Thanks to an immense effort, the Faculty of Sports Studies was finally established in 2002, and it became an inseparable part of Masaryk University and continues introducing and promoting the tradition of PE education here (Fasora, Hanuš, 2015).

Methods

Regarding the methods, the processing of various historical materials, records and their analysis seen in a wider context of different historical periods are involved.

Results

The archive of MU, with precise semestral records written methodically, has been administrated systematically since 1926, which enabled us to portray a detailed outline about the beginnings of PE instructions at the university. This cannot be stated about the recent history, namely since 1974. Only an insignificant amount of documents and records administrated randomly were available and could have been scrutinized. The work here involved the rearrangement of the incoherent materials with political vertones mostly.

Discussion

Our contribution deals with the beginnings and history of Physical Education instruction at MU from 1922 up to the present time. The study observes its development as a reflection of socio-historical status and values of our society.

The analysis and comprehension of historical relations, attitudes and values can guide us to understand the presence. It can enlighten and clarify the consequences of the decisions and actions that influence and shape it. The assessment and understanding of the broader context, the formulation of our priorities enables us to decide better and more efficiently about the acts in the future. This work aims to describe the history of PE instruction at Masaryk University and to provide the outlook on this issue in a broader socio-historical context.

The method of mapping of materials available and their analysis in the broader context of different historical periods are involved. We provided a comprehensive overview of 93-year history of Physical Education training at Masaryk University.

Conclusions

Since the establishment of Masaryk University in 1919, its management has always been trying to support as suitable conditions for PE education of all its students as time possibilities and other aspects allowed, both financially and administratively. Thanks to this effort, the continuity of the PE education at the university has always been asserted and maintained in a unique way. Thus it can be stated that the conditions of PE education at the university ranks high and occupies an exceptional position among all Czech universities, where this kind of education was cancelled in 1989 and today it is being reintroduced intricately or is still neglected by university managements.

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"YES I CAN" EXERCISE ADOPTION/ADHERENCE MODEL

Peter Rehor
Faculty of Physical Culture, Palacky University Olomouc, Czech Republic

Abstract

Although other correlates of physical activity among youth have not been clearly established, a growing literature has suggested that social-cognitive factors such as attitudes, social norms and self-efficacy influence the decision to become physically active among youth. The "Yes I Can" builds on existing prominent theoretical models employed to study physical activity determinants and provides a curriculum design framework for the development of specific fitness education programs in schools and other educational settings.

Keywords: *exercise adoption, exercise adherence, self-efficacy, chronic disease management, transtheoretical model, psycho-social determinants, environmental fitness*

Introduction

In Canada over the next four years, deaths due to chronic diseases are projected to increase by 17 per cent. Out of the projected six million people who will die by 2015, four million will die of a chronic disease - unless urgent action is taken. Given that both physical inactivity and obesity are strong independent causes and predictors of chronic illness and disability, it has been estimated that they impose a significant economic burden on the health-care system in Canada. The most recent research, in the Canadian Health Measures Survey released by Statistics Canada, indicates that only 7.5 per cent of children and 15 per cent of Canadian adults are physically active for at least 150 minutes per week, while 18.7 per cent are obese and 46 per cent are overweight.

Although the health effects of regular physical activity have been well documented, the majority of the western society outside of Canada also remains sedentary. Recent surveys conducted in Australia, Canada, England, and the United States indicated that only about 10% of the adult population of each country could be called "aerobically active" (Stephens & Caspersen 1994). In Australia, during the 12 months ended June 1996, over 5.8 million people (35.5% of the population aged five years and over) participated in organized sport and physical activities. The highest participation rate was exhibited by children aged 9-11 years (71.0%), with the rate declining for each

successive age group. The largest falls occurred between 15-19 year olds and 20-24 year olds (14.0 percentage points) and between 12-14 year olds and 15-19 year olds (12.5 percentage points) (Australian Bureau of Statistics 1998). The diminishing rates in these age groups coincide with the ages at which people leave school and the years when their interests, preferences and commitments may be changing (Rehor & Cottam 2000).

The lack of physical activity is said to be a major cause of increasing chronic disease prevalence and incidence levels and decreasing physical fitness. A major cause of this has been lifestyle change. Change in labour saving technology has encouraged Canadians to lead a less active lifestyle. In today's modern, industrialized and automated society machines do most of the work. Computers and push button, labour saving devices are a big part of our everyday lives. For example, at home we use dishwashers, automatic washing machines and even ride-on mowers. There are escalators and lifts to save us walking up and down stairs. Many children, teenagers and adults are driven to school or to their jobs rather than walking or riding their bikes and a lot of time is spent in front of television and computer screens, rather than being physically active. As a result of these technological changes, many of us live a more sedentary lifestyle. To put it simply, more time is spent sitting around rather than moving! In order for us to be fit for live, we've got to be more active!

The view of physical activity as a health-promoting behavior is gaining recognition throughout the scientific literature. Physical educators across the nation are working to strengthen fitness education curricula, and particularly to find ways to achieve desired outcomes relating to the adoption and maintenance of personal exercise programs beyond school years. Despite the remarkable growth of interest in the effect of physical activity on the incidence of certain diseases, and recent promotional efforts to increase physical activity, national objectives for participation in physical activity (Center for disease Control and Prevention, 1997) have not been met. Physical activity contributes to physiological benefits such as a lower risk of cardiovascular disease (CHD) (U.S. Department of Health and Human Services 2000; Malina 1996), better control of hypertension (Haapanen-Miemi at al. 2000; Hagberg 1997) and diabetes mellitus (Helmrich, Ragland, Leung & Paffenbarger 1991; Shwartz 1997), reduced risk of certain types of cancer (Lee 1994), and lower risk of osteoporosis (Surgeon General's Report on Physical Activity and Health 1996). Physical activity also contributes to psychological benefits such as improving self-esteem and self-concept (Calfas, Taylor 1997) and reducing depression (Morgan 1994), anxiety, and stress (Surgeon General's Report on Physical Activity and Heralth 1996). Physical activity during leisure time therefore becomes even more important and can contribute greatly to fitness and well-being. It has been shown that increasing the level of leisure time

physical activity benefits both men and women as it lessens the mortality risk in both obese and non-obese individuals (Haapanen-Miemi at al. 2000). Whether this physical activity is derived from organized sport or a generally more active lifestyle appears less important than the overall benefits that it can provide. In general, staying active combined with a balanced diet maintains a healthy bodyweight, decreases the risk of CVD and makes a healthier and fitter individual.

For some time physical educators have recognized the need for fitness education focused on exercise adoption and adherence. While many school districts have made progress in demonstrating gains in student fitness scores, the absence of a comprehensive, theoretically sound curriculum development model, oriented toward change in exercise behavior, has limited the success of school fitness programs. The Yes I Can Exercise Adoption/Adherence Model is offered as a framework for planning instruction focused on long-term commitment to a personal active lifestyle (Figure1).

"Yes I Can" Exercise Adoption/Adherence Model

The model focuses on the development of a habit of regular exercise rather than on the enhancement of physical performance. The need for the model grew out of dissatisfaction with our present instructional content focused on teaching of motor skills. The majority of today's physical education curricula are designed with the basic assumption that desired changes in fitness participation and performance can be sought in the same fashion as enhancement of motor performance. And yet, our goals and objectives in each of these two major areas are quite different.

The primary aim of teaching motor skills is the acquisition of a higher order of movement process skill. Instruction is organized in sequences leading to progressively higher levels of skill. While fitness instruction is sometimes directed toward the attainment of a specific fitness activity participation skill, the main focus of instruction should be on permanent adoption of regular exercise habits. The fitness education construct is of a behavioral nature, structured around personal intentions, individual incentive motivation, and a framework of personal meaning.

Curriculum Framework

The foundations for the model lie in social psychology and in a personal meaning philosophy of education. Social psychologists have provided a number of attitude-behavior models (Godin & Shepard, 1990). The two key concepts of the Yes I Can Exercise Adoption/Adherence Model derived from these models postulate (1)

a sequence of behaviors leading from intention to exercise to adherence to a personal exercise program and (2) three categories of factors that influence the intention to exercise.

A basic assumption of the Yes I Can Exercise Adoption/Adherence Model is that the development of a regular exercise pattern must begin with the individual's perception of some aspect of personal meaning leading to the intention to exercise. Intentions to exercise are influenced by personal beliefs, social norms, and self-efficacy. (Fig.1)

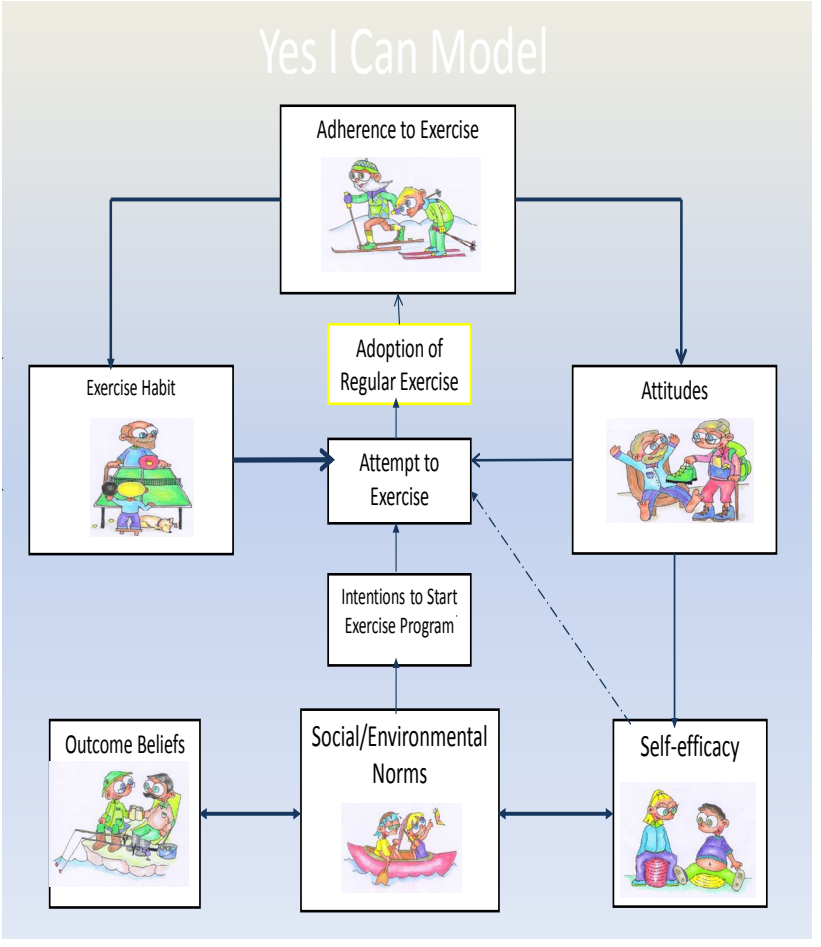

Fig. 1 Yes I Can Exercise Adoption/Adherence Model (Rehor 2011)

Beliefs

Personal beliefs about the values and benefits that will follow from exercise participation are considered to be an important factor leading to the intention to exercise. The belief component also includes expectations that performance of exercise will result in the desired outcomes. The perceived consequences of participation are then compared against an individual's predisposed values, such as a desirable lifestyle.

Social Norms

The second component, *social norms*, may also be a crucial factor in determining whether an individual develops a positive intention to exercise. Normative belief carries a connotation of self-responsibility and willingness to behave according to personal principles. Unfortunately, at this point in time, regular exercise is not a normative expectation from the social and societal point of view in the way that other aspects of personal health care are. Consequently, motivation to comply may have to be substituted for societal expectations, in influencing the intention to exercise. Furthermore, the motivation to comply may be either strengthened or depressed by the student's perception of the role model and subjective analysis of the importance of compliance in the particular setting. The perceived exercise exertion that will be required also shapes the motivation to comply.

Self-efficacy

Self-efficacy or perceptions of how easy or how difficult the adoption of a regular exercise regime is likely to be, is the third component that, like personal beliefs and social norms, can influence the intention to exercise. Self-efficacy reflects attitudes about the difficulty of adopting an activity behavior, formed mainly by personal experiences, but also affected by examples of others. It also reflects a personal belief about resources and opportunities available to acquire the desired behavior.

These three categories of factors that influence intention to exercise are shown horizontally as the base of the Yes I Can Exercise Adoption/Adherence Model (Figure 1). The sequence of behaviors leading to adherence to regular exercise, or a physically active lifestyle, are represented vertically within the figure. Beliefs, social norms, and self-efficacy influence intention to exercise; intention, to exercise can lead to actual exercise acquisition. The acquisition of regular exercise behavior is viewed as a three-stage process originating with an attempt to exercise, followed by exercise adoption, and terminating with adherence.

In addition to factors influencing intentions, and the sequence of behaviors leading to exercise adherence, the Yes I Can Exercise Adoption/Adherence Model includes two other components, attitudes and habit. Attitudes include feelings experiences during exercise participation. Based on the exercise duration, intensity, type, and setting, these feelings can be pleasant or unpleasant, interesting or boring. This component is shaped by the recall of previous experiences, including memories of feelings experienced during earlier attempts to change exercise behavior and during periods of initial adoption of exercise programs. The enjoyment or pleasure experienced during exercising has an important effect, both on self-efficacy and on subsequent intentions to exercise.

Habit

The biochemical and psychosocial feedback resulting from exercise participation established by past exercise participation at the adherence stage, is now clearly identified as an important determinant of current exercise behavior. The model postulates that adherence to exercise is a habit-forming behavior, deriving either form somatic responses or adaptations or from psychosocial interactions such as belonging or identity. Habit, together with facilitating and reinforcing factors, moderates the predication of exercise adherence from intention.

Selection of Instructional Content

Present practice in physical education is typically oriented toward the teaching of motor performance skills. The Yes I Can Exercise Adoption/Adherence Model s designed to provide a framework for curriculum development focused on long-term commitment to a personal active lifestyle. In behavioral fitness programs the main focus of instruction should be on permanent adoption of regular exercise habits. Curriculum planners using the Yes I Can Exercise Adoption/Adherence Model take a different approach in selecting the content for exercise programming and physical education classes. Planners address the particular basic components of the model that are appropriate for the personal fitness status and developmental levels of the students in choosing learning activities and instructional techniques.

Beliefs

If the personal fitness trainer or physical educator is to influence relevant personal beliefs, the curriculum should include provision of knowledge about the benefits of exercise. It should be designed to emphasize demonstrated relationships of regular

exercise participation to health, productivity, personal appearance, feelings well-being, and other outcomes valued by the students. Most important, it should foster belief in the likelihood that regular participation really will lead to these desired results.

Social Norms

Typical adult physical activity patterns, and social expectations in the industrialized world today, do not provide much motivation for young people to development commitment to physically active lifestyles. Consequently, it is especially important that the behavioral fitness curriculum develop effective techniques for self-motivation to exercise. This challenge can be addressed through curriculum content related to planning for supportive environments for desired exercise behavior, to exploring the characteristics of physical activity that make regular exercise attractive and enjoyable for the individual, and to developing the personal attributes that lead to self-motivation (Rehor, 1994).

Self-efficacy

A number of curriculum strategies are available for helping students to develop positive perceptions about their abilities to acquire the desired exercise behaviors. Teaching students to set personal goals that are both realistic and challenging is basic to many of the other self-regulatory skills for reinforcement of effective and satisfying exercise behavior. Activities selected to strengthen the student's internal locus of control increase the feeling of personal control and the belief that a particular action will lead to the particular outcome sought.

A wide variety of self-assessment techniques have been designed and utilized to involve the student in self-testing personal fitness status and progress in self-management. Self-assessment provides both the foundations for sound goal setting and motivation for further achievement. Teaching students that there are effective strategies for exercise adherence helps them to believe in their capabilities for experiencing success in their efforts to develop and maintain active lifestyles.

Intentions

Every curriculum plan for behavioral fitness education begins with the recognition that the students must be directed toward positive intentions to develop habits of regular exercise behavior. The standard curriculum approach is to include instruction in designing a sound personal exercise program. Implementation of this component

of the Yes I Can Exercise Adoption/Adherence Model is most likely to be successful if instruction includes the planning and monitoring of an exercise program for current use, help in adapting various exercise plans for individual use, and assistance in understanding how personal programs can be modified to adjust to future changes in life circumstances.

Exercise Attempt

Curriculum planning designed to focus on the attempt component in the three-stage process of acquisition of regular exercise behavior usually employs time management, behavioral contracts, and feedback. Since the most frequently cited obstacle to regular exercise participation is the perception of too little time, instruction suggesting alternative ways to plan time for exercise can be very helpful. Behavioral contracts, which lead the student to agree to meet certain exercise performance standards, are frequently used to encourage students to make serious attempts to exercise. Ensuring positive feedback, especially pleasurable somatic responses to participation, is generally believed to be successful in eliciting future attempts to become involved in regular exercise programs.

Exercise Adoption

Strategies identified for supporting the adoption of personal exercise programs include rewards, self-monitoring, and stimulus control. The use of rewards, or varied desirable contingencies for providing extrinsic motivation, is a common behavior modification strategy, sometimes used to stimulate exercise adoption. Self-monitoring is an associational learning cognitive behavior modification technique that requires participants to keep records of completion of specific exercise behaviors. Stimulus control is a facilitating and reinforcing technique in which the environment is restructured in order to remove or diminish real or imagined barriers to activity.

Exercise Adherence

When the individual reaches the stage of actual adherence to a regular exercise pattern, curriculum support for maintaining this achievement can be provided by instruction designed to prevent relapse behavior. This usually takes the form of identifying participation. Identifying these risks in advance, and providing instruction in how to deal with these situations, helps students to avoid the potential relapse.

Conclusion

In implementing the Yes I Can Exercise Adoption/Adherence Model as a guide for selection of instructional goals and students learning outcomes, curriculum planners need to address the particular basic components of the model that are appropriate for the personal-wellness status and developmental levels of the students in choosing learning activities and instructional techniques. Much attention is given to self-assessment, self-monitoring, and other self-management skills. Learning activities are selected to develop the personal attributes that lead to self-motivation. A supportive learning climate is needed to ensure individual success and greater self-efficacy. Clients and students need to develop goal-setting skills and require guidance in learning to set goals that are both realistic and challenging. A wide variety of self-assessment techniques are employed; self-assessment abilities need also to be supported by skills for self-reinforcement.

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SPORT MEDICINE

EVALUATION OF REHABILITATION EFFECT WITH 3D SCANNING MEASUREMENT IN FLATFOOT DIAGNOSIS IN CHILDHOOD

Lucie Kinclová[1,2], Pavel Korvas[1]
[1]Faculty of Sports Studies, Brno, Czech Republic
[2]Privat clinic LOGO s.r.o., Brno, Czech Republic

Flatfoot diagnosis in childhood belongs to the most frequent diagnosis in the orthopedic and physiotherapist clinics. The aim of this research is to evaluate the influence of rehabilitation on the flatfoot diagnosis in childhood using a new 3D profilometry scanning method. The research group consisted of 8 participants with the flat foot diagnosis (3 girls and 5 boys), aged 6.6 ± 1.5 years. Each leg was scanned in sitting and one leg standing positions. The measured parameters were: the arch height without loading and in loading and longitudinal arch angle. This measurement was performed before and after rehabilitation intervention. Statistical analysis of data showed statistically significant changes of all parametres after the intervention ($p<.05$). This is the first study, which describes the possibility of using 3D scanning method for diagnosis and evaluation of therapy effect in flatfoot diagnosis in childhood.

Keywords: *foot arch, 3D scanning method, flatfoot, children*

Introduction

Flatfoot is relatively frequent foot deformity occuring during childhood phase, which manifests itself with difficulties especially in static load. Prevalence of flexible flatfoot among preschool population is 21-57%. Although the prevalence decreases with higher age, flatfoot could lead to muscular-skeleten difficulties, or become a cause of pains.(El et al., 2006; Lin, Lai, Kuan, & Chou, 2001; Pfeiffer, Kotz, Ledl, Hauser, & Sluga, 2006).

The term „flatfoot“ generally means lowering of inner longitudinal arch. It is distinguished between two types of flatfoot: flexible and rigid. Flexible one is characterized by lowering of inner longitudinal arch in loading (stand, walk). Lowering of inner arch in rigid one is evident in both loading and non-loading position (seat).

Evaluation of foot arch is possible with using both podometric and plantographic methods. More sophisticated measurements could be achived with using dynamic plantographic. Nevertheless, such methods could support us only with 2D footprints. Flatfoot is however characterized as 3D deformity, which includes also rearfoot pronation, midfoot abduction and supination of forefoot. Methods used for evaluation

foot archs from the point of 2D cannot then propose complex information regarding foot arch. Despite of few studies concerns with 3D foot scanning, the authors evaluate only 2D parameters, such as foot dimensions or varus angel of forefoot (Meneses, Gharbi, & Cornu, 2002; Witana, Xiong, Zhao, & Goonetilleke, 2006). Only few studies were really focused on arch description from point of 3D scanning.

Method described in our article is based on 3D profilometric scan. The aim is to estabilish the suitable parameters for foot arch description from point of 3D perspective. Consquently we also use the method to evaluate the outcome of rehabilitation performa

Methods

Participants

The research group consisted of 8 children (3 girls, 5 boys) with avarage age 6.6 ± 1.5 year with flexible mutual flatfoot and without any significant pain. Diagnosis passed off based on evaluation of plantogram using visual analog scale.

Flexibility of foot arch was realised by means of tip toe stand test and Jack's toe raising test

Equipment

Our 3D profilometric scan workplace consists of FULL HD DLP projector, digital camera CANON EOS 700D with lens Canon EF 50mm F1.8 II and laptop (Fig. 1).

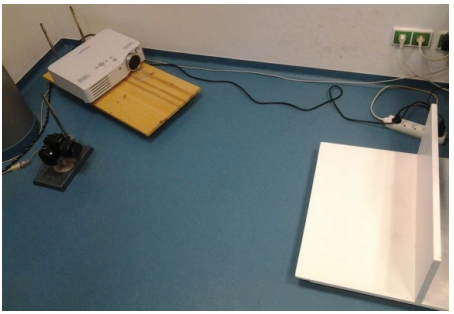

Fig. 1 Measurement workplace arrangement

Measurement technique

Three palpable points were marked on foot of each probands being in the sitting position in neutral position of hock joint: 1. metatarzophalangal joint, os naviculare and malleolus medialis. These point were choosen due to theirs connection with foot arch and for measurement of following datas: foot arch heiht (represented by height of os naviculare) and longitudinal arch angle (Nillson et al., 2012), see Fig. 2. All these datas were obtained by 3D scanning method, which is very accurate.

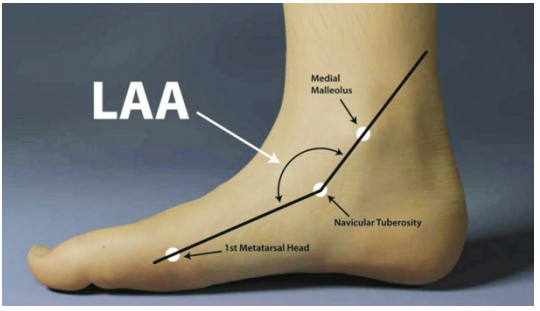

Fig. 2 Longitudinal arch angle - LAA

Each foot was primaly measured without loading, proband being in the sitting position. Tested foot was then placed with sole onto platform, being in 90 angle flexion in knee and hip joint. Afterwards, foot was measured without any loading, proband being in one leg standing position, second non-tested leg was bended in knee and lifted up. Proband was asked to handle side handgrip because of balance (Fig. 3 and 4). Sets of six periodical models at two wave lenght were screened onto the foot and however it was taken by the camera (Fig. 5). Scanning duration was about 30 second.

Software Matlab was used to analyse the datas. Figures were divided and continual skin surface was mapped in the space. Then using this informaton the in-depth map was made (Fig. 6). Software Matlab was also used to create 3D model of scanned arch. Futher information regarding data analaysis can be found in the article Kaller, Kratochvíl, Vorlíčková and Boleček (2013).


Fig. 3 and 4 Foot arch without loading and in loading – coloured input picture


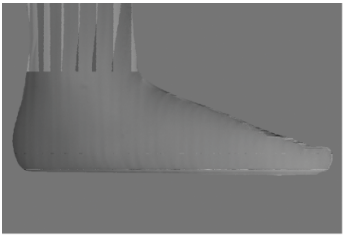

Fig. 5 a 6 Set of six periodical models and final in-depth foot map

Rehabilitation intervence was performed twice a week 45 minutes, total number of therapies was 10. Rehabilitation intervences took 5 weeks. Exercices consist of practice of three points leg support with centering location of hock joint in sitting, standing and one-leg standing position. Further it was excercised in centering position of all leg according to the Propriofoot concept. This concept includes practise on special balance pads, whose combination enables performance of 17 excercises (Fig. 7).Then we practice the cenering position of foot in position from developmental kinesiology.

Fig. 7 Exercise according to the Propriofoot concept

Data analysis

Statistical data analysis was done in programme Statistika. Significance level was defined $p<0.05$. All datas came from standart normal distribution (tested with Kolmogorov-Smirnov test). To compare datas before and after rehabilitation the paired t-test was used.

Results

Foot arch height (os naviculare height) was evaluated on left and right leg without loading before and after rehabilitation. We can see the significant elevation in foot arch in both legs with intervention (Fig. 8 and 9).

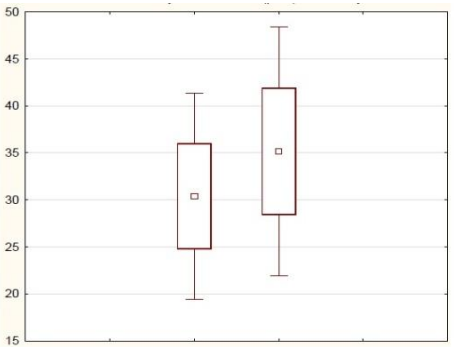

Fig. 8 Os naviculare height (mm, y axis) without loading in right leg before (left box) and after (right box) intervention (x axis)

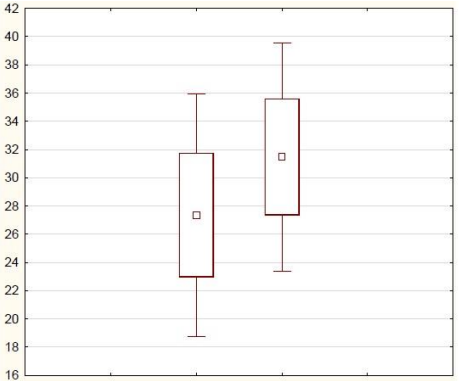

Fig. 9 Os naviculare height (mm, y axis) without loading in left leg before (left box) and after(right box) intervention (x axis)

We can see significant increase in foot arch height in both legs in loading with intervention (Fig. 10 and 11).

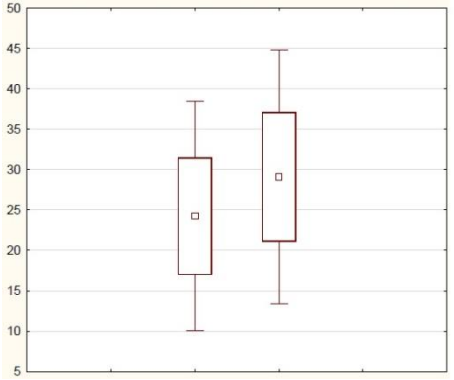

Fig. 10 Longitudinal arch angle in left and right leg before and after intervention

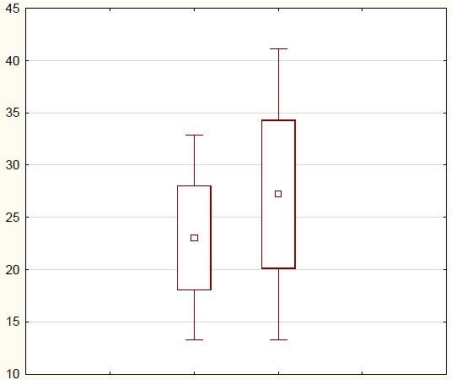

Fig. 11 Os naviculare height (mm, y axis) in loading in left leg before (left box) and after (right box) intervention (x axis)

Evaluating longitudinal arch angle in left and right leg we can see statistiscal significant difference in foot arch elevation as a consequence of rehabilitation (Fig. 12 and 13).

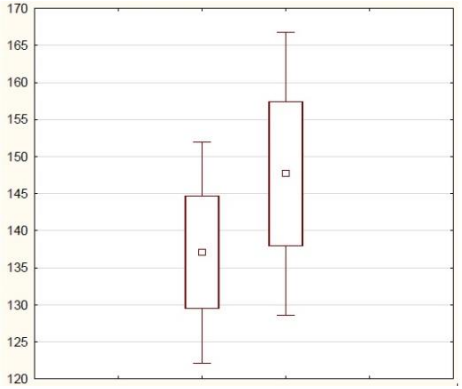

Fig. 12 Longitudinal arch angle (º , y axis) in right leg before (left box) and after (right box) intervention (x axis)

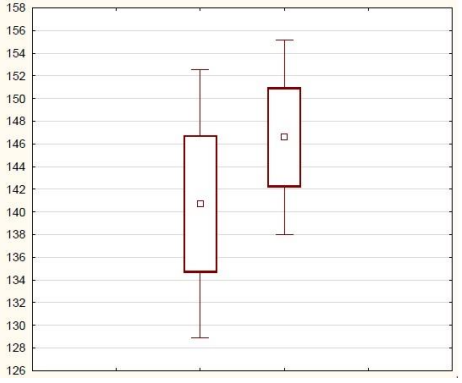

Fig. 13 Longitudinal arch angle (º , y axis) in left leg before (left box) and after (right box) intervention (x axis)

Legend:

Mean

Mean ± standard deviation

Mean±1.96*standard deviation

Regarding all variables t-test can be evaluated as significant ($p<0,05$). Regarding monitored group the significant increase of foot arch was seen after the intervention.

Discussion

Prevalence of children flat foot is heigh, even the authors do not agreed regarding its rehabilitaion. Ex. Adamec (2005) describes in his article, that rehabilitaion has no any significant effect. Contrary Dobeš, Kolář and Dyrhonová (2009) recommend active therapy in flat foot treatment. That is supported also by Rose (2007). Our research can be compared with our previous research, in which we evaluated children flat foot rehabilitation using dynamic plantography. (Vorlíčková&Korvas, 2014).

This study was focused on influence of rehabilitation intervantion using new 3D profilometric scanning methods. The foot arch height was measured in loading and without loading and longitudinal arch angle. We realised significant elevation of foot arch in sample population (8 children with diagnosis of flat foot).

The only study occuppies with description of foot arch using 3D view is the study of Chang and collective (2012). In this study foot arch was measured in population of 44 children (aged 2-6) using 3D scan in sitting and one leg standing position. The points marked on feet were also the same. Authors described the method for evaluation of foot arch, but it is only the hypothehical space determined with intersection of three planes which is connected with foot arch but can not be estabilished as volume of arch.

Our aim is in future also estabilish the arch volume using the measured datas. Currently we are only able to define this volume in non-dimensional units (Voxels) and express arch volume in percantage. This technology can reveal foot arch information in all planes and by that improve the quality of foot arch deformity diagnosis.

Conclusion

One of the possible rehabilitation to activate foot arch muscles is Propriofoot concept. This study shows positive effect of rehabilitation of children flat foot. This effect was measured with 3D profilometric scanning methods. 3D scan method of foot arch provides precise datas regarding foot arch height and can be suitable complement of traditional 2D methods in both diagnosis and evaluation of intervention treatment. To have more precise results it is neccessary to extend the research group.

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INJURIES IN WINDSURFING SPORTS

Petr Kučera[1], Vladimír Psalman[2]
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic[1]
Pedagogical Faculty, Southern Bohemia University, České Budějovice, Czech Republic[2]

Abstract

The purpose of this research was to figure out injuries in windsurfing sport, their reasons and prevention. Together 104 windsurfers in three different groups A,B,C (based on sport discipline and sport performance) were asked in 2 questionnaires about their injuries (body region, type of injury and number of injuries). Sport performance, sport load, technical skills and process of regeneration were taken into the consideration as well. Age varied from 20.8 to 43 years. Injury rate was calculated in all tested groups (number of injuries/athlete/year). Windsurfing load intensity reaches a high level, as evidenced by the values (heart rate in beats per minute) obtained during training and competition monitoring. While in training, the maximum value is approaching the value of 200 beats per minute, with the addition of mental stress during competition was recorded highest value of 214 beats per minute. Crossing the threshold of 200 beats per minute is becoming common in many competitors. The complex readiness for sport performance is an important prerequisite for prevention against injuries. In group C it was found a significant relationship between sports performance and regeneration, which proved to be very beneficial. While the total loading time has proved to be statistically insignificant, number of training units and adequate regeneration to sport performance was highly significant at the $p = 0.05$. Three groups differed by discipline and levels of physical and technical preparedness achieved following values: 92 injuries (group A), 47 injuries (group B) and only 15 injuries in group C. The most injuries appeared in lower extremities (group A, 42%) and in upper extremities (group B, 52% and group C, 53%). Injury rate represents the number of injuries per athlete per year. The following values were found: 2.63/athlete/year in group A, 1.04/athlete/year in group B and 0.63/athlete/year. The frequency of various injuries, their type and location are given in tables 1-6. The number of injuries in windsurfing depends on the implementation of the disciplines where funboarding is much more risky than raceboarding. Next addiction is related to the level of fitness and coordination preparedness, while important is the level of technical skills. Last but not least as substantial showed quality and quantity of the regeneration process, and adequate rest.

Keywords: *injuries, windsurfing, sport loading, prevention*

Introduction

Windsurfing is a relatively new sport which has become very popular at both recreational and competitive levels with millions of participants worldwide. There are six recognised disciplines, but, on the basis of differences in equipment and type of activity, these can be grouped into two major divisions:

(a) raceboarding, in which a standard course is completed as fast as possible
(b) funboarding, wave, slalom, in which competitors perform freestyle acrobatic and aerial manoeuvres.

The Olympic form of the raceboard event is highly demanding not only in terms of the whole body strength and endurance needed to control the sail and boom relative to the wind strength and direction requirements, but also when working to maintain speed with little wind. In light to moderate winds, a forced movement of the sail away from and towards the body (termed pumping) is used to promote sailboard progression by catching and enhancing the effect of any existing wind. Pumping was first allowed in the 1996 Olympics, thus increasing the physical and muscular demands in both training and competition. There are no general regulations relating to clothing or equipment, although at Olympic level sailboards and sailing rig may be designated.

Nowadays windsurfing is an Olympic sport and has been part of the list of sailing sports since the 1984 Los Angeles Olympics. It is now in an enviable position, with numerous participating countries, converting it into an attractive sport that is in direct contact with the environment. Windsurfing has shown itself to be a highly demanding discipline. De Vito et al. (1997) showed that when sailing with a wind speed of 4–5 m/s, average value for oxygen consumption was 43±4ml/min·kg (73% of HR max) and the average heart rate (HR) was 169±12 b/min (92% of HR max). The physiological demands appear to be influenced by the strength of the wind. During Olympic races with light winds (3–5 m/s), it has been shown that average heart rate during competition is 167 b/min. However, in the same conditions in strong winds (12–15 m/s), average heart rate is 154 b/min. These values suggest that, in light wind conditions, there are less physiological and metabolic demands. This may be due to the permanent pumping action needed to increase the speed of the board when the wind is not strong enough. Other authors, such as Vogiatzis et al. (2002) showed that the pumping action needed to sail with a wind speed of between 4 and 15 m/s leads to a significant increase in the physiological demand on windsurfer (from 110 to 165 b/min).

Regarding injuries, windsurfing ride straining the spine, upper and lower limbs (Dyson, Buchanan, Hale, 2006). Recreational form at mastering the proper technique burdens the body evenly. Calluses are very common. Acute cases include bruises and contusions to various parts of the body. Then chronic pain e.g.: overstretched

muscles of the back (especially lumbar spine straightening), inflammation of the tendons and ligaments congested flexor fingers and elbow. The most common acute injuries include: fracture, cut/graze, serious bruising, muscle strain, tendon strain, ligament sprain, dislocation and concussion (Nathanson, Reinert, 1999). Collision with equipment when overpowered by wind and waves is the major contributory factor to injury occurrence in the windsurfing. Changing equipment involved in the injury incident: raising the boom, changing a harness, or wearing a back support or a helmet. However, modifying technique was considered to be the most effective way of minimising or preventing injury (Psalman, 2010). Such modifications include better warm up, improving stretching procedures, increased lower body strength and body posture to aid optimal sailing technique, and the development of greater upper body strength to cope with the demands of pumping in light winds. Physiotherapy was the most common form of remedial treatment, with hospital attendance required for head injuries, fractures, and lacerations (Zvonař et al., 2010).

Purpose

The purpose of this research was to figure out injuries in windsurfing sport, their reasons and prevention.

Methods

Our research study consisted of three groups of athletes performing two disciplines of windsurfing. Group A was created of 35 recreational windsurfers who did funboarding disciplines, including the slalom and waves. Their average age was 25.3 years, the minimum age was 21.8 and maximum age of 32.3 years. Group B with higher athletic performance had 45 windsurfers in the discipline raceboarding with the national level of performance (average age 29.4 years, 20.8 years minimum age and maximum age 43 years). The highest quality group C consisted of 24 athletes - professionals in raceboarding discipline in the age from 22.5 to 33.7 years (average age 27.7 years). To obtain information on the incidence of injuries in the three different groups of windsurfing we used two questionnaires. In them we asked for daily sports load and its duration, the number of training units, the quantity and quality of regeneration, type of injury and its location. Types of injuries and their prevalence in the studied groups A, B, C were processed graphically (percentage output) and in tables.

Sports load in training and competitions and also overall load of the athlete during the day was evaluated subjectively. These states were evaluated on 10 cm long lines, where the athlete vertically indicates the current status. Because the scale is measured in the range 0-10, the assessment can be translated to the percentages (0-100 percent). Objective

evaluation of the training load was carried out by measuring heart rate with Polar equipment. All variables - indicators are characterized by means of the statistical characteristics of position and variance - arithmetical average, standard deviation, minimum and maximum.

Results and Discussion

From the perspective of power capability windsurfing is classified to static-power endurance discipline. During windsurfing ride alternate static position with acyclic movements. There is a change in muscle tension, isometric contraction alternates with isotonic. When driving are the most burdened muscles of the arm, shoulder and back. In managing of the board by feet, windsurfer has to use his body as a counterweight to the wind, which operate continuously with the sail. Also he needs to hold boom firmly with both hands, in this position the most loaded are finger flexors and elbow flexors (m. biceps brachii, m. brachialis a m. brachioradialis). On the trunk mainly extensors of the spine (m. erector spinae a m. quadratus lumborum) are in the permanent load. In terms of endurance load type is continuous for the duration of the olympic race about 60 minutes, so windsurfing belongs to the long-term endurance sports with sub-maximal load.

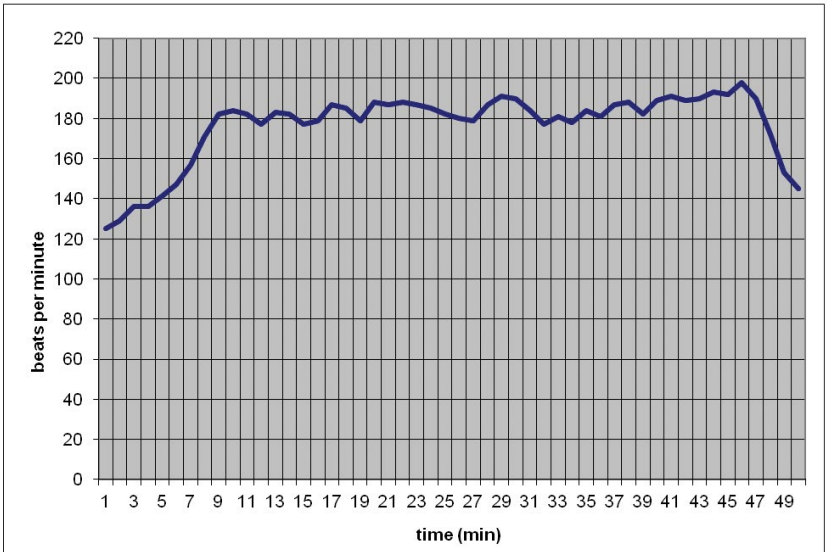

Fig. 1 Sport loading (heart rate in bpm) during the windsurfing race in light wind (1-4 meters per second)

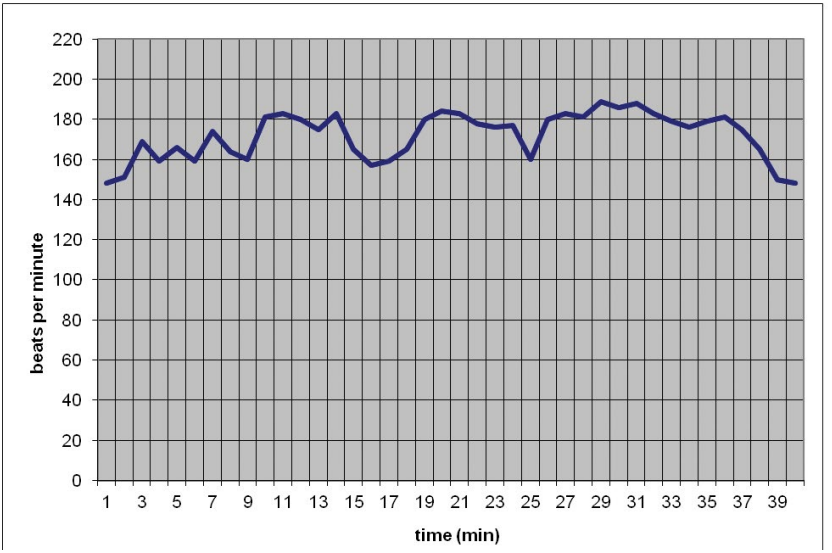

Fig. 2 Sport loading (heart rate in bpm) during the windsurfing race in strong wind (10-13 meters per second)

Graphical presentation (figures 1 and 2) showed the load level in best-prepared competitors - windsurfing professionals in various wind conditions (light and strong winds). Windsurfing load intensity reaches a high level, as evidenced by the values (heart rate in beats per minute) obtained during training and competition monitoring. While in training, the maximum value is approaching the value of 200 beats per minute, with the addition of mental stress during competition was recorded highest value of 214 beats per minute. Crossing the threshold of 200 beats per minute is becoming common in many competitors. Interestingly, the highest heart rate values are achieved in the race in light wind, which is a prerequisite for success using high-intensity pumping. Found high levels of heart rate confirm the fact that professionals are well prepared for achieving quality sport performance.

On the other hand this complex readiness for sport performance is an important prerequisite for prevention against injuries. In group C it was found a significant relationship between sports performance and regeneration, which proved to be very beneficial. While the total loading time has proved to be statistically insignificant, number of training units and adequate regeneration to sport performance was highly significant at the $p = 0.05$. Number of training units mainly depends on the coach, who in the case of excessive fatigue in prolonged training session can divide it into several

smaller ones. Among them was time for passive or active rest and partial recovery. At least quality group of recreational windsurfers realized the most risky windsurfing discipline and therefore it was found the highest number of injuries (tables 1, 2, 3, 4, 5, 6).

Tab. 1

Discipline - Funboarding, wave, slalom - recreational level n=35		
Body region	Number of injuries	Percent of injuries
Head and neck	21	23
Upper extremity	18	20
Trunk	14	15
Lower extremity	39	42

Tab. 2

Discipline - Raceboarding - national level n=45		
Body region	Number of injuries	Percent of injuries
Head and neck	6	13
Upper extremity	25	52
Trunk	4	9
Lower extremity	12	26

Tab. 3

Discipline - Raceboarding - professional level n=24		
Body region	Number of injuries	Percent of injuries
Head and neck	2	13
Upper extremity	8	53
Trunk	1	7
Lower extremity	4	27

Tab. 4

Discipline - Fun boarding, wave, slalom - recreational level		
Type of injury	Number of injuries	Percent of injuries
Laceration	21	23
Strain, overstrain	18	20
Sprain	16	17
Contusion	25	27
Concussion	2	2
Fracture	2	2
Dislocation	8	9

Tab. 5

Discipline - Race boarding - national level		
Type of injury	Number of injuries	Percent of injuries
Laceration	22	47
Strain, overstrain	8	17
Sprain	3	6
Contusion	7	15
Concussion	1	2
Fracture	1	2
Dislocation	5	11

Tab. 6

Discipline - Race boarding - professional level		
Type of injury	Number of injuries	Percent of injuries
Laceration	6	39
Strain, overstrain	3	20
Sprain	1	7
Contusion	4	27
Concussion	0	0
Fracture	0	0
Dislocation	1	7

Significant contribution to the high incidence of injuries also contributed poor physical and technical preparedness. After carrying out all research observations, returned questionnaires were evaluated by comparative method and found the number and type of injury in windsurfing. Three groups differed by discipline and levels of physical and technical preparedness. In group A there were registered 92 injuries, in group B 47 and only 15 injuries in group C. Percentage of individual types and location of injury is presented in tables 1-6.

Injury rate represents the number of injuries per athlete per year. The following values were found: 2.63/athlete/year in group A, 1.04/athlete/year in group B and 0.63/athlete/year in group C. The frequency of various injuries, their type and location are given in tables 1-6.

Conclusions

It was proofed that complex readiness for sport performance is an important prerequisite for prevention against injuries. In group of professional windsurfers was found a significant relationship between sports performance and regeneration. This was also confirmed by comparison between professional and national level, in both groups the upper body injuries mostly appeared. On the other hand, funboarding is more risky discipline which brings more injuries (very high amount of injuries – 92), especially in lower parts of the body (injury rate is quite high – 2.63/athlete/year). Regarding type of injury, the most common injury is laceration and contusion.

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EFFECT OF DIETARY NITRATE SUPPLEMENTATION ON PLASMA NITRATE/NITRITE IN PHYSICALLY ACTIVE MEN

Lucia Štulrajterová, Pavel Stejskal
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Beetroot juice (BJ) has been reported to improve certain aspects of exercise performance, which may be linked to increased nitric oxide, which blood levels are connected with plasma nitrates and nitrites. The aim of this study was to investigate the effect of dietary nitrate supplementation by BJ on plasma nitrate/nitrite.

In two separate experiments, eighteen healthy males, who were active in sporting activities, volunteered to participate in this study. BJ supplementation or placebo (PL) were taken 6 days in a row. Blood samples were taken in 4^{th}, 5^{th}, and 6^{th} day, 2 hours after (first experiment) or 4 hours (second experiment) BJ or PL consumption. Blood samples were drawn from vena cubiti, after a five-minute rest in the half-sitting position into S-Monovette lithium heparin tubes (2.7 ml). Plasma samples were separated in a cooled centrifuge. Nitrate and nitric plasma levels were determined by a commercially available nitrate/nitrite colorimetric assay kit (Cayman Chemical) in samples stored at -80°C.

Levels of plasma nitrates were in all experimental situations (4^{th} – 6^{th} day) and in all measured subjects higher after BJ supplementation in comparison to PL ($p = 0.0007$ - 0.00002). On the other side, plasma nitrites have not changed significantly after BJ consumption. 5^{th} and 6^{th} day of BJ supplementation 2 hours before testing, average of plasma nitrites and plasma nitrites were lower in most of subjects in comparison to PL. BJ supplementation 4 hours before testing showed increase of plasma nitrites in all experimental situations and in most of subjects. However difference was not significant in all measured days ($p = 0.670$; 0.145; 0.056).

Our data indicates that ingestion of BJ significantly increased plasma nitrates, but plasma nitrites have not been influenced significantly. Certain differences have been ascertained depending on time consumption. The authors discuss the possible causes of these results.

Keywords: *Nitrate supplementation, plasma nitrates, plasma nitrites, beetroot juice*

Introduction

Nitric oxide (NO), as ubiquitous physiological signalling molecule, is generated through the oxidation of L-arginine in a reaction catalysed by a family of NO synthase (NOS) enzymes, resulting in the endogenous production of nitrate and nitrite. Now, it is known that nitrate and nitrite can be also reduced back to NO *in vivo*. This fact was identified as alternative pathway that may complement the L-arginine–NOS–NO pathway by enabling NO production in conditions of low oxygen availability in which NOS activity may be reduced (Lundberg, Weitzberg et al. 2008).

Levels of nitrate and nitrite in the human body may be also increased exogenously through the diet, particularly through the consumption of green leafy vegetables and beetroot (Bryan 2006). Ingested inorganic nitrate circulates in the plasma, and about 25 % is taken up by the salivary glands and concentrated in the saliva (Spiegelhalder, Eisenbrand et al. 1976). Facultative anaerobic bacteria on the tongue surface reduce nitrate to nitrite (Duncan, Dougall et al. 1995). Some of the swallowed nitrite is reduced to NO in the acidic environment of the stomach. Substantial amount of nitrite enters the systemic circulation, elevating the plasma nitrite concentration (Lundberg and Govoni 2004). After nitrate ingestion, plasma nitrate concentration peak is after 1–2 h (Winyard, Jeukendrup et al. 2014) and plasma nitrite peaks after 2–3 h. After this, both gradually fall, arriving back at baseline values after about 24 h (Webb, Patel et al. 2008). The conditions of low oxygen availability and low pH facilitate this process (Modin, Björne et al. 2001), enabling NO to be produced where it is most required. These conditions (low partial pressure oxygen and pH) may also exist in skeletal muscle during exercise.

Several-day of dietary supplementation with pharmacological sodium nitrate reduced the pulmonary oxygen uptake (VO_2) of submaximal cycling at work rates in 45 – 80 % of maximum VO_2 (Larsen, Weitzberg et al. 2007). That this effect occurred without any increase in estimated no oxidative energy production (as reflected by an unchanged blood lactate) suggested that sodium nitrate ingestion improved the efficiency of muscle oxidative metabolism.

Nitrate supplementation also reduced VO_2 during moderate exercise. The reduced VO_2 of exercise appears to be because of a reduced ATP cost of muscle force production. With nitrate supplementation, the gain of the increase in VO_2 following the onset of moderate exercise was reduced by 20 %. During severe exercise, the VO_2 slow component was reduced, and the time-to-exhaustion was extended. The reduced muscle metabolic perturbation allowed high-intensity exercise to be tolerated for a greater period of time (Bailey, Winyard et al. 2009; Bailey, Fulford et al. 2010).

We can say that enhancing NO bioavailability by the nitrate–nitrite–NO pathway may influence muscle function and exercise performance. NO can influence skeletal

muscle function through its role in the regulation of blood flow, contractility, glucose and calcium homeostasis, and mitochondrial respiration and biogenesis (Stamler and Meissner 2001). Several studies have reported that plasma nitrite is positively associated with exercise capacity in humans (Dreißigacker, Wendt et al. 2010; Totzeck, Hendgen-Cotta et al. 2012). These findings raise the possibility that augmenting plasma nitrite through dietary nitrate supplementation might have ergogenic effects.

Nitrate may also have positive effect on cardiovascular health in the general population due to reductions in blood pressure (Cosby, Partovi et al. 2003; Webb, Patel et al. 2008), during exercise in hypoxia (Masschelein, Van Thienen et al. 2012), in some diseases (Kenjale, Ham et al. 2011) and also in older populations (Presley, Morgan et al. 2011). Nitrate supplementation may act as preventative medicines for cardiovascular diseases or any disease characterized by an insufficiency in NO or conditions whereby enzymatic NO production from NOS is insufficient. Optimal diet may then consist of a sufficient supply of nitrite and nitrate for health and disease prevention.

Nitrites in tissues increase with plasma concentrations but very quickly return to baseline concentrations. During periods of fasting or low nitrite intake, NOS become more active to maintain NO production as well as a sufficient pool of nitrite. But only when L-arginine and other cofactors are available (Bryan 2006). When there is lack of NOS due to depletion of L-arginine or oxidation of cofactors in combination with a poor diet low in nitrate, system can´t maintain homeostasis and disease appear. It is possible that the tissues rely on their own production and metabolism and only draw upon the plasma reservoir in times of distress such as oxidative stress (Bryan 2006). Therefore nitrite becomes an important regulatory molecule in physiology and may serve as a potential rescue molecule under conditions of insufficient NO as a result of impaired NOS activity.

The aim of this study was to determine whether the repeated supplementation of a beetroot juice concentrate would significantly increase the plasma nitrates and nitrites levels in young healthy subjects.

Methods

The experiment, which has not been launched in Czech Republic yet and the main objective was to evaluate the effect of dietary nitrate supplementation on the activity of the autonomic nervous system and VO_2 in moderate and high intensity exercise, was proceeded in two periods; in the first, the interval between supplementation intake or placebo and test was 1.5 to 2hours, 4 hours in the second.

The randomized double-blind placebo-controlled crossover study was realized in Faculty of Sport Studies in Masaryk University, Brno and biochemical laboratories

of BioVendor - Laboratory Medicine Brno. Available laboratory equipment of faculty covered the requirements of research.

Subjects consume beetroot juice and placebo. Supplementation and placebo were products of the James White Drinks Ltd (White's Fruit Farm, Helmingham Road, Ashbocking, Suffolk, UK) in collaboration with the University of Exeter (Prof. Ben Benjamin). Both institutions have research experience in the field of nitrate supplementation, and their results are published on a public website James White Drinks. Beet It Sport Shot was used as supplementation. It contains 0.4 grams of dietary nitrate and administered in 70 ml dose, 6.45 mmol. Amount of nitrates corresponded to dose used in similar experiments. Placebo was prepared at the University of Exeter by process in which the beetroot juice was depleted in nitrates. The amount of remaining nitrate was approximately 0.003 mmol for the aim to preserve sensory properties of beetroot. Supplementation and placebo were administered in the same bottles (different expiry date) to maintain conditions of double-blind study. The subjects were taking beetroot supplementation in one of the two cycles of the research and then placebo (random selection), for six days, and either of 1.5 - 2 hours (first period) or 4 hours prior to the first testing. The individual cycles were separated by 15 day "wash-out" testing phase. Each subject attended both supplementation periods.

The subject of research in the first period was 10 men (21-41y., 75-94kg), in the second 8 men (21-23., 62-100 kg). They were healthy, with no subjective complaints, without contraindications and medical indications excluding consumption of nitrates, non-smokers who are not taking any sports supplements.

In four weeks, subjects attend 8 laboratory visits. During the first visit to the laboratory, subjects performed a ramp incremental exercise test for determination of the peak V_{O2} (V_{O2} peak), respiratory threshold (RP) and load determination. On the 4th day of supplementation or placebo ingestion, subjects completed two bouts of sub-maximal cycling (80% RP), while on days 5 and 6 the subjects completed one bout of sub-maximal cycling and one bout of maximal cycling (70% of the difference between the load at RP and V_{O2} peak). The two bouts of exercise on each day were separated by 25 min of passive recovery. All exercise bouts were of 6-min duration, with the exception of the severe exercise bout on the final day, which was continued until task failure as a measure of exercise tolerance. The time to task failure was recorded when the pedal rate fell by ± 10 rpm below the self-selected pedal rate. In these bouts, the subjects were verbally encouraged to continue for as long as possible. Each test started by 2 minutes of pedalling at a load of 20 W (warm-up). Before each exercise bout spectral analysis of heart rate variability (SAHRV) was measured, BP and venous blood samples were collected.

The results could be affected by taking more dietary nitrates from food or food supplements in sports. Therefore it was essential that subjects had modified diet

containing less nitrate and no sport supplements. Everyone got recommended diet with the nutritional requirements. Daily diet was registered by subjects. At the same time they had to strictly avoid heavy exercise day before testing (limitation of physical activity). The subjects were aware about the possible side effects of supplementation (gastric discomfort, decreases in blood pressure). All subjects were fully familiar with laboratory exercise testing procedures. The protocol was approved by the Ethics Committee of Faculty of Sports Studies in Brno, Czech Republic.

Participation in research required more restrictions during all the supplements days (immediately before and after ingestion supplementation without use of toothpaste, mouthwash and mouth spray, ingestion of supplementation at about the same time, diet without taking any sport supplements, reduction of nitrates intake) and other restrictions related to testing (optimizing hydration prior to the examination, 24 hours prior to testing without exhausting physical activity, alcohol free, six hours before testing without drinking coffee). The personal data were used solely for research purposes without publishing the name of the subjects. In the processing and execution results are used numerical codes to identify subjects.

Blood pressure was measured and venous blood was collected before the start of the supplements period and thereafter before the exercise tests (8 times). Blood pressure was measured by automatic measurement of blood pressure – Omron, 3 times each day and the measured values were then averaged.

Blood samples were drawn under aseptic precautions from vena cubiti, after a five-minute rest in the half-sitting position into S-Monovette lithium heparin tubes (20 IU heparin/ml blood). Plasma samples were separated in a cooled centrifuge (Siemens, Advia 1650). Nitrate and nitric plasma levels were determined by a commercially available colorimetric assay kit (Cayman Chemical Company, Biotek EL808) in samples stored at -80° C. The assay allows to determine nitrate together with nitrite level, and nitrite levels separately. The limit of detection of the assay was 0.25 μM for the nitrite/nitrate assay and 0.5 μM for the nitrite assay; the intra assay and inter assay coefficients of variation were always less than 5 %.

Differences in the plasma nitrates and nitrites between conditions (supplement vs. placebo) were analysed with two-tailed, paired-samples *t*-tests.

Results

From Table 1 and 2 it is clear that the total value and individual plasma nitrates and nitrites did not differ before the supplementation in the both periods (day 1 of each cycle). After dietary nitrate supplementation, the total value of plasma nitrates and nitrites and separate nitrates values (4th to 6th day in both periods) was significantly higher in all cases than after placebo. Average values of plasma nitrites were also

higher after nitrate supplementation than after placebo, but the difference was not significant in both periods.

Tab. 1 Plasma nitrates (na) and nitrites (ni) (μM) in first period (n = 10). P – placebo, N – dietary nitrate supplementation.

Suppl.	Day	Variable	Average	Standard deviation	Difference	p
P	1	ni + na	7.09	2.01		
N	1	ni + na	8.20	1.99	-1.11	0.283540
P	1	ni	3.63	2.27		
N	1	ni	3.74	3.98	-0.11	0.911235
P	1	na	3.49	2.09		
N	1	na	4.68	2.70	-1.19	0.204163
P	4	ni + na	6.27	2.32		
N	4	ni + na	46.57	6.24	-40.31	*0.000000
P	4	ni	2.49	1.72		
N	4	ni	5.50	6.85	-3.01	0.170005
P	4	na	3.88	2.62		
N	4	na	41.07	8.88	-37.20	*0.000000
P	5	ni + na	9.52	8.97		
N	5	ni + na	40.61	9.95	-31.09	*0.000006
P	5	ni	2.77	1.58		
N	5	ni	3.60	2.43	-0.83	0.067082
P	5	na	6.06	9.78		
N	5	na	37.84	10.64	-31.78	*0.000005
P	6	ni + na	6.96	3.57		
N	6	ni + na	39.83	9.04	-32.86	*0.000002
P	6	ni	3.76	4.04		
N	6	ni	3.90	5.60	-0.14	0.940380
P	6	na	3.62	2.65		
N	6	na	36.06	10.14	-32.44	*0.000001

Tab. 2 Plasma nitrates (na) and nitrites (ni) (μM) in second period (n = 8). P – placebo, N – dietary nitrate supplementation.

Suppl.	Day	Variable	Average	Standard deviation	Difference	p
P	1	ni + na	7.21	6.16		
N	1	ni + na	5.99	2.54	1.22	0.571748
P	1	ni	2.83	3.16		
N	1	ni	2.24	2.12	0.59	0.670487
P	1	na	4.38	6.59		
N	1	na	3.75	1.77	0.63	0.757987
P	4	ni + na	6.34	1.71		
N	4	ni + na	30.01	8.81	-23.67	*0.000104
P	4	ni	1.95	0.86		
N	4	ni	4.57	4.73	-2.62	0.144755
P	4	na	4.39	1.69		
N	4	na	25.44	10.14	-21.05	*0.000671
P	5	ni + na	5.42	1.61		
N	5	ni + na	28.46	6.15	-23.04	*0.000023
P	5	ni	1.70	0.86		
N	5	ni	2.04	1.61	-0.34	0.635892
P	5	na	3.81	1.20		
N	5	na	26.42	6.83	-22.62	*0.000053
P	6	ni + na	4.90	1.75		
N	6	ni + na	30.84	8.02	-25.94	*0.000021
P	6	ni	0.98	0.51		
N	6	ni	2.19	1.77	-1.20	0.056179
P	6	na	3.92	2.08		
N	6	na	28.66	8.95	-24.74	*0.000059

Discussion

While the total value of plasma nitrates and nitrites were after supplement ingestion significantly higher than placebo, in nitrites individually, significance of difference was not confirmed. In 30% of subjects were nitrites values after supplement usage even lower than with placebo. The cause of this result may lie in the methodology for determination of these substances in plasma. In our case we used Colorimetric Assay Kit (Item No. 78001) available from Cayman Chemical Company. When evaluating the results of the determination of nitrite we use a calibration range from 0 uM to 35uM. Most of the samples were located in the lower part of the curve between points 0uM to 5M. The manufacturer declares a detection limit of nitrites at about 2 uM, which may cause the difference between the actual and measured concentrations of samples whose value was less than 2 uM. In subjects with a paradoxical decrease in nitrite after administration supplement was 86% below the value of specified threshold sensitivity. In the publications, where not only to a significant increase of nitrates, but also nitrite was detected (Fulford, Winyard, et al. 2013), they used for determination chemiluminescence and levels of nitrites are given in nM (Bateman, Ellis et al., 2002) and under detection limit specified by the manufacturer we used colorimetric kit.

Several critical reports and comprehensive reviews reporting weak associations and equivocal evidence of nitrite human health safety have fostered concerns and debate among scientists, regulators, press, consumer groups, and consumers. Despite periodic controversy regarding human health concerns from nitrite consumption, a building base of scientific evidence about nitrate and nitrite in humans has and continues to affirm the general safety of nitrate and nitrite in human health (Sindelar and Milkowski 2012). While the acute toxicity of nitrate is very low or absent, any confusion leading to a large unintentional intake of nitrite or organic nitrates and nitrites is potentially life threatening (Lundberg, Larsen et al. 2011). In contrast, with natural sources of nitrate as whole vegetables or vegetable juices, risk doesn't exist.

Although it is known that the level of nitrite in plasma varies depending on the administered supplement dose, we decided from the above mentioned health and ethical reasons, to use of commercially available, relatively low dose of nitrates in supplement. This procedure could be another reason why all measurements were made only to an insignificant increase in plasma nitrite. An interesting conclusion was reached by Winyard, et al. (Winyard, Jeukendrup et al. 2014), who investigated the effect of nitrate supplementation on physiological response during exercise moderate and high intensity. The lowest dose (70 ml containing 4.2 mmol nitrate) significantly doesn't reduces VO_2 during physical work of moderate intensity and did not increase exercise tolerance of high intensity. Several times higher doses (140 and 280 ml, containing 8.4 and 16.8 mmol nitrate) were effective. Because the dose of nitrates

in supplement approached dose of cited authors, we cannot exclude that in some individuals is a subsequent increase of plasma nitrites relatively small and will not affect the efficiency of muscle work.

Under the conditions mentioned above (a relatively small dose of the nitrate supplementation and nitrate less sensitive method for the plasma nitrites analysis) it is probably better to use for the evaluation of the effects of supplementation, not nitrite levels, but the overall levels of nitrates and nitrites in the plasma.

Conclusion

Inorganic dietary nitrates and endogenous nitrates are substrates from which is forming NO *in vivo*. Besides the undeniably positive effects on health, including nepotism against some mass non-infectious diseases, the diet rich in nitrates can affect efficiency of muscle work. However, it seems that the ingestion of relatively small doses of nitrate supplements may not work for some people to effectively increase blood plasma nitrites. In further research will be necessary to pay attention to both causes - relatively large variability in the conversion of nitrate to nitrite in blood plasma and also the relationship between the dose of dietary nitrate and their effects on human health and to increase the efficiency of muscular work.

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RELATION BETWEEN SEXUAL ACTIVITY, SEXUAL BEHAVIOR AND SPORT PERFORMANCE

Petr Vajda
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Sexual abstinence before exercise is ingrained. Present knowledge in these fields is inconsistent. This paper aims is to relate combat sport performance and sexual activity. The main goal is to describe the subjective perception of the impact of sexual activity on the sport performance and potential changes in sexual behaviour associated with increased training and competition loads at combative sports athletes and describe the sexual behaviour the athletes have in combative sports. Data was collected through anonymous questionnaires from 67 athletes actively competing in combative sports over 18 years old and older. Competitive level of the athlete covers all levels including regional to national team. The result shows that the frequency modification of sexual habits before and during competitions at the period when the burden rises to a competitive level. Frequently mentioned changes in sexual activity before the competition, was reduced frequency of sexual activity or abstinence. In the research the athletes indicated that in a 47% they feel some changes during the sports performance connected to sexual activity and an 83% perceive changes in the psychological component of their performance. In the psychological component are changes in most cases positive, but in the opposite in physical component are changes more negative. The group of athletes which were part of the research exhibited an increasing appetite for sexual activity and numerous of sexual partners than the average population in Czech Republic. In light of the results it can be presumed that there is some influence of sexual activity or abstinence on combative sports athletes' performance, even though some research shows the opposite opinion. The knowledge of this influence is incomplete and needs another review. Mainly in research effect of sexual abstinence on sport performance.

Keywords: *Athletic performance, sexual abstinence, habits, questionnaires, athletes, effect*

Introduction

The knowledge of this topic has long time disagree with the practices of athletes. In combat sports, the strongly established abstinence before a sport activity is definitely not a recent trend. Already in the first century Greek physician Dr. Aretaeus asserted that male power can be increased with the retention of semen and even today it is

possible with this assertion meet with prominent trainers (Bishop, 2012). The actual scientific knowledge varies. Studies show that sexual activity has minimal or no effect on athletic performance. Johnson (1967) conducted a research on the maximum power output, from which it emerged that coitus night before a sport activity does not affect the maximum strength. Likewise, it was shown that sexual activity 12 hours before the sport activity does not affect the aerobic performance (Boone & Gilmore, 1995). Two hours after sexual activity, showed a minor difference in the heart rate increased on a cyclo-ergometer, however these symptoms disappeared 10 hours after sexual activity, which disproved the possibility of influencing the performance of sexual activity with sufficient recovery time. Sexual activity at the same time did not influence psychical concentration (Sztajzel, Periat, Marti, & Rutishauser, 2000). The studies until 2000 is integrally summarizes in the work of Shrier and McGlone (2000). They argue that the information is insufficient and the effect may be highly individual, at the same time they draw attention to the hypothesis that sexual frustration can be transformed into aggression that support the performance. The opinions of many coaches that supports this study, which claims that the dangerous behavior during the performance could be the behavior often associated with sexual activity (nighttime activities, lack of sleep, alcohol) (Anshel, 1981). Sexual activity affects the organism calming effect, reduces stress and suppresses aggression (SayfollahPour, Heidary, & Mousavi, 2003). Is true that this may become a negative factor in combat sports, where there is often required a considerable degree of aggressiveness. This is confirmed by Maria Cristina Rodriguez Gutierrez from the National Autonomous University of Mexico, which claims that in martial arts sexual activity can lead to passivity and reduction of aggression (Nieto, 2012). There are also studies showing elevated levels of testosterone during sexual abstinence (Jiang, Xin, Zou, & Shen, 2003; Krüger, et al., 2003) (Exton, et al., 2001). Testosterone influences the anabolic processes of muscle growth, strength and also is an important determinant of aggressiveness. This information may lead to a hypothesis of the improvement on the performance in combat sports during abstinence due to elevated levels of testosterone. Is interesting that, sexual activity increases testosterone levels, but not increased it chronically, after the sexual activity the level of testosterone gradually returns to normal (Dabbs Jr. & Mohammed, 1992). Also the questionnaire methods which is use in this work, have already been used. Long distance runners rated their feelings of sexual activity and the effect on its performance. It revealed that there is no effect on their performance 12 hours after sexual activity. In the brief intervals of 30 minutes after the sexual activity was recorded many changes (Pupiš, Raković, Stanković, Kocić, & Savanović, 2010).

If we look at the sexual activity as physical activity is for us essential energy expenditure, which the athlete this way will lose. This could play a relatively important role in the period of increased activity or training before the competition.

Energy output values are relatively low, Frappier, Toupin, Levy, Aubertin-Leheudre a Karelis (2013) they measured normal sexual activity in a men (age 22.6 ± 2.8) energy consumption 101 ± 52 Kcal with the intensity 4.2 ± 1.3 Kcal/min. With feelings of fatigue after sexual activity culminating in orgasm is associated increased levels of prolactin (Krüger, et al., 2003). Is probably the increased secretion of prolactin concerns the control of sexual activity (Krügera, Haakea, Hartmannb, Schedlowskia, & Extona, 2002). Increased secretion of prolactin after orgasm also reduces levels of dopamine (Robinson, 2004). In terms of performance in combat sports is an interesting fact that prolactin has a negative effect on testosterone levels (Weiss, et al., 2010, p. 88). In terms of current sports performance with physical stress comes to the increased levels of prolactin, but its effects on the efficiency of movement and performance are not described (Kenney, Wilmore, & Costill, 2012, p. 99). The study of judo athletes pointed a possible link between prolactin and performance in judo. The winners showed a lower level than losers (Suay, et al., 1999). Sexual activity and orgasm is associated primarily oxytocin secretion (Krüger, et al., 2003). It is often referred to as hormone "happiness" or "love". Overall leads to calm, credulity and reduces aggression. There are also links between oxytocin and improve therapeutic functions within the body (Magon & Kalra, 2011). The rate of secretion in sports load nor the impact in performance is not known (Kenney, Wilmore, & Costill, 2012, p. 99). Generally oxytocin can induce a feeling of sleep

In sexual behavior, we can assume that martial athletes may have an advantage when selecting a partner which does not seek long-term partnerships. In general we can say that an important role is played by the characters associated with testosterone and indicators of good immunity. For short-term sexual strategies in women are also important behavioral characteristics (bravery, strength, courage, honor, competition, creative properties etc.). There we can also include sexual aggression in milder forms (assertiveness, urgency). It will probably be carried over to their children, and can be thus to assured a better durability to transferred genes (Weiss, et al., 2010, pp. 657-658). Even successful athletes can play a role in it. Research conducted on elite cyclists pointed out the connection between success in the Tour de France and physical attractiveness (Postma, 2014). Among the students were observed differences in sexual activity between a group of athletes and non-athletes people. It was higher in athletes (Wetherill & Fromme, 2007; Habel, Dittus, De Rosa, Chung, & Kerndt, 2001).

Methods

For the realization of my research, was ensured the anonymity of the respondents in a selected method questionnaire. The used anonymous questionnaire is divided into two parts. First part consist of 19 open and close questions where we ask their

subjective perception on the impact of sexual activity and potential changes in the sexual behavior during an increase of the training and competition loads. The second part of the questionnaire is made up to 41 opened, closed questions, and it issues a scale related to the sexual behavior in combat athletes. The research sample includes 67 actively of competing martial arts athletes from 18 years and older. The respondents were represented from various levels of competition. In total 67% of the respondents competed at the national level and above, 23% of the then at the international level. In terms of age distribution were represented by athletes ranging between 18-61 years. Average age after is 25.9 years, mostly represented then by 24 years old (SD = 5.2). In terms of experience, competitive sport, the respondents were asked about the duration of performance in the sport. The average length of performance in the chosen sport is 8.1 years.

Results

Regardless of whether they perceive changes in their performance in connection with sexual activity, 34% of the respondents adjust their sexual habits in this period. While 30% of these respondents do not feel any corresponding changes to their sporting performance in relation to their sexual activity. An interesting result is that 80% of the respondents, who regulate their sexual activity, were competing at national and higher level, where you can assume significantly higher performance requirements. In questions regarding physical sport performance showed that a 47% of the respondents feel some effects. A selected group of respondents 20% perceive positive or rather positive changes. Only 14% were perceived negative or rather negative changes. A 14%, of respondents were not able to determine what if changes in terms were felt or not differently. It turned out that 36% of surveyed athletes perceive changes in the strength. As a negative perception of these influences extents to a 24% of the respondents as positive only 7%. Changes in endurance were perceived by 36%, the number of negative responses was the same as in the power output. Changes in the coordination and sensorimotor ability were perceived by a 29% of the respondents with no significant trend in the type of responses.

Referring to the theoretical knowledge about endocrine secretion during sexual activity presented in this work, I believe that the psychological factors in the sport performance, sexual activity has probably the most pronounced effect. The results identify with this assumption, since the athletes perceive changes in its mental component performance in an 83%. More than half (54%) of the respondents, thus correspond to perceive these changes as “positive” or “somewhat positive”. Negative responses indicated only 15% of the respondents. For motivation, selected athletes assess the impact of sexual activity on their own motivation to sports performance as

positive in a 46% and only a 14% as negative. At the level of before starting stress perceived some changes the 69% of the respondents. Subjectively these changes were evaluated by a selected group of athletes a 41% with varying degrees of positive and only a 7% choose a negative response. I believe, however, that the rate of the before starting stress is influenced by endocrine primarily oxytocin. This would suggest these results. Generally orgasm is related to the overall soothing. The results show that athletes in the selected group usually have sexual activity immediately before exercise, in order to reduce the level of the before starting stress. On the issue of feeling fatigue after sexual activity 58% of the respondents show pronounced fatigue and 20% of the respondents this fatigue usually leads to sleep.

In the research on sexual behavior appeared anticipated trend that martial athletes are sexually active and feel a greater sexual appetite than the average Czech men. All 67 respondents said they had sexual intercourse with a woman. Average researched athletes started having sex at 17 (SD = 1.96) years. Therefore, before the average man in the Czech Rep. in 2008 (17.85 years) (VFN, 2009). Combative sport athletes' investigation carried out that the first intercourse with a casual partner was a 48%, which is only a slightly smaller half. The statutory limit for the first intercourse of 15 years was violated by a 6% of the respondents. The average of the interviewed athletes had sex with 10.6 partners during his lifetime. The average Czech man denounced in 2008 only 9.4 partners. There must also be mention the low average age of the study sample, which is certainly lower than that of a representative sample of the Czech population. The average frequency of sexual intercourse with their partners was 11 (SD = 8.09) in the month. The average Czech man has an average frequency of intercourse about 2 times a week (VFN, 2009). Athletes file masturbate 15.3 (SD = 12.33) times per month. This value is more than double the average of the Czech population in 2008 (7.1 times per month) (VFN, 2009). The 61% of the respondents' uses masturbation pictorial pornography frequently, then sometimes a 31%. The average frequency of sexual discharge (intercourse, masturbation, etc.), 19 (SD = 12.5) times per month. Are about two times more than the average Czech men (Game & Weiss, 2001 p. 53). None interviewed athlete is considered to be gay and each one of them is sure. An interesting result, however, is the representation of bisexuals. Interviewees' respondents indicated this orientation in a 12%. The very concept of bisexual orientation is not yet well defined (Beňová, et al., 2007, p. 11).

Discussion

The problematics in the relation between sexual activity and sports performance affects the absolute majority of athletes. We live in a time of great commercialization of sport, where science is dealing with different variables that enter or affect the

movement during the performance. Nevertheless, I am forced to conclude that the evidence in this matter is inaccurate and incomplete. Measurements referred to this work since 1967 has repeatedly refuted the influence of sexual activity on the performance of the movement. These findings are contrary to the views of a large part of sports. It is often believed that these effects exist. This belief is often applied in practice. Research findings from other disciplines than kinantropology can support the possibility of a significant impact of sexual activity on the sport performance. The results of this study pointed to the fact that the athletes perceive the influences of the sexual activity in their performance, and regulate their sexual activities in connection with the preparation of a competition or the competition itself. Due to the chosen research methods, the respondents were asked about the impact of sexual activity on their aggressiveness as the rate of their own aggression is subjectively difficult-expressible. However, just in aggressiveness it assumes strong influence on sexual abstinence and an elevated level of testosterone. The psychological component performance, where athletes perceived influences of sexual activities are the most current research very incomplete. Bearing in mind that the nature of martial arts whose competitive activity, compiled from non-standard physical activities, which is constantly changing depending on the circumstances (Kurz, 2001, p. 23), assume that the effects of the psyche of an athlete may be significantly reflected in his performance.

The sexual behavior confirmed the link between sport and sexual activity known from research already undertaken see Wetherill & Fromme (2007) and Habel, Dittus, De Rosa, Chung, & Kerndt (2001). The interviewed athletes showed an increased sexual activity, number of sexual partners and a desire. There may also be a link between testosterone levels, attractiveness and sexual activity. With the increasing attractiveness naturally increases the possibility of access to a sexual partner. At the same time, the increased of sexual desire lead to earlier expressions of frustration during abstinence.

Conclusions

Previous studies have engaged the acute influence of in sexual activity on the sport performance, but the results are measured before and after abstinence. Studies show that during the abstinence there is an increases testosterone level. Its level by its nature does not affect the actual sport performance. From the viewpoint of long term increased of testosterone level, there may be an increased anabolic processes and an increase of overall strength. Furthermore, its level can affect the athlete's level of aggression, which can be a decisive factor in combat sports. However, coherent results confirm those indications have not yet been published. There is a large scope for further research which will be approached this issue in a new way and focus more

on the impact of sexual abstinence, rather than the influence of sexual activities on sports performance.

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SPORT TRAINING

THE ANALYSIS OF 100 M HURDLES COMPETITIVE ACTIVITY

Vesna Babić, Darko Katović, Andrea Ivančević
Faculty of Kinesiology, University of Zagreb, Croatia

Abstract

The purpose of this research was investigation of 100 m hurdles running event. The main aim was to analyze dynamics of running speed in the 100 m hurdles event. The research was carried out on 13 variables overall; 10 time parameters' variables which included split times at each hurdle and athletes' final running time, athletes' latent reaction time and their age. The basic descriptive statistics and descriptive analysis of individual changes were obtained. In this study, the different examples of competitive activity structure, which differs depending on results' achievements, are shown. The more the results' achievements are closer by its final running results; the dynamics of track running is more similar. Displayed examples may clearly indicate running details, regarding the successful realization of movements' structure patterns, which make for the better placement in athletes' running times. The obtained results indicate that the most successful, that is, the fastest athlete, was the one who incrementally increased running speed until fourth or fifth hurdle and successfully maintained that speed for as long as possible. For all athletes, the deceleration phase was after eight hurdle. Latent reaction time as well as running time at first and second hurdle are integral to start acceleration and are important for establishing good running rhythm.

Keywords: *competitive activity, 100 m hurdles, dynamic of running*

Introduction

Track event 100 m hurdles is very attractive event in competition and is comprised of sprint running over ten hurdles. One of the main prerequisites for achieving top level result in this event is to master the technique of running fast over the hurdles. The main aim of hurdles' running is to achieve running economy with minimum speed lost. For top level results in this event it is necessary to exhibit high level of technique, coordination, rhythm, speed, balance, flexibility and strength.

The present female 100 m hurdles world record holder is Yordanka Donkova (BUL) with 12.21 s ran in 1988. In Croatia the national record is 12.87 s set by Andrea Ivančević in 2015.

Efficacy and quality of competitive activity in 100 m hurdles event is determined by steady running rhythm in between hurdles, speed of running over the hurdles, rational technique of running over all the hurdles in the race, specific sprinters' endurance and ability to achieve and maintain maximum speed in the sprint race. In available research studies the authors have mostly investigated specific segments and elements of technique of hurdles' running (Ecker, 1977; McDonald and Dapena, 1991; Winckler, 1994; Čoh and Dolenc, 1996; Čoh, Kastelic and Pintarič, 1997; Kampmiller, Slamka, Vanderka, 1999; Gonzales, Mallo, Veiga and Navarro, 2008; Iskra and Čoh, 2012.)

Not so many authors have investigated the running dynamics of 100 m hurdles event. The running dynamics should be investigated in competition conditions which is not simple at all and that could be one of the reasons for the lack of research in this area. The hurdles' events might also be difficult to investigate because of their structure and specificities. Up until nowadays, data from biomechanical research studies of specific track events published in the scientific research projects of IAAF (1998, 1997, 2009, and 2011) showed the importance of stable pattern of competitive activity, especially during achievement of the best results. This research study will utilize the same data to carry out the competitive activity analysis.

The aim of this study is to analyze the competitive activity through the dynamics of running speed of elite female athletes in 100 m hurdles event at the most important athletic competitions of first category; namely: Olympic Games in Seoul (1988), World Championships in Athens (1997), Berlin (2009) and Daegu (2011). Also, the results in 100 m hurdles race from the most successful heptathlon athletes from World Championship in Berlin (2009) will be included in analyses too.

These results will serve to:

1. Obtain basic descriptive parameters
2. Establish individual differences in 100 m hurdles running dynamics

Methods

Participants

The participants' sample is deliberate and representative. It is comprised of 15 female athletes (average age is 27.8 years) who managed to qualify for 100 m hurdles finals as well as to achieve top three placements in the finals of the most important athletic competitions: Olympic Games in Seoul (1988), World Championships in Athens (1997), Berlin (2009) and Daegu (2011). The most successful heptathlon

athletes from World Championship in Berlin (2009) are part of participants' sample as well.

Variables Sample

The sample of variables in this study is comprised of 13 variables. The instruments for estimation of running dynamics are defined by 10 time parameters' variables which include split times at each hurdle during 100 m hurdles race (T1 to T10). Three remaining variables of interest are: athletes' final running time (Result), athletes' latent reaction time (RT) and their age (DOB).

Data used in this study were obtained from official IAAF publications (International Association of Athletics Federations) (Brüggemann, Glad, 1988. and Brüggemann, Koszevski, Müller, 1997.) and from results published at the IAAF website (Hommel et al., 2009; Young-Sang et al., 2011).

Statistical analysis

Descriptive statistics: mean (AS), standard deviation (SD), minimal (MIN) and maximal (MAX) result, range (RR) and variability coefficient (VAR) were calculated from the obtained data.

The analysis of changes in 100 m hurdles running dynamics was obtained by descriptive analysis of individual changes using dynamics indicators with changeable basis. The individual changes' dynamics' indicators with changeable basis reflect the change in participant's condition at specific time point regarding the condition at previous time point.

Results and Discussion

Tab. 1 Descriptive parameters of running dynamics' indicators in 100 m hurdles race finals for medal winners from Olympic Games in Seoul (1988), World Championships in Athens (1997), Berlin (2009), Daegu (1011), as well as for the most successful female heptathlon athletes from World Championship in Berlin (2009).

Variables						
	AS	MIN	MAX	RR	SD	VAR
DOB	27.80	23.00	35.00	12.00	3.90	14.01
RT	0.151	0.126	0.178	0.052	0.017	11.10
T1	2.60	2.52	2.74	0.22	0.06	2.43
T2	3.61	3.52	3.84	0.32	0.09	2.61
T3	4.62	4.49	4.91	0.42	0.12	2.54
T4	5.60	5.42	5.98	0.56	0.15	2.73
T5	6.58	6.37	7.02	0.65	0.18	2.77
T6	7.56	7.31	8.06	0.75	0.21	2.83
T7	8.54	8.27	9.13	0.86	0.25	2.88
T8	9.53	9.22	10.19	0.97	0.28	2.92
T9	10.54	10.21	11.26	1.05	0.31	2.96
T10	11.56	11.20	12.33	1.13	0.34	2.93
Result	12.68	12.28	13.50	1.22	3.90	2.88

Descriptive parameters' analysis (Table 1) shows that the average result (Result) of elite athletes, medal winners, in 100 m hurdles event was 12.68 s whereas the range of results is from 12.28 (MIN) to 13.50 (MAX). The average age of participants is 27.8 years; the range is from minimal 23 to maximal 35 years. The age range of participants at Olympic Games in Seoul 1988 was from 24 to 27 years, whereas at World Championship in Athens the age range was from 27 to 33 years, and at the World Championship in Berlin 2009, the age range of participants was from 27 to 35 years. These data may indicate that, over time, the female athletes have been staying longer in elite competitive sport.

The average reaction time of participants was 0.151 s; the reaction time range was from 0.126 to 0.178 s. The dispersion parameters' analysis showed how reaction time is an important segment of sprint race and how little the average deviation from the mean is (SD=0.017 s) compared to other parameters of competitive activity. The importance of reaction time in sprint running has most recently been proved by Babic

and Delalija (2009). In sprint training, significant attention is being given to improving start action, start acceleration and running over the first hurdle.

The data of running dynamics' time parameters showed how the average deviation (SD) from results' mean was very small at first two hurdles and was increasing more towards the end of the race. The same trend was shown in the analysis of total range parameters (RR); the more towards the end of the race, the more noticeable the results' range was and by that, the more obvious difference in achieved running results.

The absolute grade of change (Δy**)** with changeable basis reflects the difference in participants' results at specific time point compared to the result at previous time point. Results' analysis in Table 2 shows how Yordanka Donkova had the most even running rhythm in between hurdles and managed to sustain the maximal optimal speed for most intervals between hurdles. Other participants did not have bigger changes in running rhythm although, regarding the results achieved, every individual participant exhibited different realization of competitive activity.

Tab. 2 Table of individual changes dynamics' indicators with changeable basis – absolute grade change

	T2	T3	T4	T5	T6	T7	T8	T9	T10
Yordanka Donkova	1.01	0.97	0.98	0.96	0.96	0.96	096	0.97	1.01
Gloria Siebert	0.92	1.10	0.96	0.96	0.96	0.96	1.00	1.00	1.00
Zacziewicz Claudia	0.96	1.07	0.97	0.99	1.00	1.01	0.99	1.01	1.03
Ludmila Engquist	1.00	1.00	0.98	0.94	0.98	0.95	0.97	0.98	1.00
Svetla Dimitrova	1.04	0.98	0.98	0.96	0.97	0.97	0.98	0.98	1.04
Michelle Freeman	1.01	0.99	0.96	0.98	0.97	0.99	1.00	1.02	1.04
Foster-Hylton Brigitte	1.00	0.99	0.97	0.95	0.95	0.97	0.98	0.98	1.01
Lopes-Schliep Priscilla	1.02	1.00	0.99	0.97	0.96	0.97	0.99	0.98	1.02
Ennis-London Delloreen	1.00	0.98	0.96	0.96	0.97	0.97	0.99	1.01	1.02
Sally Pearson	0.99	0.97	0.93	0.95	0.94	0.96	0.95	0.99	0.99
Danielle Carruthers	1.02	0.98	0.98	0.96	0.95	0.96	0.97	0.96	1.01
Dawn Harper	1.00	0.97	0.95	0.95	0.96	0.98	0.98	0.98	1.00
Ennis Jessica	1.05	1.02	1.01	1.01	1.00	1.02	1.02	1.04	1.04
Pickler Diana	1.06	1.06	1.06	1.04	1.06	1.04	1.07	1.09	1.10
Kamila Chudzik	1.10	1.07	1.07	1.04	1.04	1.07	1.06	1.07	1.07

The graphs below show in more details the running dynamics of the medal winners. From the first graph of 100 m hurdles running dynamics' indicators for medal winners at OI in Seoul 1988 (Fig. 1.), it can be seen that the gold medal winner Yordanka Donkova had constant increase of running speed up until fifth hurdle, whereas after fifth hurdle her running speed was maintained until eight hurdle. At the last two hurdles her running speed started to slightly decrease (Table 2). The other two participants exhibited the fastest running speed in interval between the first and second hurdle. The silver medal winner Gloria Siebert was the first to achieve the maximal running speed which was maintained from fourth until seventh hurdle after which her running speed decreased. The stable pattern of competitive activity was not evident for Claudie Zacziewicz whose deviations in running rhythm are noticeable in between every hurdle (Fig. 1, Table 2).

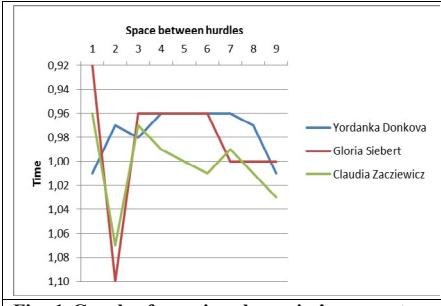

Fig. 1 Graph of running dynamics' parameters in 100 m hurdles race for Olympic Games in Seoul (1988) medal winners

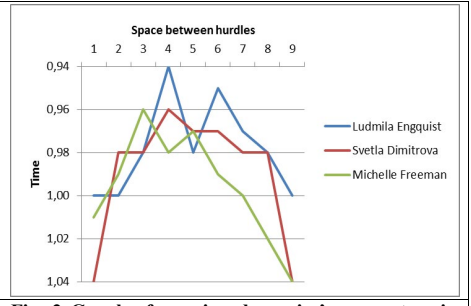

Fig. 2 Graph of running dynamics' parameters in 100 m hurdles race for World Championship in Athens (1997) medal winners

It is to assume that the first published biomechanical analyses (Brüggemann, Glad 1988) which showed that structure of competitive activity had significant influence on understanding of this sprint event also showed the specific structures that are being practiced even today.

At the World Championships in Athens (Brüggemann, Koszevski, Müller, 1997), the gold medal winner Ludmila Engquist was also increasing her running speed until fifth hurdle (Fig. 2). The fastest running speed was achieved in the interval between fourth and fifth hurdle after which her running rhythm was uneven. Her deceleration phase started after seventh hurdle. On another hand, Svetla Dimitrova showed more stable running rhythm and an effort to maintain her running speed until the ninth hurdle. Based on this and regarding that the world's best hurdles' runners are from Bulgaria (Donkova, Zagorčeva, Dimitrova et al.), we may assume that Dimitrova tried to adapt same running pattern as the world record holder (Fig. 1). Bronze medal

winner Michelle Freeman exhibited the greatest running rhythm changes. She was the fastest to attain maximal speed - already in interval between third and fourth hurdle but noticeable speed decreasement from sixth hurdle on, showed the lack of speed endurance.

From the graph of medal winners from World Championship in Berlin (Fig. 3) and from the analysis of running dynamics' time parameters (Table 2), it can be seen that the participants were trained to run the optimal speed and they tried to maintain the optimal running rhythm throughout the race.

Their realization was different according to their present competitive qualities. The differences in their results' achievements were very small (Brigitte Foster-Hylton: 12.51; Priscilla Lopes-Schliep: 12.54 and Delloreen Ennis-London: 12.55). These analyzed parameters are indicators of small differences between different medals. It may be assumed how the ability to focus played the most important part in winning specific medals in this race.

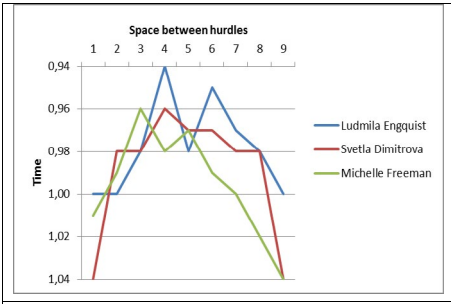

Fig. 3 Graph of running dynamics' parameters in 100 m hurdles race for World Championship in Berlin (2009) medal winners

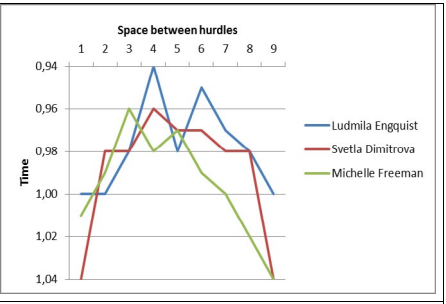

Fig. 4 Graph of running dynamics' parameters in 100 m hurdles race for World Championship in Daegu (2011) medal winners

The analyzed results (Table 2) and graph of running dynamics' parameters in 100 m hurdles race for World Championship in Daegu (2011) medal winners (Fig. 4), showed the result that was close to the world record of Yordanka Donkova (12.21 s). Sally Pearson ran the race in 12.28 s. In that race, the values of time parameters denoting the speed of running the intervals between the hurdles were all under 1 s. Unfortunately, the world record setting race data were not available but we compared the best two results from Daegu (Fig. 5); the one from Sally Paerson (12.28 s) and the one from Yordanka Donkova (12.38 s). The analysis of structure of competitive activity of these two best runners revealed the structure of very stable movements for Yordanka Donkova although her race result was inferior to the one of Sally Paerson. This movements' pattern might indicate how this particular movements' structure

was the same or alike the one during world record setting, although the competitive quality activity was probably increased in the speed of intervals' running. Both of these athletes entered the deceleration phase after the eight hurdle. It can be said that Sally Pearson had greater running speed in this race than Yordanka Donkova but however, she could probably benefit from perfecting optimal running rhythm.

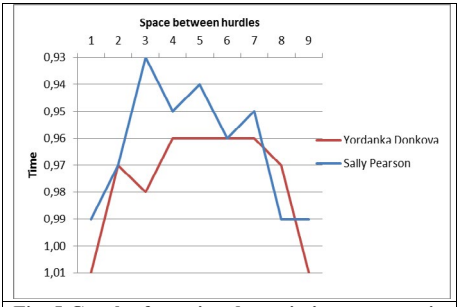

Fig. 5 Graph of running dynamics' parameters in 100 m hurdles race for Sally Paerson (12.28s) and Yordanka Donkova (12.38)

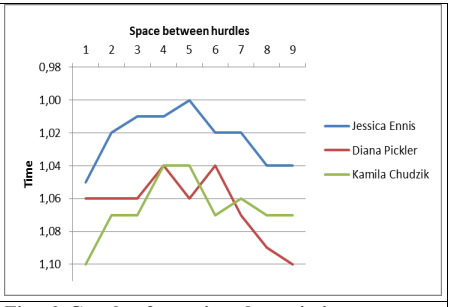

Fig. 6 Graph of running dynamics' parameters in 100 m hurdles race for World Championship in Berlin (2009) most successful heptathlon athletes

It was interesting to observe heptathlon athletes in 100 m hurdles race (Fig. 6). Jessica Enis, the winner of heptathlon as well as the winner of 100 m hurdles race with the result of 12.93 s was much faster than other two analyzed heptathlon athletes in 100 m hurdles race, who had the result of 13.50 s. From Table 2 it can be seen that Jessica Enis had greater running speed in between hurdles and how her running speed over the hurdles was over 1 s in all segments of the race. The running dynamics of athletes who ran the race in 13.50 s clearly showed different movements' structure.

Conclusion

This research study was carried out on deliberate sample of athletes who won the medals in 100 m hurdles event at the most important competitions of first category: Olympic Games in Seoul (1988), World Championships in: Athens (1997), Berlin (2009) and Deagu (2011); as well as on the most successful heptathlon athletes at the World Championship in Berlin (2009). The sample of entities was comprised of the results from 15 athletes (average age was 27.8 years), whose officially published data on time parameters of running dynamics in 100 m hurdles race were available.

The purpose of this research was to investigate the running specifics in 100 m hurdles race. The main aim was to analyze the running dynamics in 100 m hurdles race.

The research was carried out on 13 variables; 10 time parameters' variables related to split times at every hurdle, final race result, latent reaction time and participants' age.

The following statistical procedures were employed: basic descriptive parameters were calculated, as well as descriptive analysis of individual changes, the individual changes' dynamics' indicators with changeable base and absolute grade of change.

In this study different examples of competitive activity structure that differ depending on the result were shown. The more the final race results were similar, the more similar the running dynamics was. These examples, regarding the successfulness of running structure patterns realization, clearly imply on fine nuances that make for the better placement at the end of the race.

Based on descriptive parameters and graphic representations from OI in Seoul (1988), World Championships in: Athens (1997), Berlin /2009), Deagu (2011) it may be stated that the most successful, that is, the fastest athlete was the one who was increasing her running speed until fourth or fifth hurdle and managed to maintain that speed the longest possible. The deceleration phase for all athletes was after eight hurdle. Latent reaction time and split times at first and second hurdle are the integral part of start acceleration and are important for establishing good running rhythm.

The obtained results from this research study may be beneficial in athletes' training process since they indicate the specific technical and tactical segments of the 100 m hurdles race that should be carefully planned and practiced.

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ELECTROSTIMULATION: PART OF THE WARM-UP BEFORE THE PERFORMANCE IN COUNTERMOVEMENT JUMP

Jiří Bílý, Jan Cacek, Tomáš Kalina
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Neuromuscular electrostimulation is one of methods of strength development during which there is no voluntary muscle contraction and there is required an apparatus which sends electrical impulses. The purpose of this study is to find out if neuromuscular activation by using electrostimulation method, performed before performance as a part of warm-up, is beneficial for performance in countermovement jump. As participants we chose 10 healthy trained men aged between 21 and 25 years. During warm-up test subjects pedalled on a stationary bike for 5 minutes. Then performed countermovement jumps immediately after electrostimulation (applied on quadriceps femoris muscles) or without electrostimulation or with dynamic stretching. Three attempts were permitted and we recorded the best of them. There were four variants of intervention before performance - with and without electrostimulation and with and without dynamic stretching. Dynamic stretching involved the whole body, contained the same exercises and lasted for 5 minutes. Electrostimulation was applied for 2 minutes with the pre-set program „Explosive power“ on an electrostimulator. The results showed that the height of countermovement jump significantly increased after using the electrostimulation method: +1.8 % ($p = .036$; $d = .19$) without dynamic stretching and +1.8 % ($p = .036$; $d = .19$) with dynamic stretching compared to attempts without electrostimulation. We found no significant difference ($p > .05$) if we compared performance in countermovement jump after warm-up and electrostimulation and performance after warm-up and dynamic stretching. This finding suggests that electrostimulation applied before exercise can be beneficial as well as dynamic stretching. Performances in countermovement jumps after electrostimulation are statistically significantly higher than performances without electrostimulation. However, we can say that the neuromuscular activation via the electrostimulation method (immediately before performance) helps to improve the performance in countermovement jump at least as well as dynamic stretching. This study provides further evidence of a link between a type of stretching or neuromuscular activation before performance and a level of performance in vertical jump, specifically countermovement jump.

Keywords: *electrostimulation, electrical stimulation, countermovement jump, warm-up, neuromuscular activation*

Introduction

Electrostimulation (ES) is performed by using an apparatus which sends electrical impulses through electrodes to the selected muscles thereby forcing their activity. Attached electrodes replace the voluntary effort of exercisers, which leads to the delay of fatigue (Lehnert et al., 2010, Dovalil, 2009).Compared to the traditional workout ES method impact separately on the selected muscle group and 100 % of muscle fibres are activated. Such effect can´t be achieved during the classical strength training (Grasgruber & Cacek, 2008).

Several studies confirmed that intensive neuromuscular activation applied immediately before the test of the vertical jump helped to improve performance. For example, Zois et al. (2011) found out that the height of the CMJ (countermovement jump)improved by +2% after intensive neuromuscular activation using 5-RM (repetition maximum) on the legpress exercises. Witmer, Davis and Moir (2010) in their research found out that the use of resistance exercises performed prior to theCMJ can result in improvement in performance. The participants first performed five repetitions at 30% of their 1-RM, then four repetitions at 50% 1-RM and finally three repetitions at 70% 1-RM of parallel back squats. There does not seem to be any differences between men and women in this exercises. Needham et al. (2009) concluded that intensive neuromuscular activation (8 repetitions in the squat with a load corresponding to 20% of body weight) led to a better performance in the vertical jump. Villarreala et al. (2007) documented an improved performance in the vertical jump after several loaded jumps (+4.18%) and after several repetitions of squats (+2.98%).During our previous research, we found out that neuromuscular activation via the electrostimulation method can have positive effect on the height of the drop jump but using the electrostimulation method had no significant effect on the squat jump performance (Bílý & Cacek, 2014).

Neuromuscular electrical stimulation is one of possible methods of strength development. If we use electrical stimulation on human body, there is no voluntary muscle contraction and electric impulses are spread without the activation of the control brain centre. The positive effect of electrostimulation method on the increase of muscle strength after several weeks has been demonstrated by numerous studies (see meta-analysis by Filipovic et al., 2012). The objective of this research was to

investigate the immediate effect of the neuromuscular activation of knee extensors via the ES method as a part of the warm-up before the performance in CMJ.

Methods

As participants we chose 10 healthy trained men aged between 21 and 25 years. All the measured subjects of the tested sample were volunteers and students of sport sciences. For the basic characteristics of the tested sample see table 1.

Tab. 1 Basic characteristics of the tested male subjects

	Valid N	Mean	Minimum	Maximum	Std. Dev.
Age (year)	10	23.40	21	25	1.51
Height(cm)	10	183.00	175	191	5.44
Weight (kg)	10	83.20	75	95	6.07
Vertical reach (cm)	10	237.50	225	245	6.02

In our research the Sargent jump test was used for measurement of height of the vertical jump. This test of explosive strength of lower limbs was chosen for his ease of use and his reliability. The author of this method is Dudley Allen Sargent who described its methodology almost 100 years ago (Sargent, 1921).The measurements of height, weight and vertical reach were performed at first. Then participants performed counter-movement jump (CMJ) from a bench which was 42 cm high.

Four types of data were collected from each subject:

- Height of CMJ after dynamic stretching (DS) and with ES,
- Height of CMJ after DS and without ES,
- Height of CMJ without DS and with ES,
- Height of CMJ without DS and without ES

The methodology described by Neumann (2003) was used for the CMJ. Participants started their jump standing in 15 cm distance from the wall. They had chalk on the fingers of their dominant hand to mark the height of the jump on the scale which was fixed on the wall. After the jump we subtract the height of the maximum achieved vertical reach from a scale. All data were collected by the same researcher. Three attempts were allowed in each variation of the CMJ. Variations were performed in an order that had been randomly selected. There was 40 seconds pause between the attempts. We recorded the best of three attempts. Countermovement jumps were

performed with and without dynamic stretching (DS). DS was performed in the same room and lasted for 5 minutes. The participants were not allowed to exercise heavily 2 days before testing. According to Robbins & Scheuermann (2008) it is appropriate to increase muscle temperature for optimal performance in the vertical jump. They recommend pedalling on a stationary bike for 5 minutes with a submaximal workload and cadence of 70 rpm (revolutions per minute). After the warm-up (pedalling for 5 minutes on a stationary bike as recommended) there were 4 variations of intervention – with and without ES or DS or both or without both. After the intervention or instantly after warm-up the test subjects performed their jumps. The data were collected at the same time of day and only one type of measurement was performed within a single day.

The electrostimulator (Premium 200, Globus, Italy) was set on the „Explosive strength" pre-set program, the level of intensity 30. The stimulation was applied in the sitting position and lasted for 2 minutes. There were 7 big muscle contractions during this period of time. The voltage on the electrodes during a big contraction was 105 V. The electrodes were attached to the thigh by a tape according to the manufacturer's instructions. One big electrode was fixed to the proximal part of the thigh and two small electrodes were attached to the inner and outer side of the distal part of the thigh. M. quadriceps femoris, where electrodes were placed, is one of the most important muscles involving in the vertical jump and according to Filipovic et al. (2012) it is the most frequently examined muscle in studies using the electrostimulation method. The obtained data were processed via a statistical program STATISTICA 10 (StatSoft, USA). The Wilcoxon pair test was used to determine the statistical significance between measured performances in the CMJ with and without electrostimulation or dynamic stretching or both.

Results

Ten test subjects achieved the following results in the test of the CMJ:

The mean height of CMJ with DS and with ES was 56.9 ± 4.65 cm (mean ± SD). The mean height of CMJ with DS and without ES was 55.9 ± 5.65 cm. The mean height of CMJ without DS and with ES was 56.3 ± 5.14 cm. The mean height of CMJ without DS and without ES was 55.3 ± 5.23 cm. Height of CMJ after ES without DS was significantly increased ($p = .036$; $d = .19$) than height of CMJ without DS and without ES. Height of CMJ after ES with DS was significantly increased ($p = .036$; $d = .19$) than height of CMJ with DS and without ES. If we compare height of CMJ after DS (55.9 ± 5.65 cm) with height of CMJ after ES (56.3 ± 5.14 cm), the results show that the height of the CMJ was not significantly increased ($p > .05$) by using ES. Only the mean values was higher after ES than after DS.

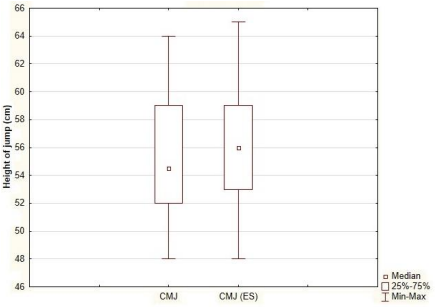

Fig. 1 Type of jump: CMJ and CMJ after ES

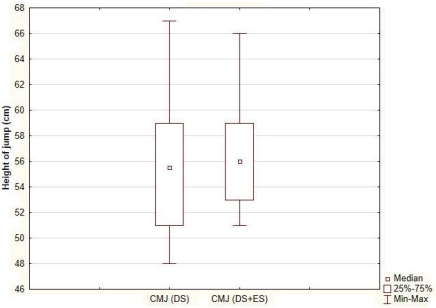

Fig. 2 Type of jump: CMJ after DS and CMJ after DS and ES

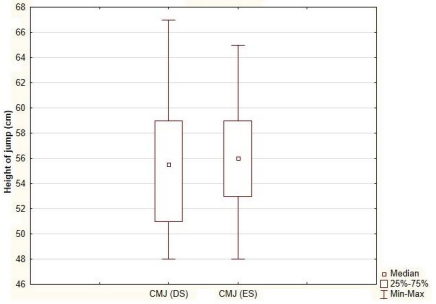

Fig. 3 Type of jump: CMJ after DS and CMJ after ES

Discussion

According to Grasgruber & Cacek (2008) up to 100 % of muscle fibres are activated during ES, so there are all muscle fibres prepared for performance. Palliard et al. (2008) and Hainaut & Duchateaua (1992) think that fast muscle fibres are activated preferentially during ES. During an exercise with greater resistance, more fast muscle fibres are involved then during an exercise with lower resistance (Bompa, 1999, Kraemer et al. 2012). Based on our findings we can conclude that performance in CMJ is similar if we use the dynamic stretching or the electrostimulation as part of the warm-up. It seems that for performance in CMJ it is not necessary to activate all the muscle fibres as it is during ES. But the same result could be achieved by activating the muscles through the DS. This could be the reason, why ES has the same effect on the CMJ performance as the DS.

The improvement of performance in CMJ after ES and with DS was +1.8 % and after ES and without DSit was also +1.8 %, both compared to jumps without ES. Similar improvement (from +2.0 to 4.18 %) was recorded by Zois et al. (2011), Needham et al. (2009) and Villarreala et al. (2007) after an intensive neuromuscular activation via loaded jumps, squats or legpress. If we want to achieve better performance in CMJ, we should focus on warm-up. DS can have the same effect as ES performed before performance in CMJ. For further research in this area, it would be essential to use participants with the same level of performance in the same sport, because the little homogeneity of the test sample was the limiting factor in this study. The use of ES of the quadriceps femoris only could be also limitation. Two electrostimulators will be needed for a simultaneous stimulation of ankle plantar flexors and hip extensors, because there are 8 cables of the electrostimulator available, so at the same time it was possible to stimulate only both m. quadriceps femoris.

The finding that an immediate neuromuscular activation via ES has a positive effect on performance may be beneficial for various athletes who need to increase neuromuscular activation before performance and lack dumbbells or enough space for dynamic stretching. They can take a small electrostimulator and apply ES in the changing room, at the area for a warm-up etc. Knowing that there exists an immediate effect of ES on performance, we can potentially use it for a better preparation of muscles during the warm-up part before performance.

Conclusions

Electrostimulation is one of the methods of strength development if it is used regularly. We can apply electrostimulation immediately before performance, which can lead to a improvement of performance. The major finding of this study is that neuromuscular activation via electrostimulation could have a positive effect on the height of the countermovement jump and hence it could be added to the warm-up part before sport performance involving vertical jumping with countermovement. The positive effect of electrostimulation is the same as dynamic stretching performed before countermovement jump. A further study can focus on other short-term performances like sprint or long jump.

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THE FREQUENCY OF QUALITATIVE GRADING LEVELS OF DEFENSIVE PLAYS AT WORLD CUP 2014 IN FOOTBALL

Oto Honz
Faculty of Mechanical Engineering, Slovak University of Technology in Bratislava, Slovak Republic

Abstract

The author presents partial results of his pre-research, which is dedicated to occurrence frequency of qualitative assessment degrees of goalkeepers´ defensive playing activities during FIFA World Cup 2014 held in Brazil.

Keywords: *football, playing performance, actions of goalkeepers, player´s assessment of playing activities, frequency, qualitative assessment degree*

Introduction

There are used various types of analysis of goalkeepers´ activities nowadays. In the most of the cases, analyzing authors are unanimous in opinion on methods evaluating the quality of a player´s performance during the match. They focus on the success of particular playing activities performed during the match. However, these activities are of different frequency of occurrence and types. A scoring scale from 3 to 5 points is often used for evaluating the quality of performance. The most frequent method used in majority of sports, including football is that of critical cases, which was established by Flanagan (1954) in work psychology. This method was successfully used in football game by Kačáni (2000) and other authors (Tarkovič, 2004; Peráček et al, 2008; Peráček et al, 2010).

Goal

The goal of the pre-research is to identify, analyze and compare occurrence of qualitative assessment degrees of defensive football activities of goalkeepers playing for winning and losing teams on FIFA World Cup 2014.

Tasks

- identify and analyze occurrence frequency of qualitative assessment degrees of defensive plays of goalkeepers in a group;
- identify and analyze occurrence of qualitative assessment degrees of defensive plays of goalkeepers in winning teams;
- identify and analyze occurrence of qualitative assessment degrees of defensive plays of goalkeepers in losing teams;
- to compare occurrence of qualitative assessment degrees of defensive plays of goalkeepers of winning and losing teams.

Methods

The studied group consisted of 40 goalkeepers, whose teams participated in FIFA World Cup 2014 in Brazil. We followed 12 defensive gaming activities.

The selected matches was watched and analyzed by video. We created a collection worksheet that allows the registration of defensive selected gaming activities for register variables. Every match was watched by two experts for verification of data. If we were not convinced with the inclusion of assessed gaming activity to specific qualitative stage, we returned back record of match. This principle watched on quality of registration and impartiality of the evaluation gaming activities. We evaluated the success rate of team by the victory, respectively loss.

We assessed:

1. The frequency of gaming activities of individual in the file, in winning and losing teams;
2. Kind of specific defensive gaming activity (Management and communication of game, The position at the shooting, The position, Catch a ball on the ground – the goal line, Catch a high ball – the goal line, Boxing the ball – the goal line, Catch a ball on the ground – the penalty area, Catch a high ball – the penalty area, Boxing the ball – the penalty area, Outside – take a ball, Outside to center, Outside the penalty area.);
3. The quality of gaming activities of individual by 5-scoring scale.
4. The success rate of team was evaluated principle by victory and loss.

A method of indirect observation and assessment was used. We tried to identify the individual gaming performance in the gaming activities in the research of match. Definition “effectiveness” will be used by the quality of gaming activities of

individual. We evaluated efficiency and quality of implementation defensive playing activities by using 5-grade scoring scale. The qualitative degree no. 1 meant maximal effectiveness of implementation gaming activity. The qualitative degree no. 5 meant the worst implementation of gaming activity. The numbers were of absolute and relative values. The results were inserted to the table for better view. We used to interpretation of results principles of logical methods. One of them was an inductive-deductive methods, such as analysis and synthesis.

Results

The result was 645 defensive playing activities of which the average occurrence during the match was 32.25, for goalkeepers 16.13 (Tab. 1).

Tab. 1 The occurrence of the qualitative assessment degrees of playing activities of goalkeepers in the group.

The scoring scale		Management and communication of game	The position at shooting	The position	Catch a ball on the ground – the goal line	Catch a high ball – the goal line	Boxing the ball – the goal line	Catch a ball on the ground – the penalty area	Catch a high ball – the penalty area	Boxing the ball – the penalty area	Outside – take a ball	Outside to center	Outside the penalty area
1	n	37	8	21	52	43	62	89	81	13	77	38	15
	%	100	80	84	54.2	67.2	87.3	97.8	96.4	86.6	88.5	76.0	100
2	n	0	0	0	1	0	1	1	1	0	3	1	0
	%	0	0	0	1.0	0	1.4	1.1	1.2	0	3.5	2.0	0
3	n	0	0	2	1	0	2	1	1	0	1	2	0
	%	0	0	8	1.0	0	2.9	1.1	1.2	0	1.2	4.0	0
4	n	0	0	1	1	0	1	0	0	1	2	3	0
	%	0	0	4	1.0	0	1.4	0	0	6.7	2.2	6.0	0
5	n	0	2	1	41	21	5	0	1	1	4	6	0
	%	0	20	4	42.8	32.8	7.0	0	1.2	6.7	4.6	12.0	0
overall	n	37	10	25	96	64	71	91	84	15	87	50	15
	%	100	100	100	100	100	100	100	100	100	100	100	100

536 defensive playing activities were evaluated as qualitative grade 1, which represents 83.1% of total number. The most noticeable activity was the catch a ball on the ground in penalty area, what made almost 98% (97. 8% - 89 playing activities) from the total number of activities. The second noticeable activity was the catch a high ball in penalty area (96. 4% – 81 playing activities), which was followed by the outside – take a ball (88.5% - 77 playing activities) and boxing the ball in the goal area - 87.3% with occurrence of 62 playing activities. The lowest rate of playing activity was the position while shooting with frequency of 8 activities.

The occurrence of defensive plays, which assessing with qualitative grade 2 to 4 was almost the same, differences were minimal (8 – 1.2%; 10 – 1.6%; 9 – 1.4%). By

defensive plays, management of game and communication, the position to shooting, catch a high ball in a goal line and outside the penalty area, we have registered zero frequency of occurrence, one by intercepting a ball in penalty area and the frequency was 2 – 6 activities by the other qualitative degrees.

The second highest frequency of occurrence defensive plays (82 – 12. 4%) from the whole frequency was the bad procedure (qualitative grade 5) in the file. On this frequency participate in wrong catch a ball on the ground in a goal line (41 – 42.7%), catch a high ball in a goal line (21 – 32.8%) from the frequency on the given playing activities. We have not noticed grade of assessment 5 in defensive plays, management of game and communication, catch a ball on the ground in penalty area and run out next penalty area. The frequency of occurrence was low from 1 to 6 actions by the other playing activities.

We recorded 315 (48.8%) defensive plays and average frequency of occurrence in the match 15.8 playing activities by goalkeepers of winning teams (Tab. 2). The two hundred and eighty defensive plays was assessed by an qualitative grade 1, what meant 90% (280 – 88.9%). On this value with the highest degree was playing activities such as catch a ball on the ground in penalty area (42 – 97.7%), the whole occurrence in this playing activities followed by the catch a high ball in penalty area (40 – 97.6%), outside – take a ball (34 – 87.2%), boxing the ball in the goal line (31 – 88.6%). On the value with lower frequency of occurrence was catch a ball on the ground in the goal line (29 – 69.1%), catch a high ball in the goal line (28 – 93.6%), run out an attacker (21 – 80.8%), management of game and communication (20 – 100%). The last of them, the value with the lowest frequency was playing activities the position (13 – 92.9%), run out the penalty area (12 – 100%), boxing the ball in penalty area (6 – 85.7%) and the position while shooting (4 – 82.9%).

Tab. 2 The frequency of occurrence of qualitative degrees assessment of playing activities an individual to winning teams.

The scoring scale		Management and communication of game	The position while shooting	The position	Catch the ball on the ground – the goal line	Catch the high ball – the goal line	Boxing the ball – the goal line	Catch the ball - the penalty area	Catch the high ball – the penalty area	Boxing the ball – the penalty area	Outside – take a ball	Outside the center	Outside the penalty area
1	n	20	4	13	29	28	31	42	40	6	34	21	12
	%	100	100	92.8	69.1	93.6	88.5	97.8	97.6	85.7	87.1	80.8	100
2	n	0	0	0	1	0	1	1	1	0	1	0	0
	%	0	0	0	2.4	0	2.9	1.1	2.4	0	2.6	0	0
3	n	0	0	0	1	0	2	1	0	0	1	2	0
	%	0	0	0	2.4	0	5.7	1.1	0	0	2.6	7.7	0
4	n	0	0	1	1	0	0	0	0	1	2	1	0
	%	0	0	7.2	2.4	0	0	0	0	14.3	5.1	3.8	0
5	n	0	0	0	10	3	1	0	0	0	1	2	0
	%	0	0	0	23.7	6.4	2.9	0	0	0	2.6	7.7	0
overall	n	20	4	14	42	31	35	44	41	7	39	26	12
	%	100	100	100	100	100	100	100	100	100	100	100	100

The frequency of occurrence of defensive plays, which are evaluated an qualitative degrees 2 – 4 was the lower (5 – 1.6%; 7 – 2.2%; 6 – 1.9%). We recorded zero frequency by playing activities like management of game and communication, the position while shooting, run out the penalty area to degrees such as 2; 5 and by degrees 3, 7, 4 to 6 an interventions.

The value 17 – 5.4% represented the frequency of defensive playing activities an qualitative grade of assessment 5. The goalkeepers of winning teams had a few faulty actions. This is confirmed by zero frequency to 7 playing activities. An exception creates playing activity, catch a ball on the ground in goal line with 10 faulty actions.

We recorded 330 defensive playing activities by the goalkeepers of losing teams, what meant 51.2%, so it is the higher frequency of occurrence. It is expressed as the absolute value of 15 playing activities and in relative values is higher about 2.32%, than for the goalkeepers of winning teams. An average occurrence in the match have been found in 16.5 playing activities (Tab3). It was higher by 0.75%.

The qualitative grade of assessment 1 were evaluated 256 defensive plays in relative values 77.6%, what meant lower frequency of occurrence in absolute values by 24 playing activities and in relative values by 11.32%, than the goalkeepers of winning teams. We recorded differences by 10 defensive plays. The frequency of occurrence was the same in the two defensive plays.

We registered the most differences in the catch a high ball in the goal line (13 playing activities), outside the penalty area (9 playing activities) and in catch a ball on the ground in the goal line (6 playing activities).

We recorded the largest differences to favor of the losing teams in defensive plays like outside – take a ball (9 playing activities) and the catch a ball on the ground in penalty area (5 playing activities). Other differences were very low.

Tab. 3 The frequency of qualitative grading levels of defensive plays an individual of losing teams.

The scoring scale		Management and communication of game	The position while shooting	The position	Catch the ball– the goal line	Catch the high ball – the goal line	Boxing a ball – the goal line	Catch the ball– the penalty area	Catch the high ball – the penalty area	Boxing a ball – the penalty area	outside – take a ball	Outside to center	Outside the penalty area
1	n	17	4	8	23	15	31	47	41	7	43	17	3
	%	100	66.7	72.7	42.6	45.5	86.1	100	95.4	87.5	89.6	70.8	100
2	n	0	0	0	0	0	0	0	0	0	2	1	0
	%	0	0	0	0	0	0	0	0	0	4.2	4.2	0
3	n	0	0	2	0	0	0	0	1	0	0	0	0
	%	0	0	18.2	0	0	0	0	2.3	0	0	0	0
4	n	0	0	0	0	0	1	0	0	0	0	2	0
	%	0	0	0	0	0	2.8	0	0	0	0	8.4	0
5	n	0	2	1	31	18	4	0	1	1	3	4	0
	%	0	33.3	9.1	57.4	54.5	11.1	0	2.3	12.5	6.2	16.6	0
overall	n	17	6	11	54	33	36	47	43	8	48	24	3
	%	100	100	100	100	100	100	100	100	100	100	100	100

The detected frequency of qualitative grading levels of defensive plays 2 to 4 of scoring scale was the low (after the 3 playing activities). It was lower than the goalkeepers of winning teams by two. four and three playing activities, respectively an interventions.

The zero frequency of occurrence by the defensive plays is very important. This occurrence is recorded mainly by the goalkeepers of losing teams, such as 10 defensive playing activities were in 2,3 and 4 the qualitative degree of assessment. We registered zero frequency of occurrence by the goalkeepers of winning teams to 7 defensive plays in 2,3 and 4 the qualitative grading of assessment.

The qualitative grade of assessment 5 proved the bigger differences in the frequency of occurrence to defensive plays the goalkeepers of winning and losing teams. We noticed 65 defensive plays that is 19.7%, by the goalkeepers of losing teams. Difference in absolute values was 48 defensive playing activities and in relative values was 17.3%. According to result, we have seen that defensive plays the goalkeepers of losing teams were evaluated significantly the qualitative grade

of assessment 5. This means that they made more mistakes than the goalkeepers of winning teams. The amount of errors has been incremented by defensive plays as catch the ball in the goal line (distinction was 15). We also noticed in zero frequency of occurrence (3 and 7 defensive playing activities).

Conclusion

We have used five-point scale to assessment of quality defensive plays. We also used an objectivity comparison Přidal (2001) "three-point scales present the bigger objectivity than five-point scale". According to Buchtel, "five-point scale is better. This scale is detailed to distinguish the quality of an individual playing activities." The objectivity need directly definition of an individual evaluative degrees.

- The qualitative assessment grade 1 have been evaluated 83.1% defensive plays in the file.
- The second highest frequency of occurrence defensive plays 12.4% were faulty actions.
- The qualitative assessment grade 1 have been evaluated 90% defensive plays by the goalkeepers of winning teams.
- The goalkeepers of winning teams had a few faulty actions (5.4%).
- The qualitative assessment grade 1 have been evaluated 78% defensive plays by the goalkeepers of losing teams.
- The goalkeepers of losing teams made a lot of mistakes than those of winning teams - 19.7% (division is 14.3%).

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BACKGROUND FOR PREPARING EDUCATION CURRICULUM FOR COACHES OF RHYTHMIC GYMNASTICS

Iveta Holá, Jan Chrudimský, Viléma Novotná
Faculty of Physical Education and Sport, Charles University in Prague, Czech Republic

Abstract

The goal of the article is to describe opinions Rhythmic Gymnastics (RG) specialists on the content of sports preparation, training and education for coaches of female rhythmic gymnasts interested in RG aged 7-9 years. Evaluation of the study of sixteen semi-structured interviews with experts (on a non-randomized selected group of specialists) was researched according to the method Repertory grid technique (RGT). The investigation by RGT, an analysis of interpersonal and intrapersonal data obtained by conversation between researcher and interviewee expert in RG training process. The results from the year 2014 are documenting the attitudes of qualified specialists in RG sports preparation and training. Experts deem set of exercises for correct body posture as most necessary component (RGT element) in the preparation of younger school age rhythmic gymnasts. The second is a set of exercises for no apparatus technique and a set of exercises for manipulation skills with hand apparatus. The set of exercises for classical dance (ballet) technique was considered by respondents as more necessary component of sports training that age. But in contrast, a set of exercises for orientation in space, the experts called as the least necessary component of sports preparation of young gymnasts. In terms of education of coaches are essential outcomes from categorization of all constructs (opinions of all coaches in research). Experts emphasize for instance about systematic approach to training process, its regularity, permanence and longevity, to training under the supervision of a coach and also unassisted exercise. A positive effect of RGT method is obtaining many individual constructs in terms of their uniqueness and attractions. Overall constructs can be evaluated as completely individually and uniquely spoken opinions and ideas of each individual respondent. In summary, the results of the analysis of actual interviews describe the attitudes and opinions of respondents to the training content of RG in Czech Republic. It is also possible to use the results for improving the education of coaches.

Keywords: *Rhythmic Gymnastics, Repertory grid technique, education for coaches*

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Introduction

The expected benefit of science and research in top-performance sport is to contribute to increasing the performance level of athletes. This is achieved through a variety of research designs, scientific methods and derived techniques drawing upon both quantitative and qualitative methodology. An example of scientific research aimed at finding partial performance or achievement parameters is the RGT technique - Repertory Grid Technique (RGT). In open literature (Kocianová, 2003), we also come across the term Repertory Grid Interview (RGI), or the term is shortened into rep-grid. It is a method belonging to partially structured interviewing, or according to van de Kerkhof (2004), it is a semi-structured interview. The RGT technique was founded by George Alexander Kelly in 1955 in his professional book Personal Construct Psychology, where he formulated the fundamentals of a theory called "psychological constructivism" based on a dichotomous perception of the world in the context of the personal construct theory (Kelly, 1955).

Based on the experience gained during our life, personal values or ideas (constructs) change, therefore, the rep-grid technique describes the perception of a situation, environment or an issue as it is "here and now". It does not seek answers, but an individual system of constructs. The aim of interviewing is not to obtain a correct but a distinctive answer, constructing the picture of the world seen through the eyes of the interviewed individual (Fromm, 2004). The starting point is the notion that the interviewed persons first create reality and then relate their acts to this subjective reality. Thus, new experience may enrich personal constructs only in the case that the person (their construct) is in some way open to this "enrichment". Kelly also defined his philosophy as constructive alternativism, whose basic idea is that all of our present interpretations of the universe are subject to revision or replacement, and, in all situations, there are always different alternative perceptions available. No construct is the ultimate and, therefore, final position in perceiving the world. You can always create an alternative construct that will better describe or characterise what is being explored (Jankowicz, 2004).

The application of the rep-grid research method in the domain of physical education and sport is quite uncommon. Yes, gymnastic sports are not regarded a common environment for using rep-grid these days. Studies applying this method to sporting issues are rare, e.g. Baldson and Clift (1990) and Dowdell (2010) studying gymnastics in particular and Clark (1996) exploring stress experienced by athletes. Šimůnková (2014) applied the rep-grid technique to surveying the views of selected professional coaches on the content of sports training of girls aged 7 to 9 years in Rhythmic Gymnastics (RG). Thanks to the identification and formulation of personal constructs according to predetermined elements, which comprise the basic building

blocks of interviews, she obtained opinions of experts in RG. The aim of our paper is to describe the views of RG coaches on the content of sports training and education of coaches of female rhythmic gymnasts aged 7-9 years.

Methods

The evaluation of our study including sixteen interviews (Table 1) with experts (within a non-randomized selected group of experts) was performed according to the Repertory Grid Technique. The method is based on acquiring one interview from one expert (interviewed) to compare the basic elements (triads) characterising a respective topic. The basis of research applying the rep-grid technique is the identification of the topic and elements. The basic elements were identical for all interviews. The starting point for the formulation of the elements was content analysis adopted from scientific literature dealing with the basic sports training of female gymnasts aged 7-9 years. The content and significance of the defined elements relates to the issues of cultivating physical literacy towards shaping the dispositions for sports performance in Rhythmic

Gymnastics. The survey covered the following:

1. Exercises for correct body posture.
2. Exercises for basic locomotion.
3. Exercises for orientation in space.
4. Exercises for music movement coordination.
5. Exercises for physical fitness.
6. Exercises for no apparatus technique.
7. Exercises of classical dance (ballet) technique.
8. Exercises for manipulation skills with hand apparatus.

Tab. 1 Characteristics of the surveyed group

16 interviews	interview length [min]	age [years]	practice [years]
average	94.69	42.38	19.50
s.d.	12.68	12.80	10.66

Guided by the objective of our study, we chose the calculation of both the absolute and relative frequency of individual respondents' responses assessing the significance of individual elements on a five-point rating scale (1– highest rating, 3 – intermediate and 5 – lowest significance) from a wide variety of methods of qualitative and quantitative analysis, i.e. the analysis of interpersonal and intrapersonal data obtained

from interviews between the interviewer and an interviewed expert in RG training (coaches with the highest qualifications). Besides, we used the cluster analysis method for finding common sets of elements that describe their significance for cultivating the sports performance in RG of female gymnasts aged 7 to 9 years.

The correlations of individual constructs were described by the so-called categorization - using the "bootstrap" technique. It creates several categories into which all the constructs from all interviews are classified according to their significance. Some constructs (around 5%) cannot be classified into the appropriate categories created, and a separate category for unclassified constructs must be designed for them. The objectivity of the categorization was verified by the calculation of the reliability coefficient (Smith, 2000) - index A (percentage of identical constructs with respect to all constructs in all categories) and index B (percentage of identical constructs with respect to all constructs in identical categories). The ideal result is index B = 90% (reliability coefficient of 0.9 or higher). In our survey, index B had a value of 0.94.

The categorization is the starting point for another analytical technique – Honey's content analysis (developed by Peter Honey in 1979), which is based on a thematically predefined, supplied construct of the overall assessment of all elements (Jankowicz, 2004), in this case on the formulation of a "more and less necessary component of sports training in RG". It searches the difference (or agreement) between the evaluations of partial constructs and the supplied common construct of the overall evaluation. According to the calculation and subsequent identification of the H-I-L index of relative significance, the constructs are divided into three equally represented groups and labelled according to the percentage of their difference as a high (H - high), intermediate (I - intermediate) or low (L - low) index of the correlation of constructs. The following formula is used to describe the relations between individual constructs and for Honey's analysis: $S = 100-(\{SD/[(LR-1)xC]\}x100)$; (where: S= similarity, LR = largest rating, C – number of constructs, SD – sum of differences).

To analyse the acquired data the statistical Microsoft Excel package, RepGrid and RepNet IV programmes were used.

Results and Discussion

The research results indicate (Table 2) that the experts consider a set of correct body posture exercises the most necessary component in the RG training of junior school children with the highest relative frequency of its significance evaluation (81.25%) rated 1. The second most necessary component identified by the respondents was a set of exercises for no apparatus technique and a set of exercises for manipulation skills with hand apparatus. A set of exercises for ballet technique was considered a more necessary component of the sports training in the respective age group by

the respondents with the prevailing rating of 2. On the contrary, a set of exercises for orientation in space, with the prevailing rating of 5, was identified as the least necessary component of the sports training of female gymnasts by the experts.

Tab. 2 Rating of the "more necessary component of sports training in RG" supplied construct by sixteen experts

Elements	The relative frequency of evaluation by experts [%]				
exercises for correct body posture	81.25	6.25	12.50	-	-
exercises for basic locomation	25.00	18.75	43.75	12.50	-
exercises for orientation in space	12.50	6.25	18.75	6.25	56.25
exercises for music movement coordination	18.75	12.50	37.50	12.50	18.75
exercises for physical fitness	12.50	12.50	43.75	12.50	18.75
exercises for no apparatus technique	75.00	18.75	-	6.25	-
exercises of classical dance (ballet) technique	37.50	50.00	12.50	6.25	-
exercises for manipulation skills with hand apparatus	56.25	18.75	12.50	6.25	6.25

Professional literature does not state the percentage of the frequency of individual sets of exercises, but, based on the concept of the long-term sports training theory, it can be concluded that correct body posture and movement in space known as basic locomotion is essential for the overall development in this age category (Novotná, 1986). Practising elements of difficulty (a set of exercises for no apparatus technique) should follow after mastering good posture and posture parts in space, after mastering basic locomotion and its various forms, e.g. jumps, dance steps, various types of walking, etc. A set of exercises for physical fitness, together with a set of exercises for harmonising the music movement coordination, is considered intermediate in significance (with a rating of 3) by an average of 37.5% of the experts. The very issue of musical and movement education in contemporary RG is mostly focused solely on mastering the free exercise without any deeper emotional and movement expressiveness on the part of female gymnasts (Novotná et al., 2012). A set of exercises for harmonising the rhythm of movement with music is also an important

factor in terms of the sport sector's rules, which, however, tends to be less emphasized compared to the set of technical training exercises. In this respect, we must realize that the importance of music is not limited to motivation; a well-chosen musical accompaniment not only enhances the gymnasts' performance, but is primarily essential for keeping the rhythm (Jasterjambskaia & Titov, 1998).

The correlations between the surveyed elements can be found in cluster analysis chart (Chart 1). Cluster analysis applies the principle of rotation in the positions of constructs and, as a multidimensional approach; it highlights the relationships in the repertory grid by means of the dendrogram. According to the evaluation, the elements are divided into three main clusters in the given case. The cluster of a set of exercises for ballet technique and a set of exercises for no apparatus technique testifies to the fact that both are necessary for training in RG and to the fact that the no apparatus technique is based on the classical ballet technique, being its modification (Freyová et al., 1987; Šimůnková, 2014). Similarly, another repeating cluster is a set of exercises without equipment for no apparatus technique and a set of exercises for correct body posture and, last but not least, the analysis of experts' opinions indicates a connection between a set of exercises for orientation in space and a set of exercises for basic locomotion.

The dendrogram of constructs has a tree-like arrangement being composed of a relatively large number of smaller clusters. The constructs closest to each other are the constructs "without equipment" and "without using aids". Furthermore, the constructs "sufficient number of repetitions is necessary" and "more physically demanding" account for an almost 90% agreement, which indicates the need for a continuous and systematic development of adequate physical fitness of female rhythmic gymnasts.

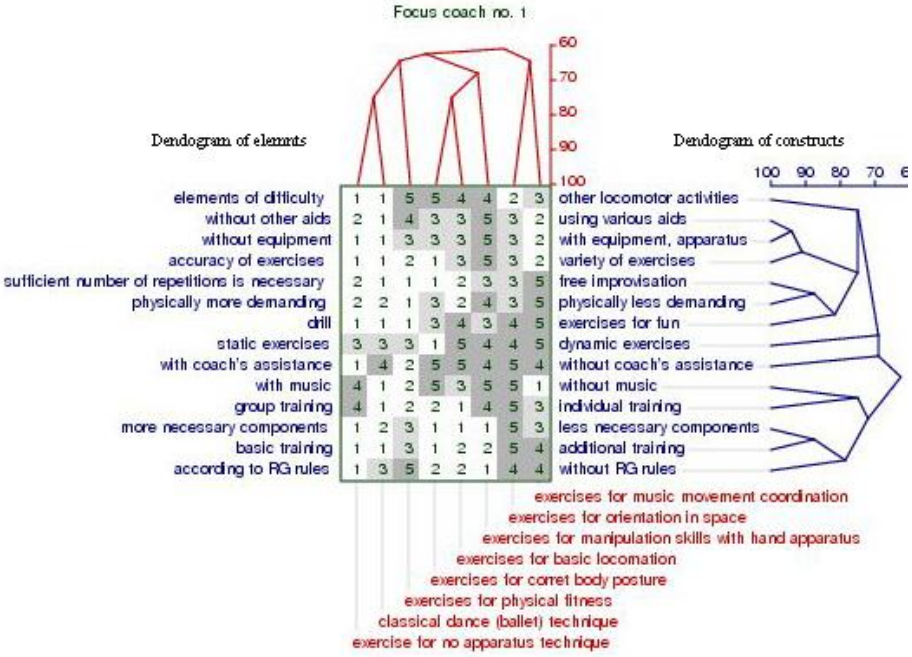

Fig. 1 Cluster analysis as part of RGT technique-based data analysis

Among the categorization results produced by the "bootstrap" technique with a verified reliability of 0.94 for individual constructs, nine categories may be denoted as significant: a) development of creativity, perception of rhythm and dance performance of movement; b) physical fitness and development of locomotor skills; c) acquiring specific skills according to RG rules; d) exercising through games; e) basic physical training and all-round exercises; f) organization and content of training units; g) perception of oneself and the surroundings; h) education of coaches; i) health support. The content and significance of individual categories are presented by the constructs of individual respondents in their dichotomous significance, such as rhythmization of movement versus free realization of movement in time (Table 3).

Based on the results of Honey's analysis, individual constructs may be assigned their significance not only in terms of the planning, organization and evaluation of the content of sports training of rhythmic female gymnasts aged 7 to 9 years, but the results achieved may be applied in the area of coaches' education where the education of coaches is also one of the resulting categories of the performed categorization (Table 4).

Tab. 3 Example of the results of categorization and Honey's analysis

category	selected constructs	dif.	%	H-I-L
development of creativity, perception of rhythm and dance performance of movement	stress on precision, aesthetics of performance – without a necessity of aesthetic performance	10	38	H
	rhythmization of movement – free realization of movement in time	9	44	H
	dance performance of movement - drill, accuracy	12	25	I
	possibility of improvisation, showing off – precisely defined exercises	11	31	I
	conditional on children's creativity – conditional on coach's creativity	9	44	H
	outside movement control, music affects the course of movement – internal movement control	8	50	H

Tab. 4 Example of the results of categorization and Honey's analysis for the category of "Education of Coaches"

category	selected constructs	dif.	%	H-I-L
necessary education of coaches	set of exercises preferred by coaches – set of exercises neglected by coaches	4	75	H
	is indeed included in practice – is not included in practice	5	69	H
	regularity, permanence, long-term nature – included occasionally	3	81	H
	more used exercises – less used exercises	10	38	H
	systematic approach is necessary – any natural technique	10	38	H
	with coach's supervision and correction - without coach's supervision	12	25	I

The comparison of the educational content specified in the Qualification Rules of the Czech Rhythmic Gymnastics Union (ČSMG, 2007) and the significance of selected constructs implies that the personal opinions (constructs) of the interviewed experts also overlap with the content of the educational curriculum of coaches in RG. To each category, some topic from the educational area may be assigned, e.g. the category of "development of creativity, perception of rhythm and dance performance of movement" corresponds to the issue of musical and movement education and creation of sequences. The category of "specific RG skills according to rules" in relation to education is represented by four topics - classical dance training, technique and didactics of exercises without equipment and with equipment and RG rules. Similarly, four topics may be assigned to the category of "necessary education of coaches". The topics comprise the sports training theory in RG, selection of young people with talents for sports, history and technical terminology in RG. The obtained results from the categorization and Honey's analysis show that all interviewed experts consider it important to create conditions for the future growth of the sports performance of

female rhythmic gymnasts, and this must be done not only through the acquisition of a wide range of skills with an emphasis on health maintenance and prevention.

Conclusion

In the perspective of the method used for data collection, we admit that the achieved results of our survey may be partly affected by the subjective perception of the sports training issues by each expert (the data may be biased). On the other hand, it is evident that the high demands of the rep-grid technique do not allow the interviewed person to create deliberately fabricated or untrue constructs. Potential limitations of the study may be found in the "insincerity" of the responses, i.e. in the formulation of opinions - constructs. Despite some limitations, however, we consider the Repertory Grid Technique appropriate for gaining information and opinions from educated coaches. Fittingly, (Švaříček and Šeďová, 2007) consider an interview the most widely applied method of data collection in qualitative research.

The results of analysed interviews also manifest that the education of coaches cannot be separated from sports practice. The opinions of the interviewed experts in Rhythmic Gymnastics clearly show that the emphasis in the sports training of female gymnasts aged 7 to 9 years must be on cultivating the physical performance of the gymnasts through a set of exercises for correct body posture, a set of exercises for no apparatus technique, a set of exercises for manipulation skills with hand apparatus. From the perspective of future coaches' education, what matters is mainly the expertise in the respective branch and its application. We can say that the competences of coaches of junior school children must be affected through such education where the prevailing organizational form of training is the game, the emphasis is on the all-round development of an individual, on raising the awareness of the course of movement, the body movement as a whole and the movement of its individual parts in space and in time, and where conditions must be created for the development of creativity and aesthetic feeling.

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ARE THERE ANY DIFFERENCES BETWEEN MALES AND FEMALES IN THE SUCCESS OF TEACHING WINDSURFING

Bor Oreb, Ivan Oreb, Goran Oreb
University of Zagreb, Faculty of Kinesiology, Croatia

Abstract

The purpose of this study is to establish if there are any differences in the success of teaching windsurfing between males and females. The inquiry was conducted on a sample that consisted of 122 male students and 58 female students of the faculty of Kinesiology at the University of Zagreb, enrolled in their third year of study for the academic years *2009/10* and *2010/11.* For the realization of set goals it was necessary to design a quality system of gathering information, which was based on the evaluation of motor knowledge supported by three main technique elements of windsurfing: *Start, Tack, and Gybe.* Based on experience, it is considered that mastering this kinesiology activity of motor knowledge is best evaluated by these three main elements. Judges have estimated the mastering of the aforementioned technique elements with grades from one to five. The methods applied for the analyzation of the data are aligned with the goal of the study, based on earlier insights and considered appropriate for this type of work. By discriminant analysis statistical differences between the success of male and female instruction of the main technique elements of windsurfingn have been detected, with the applicable 5 percent deviation in the results. The difference in the results was influenced by all three key elements of wind surfing technique, while the Start element caused the biggest distinction.

Keywords: *males, females, windsurfing, differences, instruction, discriminant analysis*

Introduction

In windsurfing, as in any sport, the beginning is the hardest. Mastering the technique of navigating a board without a helm is dependant of several factors of which the most important one is – instruction.

Since research on the above-mentioned topic are scarce the necessity for new research on the topic of windsurfing instruction is that much higher. The goal of this research was to ascertain are there differences between males and females in instructing windsurfing.

In an overview of research conducted on the topic of windsurfing several important conclusions were made.

Oreb G. (1984) has conducted a research on the students of the Faculty for Physical Education, where it was established that the synthetic method was better than the analytical method in windsurfing instructing. The advantage of the method was contributed to the suitability of the educational process, the structural characteristics of motor activities and greater motivation of subjects due to the synthetic method instruction.

In his research, Saks (1987) wanted to establish is there a significant difference in mastering the basic windsurfing technique between male and female students. His research was conducted on a stratified sample of above average students selected from the population of students at the Faculty for Physical Education, University of Zagreb counting 80 male and 63 female students. By the discriminant analysis statistical differences between the success of male and female students have been detected, where male students had more success in mastering the main technique and elements of windsurfing. Elements that contributed to group separation were a windward turn and a 360° turn.

Marinović (2002) wanted to determin if there is a connection between motor abilities and the success in windsurfing instruction. He has conducted a research on a sample of 75 students enrolled in their fourth year on the Faculty of Kinesiology. By regression analysis the author has determined a connection between manifested motor abilities and test scores. A statistically significant influence on the success rate of windsurfing had MAFOSS (the figure of eight with a bend) and MAGKU 360 (side step with a 360° turn) variables.

By factor analysis of predictor set of manifested variables it was determined that coordination, agility and rhytm had a statistically significant influence on windsurfing instruction.

On a sample of 84 female students from the Faculty of Kinesiology Kutrović (2004) has reached similar conclusions, maintaining that a great part of windsurfing instruction can be attributed to rhythm, agility and explosive strength.

Karađole (2007) has systematized the main winsurfing technique elements and presented a windsurfing technique which has undergone several changes due to technological advancements in windsurfing.

Goal

The goal of this study was to establish if there are any differences in the success of males and females instruction in the main technique elements of windsurfing *Start, Tack, and Gybe.*

The research has been conducted on a sample which is distinguished from the population by motor knowledge of main technique elements in windsurfing and the data will be interpreted accordingly.

Accordingly, a null hypothesis has been postulated that states there is a statistically significant difference between the success of males and females instruction of the main technique elements of windsurfing with the applicable 5 percent deviation in the results.

Methods

3.1. Sample

The sample consisted of 58 female and 122 male healthy students, selected for motoric skill and knowledge, ages between 22 nad 25 from the Faculty of Kinesiology, University of Zagreb, enrolled in their third year of study for the academic year *2009/10* and *2010/11.*

The subjects have passed the field class required in the course *Water sports – Windsurfing* which included twelve hours of practical work without prior knowledge or experience in windsurfing.

The research has been conducted within the *Windsurfing* course. All of the subjects have successfully finished the practical part of the *Water Sports* exam in accordance with the curriculum.

3.2. Sample variables

Sample variables were based on the evaluation of motor knowledge supported by three main technique elements of windsurfing: *Start, Tack, and Gybe.*

Based on experience, it is considered that mastering this kinesiological activity of motor knowledge is best evaluated by these three main elements.

The evaluation was held on the south side of the Badija island (the Korčula Archipelago), after finishing a seven-day field class. The wind force was between four and six knots, direction NW.

The exam was held on basic windsurfing boards with rigs which were appropriate for the level of motor knowledge and weather conditions.

The level of motor knowledge was evaluated in the following way:

- grade 5 – the motor movement is accurate, without deviation from optimal trajectory or the exhibited deviations are miniscule and can be attributed to the subjects personal style.
- grade 4 – there are small errors in motor movement, which do not affect the basic structural movement. The structural movement is accurate, but affected by interrupting factors which leads to deviance from the optimal motor movement trajectory.

- grade 3 – multiple errors in motor movement. The subject cleary deviates from proper movemet execution, but this does not affect the structural movement trajectory. The subject does the motor movement in its entirety, the movements are rough and clumsy.
- grade 2 – extensive errors in motor movement are present which lead to deviation from the desired trajectory. The subject has the conception of the movement, but the execution is partial.
- grade1 – the motor movement cannot be done. The subject has no motor or symbolic information about the way how to execute the motor movement.

3.3 Data Analysis Methods

All data analysis were done in the statistical system Statistica 7.1. Basic variable parameters as arithmetic mean, standard deviation, minimal and maximum variance, grade dispersal, Skewness and Kurtsis for measuring asymmetry and the degree of peakedness of distribution were calculated.

The normal data distribution frequency was ascertained using integrals in the Kolomogornov – Smirnov Test. The homogeneity was calculated based on particle intercorrection and is show as mean value.

Are there differences, how big are they and according to what do the two groups differ from one another on a multivariant level was determined by regression analysis.

Results and Discussion

Descriptive statistical parameters of condensed basic windsurfing technique elements grades *Start, Tacking, and Gybe* were calculated separately for the male and female student sample. The normal disturibution rate was tested by Klomogorov-Smirnov Test for every test to determine if the distributions of tests have a significant deviance from normal distribution.

Tab. 1 Descriptive parameters of male sample (n=122)

	Arithmetic mean	Standard deviation	Min.	Max.	Range	Skew.	Kurt.
START	3.75	0.72	2.00	5.00	3.00	-0.14	-0.68
TACK	3.81	0.69	1.67	5.00	3.33	-0.33	-0.14
GYBE	3.85	0.70	2.33	5.00	2.67	-0.21	-0.90

According to the arithmetic mean the male subjects have recieved the lowest average grade for *Start* (3.75), then *Tack* (3.81) and the highest average grade for Gybe (3.85). There is a slight difference between the lowest average grade and the highest average grade based on which it can be concluded that the male subjects were equally successful in executing all the basic windsurfing technique elements.

Since the lowes average grade was on *Tack* (1.67) it is possible to conclude that all male subjects have mastered the motor movement for independent execution, although some are not able to connect the movement in a whole.

Standard deviation in subjects as a measure for variance in the three basic elements is between 0.69 and 0.72. This indicates that the grade variance in all basic technique elements was approximately the same. The range confirms this conclusion hence in all the technique elements it was between 2.67 and 3.33.

Descriptive statistical parameters of condensed basic windsurfing technique elements grades *Start, Tack, and Gybe* for female subjects are shown in *Table 2*.

Tab. 2 Descriptive parameters of female sample (n=58)

	Arithmetic mean	Standard deviation	Min.	Max.	Range	Skew.	Kurt.
START	4.24	0.62	2.67	5.00	2.33	-0.52	-0.55
TACK	4.09	0.63	2.33	5.00	2.67	-0.50	-0.02
GYBE	4.17	0.63	2.67	5.00	2.33	-0.61	-0.26

According to the arithmetic mean the female subjects had the lowest average grade for *Tack* (4.09), then *Gybe* (4.17) and the highest average grade from *Start* (4.24). In female subjects the difference between the lowest average grade and the highest average grade is miniscule. Since the standard deviation between all the variables is from 0.62 and 0.63 and the range is between 2.33 and 2.67 it can be concluded that the grade variance in female subjects in all three basic technique elements is negligible. It is important to take into account that the number of female subject (n=58) is much lower than the number of male subjects (n=122) which could have caused less dispersion in all three basic technique elements grades.

Both male and female subjects had the lowest average grades in *Tacking*. We can assume that the reason is insufficient knowledge and lack of experience in wind management.

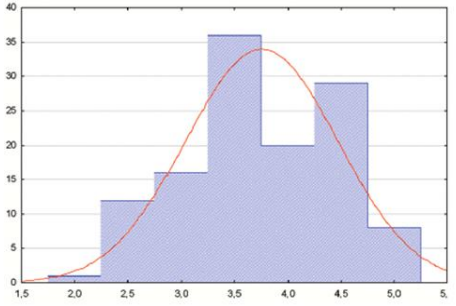

Fig. 1 Variable Start (S) – male

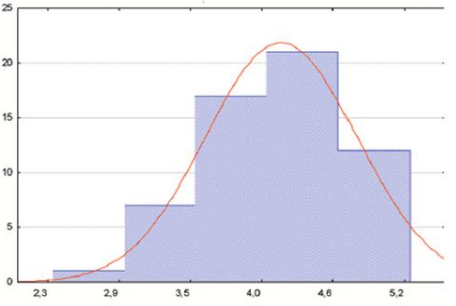

Fig. 2 Variable Start (S) - female

Skewness in the *Start* variable male subjects (-0.68), female subjects (-0.55) indicates a negatively asymmetrical distribution which means a large data cluster in the higher grades zone has occurred.

Kutrosis in the Start variable male subjects (-0.14), female subjects (-0.54) indicates a slight flattening in the data distribution. Greater distribution of data is evident in female subjects which is understandable since the sample is significantly smaller in relation to the male sample. (*Table 1,2*)

Normal distribution analysis was conducted by Kolmogorov-Smirnov Test which is based on the analysis of the extent of deviation of the observed distribution frequency data from the theoretical Gaussian distribution frequency. The extent of deviation indicator is the maxD coefficient (maximal distance between the relative observed frequency and relative theoretical frequency) is correlated with the coefficient from the Kolmogorov-Smirnov Test. If the maxD does not exceed the critical values of K-S test it can be determined that the observed distribution frequency does not significally deviate from the Gaussian distribution frequency.

However, the results of the Kolomogorov-Smirnov Test only give us the information if the difference in the calculated data distribution and normal distriburion is significant or not.

To precisely define the sensitivity of the measuring instrument it is necessary to interpret the peakedness and symmetry of the data (kurtosis and skewness)

Tab. 3 Kolmogorov-Smirnov Test

	MAX D - male	MAX D - female
START	0.10	0.16
TACK	0.11	0.15
GYBE	0.14	0.15

-Critical value of the K-S Test for male (n=122) n=100 p=0,01; 0,16

-Critical value of the K-S Test for female (n=58) n=55 p=0,01; 0,21

-Max D-maximal deviation of relative cumulative empirical frequency from relative cumulative theoretical frequency

Testing the normal distribution in variable *Start* the value maxD – men (0.10) is lower than the critical value of the K-S Test (0.16) concluding that the emphirical distribution does not significantly deviate from normal distribution with the applicable 1 percent deviance in results.

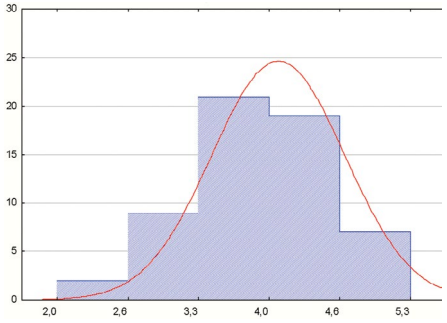

Fig. 3 Variable Gybe – males

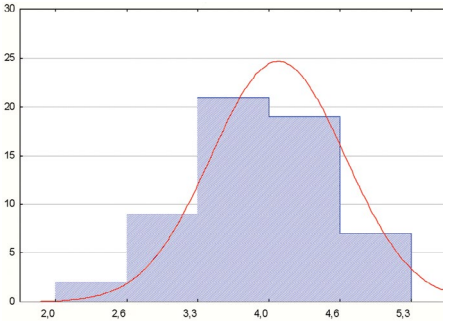

Fig. 4 Variable Gybe - females

In the *Tack* variable the degree of peakedness is negative in male subjects (-0.14) and in female subject (-0.02). The negative asymmetry indicates a large number of subjects with above average results.

Both distributions are slightly flat-topped. The platykurticity is more prominent in female subjects (-0.50) than in male subjects (-0.33). The results indicate that a lower number of data is centered around the arithmetic mean than there are in the normal distribution thus concluding that the sample is heterogeneous and the test sensitive.

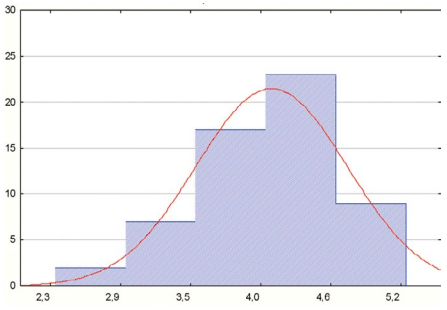

Fig. 5 Variable Tack - males

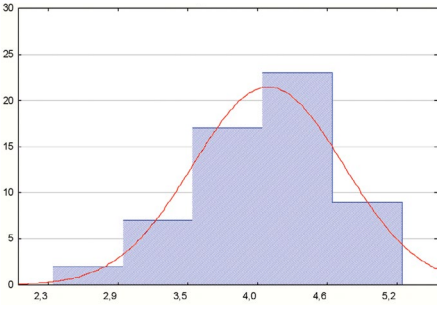

Fig. 6 Variable Tack - females

The asymmetry coefficient in the Gybe variable indicates a slight negative asymmetry in male subjects (-0.21) and a more prominent negative asymmetry in female subjects (-0.61). Based on these results we can determine that the female subjects had achieved better results than male subjects.

The peakedness coefficient is negative in both genders, male (-0.90) and female (-0.26). In female subjects the distribution according to the K-S Test of normal

distribution is acceptable, while in male subjects a higher degree of peakedness deviation is observed, but according to the critical value K-S Test for n=122 (p=0.01) from 0,16 it can be concluded that the Gybe variable (K-S 0.14) does not deviate from normal distribution. The results could be interpreted that the Gybe variable is too easy for both genders which caused a deviation from the Gaussian distribution and indicate that the Gybe variable or the execution style should be changed in future research.

From the presented data it is possible to conclude that all three observed distributions in male and female subjects are bell-shaped, unimodal, slightly negatively asymmetrical and flat-topped.

Generally it is possible to conclude that a low number of male and female subjects had bad results, which indicates that there were no difficulties in mastering the basic windsurfing technique elements in most subjects. This result is corroborated by the fact that the sample consists of a selected population of third year students from the Faculty of Kinesology who have passed through multiple selection steps.

4.1. Judge objectivity

In order to give validity to the statistically analyzed data measures of variable reliability were calculated separately for male (*Table 4*) and female (*Table 5*) subjects.

Tab. 4 Results of the realiability analysis for male subjects (n=122)

	Start	Tack	Gybe
RELIABILITY-Cronbach alpha	0.77	0.75	0.79
HOMOGENEITY-Average inter-item corr.	0.52	0.51	0.57

Tab. 5 Results of the realiability analysis for female subjects (n=58)

	Start	Tack	Gybe
RELIABILITY -Cronbach alpha	0.74	0.76	0.78
HOMOGENEITY -Average inter-item corr.	0.49	0.52	0.54

The Cronbach coefficient of reliability indicates a satisfying objectivity of this set of judges in grading the execution of basic windsurfing technique elements.

The value of the judge's reliability coefficient is higher in male subjects in the *Start* (male subjects 0.77 - female subjects 0.74) and Gybe (male subjects 0.79 – female subjects 0,78), while in female subjects the *Tack* element is higher (male subjects 0.75 – female subjects 0.76). Differences in the judge's objectivity between males and females is relatively small which indicates a satisfying conciliation of judges.

The homogeneity is based upon the assumption that the correlation between elements will be higher than assumed. i.e. the correlation between elements will be close to zero if the elements have multiple independent tests.

The lowes average judge's homogeneity value was shown on the Start variable (0.49) in female subjects, and the highest on the Gybe variable (0.57) in male subjects. It is interesting to note that there is no significant deviation between judges on any of the three variables. The average correlation between the lecturer, course associate and part-time associate indicates a medium homogeneity between judges. The presented data could be explainded by the fact that the lecturer was present during the whole educational and instructional process. Observing the subjects during the process of mastering the basic windsurfing technique elements gave the lecturer a wider understanding of the subject's abilities and achieved results, which could have led to bias grading. The lecturer has the most experience in grading, while a part-time associate is the least familiar with the process causing a mild discrepancy in subject grading.

4.2. Discriminant analysis

According to the results of the discriminant analysis (*Table 6*) it is evident that the difference between male and female subjects in the observed set of variables is statistically significant with the applicable error $p<0.05$ and is in accordance with the postulated null hypothesis.The canonical discriminant coefficient (0.35) shows a mediocre ability to distinguish between males and females based on the results on the standardized discriminant function.

Tab. 6 Results of the discriminant analysis – statistical significance and arithmetic mean of discriminant function groups (DF1)

DF1
λ1 0.14
Rc 0.35
Wilks' 0.87
Chi-square 23.75
df 3.00
p 0.00
XM -0.26
Xf 0.55

Legend: λ1- discriminant function variance; Rc – canonic discriminant coefficient; Wilks' – Wilks lambda distribution; chi- square distribution; df – degree of freedom; p – minimal statistical error of discriminant function; XM – arithmetic mean of male subject on the discriminant function; Xf – arithmetic mean of female subjects on the discriminant function

As the arithmetic mean of the female subjects is on the positive end of the discriminant function (0.55) and the arithmetic mean of the male subjects is on the negative end (-0.26) it can be concluded that in the set of analysed tests the female subjects achieved better results.

The differences could be contributed to anthropometric gender characteristics, mainly body weight and body height. It is a known fact that women are of a more gracile built, shorter and lighter than men. In demonstrating the basic windsurfing technique elements such as shifting your body centre women disturbed the board's stability less than men. Disturbing the stability is an additional factor in the beginning of training and in performance assessment. With less robust board movements and more patience they wait for it to react to the wind, especially during Gybe, because in its structure and performance conditions it is the most complex of all variables.

Similar characteristic were examined in the Hošek-Momirović (1981) research. The connection between morphological manifested and latent coordination dimensions where it is stated that adipose body volume, defined as a massive skeletal system along with a hight fat content, generally has a negative effect on the ability to master and perform complex locomotor tasks.

Contrary to women, men with fierce movements and a higher amplitude of agility accomplish greater angular velocity, applying a greater force on the board itself, which results in a balance sling.

Namely, men have a more aggressive approach than women, forcing the strenght they feel is necessary to perform the basic elements. With this approach they forcefully oppose the wind, which is absurd. Women are less aggressive and they start implementing the correct thechnique quickly which gives them an edge during the first days of windsurfing instruction.

Tab. 7 The results of the discriminant analysis – the structural matrix of the discriminant function (DF1)

Functions (DF1) DF1
START 0.88
TACK 0.42
GYBE 0.59

The largest discriminant function correlation was established for the *Start* variable (0.88) followed by Gybe variable (0.59) and *Tack* (0.42) with the lowest correlation (*Table 7*). According to the results the *Start* variable produced the most noticable distinction between males and females.

Start as an element puts the emphasis on static balance, as opposed to other elements in which the dynamic balance is prominent, and this is considered to

be a contributing factor in gender differences in this study. During their study on the Faculty of Kinesiology the female subject sample (female students) had more chances to practice and master the different elements in which the static and dynamic balance was key, such as rhythmic gymnastic. The main reason male students have achieved worse results in basic windsurfing training is that they had fewer courses and opportuinities to practice and develop a steady balance.

Conclusion

The sample consisted of 58 female and 122 male healthy students, selected for motoric skill and knowledge, ages between 22 nad 25 from the Faculty of Kinesiology, University of Zagreb, enrolled in their third year of study for the academic year *2009/10* and *2010/11*.

The goal of this study was to establish if there are any differences in the success of males and females in windsurfing instruction.

The variable set consisted of three main technique elements of windsurfing: *Start, Tack, and* Gybe.

The execution of main elements has been graded by three judges: the lecturer, course associate and a part-time associate from the Faculty of Kinesiology. The grading system was on a scale from one to five. The grading was conducted as a part of the *Water Sports* course practical exam.

By discriminant analysis differences in the success rate of teaching windsurfing have been detrmined.

The following has been established:

- the judge's objectivity in grading the main windsurfing technique elements (*Start, Tack* and Gybe) is satisfactory
- the canonical discriminant coefficient (0,35) indicates a mediocre distinguishing ability between males and females on the established discriminant function
- arithmetic mean of the female subjects is on the positive end of the discriminant function (0,55) and the arithmetic mean of the male subjects is on the negative end (-0,26) it can be concluded that in the set of analysed tests the female subjects achieved better results
- the *Start* variable (0,88) produced the most noticable distinction between males and females

The conclusion of this research is that there are statistically significant differences between males and females in basic windsurfing technique elements. Further research is needed to enhance teaching windsurfing and to make it more gender appropriate.

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ANALYSIS OF THE GAME CHARACTERISTICS OF A FINAL JUNIORS MATCH UP TO 14 YEARS AT WORLD JUNIOR TENNIS FINALS (WJFT) IN 2013

Michal Polách[1], Jiří Zháněl[1], Jiří Pačes[1], Miroslav Černošek[2]
[1]Faculty of Sports Studies, Masaryk University, Brno, Czech Republic
[2]TK Plus Prostějov, Czech Republic

Abstract

In many ball sports the results of the game analysis are used to obtain feedback for the player and the coach. In tennis, the most frequent method is the analysis of game characteristics - questionnaires for players, match minutes (written or visual) or using various kinds of computer programs. The results of analyses of the most important game characteristics are now available electronically at major tennis tournaments. The most frequently analysed data are: aces, double faults, first and second serve success, points won after first and second serve, return points won, net points won, breakpoints won, total number of winners, unforced errors and total number of points won. The aim of this research is to perform an analysis of game characteristics of junior´s final match up to 14 years at World Junior Tennis Finals in 2013 in Prostějov (WJTF, World Championship teams of boys and girls up to 14 years) and at French Open 2013 (Paris, Roland Garros. Our goal is to determine which game characteristics are important for the match results by juniors and adult players. At the same time, we aim to compare the results of juniors (WJTF) and adult players (French Open). The final match of juniors at WJTF 2013 (USA x Russia, players PKY and PKL) were analysed from video, the evaluation of observed game characteristics was accomplished according to the uniform methodology developed by tennis experts. Game characteristics of the final match at French Open 2013 (Spain x Spain, the players RN and DF) was obtained from statistical data software database OnCourt. Based on the game characteristics analysis performed by finalists WJTF 2013, it was noted that the winning player PKY was more successful in first serve success, number of double faults, points won after first and second serve, return points won, number of unforced errors and also breakpoints won. Defeated player PKL was successful in net points won and he recorded more aces and winners. The winner of the French Open 2013 player RN was more successful in all above-mentioned game characteristics than his opponent DF. The comparison of game characteristics by the winners of the male (RN) and junior (PKY) finals showed that the player RN achieved higher first serve success, higher number of aces, more points won after first and second serve, more return points won, less number of unforced errors and higher number of winners. The

junior winner PKY gained less double faults, more breakpoints won and net points won. The number of unforced errors, winners, points won after first and second serve and return points won can be considered as the most important game characteristics for the results of the game.

Keywords: *game analysis, match statistics, tennis, sports performance, key characteristics*

Introduction

The outcome of a tennis match is influenced by many factors, so it is essential to create a link between players, coaches and researchers. The analysis of game characteristics is one of the ways how to obtain feedback for the following training process. According to Hughes and Franks (2004) there are many areas in tennis that still can be explored. These areas may include statistical analysis of game characteristics. As indicated by Crespo and Miley (2003) processing of these data enables formulation of new training objectives, the strategy and tactics evaluation, mental readiness, and competitor's analysis etc. According to Over and O'Donoghue (2008) it is not usual to have personal analyst of tennis matches. Coach and tennis player themselves perform this function. Filipčič, Čakš and Filipčič (2011) mention that the statistical analysis of the game characteristics allows to better describe the causes of defeat or victory in a match. Hughes and Bartlett (in Pfeiffer, Hui and Hohmann, 2010) indicate, given the example of table tennis that athletes and coaches can obtain optimum feedback from the record of game characteristics by continuous protocoling. This feedback can subsequently be used for performance enhancement.

Numerous methods can be used to analyse a tennis match. Molina (2004) suggests to work with a table that would include performance criteria (such as consistency, ball placement, concentration, change of rhythm, moment of surprise, fight effort). Player completes this table and then performs post-match evaluation together with coach. The traditional research method is strategic and tactical evaluation of game characteristics. Hughes, Hughes and Behan (2007) inform that first hand notational analysis system in tennis was published in 1973 in Britain by Downey. Authors Hui, Lijuan and Jinju (2010) and Pearce (2005) inform that hand notational analysis has been replaced by computer programs. Companies and research institutions develop new computer programs for technical and tactical analysis of sport matches, such as SIMI Scout, Dartfish, Utilius® VS, Digital Scout etc.

Various authors analyse selected game characteristics in tennis. Brody (2004) addresses service and concludes that the decisive moment for winning own serve is not the first serve success percentage (more than 65 %) but the percentage of points won

after first serve. Some researches (Bedford, Barnett and Pollard, 2010; O´Donoghue and Ingram, O´Donoghue and Ballantyne in Filipčič et al., 2011) reveal that women obtain a higher first serve success percentage on all surfaces than men, whereas men gain a higher percentage of points won after first and second serve. Total points won is another frequently analysed game characteristic. Filipčič et al. (2011) point out that winners gained more points in total and also obtained more points in series (three points in a row or more) than defeated players. This was confirmed also by Schönborn (2006). His analysis shows that in most cases the match was won by the player with a higher number of total points won. There were only few exceptions (defeat in one set 0:6 or tight winning of games after own serve).

One needs to keep in mind that surface has an important influence on player's tactics. Barnett and Pollard (in Katić, R., Milat, S., Zagorac, N., & Đurović, N., 2011) compared game characteristics on tournaments Wimbledon (grass court) and Roland Garros (clay court) in 2004. They conclude that the number of aces, more frequent play on the net and serve points won were more usual on Wimbledon whereas the slower clay court on Roland Garros has an influence on serve effectiveness that results in a higher number of breakballs and longer rallies. From this data we can conclude that the post-match analysis of statistical data plays an important role in the performance assessment. Aces, double faults, first-serve success, first-serve points won, second-serve points won, net points won, breakpoints won, return points won, winners, unforced errors, total points won are the game characteristics that are most frequently used for post-match analysis. Following data can be useful for coaches and players to enhance the performance: statistical data collected during tennis matches, broadcasted match statistics or data obtained through special tennis software. Some of them work also with mathematical models (Bedford, Barnett and Pollard, 2010).

There are various Internet and Software sources for tennis match analysis. The game statistics of the most important tournaments is broadcasted directly after match on television or can be found on Internet. Schönborn (2006) recommends PointStream software developed by IBM (Slamtracker). This computerised graphic system is used on all Grand Slams (Australian Open, French Open, Wimbledon and US Open). According to IBM (2011) the live scores and statistics are available on the Internet and players receive detailed analyses after the match. There are also specialized Internet servers that enable access to statistics of tournaments in progress or those already finished, for example www.matchstat.com and www.atpworldtour.com. Another source of tennis match analysis are software programs. OnCourt (www.oncourt.info) includes various data from the history of tennis matches. Programs SIMI Scout, Silicon Coach, V1 Sports serve to the technical analysis of tennis match. Another company Dartfish offers a programs (for desktop computers: Dartfish ConnectPlus or for tablets and mobiles: Dartfish Note) that evaluate specific game parameters

defined by customer. Dartfish uses tagging for reviewing and analysing key moments in a game. Program Break2Win (www.break2win.com) works similarly. Another example is programme Tennis Metrics. Albamonte, Lescano and Morales (2011) explain that Tennis Metrics is a system which uses video to analyse data on players, the court and relation between them (for example distance run, speed of the sprints).

Methods

From the view of research methodology it was a quantitative research – comparison. The aim of the research was to analyse game characteristics of the final match at World Junior Tennis Finals (WJTF) in 2013 and final match at men French Open in 2013. We wanted to identify differences in the game characteristics between juniors and adults. Participants of the final match at WJTF 2013 were juniors PKY (USA) and PKL (RUS). In the final of the French Open 2013 were players RN (Spain) and DF (Spain).

Research questions:

1. Which game characteristics are significant for results of the boys´ final match at WJTF in 2013?
2. Which game characteristics are significant for results of the men final match at French Open in 2013?
3. What conclusions can be deduced from a comparison of game characteristics at WJTF and at French Open?

Final junior match was recorded on video and subsequently the analysis of game characteristics was accomplished according to the methodology of Schönborn and Zháněl (2007). The evaluation methodology included following points:

1. Ball placement of both players during every point
   a) Service (zones: out of the court, court centre, T-line)
   b) Return (zones: right, left, centre, red, out, net)
   c) Groundstrokes (same zones as by return)
   d) Volleys (same zones as by return)
2. Zones where players hit the ball during every game (zones: behind and in front of the baseline, in front of the service line, on the right and the left half of the court, next to the right and left sideline)
3. Errors that hit the net, errors behind the sideline, errors behind the baseline
4. Number of strokes during one point (including service)
5. Winners by each player (forehand, backhand, volley, service, return, stopball, passing shot, lob, overhead shot)
6. Forced errors by each player (forehand, backhand, volley, return)
7. Unforced errors by each player (same as forced errors)

8. Interim points by both players
9. Number of first and second serve by each player (good, ball ends in the net, out)
10. Measurement of the rally length

To obtain research data using the above methodology Dartfish software version 7.0. was applied in addition to a manual notation. The resulting data was then processed into tables. The calculations were performed using MS Excel software.

Results and Discussion

Tables 1 and 2 show an overview of game characteristics of the final junior match at WJTF 2013

Tab. 1 Game characteristics on serve WJTF 2013

Analysis of a junior final match		
Game characteristics on serve	USA : RUS 7/6 (4), 7/5	
	PKY	PKL
Aces	1	7
Double faults	1	6
1st serve in	48/76 (63%)	46/83 (55%)
Points won after 1st and 2nd serve	45/77 (58%)	42/84 (50%)

The comparison of 1st serve in (Table 1) shows that the winner player PKY was better (63 %) than his opponent player PKL. He was also better in a total points won after 1st and 2nd serve (58 %). The defeated player PKL served more aggressively in comparison to his opponent PKY and it resulted also in a higher number of not only double faults (6) but also aces (7).

Tab. 2 Others game characteristics WJTF 2013

Analysis of a junior final match		
Other game characteristics	USA : RUS 7/6 (4), 7/5	
	PKY	PKL
Return points won	42/84 (50 %)	32/77 (41 %)
Net points won	6/7 (86 %)	5/5 (100 %)
Breakpoints won	7/11 (64 %)	4/7 (57 %)
Unforced errors	33	52
Winners	22	24
Total points won	87	74

The comparison of return points won (Table 2) shows that the winning player PKY was more successful (50 %) than his opponent player PKL. He has also recorded more breakpoints opportunities (11), higher success rate of breakpoints won (64 %) and a lower number of unforced errors (33). The defeated player PKL was better at net points won (100 %) and he had also more winners (24).

Tables 3 and 4 show an overview of game characteristics of the men final match at French Open 2013.

Tab. 3 Game characteristics on serve French Open 2013

Analysis of a men final match		
Game characteristics on serve	SPA : SPA 6/3, 6/2, 6/3	
	RN	DF
Aces	5	1
Double faults	2	5
1st serve in	61/87 (70 %)	53/85 (62 %)
Points won after 1st and 2nd serve	54/87 (62 %)	39/85 (46 %)

The comparison of 1st serve in (Table 3) shows that the winning player RN was better (70 %) than his opponent player DF. He was also better in a total points won after 1st and 2nd serve (62 %), higher number of aces (5) and lower number of double faults (2).

Tab. 4 Others game characteristics French Open 2013

Analysis of a men final match		
Other game characteristics	RN : DF 6/3, 6/2, 6/3	
	RN	DF
Return points won	46/85 (54 %)	33/87 (37 %)
Net points won	13/17 (76 %)	10/14 (71 %)
Breakpoints won	8/16 (50 %)	3/12 (25 %)
Unforced errors	25	35
Winners	35	22
Total points won	100	72

The comparison of return points won (Table 4) shows that the winning player RF was more successful (54 %) than his opponent player DF. He was also better in net points won (76 %), more breakpoints opportunities (16), higher success rate of breakpoints won (50 %), lower number of unforced errors (25) and more winners (35).

The comparison of a selected game characteristics by the junior winner WJTF 2013 and by the men winner French Open 2013 shows Table 5.

Tab. 5 Game characteristics junior winner WJTF 2013 and men winner French Open 2013

Game characteristics of male winners WJTF 2013 and French Open 2013		
Game characteristics	PKY (USA)	RN (SPA)
Aces	1	5
Double faults	1	2
1st serve in	48/76 (63%)	61/87 (70 %)
Points won after 1st and 2nd serve	45/77 (58%)	54/87 (62 %)
Breakpoints won	7/11 (64 %)	8/16 (50 %)
Return points won	42/84 (50 %)	46/85 (54 %)
Unforced errors	33	25
Winners	22	35
Net points won	6/7 (86 %)	13/17 (76 %)
Total points won	87	100
Match result	7/6 (4), 7/5	6/3, 6/2, 6/3

It is problematic to compare boys‘ singles with men’s singles because boys‘ singles are best-of-three-sets matches whereas all Grand Slams are best-of-five-sets matches. On the other hand if we look at the total number of 1st and 2nd serve there is not a big difference (PKY – 76, RN – 87) and the statistics on the total number of return is almost the same (PKY - 84 RN - 85). For this reason, I consider comparisons within the research questions to be justified. The comparison shows that the winner of men’s single RN had better statistics in the number of aces (5), 1st serve in (70 %), total points won after 1st and 2nd serve (62 %), total return points won (54 %), the number of unforced errors (25) and winners (35). On the other hand the junior player PKY made less double faults (1) and he also gained more breakball points won (64 %) and net points won (86 %).

It is very often observed that winners have a lower percentage of 1st serve success. The comparison of both final matches (WJTF and French Open 2013) shows that winners recorded higher 1st serve success, more points won after 1st and 2nd serve and also more return points won than the defeated players. The mutual comparison of the winning players PKY a RN shows that winner of French Open player RN was

successful in all these indicators. The junior winner PKY recorded a lower number of aces and double faults. In the men final the player RN was better in both of these indicators. The comparison between junior and men winners demonstrated more aces for man player RN, but a lower number of double faults for junior player PKY. The analysis of unforced errors and winners shows that the statistics of these game characteristics is significant for the result of the match. This statistics decides about the winner and the defeated player of the match and this not only in junior matches but also in the adult category. It is necessary to add, that a worse result in one of these indicators can be compensated by a better outcome in other game characteristic category. This fact was confirmed in junior final where the winning player gained a lower number of unforced errors but he also recorded a lower number of winners. Mutual comparison of the winning players shows higher percentage of unforced errors and winners for player RN. In both analyzed matches the winner was the player with more total points won at the end of the match. Surprisingly, the defeated player PKL gained more net points won in the junor final while in the adults match it was the winner RN. When comparing both winners, player PKY was more successful in netpoints won. Both winners PKY and RN have a better percentage of breakpoints won in comparison to their opponents, while player PKY used more breakpoints than player RN.

Conclusions

The analysis of game characteristics and the identification of differences in game characteristics by junior player and adults the methodics created by Schönborn a Zháněl (2007) has been applied. To answer the last research questions the game statistics from French Open 2013 have been used. The winner of the junior final match player PKY has a higher percentage of 1st serve in, less double faults, more points won after 1st and 2nd serve, more return points won, less unforced errors and he used more breakpoints than his opponent. The defeated player PKL gained more netpoints, higher number of aces and winners than the winning player PKY. In the men final the winning player RN was better in all mentioned game characteristics. The mutual comparison of both winners shows that player RN gained better results in 1st serve in, aces, points won after 1st and 2nd serve, return points won. He also had less unforced errors and more winners. Player PKY has better statistics in number of double faults, breakpoints and net points won.

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AGE-RELATED SPRINT PERFORMANCE CHARACTERISTICS OF ELITE MALE SOCCER PLAYERS

Karlo Reinholz, David Zubčić, Vlatko Vučetić
Faculty of Kinesiology, University of Zagreb, Croatia

Abstract

The main objective of this study was to analyze the differences in the parameters for the assessment of sprint performance of soccer players, from beginners to seniors. The study was conducted on Croatian national level soccer players (n=269) classified into thirteen levels of competition with respect to age categories (under = U8 to U18 and seniors= 19+). Soccer players were evaluated on linear sprinting on 20 m (analyzing partial times at 5 and 10 m). In the anthropometric characteristics, two stages of progressive and continuous growth in height (U8-U10 and U11-U17) were observed, as well as two stages of significant increase in body weight (U11-U12 and U14-U17). The manifestation of sprint abilities mainly follows the curve of growth in height of tested soccer players. Significant differences were observed even in small intervals of just one year (between U9-U10, U12-U13 and U13-U14; p<0, 05). These variations are the result of biological principles that take place in the development stages of the soccer players from the youngest age to the level of senior age as well as of transformation processes caused by training stimuli. This study presents typical values and changes in the parameters of sprint performance status of soccer players through all age categories, with respect to chronological age. The results of this research may enable better selection, monitoring, planning, programming and control of the training process.

Keywords: *soccer, sprint characteristics, age categories*

Introduction

In the new, but also the older insights of anthropological analysis of athletes, speed characteristics represent an unavoidable component when referring to generating performance of soccer players. Moreover, quick players are the subject of admiration and respect among coaches and sports scientists, but also the audience.

Soccer requires athletes to perform short sprints and changes of directions during the whole match (Krustrup et al., 2005; Stolen et al., 2005). Elite soccer players sprint between 1–11% of the total game time on high speed (Stølen, Chamari, Castagna & Wisløff, 2005). During the match, seniors sprint on average every 90 seconds and the duration of the sprints is normally between 2 and 4 seconds (Mohr, Krustrup &

Bangsbo, 2003). Sprint ability is significantly affected by the efficient energy transfer from the hip to the ankle joint and by other factors such as the optimization of the stride length and frequency (Mero, 1998), muscle morphology and architecture (Blazevich et al., 2003), neuromuscular coordination (Ecker, 1996) and training (Kotzamanidis, 2006).

The modern sports science and training technology from day to day tends to find solutions to affect the speed during the development of young players, but also recognizing if the young player fast is, or in another case, slow. The point of any soccer-specific identification process is to determine early predictors of future playing success (Williams & Reilly, 2000). There is a need of expert monitoring of the entire anthropological status of athletes from the earliest days up to the senior level in order to successfully influence the speed performance. A high level of knowledge about the biological principles of growth and maturation provides clear conditions for optimal monitoring, and thus enables precise planning and programming of training operators for the development of speed characteristics.

Therefore, the assessment of linear sprinting is common to soccer (Chamari et al., 2004) but there is no information in the literature regarding the annual sprint speed development in a wide range of age during entire growth period of soccer players.

For the mentioned reasons, the aim of the present study was to answer the following questions: (a) How does speed improve at the early phases of sprint during the growth and maturation periods in soccer players? (b) What is the chronological age that soccer players have the greatest increase in sprint characteristics (c) How does anthropometric characteristics increase during the growth and maturation periods?

Methods

Subjects

The study was conducted on Croatian national level soccer players (n=269) classified into thirteen levels of competition depending on chronological age.: U8 (n=16), U9 (n=16), U10 (n=16), U11 (n=23), U12 (n=20), U13 (n=22), U14 (n=22), U15 (n=22), U16 (n=17), U17 (n=28), U18 (n=20) and seniors, marked as 19 + (n=29). The athletes, and when necessary parents, were verbally informed of all experimental procedures and informed consent was completed before participation. The study was approved by the Ethics Committee of the Faculty of Kinesiology at the University of Zagreb according to the Helsinki Declaration.

Procedure

All participants were tested for each of the following physical anthropometric components: body height and body weight. Athletes performed a standardized warm-up of 15 minutes that included dynamic stretching exercises, core stabilization, specific muscles activation, jogging, and sprinting.

Linear sprint speed was evaluated using photocells on 20 m with analyzing partial times at 5 and 10 m splits. Infrared timing gates (Brower Timing, Utah) were positioned at 5, 10 and 20 m line at a height of approximately 1.0 m. Participants stood upright at the start line and began on a digital sound. The athletes were instructed to run at maximal speed through the final pair of sensors and performed three trials with the average score used for statistical analysis. A minimum of three minutes of rest was provided between trials to reduce the fatigue.

Statistical Analysis

Data are presented as mean and SD. A one-way ANOVA was used to compare the sprint performance characteristics between each year of chronological age. When a significant F-value was observed, Bonferoni post-hoc analyses were conducted to determine differences. Significance was set for the calculations at 5% ($p < 0.05$). All statistical procedures were performed using Statistica Version 12.0.

Results

Anthropometric data are shown in Table 1.

Tab. 1 Anthropometric and sprint performance characteristics (Mean ± SD) for

Age (years)	7.6±0.3	8.8±0.2	9.8±0.2	10.6±0.3	11.6±0.2	12.5±0.3	13.6±0.3
Height (cm)	126.5±6.1	134.4±6.3	141.1±6.1	142.9±5.3	151.2±7.2	156.8±6.7	161.8±8.9
Weight (kg)	25.6±3.4	30.3±3.9	32.2±2.2	34.9±3.1	42.0±5.3	43.6±4.4	48.6±6.2
Sprint 5 m (s)	1.91±0.08	1.87±0.08	1.80±0.08	1.73±0.09	1.73±0.08	1.68±0.08	1.62±0.07
Sprint 10 m (s)	2.92±0.13	2.83±0.12	2.72±0.11	2.62±0.13	2.63±0.11	2.57±0.08	2.47±0.09
Sprint 20 m (s)	4.89±0.27	4.69±0.22	4.32±0.18	4.29±0.26	4.25±0.19	4.14±0.12	3.95±0.15
	U15 (n=22)	**U16 (n=17)**	**U17 (n=28)**	**U18 (n=20)**	**U19 (n=18)**	**19+ (n=29)**	**p**
Age (years)	14.7±0.3	15.6±0.4	16.6±0.3	17.7±0.3	18.8±0.2	22.1±3.3	
Height (cm)	168.7±10.0	173.1±8.1	179.7±7.1	181.3±5.8	181.1±5.9	180.0±7.3	<0.01
Weight (kg)	58.4±9.5	62.2±6.6	71.9±9.3	71.5±7.4	73.8±5.0	76.1±6.9	<0.01
Sprint 5 m (s)	1.56±0.04	1.50±0.06	1.50±0.05	1.53±0.06	1.51±0.04	1.45±0.05	<0.01
Sprint 10 m (s)	2.37±0.07	2.30±0.07	2.27±0.07	2.29±0.07	2.26±0.05	2.22±0.06	<0.01
Sprint 20 m (s)	3.74±0.13	3.66±0.11	3.61±0.13	3.60±0.12	3.54±0.07	3.46±0.09	<0.01

Analyzing the graphs (Fig. 1 and 2), it can be observed that the values of body height and body weight have continuous increase due to age groups.

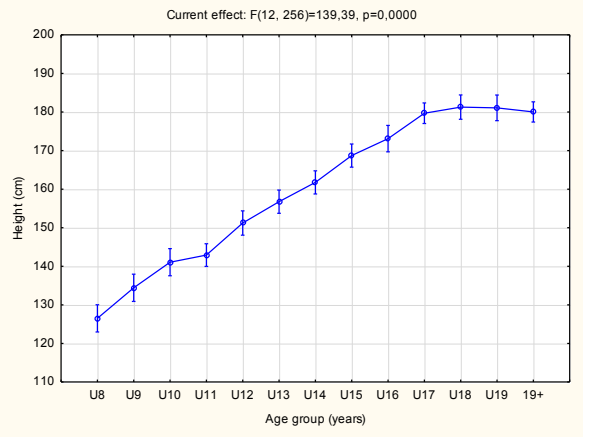

Fig. 1 Differences in height in soccer players *(U8-19+)*

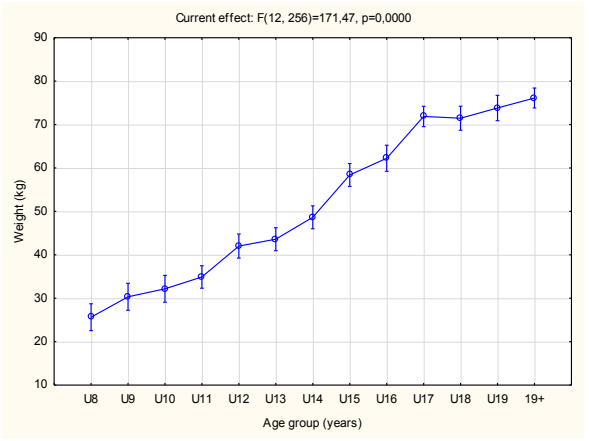

Fig. 2 Differences in weight in soccer players *(U8-19+)*

Results indicated two stages of progressive and continuous growth in height (U8-U10 and U11-U17), as well as two stages of significant increase in body weight (U11-U12 and U14-U17). Post hoc analysis revealed that U12 players were significantly ($p<0.01$) taller (151.2±7.2 cm) than U11 players (142.9±5.3 cm). The second sudden increase occurred between U14 (161.8±8.9 cm) and U15 (168.7±10.0) age category, but not statistically significant ($p>0.05$). In body weight, post hoc analysis showed three significant differences ($p<0.01$) when taking into account the distance of one year, between U11 (34.9±3.1 kg) and U12 (42.0±5.3 kg), U14 (48.6±6.2 kg) and U15 (58.4±9.5 kg), and between U16 (62.2±6.6 kg) and U17 (71.9±9.3 kg). After U17 category there were no longer a linear growth trend in body height and body weight, respectively.

Sprint values for 5, 10, and 20 m across chronological ages are presented in Fig. 3, 4 and 5.

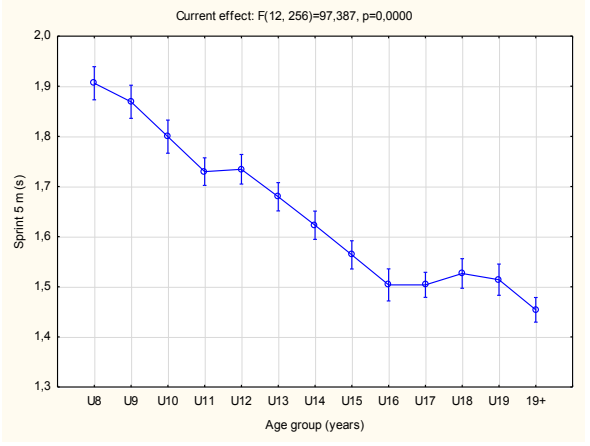

Fig. 3 Differences at 5 m sprint in soccer players *(U8-19+)*

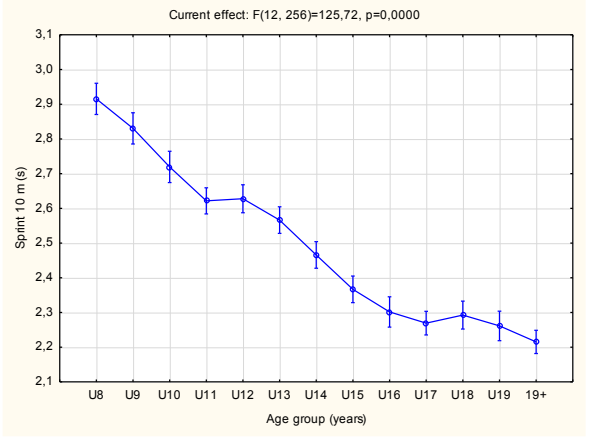

Fig. 4 Differences at 10 m sprint in soccer players *(U8-19+)*

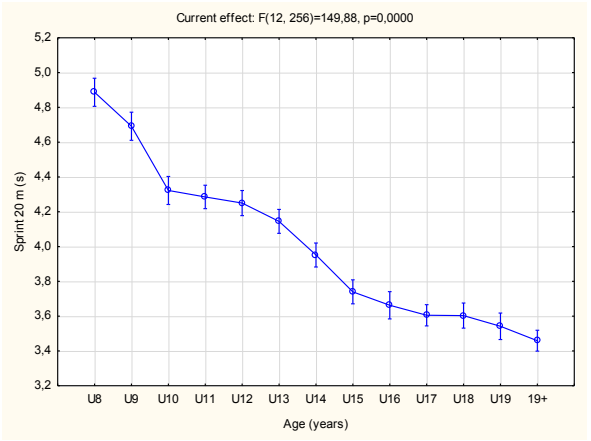

Fig. 5 Differences at 20 m sprint in soccer players *(U8-19+)*

Results demonstrated a gradual significant improvement with respect to age. A very similar trend observed at 5 and 10 m phase was also followed at the entire 20 m sprint. Post hoc analysis revealed that there were no significant differences ($p>0.05$) between groups in intervals of one year considering the sprint at 5 m. Significant differences ($p<0.05$) at 10 m sprint phase were found between U13 (2.57±0.08 s) and U14 (2.37±0.07 s) and between U14 and U15 (2.37±0.07 s) age group. For 20 m sprint significant one-year differences ($p<0.05$) were observed between three age groups: between U9 (4.69±0.22 s) and U10 (4.69±0.22 s), U12 (4.25±0.19 s) and U13 (4.14±0.12 s) and between U13 and U14 (3.95±0.15 s). Visually inspecting the graph, it could be stated that the largest increase in the sprint occurs through 2 stages of U8-U11 and U12-U15 age group. After U16 age group is evident delay in speed development and with the senior age (U19 and 19 +) results were progressing again.

Discussion

From the aspect of anthropometric characteristics, rapid increase in height between U14 and U15 age group coincides with the research when it comes to peak height velocity (Malina et al., 2007). A huge difference between U11 and U12 age groups could have caused the lack of subjects in this cross-sectional study, thus it cannot be concluded with certainty that peak height velocity usually happens in this age. The plateau appeared after U17 age category, which is in accordance with research from Payne and Isaacs (1995), that boys achieve 98% of their body height to the age 18. It can be seen that in most categories increasing trend of body height follows

a component of body weight. Players at the stage of late adolescence were achieving higher values of body weight, which can be explained by a significant increase of mesomorph characteristics (Torteva, 2002).

Our data supports and expands upon previous findings that speed development generally follow the curve of growth in height and maturation (Malina et al., 2004; Rowland, 2005; Stark et al., 2010). In present study have been found age-based differences of the sprint performance qualities. The greatest development in sprint characteristics have been found between U8 and U10 and between U12 and U15 age category. This is not surprising considering that other investigators have reported that the greatest rate of improvement in sprint ability occurs in two acceleration stages, from 8 years and between 12 and 15 years (Reilly et al., 2000). The speed development during growth and maturation periods, proved in the present study, can be due to the interconnectedness of training transformational process and natural biological development of any individual. Body height that is associated with the length of legs can affect the length of the stride (Ecker, 1998; Rowland 2005). On the other side, neural changes cause better neuromuscular coordination (Ross et al., 2001) and stride frequency (Mero, 1998). Furthermore, with the maturity comes to changes in the strength and power which can expressly affect the speed characteristics (Kotzamanidis, 2006).

Results showed best sprint performance on senior players and one of the reasons could be more frequent strength and conditioning as well as soccer training sessions in older age categories. This refers to the anatomical and biomechanical adaptation of the neuromuscular system by activating muscle groups around foot and knee joints. It can be assumed that some of the subjects had a greater impact of the training stimulus, and some of the natural curve of development. In the best case, there is a hypothetical possibility that both components occurred. Synergy of these factors could provide a satisfactory level of speed in top senior football.

Lastly, it is inevitable to refer to the lack of information on the individual characteristics of each subject at the beginning of his career as well as training operators which affected on the players. Nevertheless, the variations indicate different sprint performance characteristics between chronological categories of soccer players.

Conclusion

The study indicates that chronological age is a factor that affect the sprint performance during growth and maturation periods. The present data might provide the groundwork for expedient individual approach in evaluating and monitoring the sprint characteristics. Specifically, such normative databases may constitute a rough guideline for the coaches to determine the current status of sprint performance. After that, it can be of great help in creating optimal training strategies for the soccer players in sprint abilities development.

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SPORTS TRAINING WITHIN A SPECIAL OLYMPICS FITNESS INNOVATION PROGRAMME

Hana Válková
Faculty of Sports Sciences, Masaryk University, Brno

Abstract

The presented article is focused on athletes – Special Olympians and their fitness within a track and field environment. The basic principle of the Special Olympics (SO) sports programme is participation in year round training and competition. The improvement of fitness is considered as the basis for future sports achievement and the improvement of athletes´ health related fitness variables. Special Olympics Europe/Eurasia selected six European SO Healthy Athletes' programmes to innovate the fitness of athletes with a mental disability. This was accomplished with the aid of a European Union grant. The Czech Republic's SO programme is focused on the education of coaches and athletes on fitness training. The presented article describes the case studies of 11 athletes (beginners, as well as advanced athletes). It includes their training achievements in athletic running events (100 – 200 – 400 m), measured over the last two years (in 2014 and more especially in 2015). Running events were chosen because the natural movement involved is minimally polluted by skills (influenced by cognitive limits). Examples are given of athletes´ performances in different age cohorts and in different training regimes. In conclusion, athletes with a mental disability like to train and like to participate in competition. It is possible to improve their fitness and results by regular training, even those in the 40-50 year old age bracket.

Keywords: *mental disability, Healthy Athletes' programme, fitness, athletic race*

Introduction

Intellectual Disability and Physical Activities

The first research project, which focused on physical activities and sport concerning individuals with mental retardation, started in the 1970s (Broadhead & Church, 1984; Cratty, 1972; Faith, 1972; Roswal et al., 1984; Sherrill et al., 1998, 2004; Winnick & Short, 1985). The term, mental retardation, was changed to mental disability, and more recently, the term, intellectual disability, is commonly used. The description of motor abilities, fitness variables and motor skills development was a frequent topic of discussion in this pioneering period (Cratty, 1972; Pitetti et al.,

1989; Rarick et al., 1970; Rintala & Palsio, 1994; Vermeer, 1990; Vermeer & Davis, 1995; Winnick & Short, 1985). Physical activities have also been noted, in terms of improving physical, social and general life competences, as the basis for community inclusion (Ninot et al., 2000; Temple & Walkley, 2003). Positive psychosocial benefits of physical activities were found, along with positive changes to motor abilities and fitness (Nankervis, Cousins, Válková & Macintyre, 2014; Válková, 1998; Wilhite & Kleiber, 1992). The growing world popularity of the Special Olympics (SO) sports programme has been supported with the education of coaches, athletes and their parents. Secondary arguments for education and training programmes had to be accompanied with relevant research (Hassan, Dowling & McConkey, 2014; Special Olympics, 2011; Taggart & Cousins, 2014).

Special Olympics Programme

"The mission of Special Olympics is to provide year-round sports training and athletic competitions in a variety of Olympic-type sports for children and adults with intellectual disabilities, giving them continuing opportunities to develop physical fitness, demonstrate courage, experience joy and participate in a sharing of gifts, skills and friendship with their families, other Special Olympics athletes and the community" (Special Olympics, 2010, p.14).

The Special Olympics (SO) philosophy is based on the principle of relativity, which means that all Special Olympians can participate in appropriate groups, according to their abilities, skills and limits, with respect to the training effect. As the SO programme has become an expanding intervention sports programme, the effect of SO participation has been analysed, according to various aspects: the influence on separation or community integration, healthy lifestyle, social competence, independence and self-awareness (Coreen et al., 2009; Dykens & Cohen, 1996; Dykens et al., 1999; Hourcade, 1989; Orelove, Wehman & Wood, 1982; Roswal, Damentko, Smith, Braycich & Krogulec, 2003; Válková, Hansgut & Nováčková, 1999; Wilhite & Kleiber, 1992). Besides sports programmes, so called complimentary programmes are also realised within SO.

Special Olympics Healthy Athlete Programme

Among nearly twenty programmes, Czech Special Olympics is focused on a Healthy Athletes project and education, both with the support of universities and with the financial support of SO Europe/Eurasia and the European Union.

The key objectives of Special Olympics Healthy Athletes are to:

- Improve access to care at event-based and other health screening clinics
- Make appropriate referrals for follow-ups with community health professionals
- Train healthcare professionals and students on the needs of people with intellectual disabilities
- Collect, analyse and disseminate data on the health needs of people with intellectual disabilities
- Advocate for improved health policies and programmes for people with intellectual disabilities.

The seven Healthy Athletes Disciplines are (the starting year is in brackets):

- Special Olympics – Lions Clubs International Opening Eyes® (1991)
- Special Olympics Special Smiles® (1992)
- Special Olympics FUNfitness (1999)
- Special Olympics Healthy Hearing (2000)
- Special Olympics Health Promotion (2001)
- Special Olympics Fit Feet (2003)
- Special Olympics MedFest® (2007); (www.specialolympics.org/health programs)

Czech SO jointly ran this programme in 2000. Since that first time, the HA programme has been realised at national games or tournaments once or twice per year, especially the FUNFitness discipline.

The content of the HA FUNfitness test battery was developed in accordance with the expertise of AAHPHER, and later in accordance with EUROFIT tests, which measured variables of motor abilities (endurance, strength of basic muscle systems, flexibility etc.). Slight modifications were verified for persons with intellectual disabilities (Skowronski et al., 2009; Special Olympics, 2011).

Methods

Strategy

The improvement of athletes´ fitness, as one of the markers of their health condition and sports achievement, became a crucial issue for the SO HA Fitness Innovation Project for 2015. The SO Czech Republic project focused on the following domains:
1st domain: coaches and athletes' education in fitness training;
2nd domain: measurement of fitness variables, according to the FUNFitness manual;
3rd domain: description of athletes' training achievements in athletic running events (100 m – 200 m – 400 m), measured during the 2013 - 2015 seasons.
Running events were chosen, because the natural movement involved is minimally

polluted with skills (skills influenced by cognitive limits). The 3rd domain was selected for the article for the following reasons:

a) the competitive atmosphere provides different types of motivation compared to laboratory testing,
b) achievements on the track are more visible for athletes and coaches, as a criterion of fitness,
c) laboratory fitness testing is usual, lack of information from natural field fitness assessment.

Research procedure

The results of races (100 m – 200 m – 400 m) were measured in competitions on a national level:
July 2013, Visegrad SO Games in the city of Olomouc [abrev. 2013];
July 2014, CZ SO National Games in the city of Brno [abrev. 2014];
May 2015, National Athletic Tournament in the city of Brno [abrev. 2015];
August 2015, open competition with special focus on beginners and their motivation to participate in more demanding races [abrev. OPEN].

The cities of Olomouc and Brno were selected, because the conditions are relevant to competition on a national level: athletic stadium with an eight-lane track, artificial surface, time measurement with a camera, trained officials and university support with volunteers.

During 2015, coaches went through an education programme focused on fitness innovation (theory and practice). As the "case stories" strategy was applied, only logical analysis was used as the method for data evaluation.

Participants

The presented article describes the "case stories" of 11 athletes, advanced athletes as well as beginners.

Only participants who had competed in 100 m – 200 m – 400 m races during the 2013 – 2015 seasons, and had participated in a minimum of two events were included in the investigation. Thus, both beginners and advanced athletes contributed to the overall picture of SO athletes in sprint fitness. All of them:

- had a moderate level of intellectual disability,
- needed either a limited or intermittent level of support,
- nobody was a wheelchair user or was diagnosed with cerebral palsy,
- participated in CZ SO for more than two years (except participants in OPEN),
- registered in CZ SO, meaning they have signed an agreement with their parents.

(caregivers) to participate in non-invasive Healthy Athlete screening.
Total number of participants: 11 (six males, five females and two young beginners).

Results and Discussion

Coaches and athletes' training An important part of the Fitness Innovation Progress grant was to put together a short cohesive education programme, focused on fitness improvement. Coaches in CZ SO had to be educated on the design of the Special Olympics (request for the registration of their SO club in the Czech Special Olympics Movement) special programme for fitness improvement, in order to develop the programme. The structure of the training programme consisted of four clusters. Theory and practice with athletes has to be in harmony (*see Appendix*). The training programme was conducted during the 2015 season (May, June and August). The programme in August focused strongly on motivation and challenges in athletic races – to master more demanding races (200 m – 400 m) or to start young athletes off in open competition for persons with various types of disability.

Results of athletes' running races

A survey of the developmental line of results of selected athletes is presented in Table 1 (males) and Table 2 (females). The initial finding is – there is a lack of young athletes, which is a challenge for CZ SO in general. On the other hand, Special Olympians in the "elderly" age cohort are able to train, compete and achieve good results and optimal fitness, which is positive. In general, the results in the 15 year-old age cohort are between 18.5 - 22.0 sec. for females and between 14.5-17.5 sec. for males. In the 40 year-old age cohort, they are between 19.0 - 22.0 sec. for males. They have no problem in participating in the 400m race, according IAAF rules (to keep to their own lane). It is necessary to underline the results of some athletes (they are not included in our case stories):

- Female, 46 years old: specialist in rhythmic gymnastics (medallist on a world level), she achieved a time of 17.78 sec. in the 100m race.
- Female, 32 years old: wanted to participate in OPEN in the 400m, because her friend/female competed too. Her result – 2:23 min. She was last, but she finished. This finding goes against "academic" research, which claims that people with intellectual disabilities have no strong will and they give up if they are not in a leading position.
- Female, 52 years old: besides an intellectual disability, she also has visual problems. In spite of these problems, she competes in many sports (rhythmic gymnastics, cross-country skiing-walking and hiking). This special situation came about after the death of her father: he included in his will and testament that all his money had to be spent only on his daughter's leisure activities, well-being and happiness during her life. Her caregiver has recently become her

coach and has given her a lot of support. She had never participated in athletic competition before, but during OPEN, she competed in the 100m and 200m races, and even the relay. It was great pleasure for her to be in the team.

- During OPEN, a randomly selected male (38 years) achieved a time of 1:06.14 sec. in the 400 m race. Another male (24 years) competed for the Inas II games nomination and achieved a time of 1:01.76 sec. over the same distance.
- The results of trained athletes in the 30-year-old age cohort (between 14.5 – 16.0 sec.) are comparable with athletic fitness requests for university physical education students in the under 25-year old age cohort.
- The 4 x 100m relay became very popular, as athletes enjoy the "team atmosphere". They compete in co-educative teams, with enthusiasm and great effort. The different design of relay races was included in the Fitness Innovation Progress training programme.

Brief case stories

Males (Table 1)

John (31-33): has focused on athletics for a long time (advanced). In his age cohort, he has a stable progressive line of achievement. 100m and 200m races are typical for him. The centre he lives in is equipped with a fitness room and a music room. A musical band was established there. He likes to train in the fitness room. Besides sports, he is a member of the musical band, as the "speaker, moderator".

Ivo (27-29): has a similar development to John, as they live in the same centre and have the same coach in the SO and fitness programme. Both case studies underline the strong influence of the coach (sports and music) and the good cooperation with the board of directors at this centre.

Will (31-33): progressive development in the 200m race over two years, even though, during the spring season, he was ill. It was challenging for him to try a longer distance, the 400m, for the first time in his life. He likes cross-country too.

*Peter (54-*56): he started in competitive athletics in Special Olympics very late in life (in his 50s), but he likes to participate in all physical activities for fun (especially camping), as he grew up in a very good, culturally orientated family. After the death of his parents, he was lucky, as he was granted a place at a very good centre, with a very good caregiver. Due to his age, longer distances were better for him. He is good in these events and is happy with his success.

Charles (45-47): although he was registered in CZ SO, he participated in low-level events for a long time (50m races, standing long jump). It was recommended that he progress to a higher level and more demanding events (coach and parents) after

FUNfitness screening, due to his good results in the fitness tests. His developmental line in running races is improving.

Martin (11 in 2015): the OPEN event was his first official competitive programme. He was included as a member of the education project. In spite of his position as a "beginner, young athlete", he was very passionate with the "fitness, challenging atmosphere". Although his coach only recommended him for the 100m race in OPEN, he also wanted to try the 200m race. He was in last position, but did not give up and finished with a smile. He mastered it.

Tab. 1 Results of athletes' running races (100 – 200 – 400 m) in seconds - MALES

Nick Name	Age in 2013	2013 race - time	2014 race - time	2015 race - time	OPEN race - time
John	31	100 - 14.67	100 – 14.14	200 – 30.63	100 - 14.14 200 – 30.63
Ivo	27	100 – 15.75	100 – 14.50	200 – 32.07	100 – 14.32 200 – 31.03
Will	31	200 – 33.94	200 – 30.68		200 – 30.27 400 – 1:06.12
Peter	54	400 – 1:08.92	400 – 1:05.88	200 – 31.46	400 – 1:04,17
Charles	45	200 – 38.49	200 – 37.23		400 – 1:31.18
Martin	11 in 2015				100 – 18.22 200 – 40.36

Tab. 2 Results of athletes' running races (100 – 200 – 400 m) in seconds - FEMALES

Nick Name	Age in 2013	2013 race - time	2014 race - time	2015 race - time	OPEN race - time
Ala	40	100 – 20.75	100 – 18.58 200 – 42.15	200 – 41.60	400 – 1:27.2
Dita	27	100 – 19.80		200 – 48.74	400 – 1:34,6
Lucy	31	200 – 41.00	200 – 39.70		400 – 1:55.11
Suzy	29	100 – 15.46	200 – 32.13	200 – 31.54	400 – 1:15.22
Maya	11 in 2015				100 – 21.92 200 – 57.44

Females (Table 2)

Ala (40-42): she focuses on loco-motor activities (track and field, cross-country skiing). Her trajectory of achievements is going up and the 400m in OPEN was a great challenge for her. She was very motivated and mastered it.

Dita (27-29): has Down syndrome. She lives in a sports and culturally orientated family, and has an inclusive elementary education. She is mostly focused on long distances in cross-country skiing (3 – 5 – 10 km). Participating in athletics was

considered as an additional activity. The coach (and SO club) included her in the fitness innovation programme, and she wanted to master the 400 m race, as she was used to mastering longer distances in a skiing environment.

Lucy (31-33): she needs the support of an assistive dog for some activities, due to her problems with vision. Fitness and running training improved her performance, and mastering the 400m OPEN event successfully (independently, without the dog, in accordance with IAAF rules) was challenging.

Suzy (29-31): she is also registered in CZ SO and Inas II, but she did not achieve the "A" standard for participation in the Global Games. She is a real advanced athlete and likes the SO programme. Although she started off as a sprinter, she is gradually focusing on longer races, with good results.

Maya (11 in 2015): her story is similar to Martin's, although they are members of different CZ SO clubs. It means we can copy some facts. She competed independently in rhythmic gymnastics in front of an audience and the referees' commission. The OPEN event was her first official athletic competition, as she participated as a member of the education project. In spite of her position as a "beginner, young athlete", she was very passionate about the "fitness, challenging atmosphere". Although her coach (like Martin) only wanted to permit her to compete in the 100m race, she also asked him to try the 200m race with friends. Again, she finished in last position, but she mastered it with a smile. After that, she wanted to be a member of the relay team. She was included in 4x 100 relay as "finish girl" so that she had chance to be a team member and perceived team atmosphere. She performed this position successfully as only one task is demanding (to keep relay and run directly). She and the whole team was very happy.

Conclusion

The Fitness Innovation Progress grant is important to both the Healthy Athlete programme and the Special Olympics in general. Coaches, as well as athletes' education, not only in sports, but also in fitness improvement is necessary for achievements in athletic running events. Looking at the achievements in running races (100 m – 200 m – 400 m), we can confirm either an increasing or stable trajectory, which is positive, considering the age cohorts of athletes (from 27 to 56 years old). The positive findings regarding activity and performance of "elderly" athletes are tarnished with negative findings – a lack of young athletes. The Fitness Innovation project initiated a challenging atmosphere among both coaches (to be brave in preparing athletes for more demanding races) and among athletes (to be brave in demanding races and to be

included in the team). Secondly, the teaching materials and personal experience of all of them can help to improve and continue the programme, as fitness in this approach is not only about physical fitness, but also about the psychosocial environment in SO programmes.

Post Scriptum
In the introduction, there is the partial use of the following article: Válková, H. (in press, 2015). Effect of Special Olympics Program on Cross-country Skiers: aspects of health related variables. In *Effects of application of physical activity on the anthropological status of children, youth and adults.* NOVA SCIENCE Monograph Series 2014-05-22.

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Appendix

Cz Fitness Innovation – Syllabus For Education And Training
(Source – Midyear report, July 2015)

Focused on:

- coaches (realise fitness programme and help with assessment)
- volunteers (realise assessment, help with fitness programme)

Programme Sources:

- University SO programme of SOI (since 2001) – modified for Czech environment, in Czech language;
- Volunteers education SOI programme (2004) - modified for Czech environment, in Czech language;
- Czech workshops for SO coaches and students of Adapted Physical Activity, in Czech language;
- Original CZ videos concerning communication with persons with MD (Czech and English Languages).

Teaching modules:

1-day training programme + practice (as volunteers in assessment).

- Mental disability: terminology, origin, behaviour, communication, health and fitness status.
- Physical activities and sports: physical activity – accessibility, school PE, sport: Inas II and SOI approaches, differences.
- Special Olympics: world – Czech situation, general principles (survey):
  - complimentary programmes with accent on young, family, volunteering, education and research
  - sports developed in CZ-SO (summer, winter – adapted events).
- HA programme: general survey, attention to FF, HP, recent EU- SO Fitness Innovation Progress grant,development of flexibility, endurance, speed, strength.

COMPARISON OF THE USE OF INFORMATION TECHNOLOGIES IN NON-FORMAL EDUCATION AND INFORMAL LEARNING OF HANDBALL COACHES IN THE CZECH REPUBLIC AND SLOVENIA

Tomáš Augustýn
Faculty of Sports Studies, Masaryk University Brno, Czech Republic

Abstract

The research was focused on the issues of use of information technologies in non-formal education and informal learning of handball coaches. Information technologies play an increasingly important role in the graduation of the coaching career. The aim of this empirical research was to analyze the specific forms and methods of the using of information technologies (video channels, social networks, electronic databases, web sites, computer programmes, smart phones, etc.) in non-formal education and informal learning of handball coaches. The research combines quantitative and qualitative research methods. The questionnaire survey was made on handball coaches in the Czech Republic and Slovenia, and in both countries were selected 5 coaches for interviews. In this paper are presented data from the surveys, little commented by knowledge gained from interviews. In the research sample from the Czech Republic was higher proportion of women then in the research sample in Slovenia, the average age did not different significantly, Slovenian coaches have on average a longer coaching experience and higher education. Slovenian coaches work more with e-learning, video-conferencing and webinars, seeking information more on foreign web sites, on sites EHF and IHF. Czech coaches on the contrary, use in coaching practice materials from the site of their national handball federation more than Slovenian. Paid sources use both groups equally. Enough domestic resources on CDs and DVDs coaches assess better in Slovenia, on the contrary, foreign sources Czech coaches. With foreign-language materials on CDs and DVDs work more Slovenian coaches then the Czech ones in English and in Serbo-Croatian and Spanish. In the other way Czechs use CDs and DVDs in German, Polish and Slovak increasingly. Slovenian coaches in all surveyed parts of coaches' activities use more tablets and mobile phones than Czech coaches. Data from surveys show that most coaches uses information technology for their coaching, training and related activities ordinary. When comparing the surveyed nations Slovenian coaches are in the using of ICT more advanced then coaches in the Czech Republic.

Keywords: *information and communication technology, coaches, handball, non-formal education, informal learning*

Introduction

In recent years, lifelong learning attaches an important role in non-formal education and informal learning (Jansa, Kovář 2008; Sekot 2006; Trudel, Gilbert 2006, Mallet 2009; Nash, Sproule 2009). With the development of information technologies, these are increasingly used in education and especially in the learning process. In nowadays there are ordinary computers with data projectors in schools (Česká školní inspekce 2015), mobile phones can record audio or video and can take photographs, there are several software applications that can automatically evaluate videos from sport events, computers with high computing power are easily transferable and thanks to using touch screens we can work with them comfortably and they work very quickly. That's why the research is focused precisely on the use of information and communication technologies in non-formal education and informal learning of handball coaches.

Methods

The research was realized in three phases. In the first phase was used a questionnaire of our own design, which was distributed to handball coaches in the Czech Republic. Data were collected from 48 coaches. After the quantitative questionnaire survey were carried out case studies of three selected handball coaches from the Czech Republic. These data were obtained from them through interviews. In the third phase was made the research on coaches in Slovenia. For data collection was used the same questionnaire as for coaches in the Czech Republic, translated into Slovenian. Data were collected from 95 coaches in Slovenia. Even in Slovenia were made interviews with selected coaches (in Slovenia with 2 coaches).

Data in the Czech Republic were collected in 2013, in Slovenia in 2015, in both cases on the conferences for coaches.

Results

In Slovenia the research involved by filling out the questionnaire 95 coaches, in the Czech Republic 46 coaches. In both countries were more involved coaches men - in the Czech Republic 80% of respondents in Slovenia even 87%. The average age in both groups was similar, in Slovenia 41.1 years in the Czech Republic 41.3 years.

While in the Czech Republic 59% of coaches mention they coach as volunteers, in Slovenia it is only 29%. 26% respondents are semi-professional coaches in the Czech Republic, in Slovenia 52%, and professionals are in the Czech Republic 15% and in Slovenia 19%. There is a big difference in the distribution of semi-professionals

and volunteers, which is a significant difference in behalf of semi-professionals in Slovenia. Among professionals such differences are not significant. Percentages by coaches form of their working relationship is shown in Figure 1.

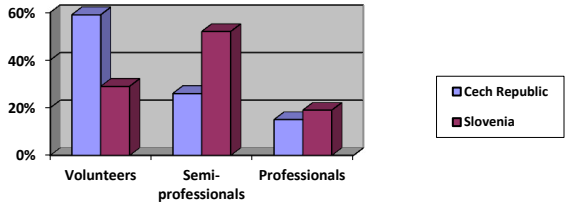

Fig. 1 Percentages by coaches form of their working relationship

The two groups of coaches differ in the length of the practice. While the Slovenian coaches indicate an average of 13.02 years of practice, the Czechs do only 9.92.

There are also differences with the highest education between the both groups. More Czech coaches have a basic education (9% vs. 1% Slovenes) and high education (61% versus 49% of Slovenians), while the Slovenes have more colleges (22% versus 4% of Czechs). Higher education has in both groups 27% of coaches, but more of Slovenes studied on sports-oriented universities (18% versus 7% of Czechs).

The highest license in handball is a Master Coach, which is organized by the EHF (European Handball Federation). This license has 7% of Slovenian coaches, from the Czech Republic nobody does. A license has more Czechs (13% versus 3% Slovenes), B licence more Slovenes (55% versus 48% of Czechs) and C license has more Czechs (39% versus 34% Slovenes).

The next series of questions investigate which sources of information are used by coaches. To evaluate the answers, it was used the percentage of yes answers of respondents who answered the questions. Absolute frequency responses and the percentage of yes answers are shown in Table 1.

Tab. 1 The use of sources for increase of coaches' work

	Slovenes			Czechs		
Source	yes	no	yes %	yes	no	yes %
E-learning courses	29	45	39.2	4	27	12.9
Video conference or webinars	25	53	32.1	6	26	18.8
Methodical materials on the national handball federation website	77	11	87.5	41	2	95.3
Methodical materials on foreign union handball website	60	23	72.3	23	17	57.5
Methodical materials on EHF website	51	32	61.4	15	21	41.6
Methodical materials on IHF website	37	41	47.4	9	23	28.1
Online paid sources	4	74	5.1	2	28	6.7

The two observed groups most use methodological materials on the web site of their national federation. Czech coaches use them more (95.3%, compared to 87.5% of Slovenes). On the second place, both groups use methodological materials on foreign websites unions, the Czechs use them less than the Slovenians (57.5% Czechs, Slovenes 72.3%). Even other sources Slovenian coaches use more: the methodical materials on the EHF website (61.4% Slovenes, 41.6% Czechs), the methodological materials on IHF website (47.4% Slovenes, 28.1% Czechs) and the video conferences and webinars (32.1% Slovenes, 18, 8% Czechs). Czech coaches use more only paid internet sources (6.7% versus 5.1% Slovenes), both groups but significantly the least from all researched sources.

For the evaluation of satisfaction with the range of methodical CDs and DVDs was used the average value of answers so that excellent response was assigned a value of 1, sufficient value of 2, rather insufficient value of 3 and completely insufficient value of 4. Values are compared in the graphs in Figure 2.

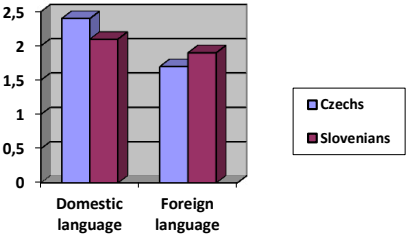

Fig. 2 Satisfaction with the range of methodical CDs and DVDs

The lower grade, a better rating, assigned to allocated home sources on CDs and DVDs Slovenian coaches (2.1 vs. 2.4 Czech coaches). The offer of foreign sources on the same media rated better the Czech coaches (1.7 versus 1.9 Slovenian coaches).

The Czech coaches are more satisfied with the offer of foreign materials on CDs and DVDs than the Slovaks, who on the contrary are more satisfied with the offer in their own language.

Czech coaches on the internet the most used materials in English (43%), than Slovak (39%), German (28%) and Polish (15%) on the internet. With materials on CDs and DVDs Czech coaches work the most in German (41%), English (39%), Slovak (28%) and Polish (11%) languages. The use of foreign sources by Czech coaches is shown in Table 2.

Tab. 2 The use of foreign sources by Czech coaches

	English	German	Slovak	Polish	Hungarian	Spanish	Other
Internet sources	20 (43%)	13 (28%)	18 (39%)	7 (15%)	1 (2%)	0	2 (4%)
CDs a DVDs	18 (39%)	19 (41%)	13 (28%)	5 (11 %)	0 (0%)	0	3 (7%)
Total	38	32	31	12	1	0	5

Slovenian coaches on the Internet use the most materials in English (85%), Serbian and Croatian (72%) and German (40%). With the materials on CDs and DVDs works most of coaches in Serbian and Croatian (67%), English (66%) and German (36%). The use of foreign sources by Slovenian coaches is shown in Table 3.

Tab. 3 The use of foreign sources by Slovenian coaches

	English	Serb./Croat.	German	Spanish	Hungarian	Polish	Other
Internet sources	81 (85%)	68 (72%)	38 (40%)	4 (4%)	0	0	3 (3%)
CDs a DVDs	63 (66%)	64 (67%)	34 (36%)	3 (3%)	0	0	3 (3%)
Total	144	132	72	7	0	0	6

In comparing both groups, it can be seen that more Slovenian coaches work with materials in English and German.

For the Czechs the third most used language is Slovak, for Slovenian the second most widely used is Serbian or Croatian. In these cases, these are languages of neighbouring countries, in both cases the same linguistic group.

The next part of the questions was focused on using computers, tablets and mobile phones in everyday work of the coaches. It was looked to the use of all three devices in six selected aspects of coaches' work: preparation for training units, during training units, evaluating training units, in preparation for the matches, during the matches and in the evaluation of the matches.

Coaches use computers most in preparation for the training units, preparing for the match and for evaluating the matches. Only in evaluating training units Czechs

use computers more (34.8%) than Slovenes (33.7%), however the difference is not significant. In all other cases computers are more used by Slovenes - in preparation for the training units (84.2% versus 70.0% of Czechs), in preparation for the matches (71.6% versus 47.8% of Czechs), evaluating the matches (56.8% compared to 50.0% of Czechs) during a training units (34.7% versus 8.7% of Czechs), and during the matches (18.9% versus 13.0% of Czechs). A graphical representation of using computers is shown in Figure 3.

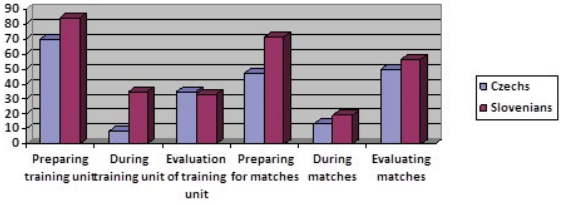

Fig. 3 The use of computers

The use of tablets is lower than the use of computers. In all monitored activities tablets are more used by coaches from Slovenia than Czechs. Most often the tablets are used in the preparation at the training units (24.2% Slovenes, Czechs 4.3%), to prepare for the matches (18.9% Slovenes, Czechs 0%), in the evaluation of the matches (16.8% Slovenes, Czechs 0%), during the training units (12.6% of Slovenians, Czechs 0%), evaluation of training units (8.4% of Slovenians, Czechs 2.2%) and the least during the matches (6.3% Slovenes, Czechs 0 %). A graphic representation of the use of tablets is shown in Figure 4.

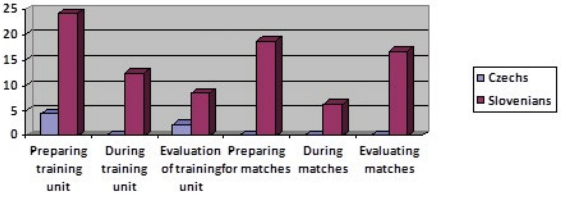

Fig. 4 The use of the tablets

The use of mobile phones is more common than the use of tablets, but does not reach such a level, as the use of computers. In all the surveyed activities, except one, mobile phones are more used by Slovenian coaches. They use them the most commonly in the preparation for the training units (24.2% Slovenes, Czechs 6.5%), during the training units (23.2% of Slovenians, Czechs 15.2%), in preparation for the matches (13.7 Slovenes %, Czechs 8.7%) during the matches (8.4% of Slovenians,

Czechs 2.2%) and in the evaluation training units (7.4% Slovenes, Czechs 2.2%). Only in the evaluation of the matches use mobile phones more Czech coaches (6.5%) than the Slovenians (6.3%), but the difference is not significant. A graphical representation of the use of tablets is shown in Figure 5.

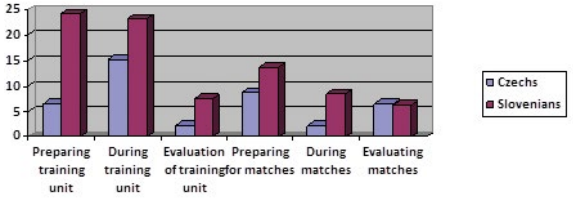

Fig. 5 The use of mobile phones

Discussion

When evaluating results is necessary to take into account two important facts. The first one is the number of respondents in both groups, when especially a group of Czech coaches is not too high (46 respondents). Therefore the results cannot be generalized to the entire coaching population.

The second important fact is time difference survey results, which were collected in Slovenia over a two-year delay of the Czech Republic. Human society has in that time seen a significant expansion of tablets and mobile phones. It can be supposed that tablets and mobile phones usage is gradually increasing among the Czech coaches. In addition to the availability of the device itself it is also increasing number of applications that can be used for coaches' work. On the other hand for the two years almost unchanged the number of computer users, but nevertheless the Slovenian coaches use computers more as well.

From the presented results it can be suggested that coaches from Slovenia are more open to new trends in compare to Czech coaches, because Slovenian coaches work more with foreign sources and with modern technologies.

Conclusions

From the presented results it can be concluded wide use of computers, mobile phones and tablets by coaches from Slovenia in compare to the Czech coaches in almost all the surveyed activities.

Slovenian coaches work more with materials in some foreign languages than Czechs. The biggest difference in the use of materials in English and Serbian/Croatian

is in favour of the Slovenes. On the contrary Czech coaches work more with sources in the Slovak language.

The Czech coaches more use the materials on the website of the Czech Handball Federation and compared to Slovenes they reported greater satisfaction with the availability of resources in foreign languages. On the contrary the Slovenians are more satisfied with resources in their own language than Czech coaches. All other obtained sources are used more by coaches in Slovenia (f.e. E-learning, videoconferencing and webinar).

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THE INFLUENCE OF DYNAMIC BALANCE ON EVALUATION EXERCISE ON BALANCE BEAM ON THE FEMALE UNIVERSITY STUDENTS

Lucija Milčić, Marija Fišter, Kamenka Živčić Marković
Faculty of Kinesiology, University of Zagreb, Croatia

Abstract

The purpose of this study was to determine the influence of dynamic balance on exercise performance on the balance beam. The sample consisted of 58 second-year female students from the Faculty of Kinesiology. Dynamic balance was estimated with a test on the Swedish bench. The test consisted of the Swedish bench, 5 wood shafts 1 meter long and two mats. In this test for the evaluation of dynamic balance, the task was walking (regular step on full feet and on tiptoes with arms raised overhead) on inverted Swedish bench from one side to the other without falling. The task was completed when both feet touched the mat placed on the other side of the bench. Time, and number of steps were measured during the execution of task. Walking on full feet and on tiptoes was performed three times, and the value for average time and number of steps needed to finish the task was taken. Grades of exercise and all elements on the balance beam were taken for analysis. Statistica for Windows 10.0. was used for data analysis. Results of descriptive indicators of performed tests shows the average grade of exercise on the balance beam (Mean = 3.55), standard deviation (St.Dev. = 1.10). The average number of steps on full feet was Mean=5.75, (St.Dev. = 0.98). Average time of walking on tiptoes was Mean = 3.13 sec, (St.Dev. = 0.92). The number of steps required for walking on the bench on tiptoes was Mean = 6.92 (St.Dev. = 0.92), while the average time of walking on tiptoes is Mean = 4.52 sec, (St.Dev. = 1.97). Results have displayed that female students walked on Swedish bench faster and with less steps on full feet, than on tiptoes, which shows that they are more stable during the execution of a task on full feet than on tiptoes. The correlation coefficients (r) indicate that there was a statistically significant correlation at level of statistical conclusions error ($p < 0.05$) between variables, number of steps on full feet and time of walking on full feet ($r = 0.73$). The number of steps on tiptoes and time of walking on tiptoes ($r = 0.54$). Results of multiple regression analysis have shown that independent variable (number of steps at full feet) explains 10.3% of the dependent variable, or grades of exercises at the level of error of 5%, while other independent variables did not affect grades of exercise on the balance beam. Therefore, from the obtained results it can be concluded that female students who are faster, and walked over the Swedish bench with less steps (full feet and tiptoes), have higher grades from the exercises on the balance beam.

Keywords: *dynamic balance, artistic gymnastic, balance beam, students, walking, exercise*

Introduction

One of the motor skills needed to solve motor tasks is dynamic balance or balance in motion. In essence, the balance is basis for mobility against gravity, adapting to changes in the surface of the support, selectable movement and automatic functional activity (Kosinac, 2009). Dynamic balance is necessary for performance of daily activities such as walking, running and climbing stairs. Most sports require specific motor control.

In different sports, balance is extremely important because the ability of taking and keeping the balance position in static or dynamic mode of action depends on the quality of motor performance of training exercises or competitive activities (Milanović, 2010). The balance is divided on static and dynamic balance. Static balance refers to maintaining a certain position of the body in a static position, and dynamic balance on the maintenance of balance position during the performance of various structures of motion. Many studies of balance have been shown that the balance is not main motor ability, but it's pretty specific with tasks which must be performed (Singer, 1980; Schmidt, 1991; Baumgartner & Jackson, 1995). Even though the balance is considered as a basic component of the performance of almost every motor task.

Manifestation of balance, especially dynamic on the balance beam is carried out by using different combinations of steps, walking and running and the elements which are performed in positions of standing, sitting or lying. The balance is considering as a very important component of almost every motor task. Functioning of balance is regulated by the central nervous system through afferent, visual, tactile, and proprioceptive information impulses, as well as vestibular systems (McLeod & Hansen, 1989; Boswell, 1993; Ageberg, Zätterström, & Moritz, 1998; Kinzey & Armstrong, 1998). Balance is the ability which develops with practice, and the balance beam is apparatus in gymnastics, which is used for its development. The exercise on the balance beam is made up of elements of coordination, strength and balance (static and dynamic).

Methods

For purposes of assessing the dynamic balance and its impact on the evaluation of elements on the balance beam of female students from KIF, test of dynamic balance on Swedish bench was used. The test consisted of the Swedish bench, 5 wood shafts 1 meter long and two mats. In this test for evaluation of dynamic balance, the task

was walking (regular step on full feet and on tiptoes with arms raised overhead) on inverted Swedish bench from one side to the other without falling. The task was completed when both feet touched the mat placed on the other side of the bench. Starting position of subjects was one foot placed on the Swedish bench and the other on the mat at the beginning. On the sign "now" subject raised her leg off the mat and performed the task. When passed to the other side and touch the mat with both feet (time required for performing the task stops and is measured in seconds). The task was performed three times, and the average time from three attempts was taken for value. The number of steps required for walking the bench was counted. Grades of exercise on balance beam (OCJ VJZB) and total grade of balance beam (OCJ UKUP) which were consisted of elements of coordination, static and dynamic balance, flexibility and strength, have been taken into the testing. Dynamic balance was estimated with variables: KORPS (the number of steps on full feet), KORUU (the number of steps on tiptoes), VRPS (time of walking the bench at full feet) and VRUU (time of walking the bench on tiptoes).

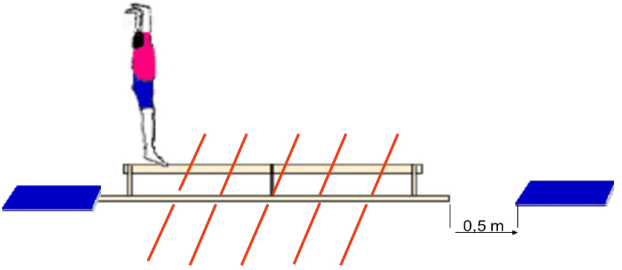

Fig.1 Description of the task

Statistica for Windows 10.0. was used for data analysis. Descriptive parameters were calculated for all variables, and for assessment the relationship of dynamic balance and other variables, correlation was used, while the influence of variables on the total grade of exercise on the balance beam was determined by regression analysis.

Results

Relationship and influence between variables has been determined by descriptive statistics and regression analysis. Statistical significance was set at $p < .05$.

Tab. 1 Basic descriptive indicators

Descriptive Statistics						
	Valid N	**Mean**	**Minimum**	**Maximum**	**Variance**	**Std.Dev.**
OCJ VJŽB	58	3.55	2.00	5.00	1.20	1.10
OCJ UKP	58	4.05	2.00	5.00	0.54	0.74
KORPS	58	5.75	3.67	8.33	0.96	0.98
VRPS	58	3.13	1.84	6.32	0.85	0.92
KORUU	58	6.92	4.67	9.67	0.85	0.92
VRUU	58	4.52	2.42	13.77	3.89	1.97

Tab. 2 Correlation coefficients

Marked correlations are significant at p < 0.05000						
	OCJ VJŽB	**OCJ UKP**	**KORPS**	**KORUU**	**VRUU**	**VRPS**
OCJ VJŽB	1.00	0.62	-0.36	-0.19	-0.13	-0.27
OCJ UKP	0.62	1.00	-0.19	0.01	0.02	-0.13
KORPS	-0.36	-0.19	1.00	0.77	0.30	0.73
KORUU	-0.19	0.01	0.77	1.00	0.54	0.62
VRUU	-0.13	0.02	0.30	0.54	1.00	0.66
VRPS	-0.27	-0.13	0.73	0.62	0.66	1.00

Tab. 3 Results of the regression analysis, the level of statistical significance of p <0.05

Regression Summary for Dependent Variable: OCJ VJŽB R= 0.40768668 R2= 0.16620843 Adjusted R2= 0.10328077 F(4.53)=2.6413						
	b*	**Std.Err. - of b***	**b**	**Std.Err. - of b**	**t(53)**	**p-value**
Intercept			5.01	1.08	4.6	0.00
KORPS	-0.69	0.29	-0.77	0.33	-2.4	0.02
VRPS	0.17	0.27	0.20	0.32	0.6	0.53
KORUU	0.36	0.24	0.43	0.29	1.5	0.15
VRUU	-0.23	0.22	-0.13	0.12	-1.1	0.30

Discussion

Results of descriptive indicators (Tab. 1) shows that average of OCJ VJZB was 3 (St.Dev.=1,10), while OCJUKP was 4 (St.Dev.=0,74). The results show that the average grade of exercises was lower than total grade on the balance beam. The average number of steps on full feet (KORPS) was 5, (St.Dev. = 0.98). Average time of walking over the bench on full feet (VRPS) was 3.13 sec (St.Dev. = 0.92). Average time of walking over the bench on tiptoes (VRUU) was 4.52 sek, (St.Dev.=1.97), while the average number of steps on tiptoes (KORUU) 6 (St.Dev. = 0.92).

Correlation coefficients (Tab. 2) indicated that there was a statistically significant correlation at the level of errors of statistical conclusion (p <0.05) between KORPS

(the number of steps on full feet) and VRPS (time of walking over the bench on full feet) of (0.73) KORUU (the number of steps on tiptoes) and VRUU (time of walking the bench on tiptoes) of (0.54).

Variables KORPS and VRPS have shown that female students who are faster and with less steps who walked the beam have higher grades. Various tests for measuring static and dynamic balance have shown that there wasn´t any correlation between two types of balance (Travis, 1945; Drowatzky & Zuccato, 1967 Sanborn & Wyrick, 1969).

Results have shown that the variable KORPS explains 10.3% of grade of exercise by regression analysis. The variable KORPS was significant at the conclusion of the statistical error of 5%. Results indicated that variables VRPS, KORUU and VRUUdid not affect the grades of exercise on the balance beam. Performance of exercise is unit, which students have to do elements to the perfect performance. Based on the results it can be concluded that students who had fewer number of steps in variable KORPS are more stable in performance of exercise.

Conclusion

The results confirmed that the dynamic balance is specific to the task. Students who were faster had better coordination, and thus were more stable on the balance beam during the exercise. Balance on beam consisted of various elements, which had to be performed technically correct, without falling off and in limited time. Average grade of exercise on balance beam was slightly lower than the average total grade of elements on beam, which was influenced by performance of exercise. Exercise on balance beam was more difficult to perform because it consisted of interconnected movements or coherent whole, in contrast to gymnastic elements which were performed separately.

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HEALTHY LIFESTYLE, ACTIVE AGEING

„COMPARISON OF PHYSICAL ACTIVITY AND HEALTH STATUS IN THE SPECIFIED FOCUS GROUP OF POPULATION OF MIDDLE-AGED AND OLDER“

Tomáš Vespalec, Martin Zvonař
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

The aim of this study was to analyze and compare data on the physical activity (PA) and health status of the adult population in the Czech Republic. This data was obtained in two stages, over a period of 6 years. Investigation was carried out in 2005 (1234 respondents, 693 women, 541 men) with an average age of 47.0 years, and then in 2011 (1171 respondents, 681 women, 490 men) with an average age of 47.7 years. Identification of differences occurring in both specific surveys and among surveys carried out within the time interval. The following data collection methods were used: a structured questionnaire focused on the area of somatic and socio-demographic data, self-reported health status questionnaire and the quantitative analysis of physical activity. Data were consequently sorted and processed using descriptive statistical methods. During the six-year study interval, there were recognized changes in the somatic characteristics of the studied population (improvement of more than 4% of females of normal weight and, contrarily, similar deterioration of males in the zones of overweight and obesity). Number of individuals “without any health problems” had increased from 11.4% to 17.7% between 2005 and 2011, the most common reported problem being the pain in the lumbar spine. In both surveys, more than half of the individuals lacked sufficient physical activity (PA). In the course of six years, the number of respondents who performed a particular PA decreased for most PA areas. Walking was reported as the most practiced PA, whilst the only PA which popularity increases with age, is medical gymnastics. The weekly amount of PA performed by the respondents did not fundamentally change within the 6 years interval; however the structure of activities differed. The physical activity of more than half of the respondents can be considered as insufficient. From the medical point of view, changes in BMI and health perception have been reported. Contrary to the assumption, no contraindications associated with higher time allotment of PA have been diagnosed.

Keywords: *Physical Activity, Questionnaire, Health Condition*

Introduction

Physical activity, defined by the EU Working Group (2008) as "any bodily movement associated with muscular contraction that increases energy expenditure above resting levels", is a contemporary issuewhich is thoroughly discussed worldwide. Development of modern civilization and a lifestyle of consumption is closely related to the decline in activity required to reach outputs (Straker et al., 2014). Technological development thus leads to a decrease in the volume and intensity of physical activity throughout the population, including children and seniors. Thus, various population groups make more or less successful attempts to partially compensate for the loss of natural physical activity (PA) by practising additional leisure-time physical activity.

Consequent health impacts resulting from insufficient physical activity have been medically diagnosed. Whether it is cardiovascular diseases (Ortega et al. 2011), metabolic disease and risk factors (Ekelund et al., 2007; Martins, Morgan, Bloom & Robertson, 2007) or orthopaedic diseases (Varo et al., 2003) including bone health (Sofková, Přidalová, Mitáš, & Pelclová, 2013), authors commonly agree about the negative impact of low or insufficient physical activity on health status. This phenomenon is referred in numerous studies as a sedentary lifestyle (Etemadi et al., 2011; Kim & So, 2013; Tremblay et al., 2010; Tudor –Locke et al., 2012).

Specialists exert their pressure for greater societal interest in the area defined as Health related fitness (Ganley et al., 2011; Schröder-Bäck et al., 2012). This is related to the need for objective methods to measure, diagnose and describe a real level of physical activity and to identify trends in various population groups.

A unified concept of physical activity does not exist within the countries of the EU, nor does a systematic diagnosis of physical activity. Thus, individual member states must deal with this issue independently. In the Czech Republic, two types of diagnostic methods have been used in the past decades to deal with this issue. The first method ascertains the "fitness" of the population by using performance tests and test batteries. The second method is represented by projects intended to determine quantitative and qualitative PA factors. In the first category, The EUROFIT test (Zinzen et al., 2013; Moravec et al., 1996) targets the European population, while the UNIFIT test (Blacksmith & Měkota 1995) is focused on the Czechoslovak population. In the second category, methods utilized questionnaire surveys (citations, Fiala, 2003) or research based on the use of pedometers (INDARES) or accelerometers (Sigmund, Sigmundová & Ansari, 2009).

Concerning above mentioned facts the goal of this study is to analyze and evaluate data on the physical activity and health status of the adult population in the Czech Republic obtained within a 6 year period and to identify population trends occurring both in individual surveys, as well as in chronological context.

Methods

The study is based on data collected during surveys conducted in 2005 and 2011, carried out in the Region of South Moravia and West Bohemia with adults aged over 30 years of age. Data were collected by instructed students of FSpS Masaryk University and the Faculty of Education of University of West Bohemia in Pilsen. Respondents were randomly selected by these students, nevertheless this sample still cannot be considered as utterly random, as the selection was limited by the principal of availability.

Paticipants

In 2005, 1,234 respondents (693 women, 541 men) aged 31-82 years (avg. Age 47.0) took part in the survey. Subsequently, in 2011, questionnaires from 1,171 respondents (681 women, 490 men) aged 30-72 years (avg. Age 47.7) were obtained. Detailed descriptive characteristics of the sample surveyed and their age intervals are given in Table 1.

Tab. 1 Age profile of respondents

Questionnaire survey respondents [n]						
	2005			2011		
Age interval	**female**	**male**	**total**	**female**	**male**	**total**
30-39 years	98	90	**188**	170	80	**250**
40-49 years	400	251	**651**	270	203	**473**
50-59 years	151	163	**314**	155	129	**284**
60 + years	44	37	**81**	86	78	**164**
total	**693**	**541**	**1234**	**681**	**490**	**1171**

Questionnaire

Data were collected by using structured questionnaires which were based on the questionnaire form used by Fiala (2002). These questionnaires focused on three key aspects:

1. Basic physical, socio-demographic data (gender, age, weight, height, address, type of job, number of hours a day in standing and sitting positions)
2. Subjective health report (pain in the cervical and lumbar spine, joint disorders, obesity, high blood pressure, headaches, digestive problems, etc.) and treatment (treated with a doctor, treated privately(without a doctor, no treatment at all)

3. Type and volume of physical activity (continuous walking, running, jogging, swimming, cycling, including treadmill or spinner, aerobics and fitness gymnastics, gym, ball games, yoga, medical gymnastics, other physical activity, seasonal sports - cross country skiing, downhill skiing, skating.

The respondents answered the questionnaires with the assistance students who were trained to evaluate and record particular types of PA, including time setting and enlisting health problems, into pre-determined categories.

Data Analyses

Data were converted from paper forms, sorted and categorized in MS Office Excel 2010 © and further statistically processed in Statistica © 12. Data were processed using descriptive statistical methods, frequency and variability. Subsequently, the calculations of correlation and ANOVA were computed. The results were considered statistically significant at the level of alpha <0.05 in all applied analyses.

Results

For comparison of the somatic characteristics in both groups we have used BMI index, despite of certain deficiencies of this characteristic (Dietz & Robinson, 1998). The mean value of BMI does not significantly deviate in either group - female (24.3 vs. 23.8), male (26.5 vs. 26.7). However, the percentage distribution of respondents into groups according to weight scale established as normal weight, overweight, obesity, or 2nd degree obesity showed differences. We can generally state that in both groups more than half of the women remain within the recommended range of BMI, while in male groups the situation is much more unsettling. Both male groups prove that more than 65% of respondents belong in the categories of overweight or obesity (65% in 2005 and 69.4% in 2011).

The evaluation of BMI distribution shows more than 4% positive difference in the normal weight female group (50.0% in 2005 vs. 54.8% in 2011), whilst over the same time period, the male group reported a 2.9% negative difference occurrence of being overweight, and 1.5% increase in 1st and 2nd degree obesity, as shown in Table 2.

Tab. 2 BMI (Body Mass Index) zone distribution

BMI (Body Mass Index) zone distribution								
BMI zone	**2005**				**2011**			
	female		**male**		**female**		**male**	
	n	**n[%]**	**n**	**n[%]**	**n**	**n[%]**	**n**	**n[%]**
very lean	9	2%	5	1%	9	1.3%	2	0.4%
normal weight	336	50%	181	34%	373	54.8%	148	30.2%
overweight	275	38%	275	50%	244	35.8%	259	52.9%
obesity	73	10%	80	15%	52	7.6%	72	14.7%
obesity II.	0	0%	0	0%	3	0.4%	9	1.8%
	avg. BMI = 24.3		avg. BMI = 26.5		avg. BMI = 23.8		avg. BMI = 26.7	

Between 2005 and 2011 both male and female groups indicate an increase of individuals who perceive their health status as good, without any inconveniences, and are considered "healthy". These findings, within the context of the information above, gives a somewhat paradoxical impression. Whereas in 2005 males reported better health status, with 13.9% of respondents without any medical problems (compared to 9.3% in female group), in 2011 it was 18.3 % of female respondents who reported no medical problems (compared to 16.9% for males).

Both surveys reported the most frequent occurrence of health problems, similar to the findings of Klemenc-Ketiš, Križmari, & Kersnik (2014), connected with lumbar and cervical spine. These problems were significantly numerous across the entire age spectrum, while cervical spine problems occurred more frequently in female groups. A significant age dependency is reported in the problems concerning joints and blood pressure. In particular, problems connected with blood pressure show the greatest difference between the youngest and oldest age groups, when the oldest population group shows nearly a tenfold increase in the frequency of this health problem. A more detailed description of the occurrence of particular health problems in each age group is given in Table 3a and 3b.

Tab. 3a Quantity of specific health problems in 2005 survey

Health problems n[%]							
	30 - 39 years			**40 - 49 years**		
	female	male	total	female	male	total
cervical spine	56.0%	45.0%	50.7%	58.0%	35.0%	49.1%
pectoral spine	18.0%	11.0%	14.6%	3.0%	5.0%	3.8%
lumbar spine	59.0%	45.0%	52.3%	49.0%	48.0%	48.6%
joints	27.0%	31.0%	28.9%	39.0%	47.0%	42.1%
hypertension	6.0%	6.0%	6.0%	10.0%	23.0%	15.0%
head pain	39.0%	21.0%	30.4%	33.0%	7.0%	23.0%
indigestion	20.0%	10.0%	15.2%	15.0%	14.0%	14.6%
other	7.0%	1.0%	4.1%	9.0%	7.0%	8.2%
	50 - 59 years			**60 + years**		
	female	male	total	female	male	total
cervical spine	49.0%	29.0%	38.6%	56.0%	14.0%	36.8%
pectoral spine	5.0%	4.0%	4.5%	0.0%	0.0%	0.0%
lumbar spine	51.0%	50.0%	50.5%	89.0%	57.0%	74.4%
joints	47.0%	50.0%	48.6%	61.0%	54.0%	57.8%
hypertension	23.0%	24.0%	23.5%	50.0%	46.0%	48.2%
head pain	26.0%	13.0%	19.3%	11.0%	4.0%	7.8%
indigestion	11.0%	14.0%	12.6%	33.0%	7.0%	21.1%
other	12.0%	15.0%	13.6%	56.0%	32.0%	45.0%

Tab. 3b Quantity of specific health problems in 2011 survey

Health problems n[%]						
	30 - 39 years			**40 - 49 years**		
	female	male	total	female	male	total
cervical spine	41.2%	20.0%	34.4%	49.3%	41.4%	45.9%
pectoral spine	1.8%	3.8%	2.4%	6.3%	6.4%	6.3%
lumbar spine	38.2%	41.3%	39.2%	48.9%	50.2%	49.0%
joints	20.6%	32.5%	24.4%	33.0%	31.5%	32.3%
hypertension	4.7%	7.5%	5.6%	12.2%	21.2%	16.1%
head pain	22.9%	8.8%	18.4%	21.5%	14.3%	18.4%
indigestion	14.1%	6.3%	11.6%	17.8%	9.4%	14.2%
other	10.0%	2.5%	7.6%	10.0%	4.9%	7.8%
	50 - 59 years			**60 + years**		
	female	male	total	female	male	total
cervical spine	53.8%	41.1%	48.2%	60.0%	39.2%	50.0%
pectoral spine	10.9%	12.4%	11.6%	9.4%	13.9%	11.6%
lumbar spine	45.5%	54.3%	49.6%	60.0%	57.0%	58.5%
joints	35.3%	41.9%	38.4%	40.0%	51.9%	45.7%
hypertension	18.6%	19.4%	19.0%	45.9%	44.3%	45.1%
head pain	25.0%	18.6%	22.2%	25.9%	11.4%	18.9%
indigestion	16.0%	18.6%	17.3%	18.8%	11.4%	15.2%
other	7.1%	9.3%	8.1%	12.9%	10.1%	11.6%

Other factors considered within the frame of the survey were the structure and time allotment of physical activity of the respondents. Based on the research by Fiala (2002) and later used in Zvonař (2005), Šrámková (2012) and Vespalec (2012), a boundary of 400 minutes of physical activity per week was set between sufficient and insufficient physical activity. In comparison with other forms of recommended PA quantity e.g. EU Working Group (2008), this value appears higher, but it stands for an overall PA of the respondent without determined intensity. Population with insufficient physical activity came out as slightly above-average (55% in 2005 and 52% in 2011) as shown in Table 4. There exist, however, certain differences between the distribution of PA quantity in various age groups. While in 2005 there were no significant differences within the proportion of sufficient and insufficient PA among age groups, in 2011 we can observe trends of higher significance. Age group 30-39 reports a greater proportion of individuals with sufficient PA (58% female and 68% male), while on the opposite end of age spectrum the ratio is reversed. In age group 60+, physical insufficiency is found

in 80% of the population (80% female and 81% male). More detailed classification is found in Table 4. More detailed classification of the amount of PA per week shows that the largest proportion of respondents (men and women) belongs to the time interval 100-400 minutes / week (Figure 1.)

Tab. 4 Sufficiency of PA

Sufficiency of PA n[%]					
		2005		2011	
		insufficient	sufficient	insufficient	sufficient
female	30–39 years	52%	48%	42%	58%
	40 - 49 years	57%	43%	51%	49%
	50 - 59 years	57%	43%	55%	45%
	60 + years	50%	50%	80%	20%
	female total	**55%**	**45%**	**53%**	**47%**
male	30–39 years	53%	47%	33%	68%
	40 - 49 years	58%	42%	45%	55%
	50 - 59 years	56%	44%	52%	48%
	60 + years	53%	47%	81%	19%
	male total	**55%**	**45%**	**51%**	**49%**
total		**55%**	**45%**	**52%**	**48%**

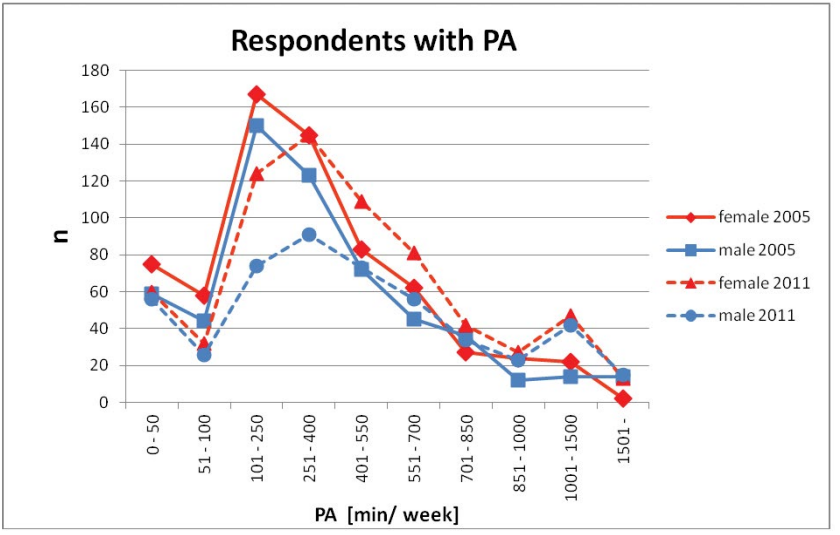


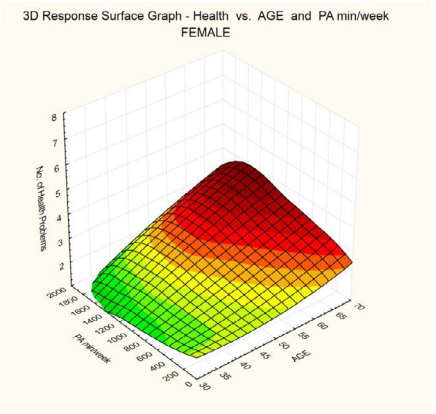
Fig. 1 Quantity of PA during one week

When listing individual physical activities both surveys report walking and cycling as the most frequent activities. Ball games and running are predominantly profiled as male activities. On the other hand, females participate in activities such as walking, yoga or medical gymnastics. Results from 2005 and 2011 reveal a decrease relating to the number of individuals engaged in a particular activity. This finding is apparent for the majority of physical activities in question. Some increases were observed in running, fitness, yoga and other categories of unclassified PA. The increase in frequency of these activities is however lower than the decline in other PA included in the survey (Table 5).

Tab. 5 Quantity of respondents doing specific PA

PA popularity - n[%] respondents doing activity						
	2005			2011		
	female	male	total	female	male	total
walking	91.1%	83.1%	87.6%	74.2%	61.8%	69.0%
running	9.9%	23.0%	15.7%	13.4%	24.3%	17.9%
swimming	44.4%	47.3%	45.7%	23.2%	25.9%	24.3%
cycling	57.6%	65.3%	61.0%	40.1%	41.6%	40.7%
aerobic + fitness exercising	25.2%	2.0%	15.0%	22.9%	18.4%	21.0%
fitness and weight lifting	11.7%	20.2%	15.4%	25.3%	19.4%	22.8%
ball games	17.7%	47.0%	30.6%	11.6%	32.9%	20.5%
yoga	9.5%	3.3%	6.8%	12.3%	4.9%	9.2%
medical gymnastic	23.9%	8.2%	17.0%	14.8%	8.6%	12.2%
other	11.4%	11.9%	11.6%	20.1%	23.9%	21.7%
xcountry skiing	32.3%	42.0%	36.5%	11.0%	15.5%	12.9%
alpine skiing	26.6%	32.6%	29.2%	12.0%	13.9%	12.8%
skating	11.4%	31.7%	20.3%	11.0%	9.4%	10.3%

When the focus group is divided according to age decades, the age dependence tendency is recognized as declining, i.e. lower frequency of a particular PA occurrence in older age groups. The activity described as medical gymnastics was the only one reported reverse tendency since its popularity increases with the increasing age of the respondents. As far as the health status of an individual in relation to the volume of physical activity performed is concerned, the optimal range is determined to be 800-900 minutes PA / week. Individuals whose PA came close to this range reported the lowest occurrence of subjective health problems. This tendency was visible in both male and female groups in both surveys. The distribution of the frequency of subjective health problems in dependence on the physical activity volume and age of men and women from both surveys is documented in Figure 2a a 2b.



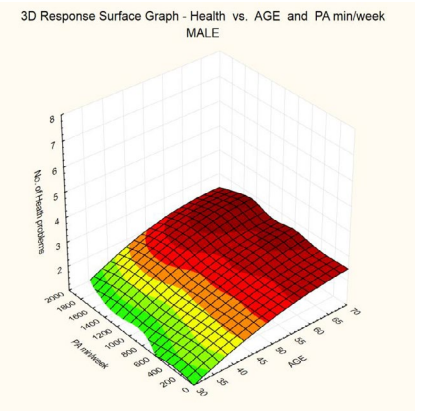


Fig. 2a, 2b 3D Surface graph – relation between no. of health problems, age and quantity of PA during one week

Furthermore, the authors have examined the hypothesis that individuals with enormous physical activity near the level of 1500 minutes per week will report more frequent occurrences of orthopedic problems (in the joints or the lumbar and cervical spine) caused by an excessive strain on the body (Zvonař, 2005). The variants of the relationship between PA and joint problems, as well as the relationship between PA and orthopedic problems (represented by an index computed from the occurrence of problems in all three areas mentioned above), were verified. In neither case, however, was a significant dependence proved. The low number of respondents in this PA category should nevertheless be taken into account on the impact of the conclusion (n = 16 in 2005 and n = 28 in 2011).

Discussion

We present this study as a two research group comparison and results couldn't be interpreted as generalized population trends and tendencies.

In relation to the test samples within the 6 years time interval, it is highly important to point out some, albeit partial, differences. The 40-50 age group was the most frequently represented in both samples, whereas in 2005 the proportional representation of females is significantly higher than males. The definite limit can be regarded as numerous representations in the number of 40 individuals, both males and females, in research in 2005. This may, to some extent, affect the results of comparison, especially in case of further segregation of the group according to other criteria. Also, the average ages in each decade are of negligible difference, no more

than one year. The only exception is in males over 60. The average age in this group differs by 2.2 years. The total difference of the average age of both groups is then 0.7 years.

Both studies deal with a slight difference in the representation of urban and rural populations. In 2005, 63% of the respondents reported their residence in towns, in 2011 the representation by the urban population had increased by 3% to reach a total of 66%. Certain differences were also noticed in the structure of jobs, both in males and females in both groups. More men than women (19% vs. 11%) described their jobs as manual in 2005. In 2011, this ratio was reversed, as more women than men (16.7% vs. 14.3%) were working manually. Contrary to general expectations, in 2011 research encountered a higher proportion of sedentary types of employment among men (42.0% men vs. 35.4% women). This could be an important change, from a medical point of view, in the representation of different groups in relation to overweight and obesity. A decrease of more than 5% in the number of female respondents belonging to the categories of overweight and obesity between the two surveys is perceived as a potential positive finding. Contrarily, growth in the categories of overweight and obesity among males is nearly 5%. The increase by 1.8% in the category 2nd degree obesity, particularly in the male group, in comparison to 2005 (with no representatives in this category) could be considered with an importance.

If we compare this finding with the distribution of specific health problems, a similar difference can be observed in respect to joints problems and articular disorders. Although in both studies women experienced a greater occurrence of health problems across the age spectrum, joint problems were more frequently reported by men. This fact can be considered as an empirical confirmation of previously published studies on the consequences of obesity in the musculo-skeletal area. (e.g. Kosti & Panagiotakos, 2006; McDowell, Hughes, & Borrud, 2006; Peytremann-Bridevaux & Santos-Eggimann, 2008; Tukker, Visscher, Picavet, 2009; Vítek, 2008).

Compared with 2005, there was a growth in the number of individuals who did not identify any health problems in the self-reported questionnaire and considered themselves as healthy. These findings are rather surprising. This finding has been observed in both male and female groups all across age groups. In the PA area, the results of studies partially differ in sufficiency as well as in representation of particular activities by age group. The sole determination of threshold motion sufficiency as 400 minutes of physical activity per week is considered as a specific. This limit has arisen from the simplification of the process of filling in the questionnaires: the respondent is not required to report the intensity of physical activity, but only its time duration. As indicated by other studies (e.g. Ainsworth et. Al., 2000; Neilson, Robson, Friedenreich, & Csizmadi, 2008), the respondents often find the assessment of PA intensity rather difficult. The data is filled in and subsequently converted to multiples

of MET and further examined. If, however, the input data is inaccurate, subsequent error increases geometrically. To avoid such an error, this survey records only the PA duration. The volume of 400 mins. PA per week is determined on the basis of Fiala (2002), and includes low intensity physical activity.

In evaluating the total results of the two test batteries in terms of physical sufficiency, there is no significant difference between the male and female groups in the 6year period. More detailed study reveals a fundamental imbalance between the youngest and eldest age groups in survey from 2011, as shown in Table 4. In the focus age group of 30-39 years there is a substantially higher number of respondents whose PA can be considered as sufficient (58% of female and 68% of male). On the contrary, in the eldest age group of over 60, the sufficient physical activity is reported for merely 20% percent of females and 19% of males. The 2005 survey, however, did not suggest any tendencies of this kind, since its results are more or less linear. One explanation of such a difference, however, is rather speculative. To some extent, it could be due to a lower number of respondents in these age categories during the 2005 investigation. Enumeration of particular physical activity indicated walking as the most frequently performed PA in both studies. This result repetitively confirms both previous and current research (eg Mitáš & Frömel, 2010; Mitas et al., 2014), revealing the "walkability" of the Czech population in comparison to European and global averages. It is, however, worth mentioning the fact that over the 6 year period a sharp decline was noticed in the popularity of walking for both men and women. A similar decline in interest is also apparent in cycling, swimming and ball games. On the contrary, an increasing interest in unclassified types of sports was reported, especially for inline skating.

Results in the area of seasonal sports with the focus on skiing and skating were rather startling. The biggest difference in interest was recorded in cross-country skiing, with an almost 24% gap, followed by downhill skiing and skating. A certain role can be assigned to specific climatic conditions in a survey year. Another obstacle to ski disciplines might lay in survey regions, where the availability of suitable locations is worse.

To verify the relation between subjectively reported health problems and factors connected with PA, there was no proof of significant relation or dependence in any of the investigations. Correlation was provided mainly by the total occurrence of medical complications with time allotment of PA per week, with the total PA excluding walking, and also in combination with specific activities. Areas of orthopaedic characteristics were consequently excluded from the reported health problems and, in the last stage, joint problems were also set aside, and further correlated with factors related to PA. However, virtually all these cases failed to find a significant dependence. One quite interesting finding is a certain restructuring of performed PA. Taking into

account that the total amount of PA time allotment between 2005 and 2011 did not change significantly, and has slightly increased, and the percentage of individuals performing specific physical activity for the same period is decreasing, one could deduce a distinct specialization of respondents to a narrow portfolio of PA. It can be assumed that a particular individual chooses a limited number of activities to which s/he devotes more time. The question is whether this explanation can be considered positive, or if it stands for less variability of physical stimuli to which the individual is exposed.

Conclusion

Our survey showed that some aspects related to the health status and physical activity of two focus groups of respondents may bring about particular changes in a relatively short period of time. Two distinct tendencies in BMI distribution have been distinguished across all population groups – positive tendencies were prominent in the female group, whereas tendencies in the male group were rather negative. Subjective self-reporting of health status shows a change between 2005 and 2011, since more than 17% of respondents considered themselves as "healthy".

The most frequently reported health problem was pain in the lumbar spine. Hypertension proves to be a health problem with the largest gradations in age dependence. The sample measured over a period of 6 years indicates a decrease in the number of PAs performed by a specific respondent. Yet the total volume of time allotment of PA is not falling, and respondents devote a longer period of time to a single PA. Generally, most respondents varied between 100 to 400 minutes of PA per week and walking was reported as the most frequently performed PA. Through examinations of health consequences as a result of increased PA time, no significant relations which would indicate a negative influence of "excessive or enormous" PA on the health of the individual were found. Moreover, individuals with PA ranging from 800-900 minutes per week represent the group with the highest number of respondents who report no health problems and are considered "healthy".

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REDUCTION OF BODY WEIGHT IN CHILDREN BY APPROPRIATE DIET AND PHYSICAL ACTIVITY

Jana Juříková[1], Jarmila Prudilová[2]
[1]Faculty of Sports Studies, Department of Kinesiology, Masaryk University, Brno, Czech Republic
[2]The Children´s Treatment Centre Křetín, Czech Republic

Abstract

There were 41 research children (16 boys and 25 girls), who stayed sanatorium for children with different kinds of disorders include for children suffering from overweight or obesity. The program for the reduction of body weight contained rehabilitation procedures, strengthening physical fitness, regular workouts in a gym, games in the open air and walking. A special diet was composed for children suffering from obesity. Together with the physical activities, the aim of the diet was to reduce body weight of obese children.

At the beginning and at the end of the cure, basic anthropometric parameters were recorded for each child. At the end of the stay, the children's body weight was measured. The results proved that the program for reducing body weight was successful for all children. Boys lost in average 4.61 ± 1.68 kg, girls lost in average 3.65 ± 1.33 kg.

Keywords: *children, percentiles of BMI, overweight, obesity, healthy nutrition, physical activity, parents*

Introduction

Industrial development, modernization, and associated lifestyle changes have led to an escalating obesity epidemic worldwide (James, 2008; Kelly et al., 2008; Mitáš et al., 2014; Bebčáková et al., 2015). From 1918 there was a marked change in the cultural, social and physical landscape of European society, which followed from the increasing mechanization of industrial production. After World War II, a more sedentary lifestyle developed from the 1960s onwards. Eating patterns changed least and slowest amongst the working classes so that once the severe economic fluctuations of the first half of the twentieth century became a thing of the past, working-class families began to exhibit weight gain as incomes rose and major variations in consumption were prevented by welfare provisions. While slimming fashions and the youth culture had their origins mainly in the interwar years, women's weight increases reflected their rising incomes as greater workforce participation outside the home

developed and as their eating patterns increased to match those of men − including, in the last quarter of the twentieth century, a greater consumption of alcohol. In short, men were fatter than women in the nineteenth century and women became fatter than men in the twentieth (Oddy et al., 2009).

The prevalence of obesity worldwide nearly doubled over the last three decades (Finucane et al., 2011). This rise was even more pronounced in the USA (Austin et al., 2011), and today, one in three adults is obese and more than two in three adults are overweight or obese (Flegal et al., 2012; Ogden et al., 2014). Obesity also increased in several European countries over the past two decades (Finucane et al., 2011; OECD, 2014; Gallus et al., 2015; Zvonař et al., 2015).

Child obesity has become a serious public health problem in many developed countries over the last several decades. The majority of overweight children remain overweight or obese in their adult years. It is estimated that up to 40 % of 7-year-old and 80 % of 10 to 15-year-old obese children remain obese as adults, which substantially increases their risk of developing a chronic disease (Webber et al, 1995; Guo et al, 1994; Whitaker et al, 1997; Stránský, 2000); Humeníková et Gates, 2007).

The incidence of childhood obesity in the Czech Republic has overcome the pessimistic assumptions of the 1980's. Nowadays every fourth child is overweight, every seventh child suffers from obesity and 4% of children suffer from morbid obesity. The prevalence of obesity differs within particular age groups and it peaks in early adolescence. The late toddler period shows the first steep rise.

Almost one quarter of children at the beginning of primary school are overweight and 10% of these children are obese. Fourteen percent of adolescents finishing their elementary school attendance are obese, and 20% of the population enter their adulthood with obesity. It is important to mention the 5% of adolescents who are underweight. In an international comparison, the 24.2% prevalence of overweight among Czech children is beginning to approach the 32% incidence in the US, but the 14% obesity rate among Czech adolescents has already exceeded the 11% rate of a group of their American Euro-Caucasian peers. The alarming situation in our children population demonstrates a 4% incidence of morbid obesity, which represents a third of obese children in this group (sdetmiprotiobezite.cz).

This work presents the results of measurements obtained in children undergoing the treatment at The Children´s Treatment Centre of Křetín.

Methods

Participants

The tested group consisted of 25 researched children (10 boys and 15 girls) who participated in a curative stay at The Children´s treatment centre of Křetín during 18th June – 16th July 2014 and 16 researched children (6 boys and 10 girls) who participated in a curative stay during 25th March - 21st April 2015. The age range of boys was 5 – 13, age range of girls was 6 – 15 years. In total 51 children were researched.

Body weight measurement

The children's body weight was measured by the InBody 220 device which determines not only body weight, but also, when the body height is given, can determine on the basis of bioelectrical impedance, other characteristics such as BMI, the amount of fat tissue, proportion of water in the body and lean muscle mass. Children entered the InBody 220 device barefoot. The accuracy of body weight was measured to 0.1 kg.

Body height measurement

Body height was measured by anthropometry ± 0.5 cm. During measuring, children stood straight, heels together, tips slightly apart. The head is vertically upward, like looking into the distance (Frankfurt horizontal).

Body mass index in children

To evaluate BMI in children we use percentile graphs that compare an individual child against the population standards for children of the same age. Graphs differ for boys and girls. Percentile graphs outline the zone in which the BMI value is considered normal - this value corresponds to the age and gender of the child. The curves above and below this zone indicate the percentage of children of the same age who have the same BMI value. Zone between the 25th and 75th percentile, in which 50% of all values belong, is considered a zone of medium values. Values above the 85th percentile are often defined as overweight in children, and obesity is defined above the 95th percentile. Conversely, underweight values are found at the bottom part of the graph, below the curve indicating the 3rd percentile, and the interval of low weight occurs between the 3rd and the 10th percentile. Percentile graphs of the World Health Organization are shown below – Figure 1 represents boys and Figure 2 represents girls.

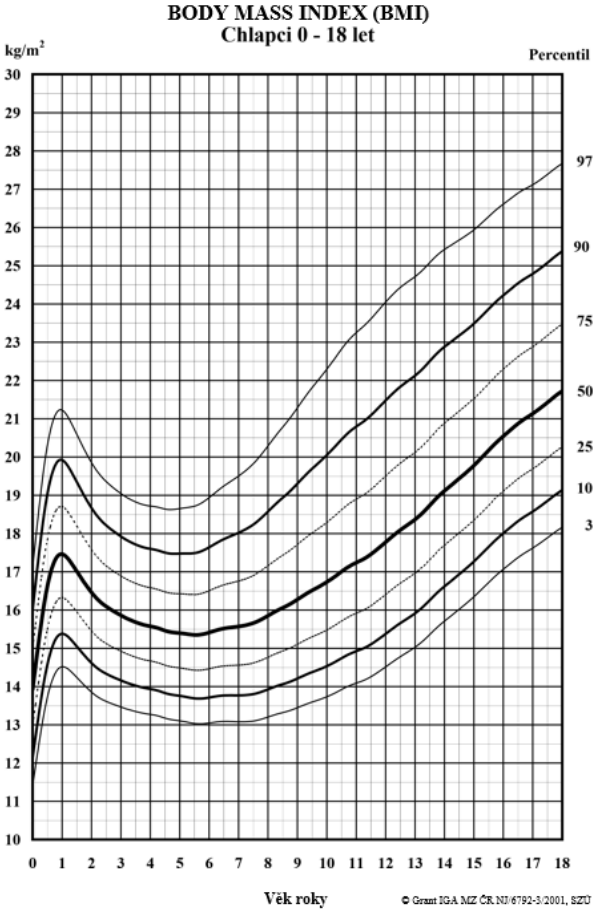

Fig. 1 BMI percentile graph – boys
Source: http://www.szu.cz/uploads/documents/obi/CAV/grafy/BMI_Chlapci.pdf
Note: Chlapci = boys, Věk (roky) = Age (years)

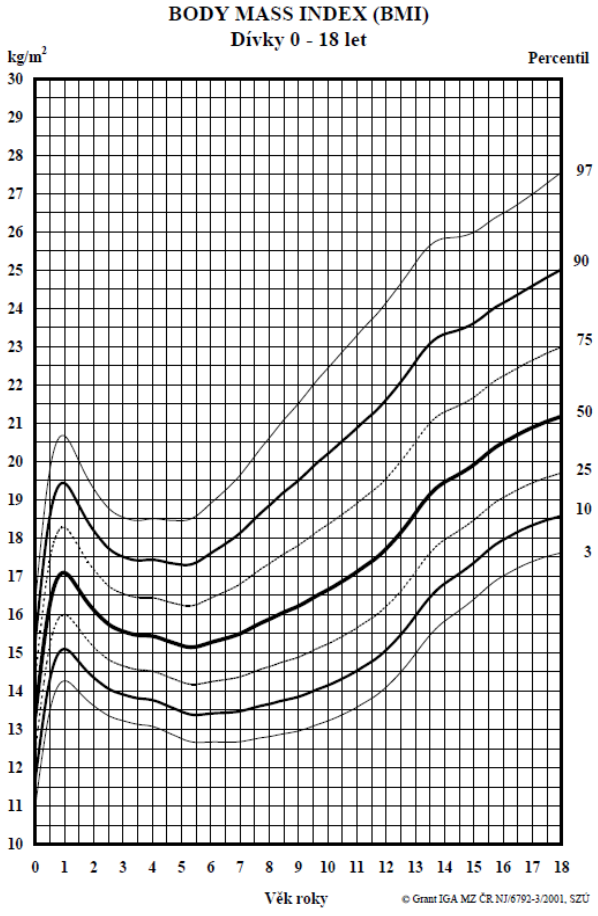

Fig. 2 BMI percentile graph – girls
Source: http://www.szu.cz/uploads/documents/obi/CAV/grafy/BMI_Divky.pdf
Note: Dívky = girls, Věk (roky) = Age (years)

Table 1 shows the classification of overweight and obesity according to BMI percentile in children.

Tab. 1 Classification of overweight and obesity according to BMI percentile in children

Percentile channel	Classification
97 <	obese
90 – 97	overweight
75 – 90	plump
25 – 75	proportionate
10 – 25	thin
< 10	underweight

Source: http://www.szu.cz/uploads/documents/obi/CAV/6.CAV_5_Rustove_grafy.pdf

Results

After the admission to the Centre all children were measured for body weight and height, BMI calculation, the amount of subcutaneous fat and circumferences of chest, waist and hips. The same parameters were measured at the end of the stay after 4 weeks of the weight reduction programme. Body height, initial and final body weight and the initial and final BMI are given in Table II for boys and in Table III for girls.

Tab. 2 Body height, body weight initial and final, BMI initial and final in tested children – boys

No.	Age [years]	Body height [cm]	Body weight [kg]			BMI		
			initial	final	difference	initial	final	difference
1	13	165	74.9	71.6	3.3	27.5	26.3	1.2
2	11	166	54.7	50.9	3.8	22.8	21.2	1.6
3	12	151	68.5	63.6	4.9	30.1	27.9	2.2
4	12	156	68.2	64.1	4.1	28.0	26.3	1.7
5	9	140	52.0	48.0	4.0	26.6	24.5	2.1
6	14	162	72.4	68.2	4.2	27.6	26.0	1.6
7	17	174	95.8	89.1	6.7	31.6	26.4	2.2
8	12	161	76.3	69.8	6.5	29.4	26.9	2.5
9	12	172	96.8	90.9	5.9	32.7	30.7	2.0
10	13	157	65.1	59.4	5.7	26.4	24.1	2.3
11	9	153	46.7	43.8	2.9	19.9	18.7	1.2
12	9	132	43.9	39.6	4.3	25.2	22.7	2.5
13	12	163	82.9	76.2	6.7	31.2	28.7	2.5
14	8	141	42.5	41.2	1.3	21.4	20.7	0.7
15	5	123	38.3	36.6	1.7	25.3	24.2	1.1
16	13	156	79.2	74.0	5.2	32.5	30.4	2.1
Average					4.61			1.73
Standard deviation					1.68			0.58

t-test:
BMI – boys
T = 8.041
t(crit) = 2.131
T > t(crit)

Tab. 3 Body height, body weight initial and final, BMI initial and final in tested children – girls

No.	Age [years]	Body height [cm]	Body weight [kg]			BMI		
			initial	final	difference	initial	final	difference
1	11	152.0	73.4	68.3	5.1	31.8	29.6	2.2
2	17	163.5	73.0	70.1	2.9	27.3	26.2	1.1
3	9	147.0	48.8	46.0	2.8	22.6	21.3	1.3
4	13	167.0	86.4	81.8	4.6	31.0	29.3	1.7
5	15	162.0	88.5	85.3	3.2	33.7	32.5	1.2
6	15	167.0	84.7	81.3	3.4	30.4	29.1	1.3
7	13	143.0	91.6	86.0	5.6	28.3	26.6	1.7
8	9	143.0	50.6	48.0	2.6	24.7	23.5	1.2
9	8	137.0	48.1	45.1	3.0	25.6	24.1	1.5
10	15	167.0	75.4	73.3	2.1	27.1	26.3	0.8
11	14	155.0	68.9	64.0	4.9	27.8	25.8	2.0
12	12	157.0	61.9	59.3	2.6	25.1	24.1	1.0
13	14	162.5	83.8	81.1	2.7	31.7	30.7	1.0
14	13	164.0	83.6	79.0	4.6	31.1	29.4	1.7
15	12	150.0	63.2	59.9	3.3	28.1	26.6	1.5
16	10	145.0	72.8	69.1	3.7	34.6	32.9	1.7
17	11	141.0	43.8	42.1	1.7	21.6	21.2	0.4
18	11	158.0	81.3	76.8	4.5	32.6	30.8	1.8
19	10	140.0	38.9	36.7	2.2	19.8	18.7	1.1
20	8	141.0	49.7	48.7	1.0	25.0	24.5	0.5
21	6	137.0	47.0	43.4	3.6	25.1	23.1	2.0
22	15	159.0	126.8	120.2	6.6	50.2	47.6	2.6
23	10	154.0	63.9	59.7	4.2	26.9	25.2	1.7
24	13	159.0	83.2	77.5	5.7	32.9	30.6	2.3
25	9	140.0	44.6	42.8	1.8	22.7	21.8	0.9
Average					3.65			1.54
Standard deviation					1.33			0.54

t-test:
BMI – girls
T = 2.864
t(crit) = 2.131
T > t(crit)

Discussion

After completion of the curative stay all children showed some weight reduction. The difference in boys was 4.61 ± 1.68 kg, in girls 3.65 ± 1.33 kg on average. There were on at the level of significance 0.05 statistically significant differences. The most significant weight loss were reported in a 12 year old boy (no. 13) who lost 6.7 kg per 4-week stay and 15 year old girl (no. 22) who lost 6.6kg. It is however essential to mention the fact that the girl had weighed 126.8 kg at the moment he was admitted to the Centre and 120.2 kg when he was released, which means that he had been defined as morbid obese. The least weight loss, merely 1 kg, was reported in an 8 year old girl (no. 20). She did, however, show an improvement in her BMI, which was above the 97th percentile at admittance, and just above 97th percentile at release. BMI in all children decreased after participating in the programme. None of the children grew in height; weight loss was the only reported change. The difference in boys was 1.73 ± 0.58, in girls 1.54 ± 0.54 on average. There were on at the level of significance 0.05 statistically significant differences. The greatest BMI decrease (of 2.6) was reported in a girl aged 15 (no. 22), and in 2 boys: one of them was 9 year old (no. 12) and the second was 12 year old (no. 13) whose difference of BMI value was 2.5. The smallest difference of BMI value was (0.5) in a girl aged 8 (no 20). In both of these children the BMI remained above the 97th percentile after the curative stay, i.e. within the zone of morbid obesity. Similarly the amount of body fat was lower in all children at the end of the curative stay.

Conclusion

After 4-weeks of curative stay we can claim that the stay was 100% successful – all children lowered their body weight (and consequently also decreased their BMI). The change of weight in both of them, boys and girls was statistically significant differences at the level of significance 0.05. Boys lost 4.61 kg, girls 3.65 kg, on average. The difference of BMI value in boys was 1.73 and in girls 1.54. In both of them, boys and girls were statistically significant differences at the level of significance 0.05 too. The question remains whether the children are capable of maintaining their reduced weight and fitter body after their return to their domestic environment.

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THE INFLUENCE OF SHORT-TERM MOVEMENT INTERVENTION ON THE QUALITY OF LIFE OF MIDDLE-AGED WOMEN

Věra Knappová, Gabriela Kavalířová, Soňa Surová
Faculty of Education, University of West Bohemia, Plzeň, Czech Republic

Abstract

Nowadays many individuals with overweight in their middle age suffer with the pain of musculoskeletal system. This pain is an indirect indicator of functional disorders of the musculoskeletal system that can lead to decrease in the overall quality of life (QOL). Both can be improved by means of the individually adapted movement intervention.

The aim of this work is to describe the influence of the short-term complex (movement and educational) intervention on perceiving the QOL of women with overweight or obesity in their middle age. Our research sample consisted of 23 women.

The QOL was evaluated pre- and post- the application of the complex program with the questionnaire Quality of Life Enjoyment and Satisfaction (Q-LES-Q). It contains 92 questions divided to 8 domains (Physical health/activities, Feelings, Work, Household duties, School/course work, Leisure time activities, Social relations and General activities). Questions are responded on the five point Likert scale (from Not at all to All of the time).

In each domain the certain changes appeared in perceiving the QOL, from which we can infer that also short-term complex intervention can be positively reflected in all domains of life. Within statistical evaluation we noticed changes on the different level of significance in all evaluated domains, except the domain "Work" (the short-term intervention took place during the weekend). Statistical significance on the level α=0.01 manifested itself markedly in the first domain of the questionnaire "Physical health/activity", next in the domain "Feelings" and then in the last domain "General activities".

The main content of the weekend program was Nordic walking, health focused conditioning and corrective exercises. Observed positive changes confirmed the suitability of the proposed movement and educational intervention for the influencing the QOL of women in their middle age. We are aware of the fact that achieved positive effect does not have to be permanent. It would be appropriate to keep the motivation of individuals in the long term.

Keywords: *hypoactivity, overweight, musculoskeletal system, corrective exercises, quality of life*

Introduction

Most authors being concerned with problems of healthy lifestyle incorporate physical activity into fundamental determinants improving life and optimizing health condition. According to Blahutková et al. (2005) the part of this process is the harmonious balanced personality in spheres of bio-psycho-socio-spiritual well-being of each individual.

Nowadays many individuals in their middle age suffer with overweight or obesity as a result of the sedentary lifestyle. The overweight and obesity is very often connected with the pain of musculoskeletal system, mainly in the spine area and in root joints. This pain is indirect indicator of functional disorders of musculoskeletal system that can lead to appearance of structural disorders and decrease in the overall quality of life (QOL).

The QOL of an individual and his/her state of musculoskeletal system is influenced by the range of bio-psycho-social factors. From that reason the QOL is part of many science fields. We can evaluate it from the point of view of an individual, where the information gained through the questionnaire help to create appropriate medical and therapeutic plan. Its efficacy can be reevaluated after period of time. In medical science the QOL is one of the most important indicators when selecting and evaluating the overall success rate of treatment (Vaďurová, Mühlpachr, 2005; Danielsson, Hasserius, Ohlin, Nachemson, 2012; Parent, Hill, Moreau, Mahood, Raso, Lou, 2007).

According to Czech authors dealing with the problems of hypokinesia and decrease of the QOL by people in their middle age (Vařeka, Vařeková, 2008; Riegerová, Přidalová, Krejčí, 2007; Vařeková 2001) we suppose that one of the possible physiological preventive intervention leading to permanent optimization of lifestyle of these individuals is, among others, the recommendation of the appropriate type of corrective movement program.

The aim of this work is to evaluate the influence of the short-term complex (movement and educational) intervention on perceiving the QOL of women with overweight or obesity in their middle age. We were interested in the fact, if the chosen intervention significantly changes their perceiving the QOL in its individual domains.

Methods

Our research sample consisted of 23 women with overweight or obesity in their middle age (their average age was 42.3 ± 4.7 years). The objective finding by all observed probands was the overload of axial system caused by staying in the sitting position by a computer for a long time followed by permanent painful difficulties connected with this kind of occupation. Probands took part in complex (movement and educational) weekend intervention.

Weekend intervention was focused on practical (8 exercise lessons) and theoretical (3 lectures) familiarization of probands with different kinds of movement activities influencing both physical and mental health. It is obvious that the health condition of clients cannot be changed for such a short time the lector works with them. Our aim was to offer the individuals suffering with overweight and obesity or another metabolic syndrome the possible way of solution of their problems. We wanted to trigger their motivation toward change in their lifestyle. The main content of the weekend program was aerobic activity in form of Nordic walking, health focused conditioning and corrective exercises. Next to that the probands were introduced to new forms of movement programs (Tai-chi, balance platforms, SM system and TRX system). The nutrition intervention was provided in cooperation with the local bio cuisine and probands also took part in the evening lecture with discussion. The mental health of participants was surely influenced by massages, beauty care, wellness zone and the walking trip to the near castle.

Data were collected during three weekend stays (spring and autumn 2013 and spring 2014) to have necessary number of respondents. The QOL was evaluated pre- and post- the application of the complex program with the questionnaire Quality of Life Enjoyment and Satisfaction (Q-LES-Q) (Endicott et al., 1993). We used the Czech translation of the questionnaire (Palčová, 2003). In the Czech Republic this questionnaire was validated by Müllerová et al. (2001) for diagnostics of depressive disorder and it is appropriate to determine influences of targeted intervention. The questionnaire is easily applicable not only in clinical environment but also in common practice, it is comprehensible and precisely distinguishes individual changes in mood in individual domains. It contains 92 questions divided to 8 domains. Questions are responded on the five point Likert scale (from Not at all to All of the time), presented in Table 1.

Tab. 1 Structure of the questionnaire Q-LES-Q

Domain	Number of questions
1. Physical health/activities	13
2. Feelings	14
3. Work	13
4. Household duties	10
5. School/course work	10
6. Leisure time activities	6
7. Social relations	11
8. General activities	16

Probands filled in the questionnaires during their arrival and evaluated their last week. During their departure they filled in the questionnaire again. The respondents evaluated the weekend with movement-educational program they took part in. We are aware of the fact that the respondents evaluated only last three days not the whole week, but they evaluated changes in perceiving the QOL immediately after finishing the short-term intervention. The questionnaire reflected changes caused by the intervention.

For the statistical evaluation we used the program STATISTICA 5.5. To compare the change within all domains pre- and post- the intervention we chose the statistical method Wilcoxon test that is used for evaluation of changes between two dependent random samples.

Results

Comparing the output and entrance data from the questionnaire Q-LES-Q the considerable change in the level of the QOL was found in some domains. The major changes were determined in the domain Physical health. The positive change also appeared in other domains, but not so strongly (Figure 1).

The fifth domain "School/course work" was filled only by two women, so we removed this domain from our evaluation and replaced it by zero value in the figure. Because according to the authors (Endicott et al., 1993) it is not possible to use results from the domain where more than half of responses is missing.

Within the statistical evaluation we noticed changes on the different level of significance in all evaluated domains, except the domain "Work". Statistical significance on the level $\alpha=0.01$ manifested itself markedly in the first domain of the questionnaire "Physical health/activity". The second statistically significant change appeared in the domain "Feelings" and the third one was in the last domain "General activities". The last domain reflects the change in overall QOL of probands.

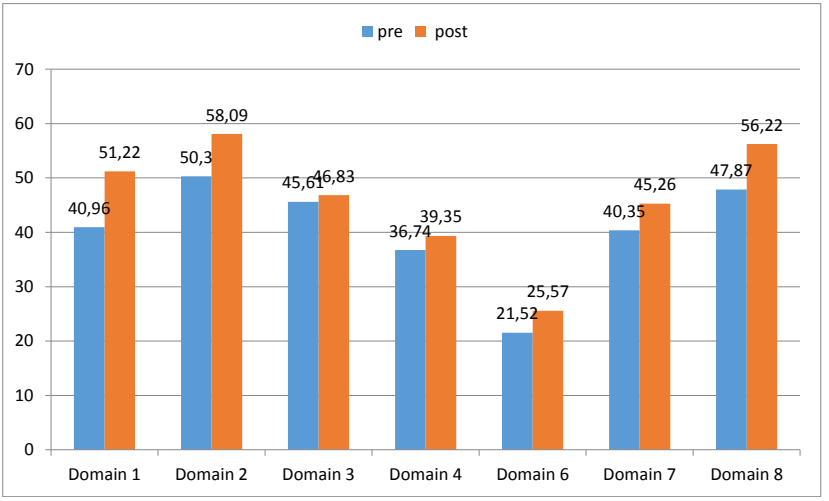

Fig. 1 The average values of all probands in individual domains

The differences between pre- and post- intervention in individual domains are shown in Figure 2.

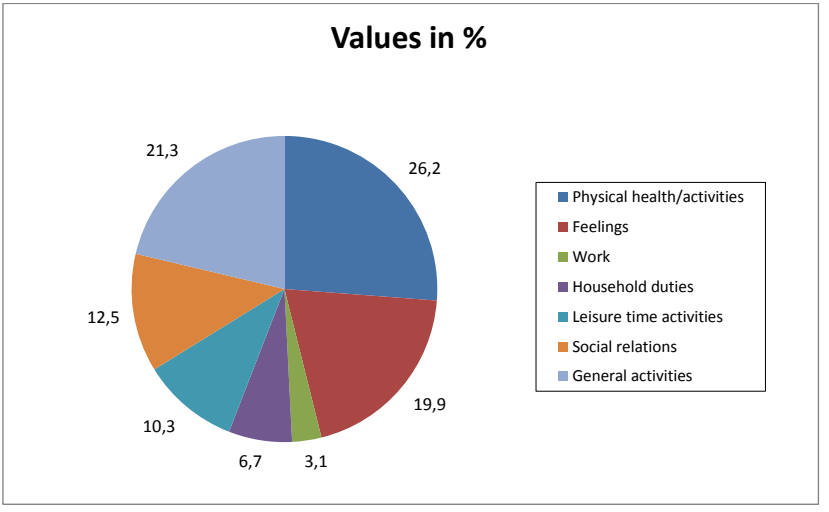

Fig. 2 The differences between pre- and post- intervention in individual domains of the QOL

Discussion

Many authors emphasize the important dependence between optimally adjusted movement activity, diet adjustment and health and mental state of an individual, e.g. Rippe, Price, Hess, Kline, DeMers, Damitz, Kreidieh, Freedson (1998), Bowen, Fesinmeyer, Yasui, Tworoger, Ulrich, Irwin, Rudolph, LaCroix, Schwartz, McTiernan (2006).

In agreement with this statement we observed increasing interest among our probands (women with overweight or obesity in their middle age) during the movement program. Women felt satisfied during exercise lessons, they connected gained theoretical information with experience and they showed improved level of perceiving the musculoskeletal system. The major changes were determined in the domain of QOL Physical health. That is why we can think that this domain was influenced by positive effect of the applied program on the musculoskeletal system of probands.

Based on this fact we recommended to probands the basic ergonomic adjustment of the movement regime during the day, especially at work, and also adjustment of the regime when acute difficulties in their musculoskeletal system appear.

According to our findings and observation of probands we would primarily recommend to individuals in their middle age (in our study from 35 to 50 years of age) to implement the lessons of corrective exercises of slow move character (individualized exercises) to their organized movement program. Within these exercises we primarily incorporate exercises for rotator back muscles and erector spinae. We purposefully stretch surface hyperactive layers of erector spinae and strengthen deeply placed muscle groups.

Changes in the domain "Work" was not significant. It was probably because of the fact that our short-term intervention took place during the weekend.

The interesting phenomenon is comparison of values of the result score in the domain 4 and 6 by the Czech women and women tested by the questionnaire Q-LES-Q in the USA. This phenomenon of the Czech environment was noticed also by Müllerová et al. (2001). While the values in domain 6 „Leisure time activities" are high and values in domain 4 „Household duties" are quite low by American women, the situation by Czech women is totally different. According to Müllerová et al. (2001) there is known from the psychiatric practice up to pathological emphasis on household duties by the Czech women that often substitutes quality interpersonal relations. The authors consider these discrepancies with the original version to be the proof that the used questionnaire works in a new environment and is able to show its

specificities. According to our opinion it would be interesting to monitor development of this trend also in future, when the younger generation of women will grow up to their middle age. These women grow up in the different socioeconomic environment that is more influenced by western world.

Conclusions

It is evident that even the short-term complex (movement and educational) intervention has influence on perceiving the QOL of women with overweight or obesity in their middle age. Observed positive changes in perceiving the QOL confirmed the suitability of our proposed movement and educational intervention. The movement intervention was focused mainly on corrective exercises and appropriate activity of aerobic character – Nordic walking. It influences both physical and mental part of the individual and it is reflected in all domains of the QOL.

The problem of the QOL and its change depends on the type and length of applied intervention. We are aware of the fact that achieved positive effect in case of short-term complex intervention does not have to be permanent. It would be appropriate to keep the motivation of individuals in long term. Nevertheless the changes in perceiving the QOL following the intervention are important with respect to evoking the interest of probands to change their lifestyle.

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MOTOR COMPETENCE AMONG CZECH PRESCHOOL CHILDREN WITH RESPECT TO GENDER

Jakub Kokštejn
Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic

Abstract

Knowing the level of motor development and potential gender differences in preschool children is important if teachers are to ensure adequate level of fundamental motor skills. The aim of this study was to report the level of motor competency through fundamental motor skills (FMS) and to find possible gender differences in FMS in preschool children 4-6 year old. A total sample of 284 children (4-6 years old; 126 girls and 158 boys) participated in this cross-sectional study. The test of the Movement Assessment Battery for Children (MABC-2; 2nd edition) was used for the assessment of FMS motor competency using a total test score (TTS) and also a score of three subtests of MABC-2 test (Manual dexterity-MD, Throwing and catching-AC, Balance-BAL). For interpretation of statistical significance Mann-Whitney U test was used for finding the gender differences in each year of age between 4-6 years old children. Four-years-old girls performed significantly better in TTS score, manual dexterity and balance subtests of MABC-2 test then boys. We found no gender differences in TTS in five and six years old children. However six-years-old boys performed significantly better in subtest of throwing and catching (AC). According to TTS score, the trend of increasing motor competency level across all age periods (4, 5, 6 years) was observed in boys while in girls we found conversely decreasing level in TTS score across age. The decreasing level of FMS motor competency level across age in girls is concerning. Special focus should be paid to improve throwing and catching skills in girls because of its important role in many sport games and activities. Early motor skill programs with gender specific approach should be encourage especially by teachers to help children master a basic motor skills from area of throwing and catching.

Keywords: *Preschoolers, gender differences, motor skills, MABC-2, standard score.*

Introduction

For a long time, fundamental motor skills (FMS) have been considered crucial construction elements of specialized motor skills which are in later years needed in order for children to participate in both organized and unorganized sports and recreational activities (Sugdan, Wade, 2013; Gallahue, Ozmun, 2006). Preschool and early school ages are key periods for mastering adequate FMS level (Hardy et al., 2010). FMS consist of locomotor (e.g. running, jumping), manipulative (e.g. catching

and throwing) and balance skills (e.g. jumping on one leg) (Stodden et al., 2008), and once they are mastered they contribute to physical, cognitive and social development in young age and thus create a so-called "healthy lifestyle" (Haywood, Getchell, 2014; Gallahue, Ozmun, 2006). Stodden et al. (2008) claim that FMS together with "perceived motor skill competence" and "health-related physical fitness" play a crucial role in predicting the level of physical activity and subsequent obesity in children. Results of some research studies have proved that adequately mastered FMS correlated significantly with a higher level of physical activity (Barnett et al., 2008, 2009; Okely et al., 2001); especially locomotor FMS highly correlates with the level of physical activity in children (Williams et al., 2008; Fisher et al., 2005). Hardy et al. (2010) assessed the level of FMS in Australian preschool children (N=425) using the TGMD-2 motor test (Test of Gross Motor Development; Ulrich, 2000). 70-75% of these children were successful in the "running" skills; however, only 9-44% of children scored appropriately in other skills (e.g. galloping, leaping, throwing, catching, kicking). Goodway et al. (2010) assessed the level of FMS in preschoolers at risk of motor delay (N=469). According to the TGMD-2 results, children's average score was below the 30th percentile and 86% of children scored below the 30th percentile. Gender differences in preschool boys and girls are very well documented in contemporary literature (Goodway et al., 2010; Hardy et al., 2010; Okely, Booth, 2004). Hardy et al. (2010) detected a significantly higher level of locomotor skills in preschool girls while in preschool boys the level of object control skills (e.g. throwing, catching, kicking) was significantly better. However, the total test scores in TGMD-2 did not differ significantly. Goodway et al. (2010) reported significantly better results in object control skills in preschool boys compared to girls. On the other hand, no gender differences were detected in locomotor skills. Okely, Booth (2004) arrived at identical results, however in older children (7-9 years), when boys achieved significantly better results than girls in manipulative skills like catching, throwing and kicking. The results reported for gender differences in balance skills which are fundamental for a number of physical and sports activities are contradictory in preschool children (Vanetsanou, Kambas, 2011).

With reference to results documented in contemporary literature, it must be noted that in the Czech Republic very little attention has been paid to the assessment the level of FMS in preschool children. Therefore, the aim of this study is to assess the level of FMS and possible gender differences in Czech preschool children (aged 4-6 years).

Methods

The research sample consisted of early school-age children aged 4-6 years (N=284; 4.9±1.0 years; 126 girls and 158 boys; Table 1) from seven preschools from Prague and Middleczech regions in the Czech Republic. These common preschools were chosen randomly. In cooperation with the management of the preschool establishments, we addressed parents to ask them about their children's possible participation in the study. An informed consent confirmed by parents was a prerequisite to a child's participation in the study. Children who had been diagnosed with mental or other serious clinical impairments (such as ADHD, DCD, LMD, developmental dysphasia) or children from special class were not recruited for the study.

Tab. 1 Descriptive data of participants (N=284)

Age (years)	Girls (n)	Boys (n)
4	47	75
5	47	45
6	32	38

MABC-2 (Movement Assessment Battery for Children-2; Henderson et al., 2007) test was used in order to assess the level of FMS. The MABC-2 test is a valid tool frequently used for assessment of motor development and identification of developmental movement difficulties. The MABC-2 test for preschool children (aged 3-6) contains 8 test items which assess three basic components (fine and gross motor skills, and balance skills) in humans. Raw scores achieved in each of the 8 test items were then converted to standard scores in accordance with age norms for Czech population (Henderson et al., 2014). The overall level of FMS was calculated by summing standard scores in individual test and stated as the total test score (TTS) using percentiles and standard scores. Levels achieved in individual components of the MABC-2 test battery – fine motor skills (manual dexterity – MD), gross motor skills (aiming and catching - AC) and balance (BAL) – were calculated in the same way. We used standard scores for TTS and three subtests of MABC-2 which are suitable for research according to Henderson et al. (2014). According to the MABC-2 test manual, standard scores are normalized distribution of raw scores with the mean 10 and a standard deviation 3 on a scale of 19 (Henderson et al., 2007). MABC-2 test has a very good test-retest reliability for TTS (intraclass correlation coefficient ICC = 0.83-0.97; Smits-Engelsmanet et al., 2011). According to the same authors, the internal consistency for the MABC-2 test was high $\alpha = 0.81$ and 0.87. Mann-Whitney

U test ($p \leq 0.5$) and coefficient *r* were used for assessment of statistical and practical significance of the differences between boys and girls in TTS and MD, AC, and BAL subtests. The values of the coefficient (for evaluating of practical significance) *r* 0.3 are interpreted as small effect, *r* 0.5 as medium effect and *r* 0.5 as large effect (Field, 2013). The statistical analysis was conducted using the IBM SPSS Statistics 22 program.

Results

At the age of 4, girls scored significantly better than boys in TTS ($p<0.01$; $r = 0.24$) as well as in all subtests of MABC-2 (MD $p<0.01$; $r = 0.23$; AC $p<0.05$; $r = 0$; BAL $p<0.05$; $r = 0.19$). However, practical significance of differences in these subtests was not confirmed between boys and girls. At the age of 5 we did not detect any significant differences between girls and boys neither in TTS nor in any of the subtests of MABC-2. TTS did not also differ significantly in girls and boys aged 6, but boys were significantly better in the AC subtest of MABC-2 ($p<0.01$; $r = 0.46$).

Tab. 2 Standard scores of boys and girls in MABC-2 test

Age	MABC-2	Boys M±SD	Girls M±SD	p value	*r*
4 year old	TTS	8.9±3,3	10.6±3.6	**0.008****	0.24
	MD	8.9±2,8	10.3±3.3	**0.010***	0.23
	AC	8.8±3,3	9.0±3.4	0.994	0
	BAL	10.3±3,8	11.8±3.8	**0.038***	0.19
5 year old	TTS	9.2±3.0	9.8±2.2	0.548	0.06
	MD	9.7±3.5	10.8±2.7	0.129	0.16
	AC	9.3±2.0	8.6±2.2	0.125	0.16
	BAL	9.0±2.2	9.7±2.1	0.157	0.15
6 year old	TTS	9.8±2.1	9.1±1.7	0.183	0.16
	MD	10.6±2.1	10.3±2.8	0.783	0.03
	AC	9.5±1.6	7.8±1.8	**0.000****	**0.46**†
	BAL	9.4±1.9	9.6±1.6	0.823	0.03

Notes: p value – statistically significant value of Mann-Whitney U test, r – coefficient of practical significance, * - $p<0.05$, ** - $p<0.01$, † - medium effect of practical significance, MABC-2 – Movement Assessment Battery for Children, M±SD – arithmetic mean±standard deviation, TTS – total test score, MD – manual dexterity, AC – aiming and catching, BAL – balance.

Discussion

The aim of the study was to determine the level of fundamental motor skills (FMS) in preschool children. At the same time, the study also aimed to indicate possible gender differences between boys and girls at each year of age.

The value of standard score of TTS in MABC-2 test in boys was slightly below the average level of 10 in each year (4 yr.-8.9; 5 yr.-9.2; 6 yr.-9.8). In girls the value of standard score of TTS moved around 10 in each year (4 yr.-10.6; 5 yr.-9.8; 6 yr.-9.1). Standard scores used in our study are normalized distribution of raw scores with the mean 10 and standard deviation 3 on a scale of 19 (Henderson et al., 2014). The standard score is used to assess the distance of a child's motor performance from the mean in each test item, in three subtests and in the total test score of MABC-2 test. The value 10 of standard score in TTS then reflects the performance at 50th percentile (median)

of the general population in a given age. Overall the average value of TTS in MABC-2 in boys and girls with respect to their age suggest normal (health) motor development. However, the trend of increasing TTS in MABC-2 test in boys across three age stages and conversely decreasing trend in TTS in girls founded in our study are concerning findings. The similar trend we detected in aiming and catching skills – while there was no difference between girls and boys at the age of 3, at the age of 6 it was girls who did significantly worse. We consider this an important piece of information as mastering objective control skills (throwing, catching, kicking) is a precondition for a number of recreational and organized sports activities. As according to the MABC-2 manual the standard score of 7.6 in 6-years-old girls falls at the 23rd percentile, we consider this finding a crucial one. We suggest that low or insufficient level of throwing and catching skills in girls could negatively affect participation of girls in a number of physical and first of all sports activities and games, which could then adversely affect psychosocial and health development.

With respect to gender, we found significantly better results in TTS and in two subtests of MABC-2 test in 4-years old girls (with the exception of AC subtest) when compared to boys of the same age. On the other hand, no significant gender differences in TTS were detected in 5- and 6-year-olds. However, in AC (aiming and catching), 6-year-old boys scored significantly better than girls. Hardy et al. (2009) and Goodway et al. (2010) also found significantly better results in object control skills (throwing, catching, and kicking) in preschool boys in comparison with girls. On the other hand, with respect to balance FMS, the results of Vanetsanou, Kambas (2011) confirm a significantly better level of FMS in preschool girls compared to preschool boys till a certain age. Vanetsanou, Kambas (2011) found significantly better results in balance FMS in girls than in boys in the population of preschoolers (4.5-5.5 years). In children aged 5.6-5.9, however, the authors did not already detect any significant gender differences. Faster maturation of neurological, visual, vestibular and proprioceptive systems of girls can serve as one of the possible explanations for the detected gender differences in children aged 4 years in our study (Mickle et al., 2011). On the other hand, some authors claim that biological differences between preschool girls and boys are not significant (Gallahue, Ozmun, 2006; Malina et al., 2004). The detected gender differences in preschool children could be then rather attributed to the process of socialization which is affected by parents, teachers and peers (Malina et al., 2004).

As the main strenght of our study we consider the use of worldwide recognized test for assessment of motor skills (MABC-2) with standardized norms for czech preschool children population. This will allow us to realize valid repeated measure with adequate time interval. According to our opinion the main limitation is small and unequal number of children in each age group. The other limitation could also

be crossectional design of our stady in comparison to more effective longitudinal research design.

Conclusion

The assessment of the fundamental motor skills in preschool boys and girls plays an important part in creating appropriate developmental strategy in later years. At the end of preschool age, the average level of FMS is on the average value for general population. On the other hand, the fact that the level of aiming and catching skills in girls has a significantly decreasing tendency across the four preschool years is a very unfavorable finding as it can critically affect the development of these skills and subsequent psychosocial and health development. Consequently, further research should be focused on detecting risk factors of the low level of aiming and catching skills in preschool girls.

Acknowledgement

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SENIOR TOURISM ON THE EXAMPLE OF MEMBERS OF THE 'FAN' ASSOCIATION FOR SPORT PROMOTION IN WROCŁAW, POLAND

Piotr Oleśniewicz[1], Julita Markiewicz Patkowska[2], Krzysztof Widawski[3]
[1]University School of Physical Education in Wrocław, Poland
[2] Wrocław School of Banking, Poland
[3] University of Wrocław, Poland

Abstract

The article refers to the functioning and development perspectives of senior tourism based on the opinion of two senior sections members of an association dedicated to sport promotion. A short presentation of the association activity is followed by an analysis of the survey responses. The research was performed among 68 seniors. The questions concerned four main topics: the respondents' personal status and physical condition, the preferred forms of recreational activity, the main purposes of travelling and tourist motivations, and, finally, the most important factors inhibiting the responders' tourist activity. The group was also asked to assess the tourist offer existing on the local market in Lower Silesia, and especially to emphasise factors that should be changed.

Keywords: *senior tourism, tourist motivations, tourism development inhibitors, tourist offer*

Introduction

The ageing of the societies in the developed countries is a fact. The process has been observed for years, with a specific culmination point, at least in Europe, in the year of 2004, when the number of seniors – people aged over 65 – exceeded the number of the youngest population (under 14 years of age) with the ratio of 75.4 million to 74 million. In the recent decade, every sixth inhabitant of our continent was over 65 years of age (Alén et al. 2012), and the situation is still dynamically changing. As Śniadek points (2006), in 2020, 25% of the European Union inhabitants will belong to the 60+ group. Every 6 seconds, the number of seniors in Europe increases by one.

Identification and explanation of the issue

Senior definition

In the context of an attempt to assess senior tourism functioning, the group that the phenomenon refers to should be determined first. In fact, some discrepancies can be observed here already. Hossain et al. (2003) use the term *senior* with regard to the age group of 55+, and the term *non-senior* for the group aged 15–55 years. Moreover, they divide the senior group into elder seniors (aged 65+) and younger seniors (between 55 and 64 years of age). In Alcaide's approach (2005), the senior age begins with 55 years of age. He considers this moment a significant turning point, as it is accompanied by the emergence of new, specific needs related to age. Condition changes also appear which are predictable and refer mainly to physical complaints. Lee and Tideswell (2005), as well as Garcia and Martorell (2007) point at the age of 60 years as an important time point of changes; in the majority of people, this is when the life rhythm is modified and needs different from those present so far arise. Walker (2004) distinguishes as many as four categories of senior age: the group of people at the pre-retirement age and those who have retired earlier (55–64 years of age), the group of the retired (65–74 years of age), the group of elder pensioners (75–84 years of age), the group of people at the age of 85 or more. Dąbrowski (2006), in turn, divides seniors into three basic groups: people advanced in years (60–75 years of age), people of old age (76–90 years of age), long-lived people, i.e. those older than 90 years of age. The World Health Organisation suggests a similar classification and the United Nations point at the age of 65 as the old age threshold (Kowalik 2009).

Senior tourism

Senior tourism, i.e. tourism of elderly people is included, among others, within social tourism regarding people whose life situation makes it entirely or partly impossible for them to partake in tourism. This can result from economic factors, physical impairment, isolation, restricted mobility. Among these groups, as Górska points out (2010), apart from children, youth, and families, elderly people are of special interest.

Senior tourism is often mentioned in the context of tourism of the disabled. Buhalis and Darcy (2011), when discussing groups of the disabled, enumerate elderly people among them – beside those with impaired mobility or those with temporary impairment, e.g. children under 6 years of age. Age, constituting one of the impairment criteria because of the specificity of the human body functioning, is also indicated in the Spanish language literature referring to tourism. Gonzalez (2008) points at elderly people as one of the three groups remaining within the range of research on tourism of

the disabled. The potential of the group with regard to tourism available in the context of demographic changes is described by Darcy and Dickson (2009), as well as by Widawski (2010, 2011).

Tourists' motivations are diverse, and this applies also to seniors. It would be difficult to point at a single, leading reason for tourist migrations in this group. They depend, as in the case of other groups, on the economic status, education, physical condition, or habits. Among the most significant reasons, the needs to rest and relax are enumerated in the subject literature (Horneman et al. 2002, Lee and Tideswell 2005). The need to meet other people and to make new acquaintances are emphasised by Acevedo (2003) or Huang and Tsai (2003). The reasons for tourist trips in the group of seniors also include the simple need to discover new destinations, with their cultural and natural attractions that the seniors have always planned to visit (Horneman et al. 2002); visiting relatives plays an important part, too. Moreover, the number of health-related stays in resorts and spa & wellness centres is rising (Widawski 2011).

The seniors' behaviour on the tourist market can also be specific (Alén et al. 2012). The choice of accommodation depends on the trip character and the participants' income; however, there is a demand for maintaining a minimum standard, which determines the fact if the senior benefits from the offer. The length of the senior's trip is obviously variable; the farther the journey, the longer its time, a dependence observable also in other groups. One can still note that seniors dedicate more time for tourism than the rest of the population. What is also significant is the source of information that seniors use when taking the decision regarding a tourist trip. Most often they rely on their own long-term experience as consumers of the tourist offer. They usually gather information personally from their relatives, friends, neighbours. The mouth-to-mouth model of passing information dominates. An essential source of information is also press, willingly read by the majority of elderly people (Horneman et al. 2002).

It is worth to attempt to verify, at least partially, the functioning of senior tourism in Lower Silesia on the basis of seniors' own opinions. This is why a study was performed among members of the 'FAN' Association for Sport Promotion in Wrocław who are engaged in tourism.

'FAN' Association for Sport Promotion

The Association was established in 2005 by members of the Gwardia Wrocław Sports Fan Club. At present, it unites 193 people bound with sport and recreation who want to develop their skills and share knowledge and experience. Within the Association, two sections were created which are oriented at elderly people, namely: the Active Senior Club and 50+ Footballers.

The former came into being in 2010. Now it has 86 members. The main statute aims are activating seniors, and developing and propagating elderly people's creative activity. The goals are accomplished through organising regular meetings or events of recreational and tourist character, such as: Club meetings (meetings or lectures with sportspersons or travellers, lectures on physical condition and good health), recreational events (various motor activities, such as integration games, gymnastics, dancing classes or the pools including the sauna and wellness sphere), Nordic walking for 60+ seniors (since 2008). Another activities such as trips: multigenerational bicycle trips (the city of Wrocław and the vicinity, planned foreign trips to Spreewald, or a trip along the Danube from Vienna through Bratislava to Budapest), sightseeing trip to get to know the cultural and natural attractions of the region and of the neighbouring countries (the schedule for 2015 includes 11 routes).

Because of the Club's activity range and character, as well as its positive reception it has been financially supported by the Wrocław municipality almost from the very beginning. In the year of 2015, the Association obtained a grant of 113,000 PLN from the Ministry of Labour and Social Policy for the implementation of a project included in the Government Programme for Senior Citizens Social Activity for 2014–2020.

The 50+ Footballers section was established in 2014 in the initiative of former footballers from the clubs of Wrocław. The founding meeting took place on March 20, 2014. The section unites 39 people coming from various environments and different regions of the city of Wrocław and the vicinity. The work-outs are scheduled twice a week, on Tuesdays and Thursdays, in Pola Marsowe by the Olympic Stadium. The footballers take part in numerous tournaments of local, regional, and international range. In June 2015, an international tournament took place in Wrocław, with players from Germany (Berlin), Austria (Vienna), and Hungary (Budapest) participating.

Methods

Research on the tourist activity of seniors from the 'FAN' Association for Sport Promotion

The main aim of the research was to describe the phenomenon of senior tourism in the tourist space of Lower Silesia, on the example of a group belonging to the 'FAN' Association for Sport Promotion. The basic questions put forward in the study referred to such fundamental areas as the main motives for tourist migrations in the group being discussed, the forms of tourism preferred by seniors, and the impact of tourism on their lives.

The inquiry research was performed in the period between April and May 2015. It was anonymous in character, and the respondents were members of the 'FAN' Association for Sport Promotion. The questionnaire consisted of 16 questions. It was

presented to the respondents in three ways: one part of them received the questionnaire electronically, one part was examined during the Active Senior Club meetings, and the rest were handed the questions during the work-outs of the 50+ Footballers section. In total, 68 members of the Association took part in the research.

The research group consisted of women in 63%, 37% were men. The participants were seniors over 55 years of age. When taking into account a detailed division by age, in the most numerous group (31%) there were the Association members aged 65–69 years. The following groups were, almost equal in number (29% and 28%, respectively), the group of younger seniors, aged 55–59 years, and the group of those aged 60–64 years. The least numerous, for obvious reasons, was the group of elderly seniors, aged 70 years or older (it constituted only 12% of the studied seniors).

The distribution by professional activity was almost equal in the group. There are slightly more (51%) people who are not professionally active any more; the rest declare some form of professional activity.

As far as the education of the researched Association members is concerned, the definitely most frequent declaration is higher education, represented by almost half of the studied seniors (49%). The following locations were secondary education (41%), vocational education (7%), and primary education (3%).

Practising tourism is bound with a specific economic status: a potential tourism participant should have certain financial resources, although it is worth to emphasise that recreation and tourism can also be practised without bearing significant costs, if any. Therefore, rather than asking about the person's income, it would be more appropriate to find out how they perceive their economic situation; it is in fact this subjective factor that seems significant for taking financial decisions with regard to various activities, including tourist or recreational activities. This is why the respondents were asked to assess their economic status. Half of them perceive the situation as good, and another 16% as very good. One third of the participants (32%) considered their economic status to be average, and 2% evaluated their household financial status as bad. None of the respondents pointed at the 'very bad' choice. These results are symptomatic, especially in the context of the relatively bad economic status of pensioners in Poland, if measured with the average retirement benefit.

Results and Discussion

Significant factor, in the case of senior tourism, is the seniors' assessment of their health status. A vast majority of the respondents consider their health condition to be good or very good. One fourth does not declare any health problems and feel very good, and 53% perceive their health status as good. Among the remaining 22% there are those who assess their condition as average (18%), those who claim that their

situation is definitely bad (1% only), and those who have problems with defining their real health status and therefore chose the answer 'hard to say' (3%). Thus the results unquestionably reveal the seniors' appropriate condition and approach to practise tourism and recreation. This is of significant importance, as bad health condition in enumerated among the main inhibitors of senior tourism development.

After the general disposition to practising tourism and recreation had been studied, the respondents were asked to point at the preferred forms of passive and active resting. Among the passive forms, reading books turned out the most popular – it was chosen by 44 people. Another activity, similar in character, was reading newspapers, pointed by 33 people. The remaining two activities were watching television and surfing the Internet: each indicated by 22 people. Only 1 person preferred the intellectual entertainment of playing chess.

Considering the character of tourism, the question about active resting seems much more significant (Fig. 1).

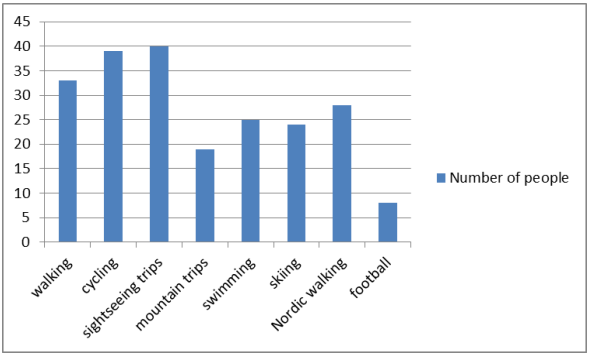

Fig. 1 Forms of active resting preferred by the respondents

The majority of choices referred to sightseeing trips (40 people). Cycling turned out almost equally popular. The following two forms were bound with hiking recreation: 33 people pointed at walking, 28 at Nordic walking. The groups choosing swimming and skiing were comparable in number (25 and 24 people, respectively), the latter not specifying whether they practised cross-country or downhill skiing. Mountain trips, specific because of the landform and the landscape, were pointed at by 19 people; football was chosen by 8, although one can assume this answer to be bound with the circumstances of the data collection, which took place during a football work-out of the 50+ seniors.

The question concerning the subjective assessment of the respondents' own level of physical activity can be treated as a conclusion to this part of the research.

In this case, slightly more than half of the participants (53%) declare that their level of physical activity has decreased as compared with the previous years; at the same time, they utter a need to come back to the former situation. The rest state that their present level of physical activity has not changed as compared with the previous years.

Having these data in mind, let us analyse the specificity of the tourist activity declared by the researched senior group.

A vast majority of the respondents travel more often than once a year. The most numerous group (53%) travel with tourist aims several times (2–3 times) a year, and ca. one third (35%) take tourist trips even more often than several times a year. This means that in the case of 88% of the studied seniors' tourist trips occupy a significant part of the free time; 9% of the respondents travel not more than once a year, and 3% travel less frequently than once a year.

Taking into consideration the preferences observed in the participants, five groups of tourist trip aims were suggested: resting trips, health resort trips, sightseeing trips, visiting friends or relatives, and active tourism (Fig. 2).

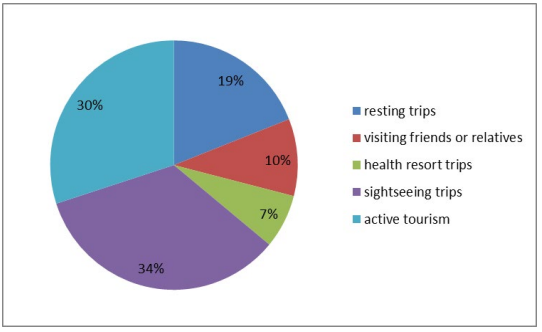

Fig. 2 Aims of tourist trips in the group of respondents

Sightseeing trips are definitely the most popular in the researched group; they were pointed at by more than one third of the respondents. Travels bound with practising active tourism are only slightly less popular. These two aims dominate. Resting trips occupy the third position (19%). Visiting friends or relatives was declared as the tourist aim by 10% of the participants, although in world tourism these two aims are considered to be the most frequent (UNWTO Tourism Highlights 2015). Health resort trips turned out to be the least significant (7%), which can be a little surprising if one considers the character of the studied group; on the other hand, if 78% of the respondents declare good or very good health condition, the limited preference of the health-related tourist aim should not be astonishing.

When asked about the reasons for travelling, the respondents most often pointed at their need to experience something new, one of the motivations described in the literature on the subject (Fig. 3).

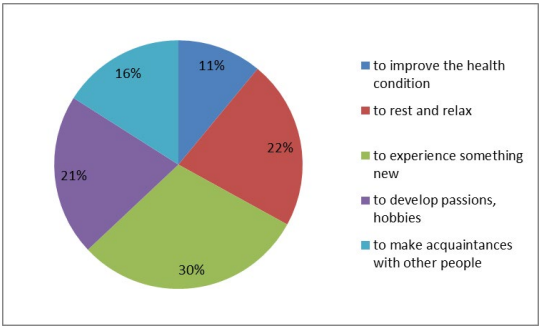

Fig. 3 Motives for tourist trips in the researched group

This option was chosen by 30% of the respondents; the fact corresponds with a wider trend of the need to make up for the time lost in the earlier phases of life, i.e. the period of everyday routine of functioning between the household and the workplace. 21% of the respondents want to develop their passions, hobbies, and interests during a tourist trip. For many seniors, also those participating in the present research, this is an ideal moment to gather new experience.

Rest and relaxation are an obvious motive for tourist trips, not only in the age group being discussed. It was pointed at by 22% of the respondents, which places the motive at the second location. The following motives chosen in the analysed questionnaires were: the need to make acquaintances with other people (16%) – a motive significant in the group in which a considerable rise in the number of single households is observed – and the need to improve one's health condition, most significant for 11% of the respondents, also comprehensible if one takes into account the specificity of seniors' physical condition.

In turn, considering the inhibitors of tourism development in the senior age group, it is worth to emphasise that slightly more than one third of the research participants (36%, the most numerous choice) declare no obstacles that would make it difficult or impossible for them to practise tourism (Fig. 4).

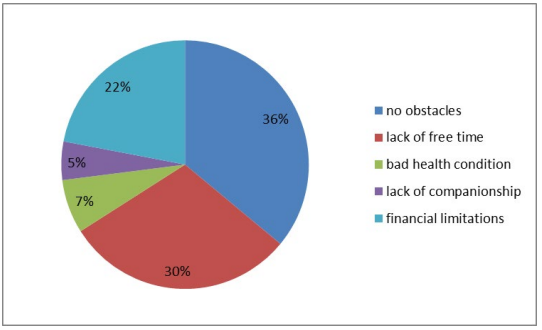

Fig. 4 Inhibitors of practising tourism among the respondents

The second position in the rating is seemingly surprising; it refers to the first significant obstacle, i.e. lack of free time. It bothers 30% of the respondents. On the one hand, this results from a relatively high level of professional activity in the researched group, which was discussed earlier; on the other hand, it is certainly bound with family situation. The model of family functioning in the Polish society comprises, among others, the multigenerational paradigm, in which not only parents, but also grandparents take part in upbringing children; the role of seniors is especially important if their children present a high level of professional activity.

The next most frequent choice (the obstacle pointed at by 22% of the respondents) refers to financial limitations, connected with the general situation of pensioners in the Polish reality. Other obstacles are perceived as sources of difficulties in taking tourist trips to a much smaller degree. For 7% of the participants the problem consists in bad health condition, 5% declare lack of companionship as the main inhibitor.

The last group of questions referred to the tourist offers that seniors took advantage of. The question if the offer addressed to the respondents was attractive was answered positively by 36 people (53%). Only 9 people (13%) denied, and the remaining 23 (34%) had no specific opinion on the subject. Asked about the source of information on the tourist offers, the seniors most often pointed at friends and relatives, who are the basic source for 39% of the respondents (Fig. 5).

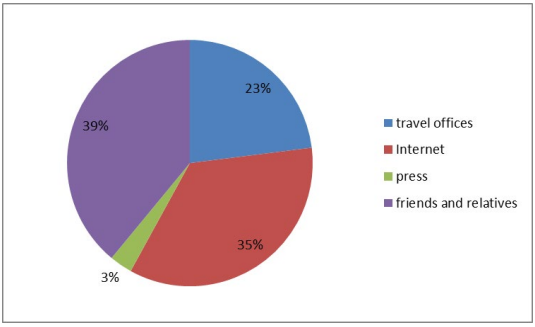

Fig. 5 Sources of information on the tourist offer as declared by the respondents

Slightly fewer, i.e. 35% of respondents stated that Internet was their fundamental source of information, which could be surprising if one considers the distrust still aroused by the medium among elderly people. Almost every fourth respondent (23%) takes advantage of travel office services, and the smallest group of seniors rely on press in this matter.

The survey also included one open question concerning tourist offer assessment; the respondents were encouraged to determine significant elements, in their opinion, that are lacking in the tourist offer addressed to seniors. The answers enumerated lack of offers for active free time management for single seniors, as well as not considering the specific needs of the group, such as *organising nearby, not tiresome, inexpensive trips connected with sightseeing*; *concerts*; or *short-term and inexpensive trips*.

Conclusion

Attempting to grasp the research results synthetically, one should point at some dependencies. Among the respondents, the dominating level of education is higher education, which definitely influences a rise in tourist activity, practised repeatedly in a year by the vast majority of the surveyed seniors. This is not surprising, especially if the obstacles are neither financial problems (these concern as few as every fifth research participant) nor physical condition (as many as 78% of respondents are satisfied with it, with only 1% assessing their health condition as bad). Practising tourism is certainly related with taking care of an appropriate level of physical activity, which has remained unchanged for years in almost half of the surveyed seniors. The most frequently chosen tourist forms are sightseeing trips and broadly understood active tourism.

Seniors partaking in tourist trips miss original, stereotype-breaking offers, especially as the most frequent motives for tourist trips declared by the researched members of the Association are the needs to experience something new, to develop passions, to relax and rest; improvement of health condition appears further in the hierarchy.

According to seniors, the perspectives for senior tourism development depend also on an increase in the tourist offer quality. Asked about considerable imperfections in this area, the respondents pointed at the lack of offers for seniors travelling alone or lack of financial support.

Although many details demand precise specification and improvement, the fundamental conclusion brought about by the research allows to clearly determine the perspectives for senior tourism development in Lower Silesia: the offer is already operating, the potential group of its recipients are willing to benefit from it, and, if the market adjusts to the consumers' expectations, the perspectives for senior tourism development seem promising.

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MOTIVATION FOR MOVEMENT EDUCATION OF SENIOR GYMNASTS OF A LARGE GROUP PERFORMANCE FOR THE WORLD GYMNAESTRADA 2015

Viléma Novotná, Iveta Holá, Jan Chrudimský
Faculty of Physical Education and Sport, Charles Univerzity in Prague, Czech Republic

Abstract

Large group performances of Czech Association Sport for All (CASfA) for the World gymnaestrada (WG) is a program of movement education for adult athletes (gymnasts). Preparing for the Gymnaestrada is a multiannual process of physical preparation culminating with performance at the international event. The three-year preparing and training process is aimed at creating an optimal content of physical literacy due to age to acquire new gymnastics skills and obtain the necessary level of physical fitness. Participation of gymnasts in group performance meets theirs specific personal needs. Evaluated by Maslow's hierarchy of needs (pyramid) are called as a category of higher order. In large group performance for WG 2015 attended 344 athletes from Czech Republic, of whom 64% women and 69% men accounted for older gymnasts aged 50-80 years. Motivation for movement education was established through a questionnaire created by the application of individual aspects (components) Maslow's hierarchy. The questionnaire contained 12 questions circuits. Responses were expressed at the five-point scale divided into five-year periods by age of gymnasts. From the response rate was created score. The questionnaire was completed by 65% of respondents. The most important motive for participation was the most commonly reported answer by athletes: I like the group exercise with the music, I like the atmosphere of this exercise (for 8 age groups, average score 4.64). Just a second, the answer was: I like to perform in group exercise, I feel good in the team with fellows and friends (for 7 age groups, average score 4.70). The third answer reached a high response to movement self-fulfilment (average score 4.54). Gymnasts' age above 70 years chose in most cases evaluation within a maximum of 4-5 - agreeing with satisfaction with the program of physical activity and with their participation. Based on the evaluation of the results of the questionnaire can be found that athletes participation in the preparation and public appearance of large group performance for WG is for gymnasts not only movement education program, but also fulfil of their social needs, the possibility of making friends and feeling of belonging to the selected group. Cooperation in the group and movement coordination among participants is filled with the needs of recognition and appreciation, satisfaction with

their own mastery of physical abilities and skills. Declared agreement with fulfilling the needs of self-realization is also significant. Every practitioner contributes to the final success with their own performances with positive and creative expression of movement. It turns out that the large group music movement composition for the WG and its preparation process of performance can be a good motivation for movement education of older athletes and can meet and bring physical, psychological, social and aesthetic needs of gymnasts.

Keywords: *Movement education, group performance, motivation, gymnastics*

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Introduction

The largest events of the Fédération Internationale de Gymnastique (FIG), its committee of Gymnastics for All, are the World Gymnaestrada events (WG), non-competitive presentations of movement compositions. They have been held in one European country every four years since 1953. They are attended by over twenty thousand participants coming from more than fifty countries. Various national concepts of gymnastics for all are presented, in particular, by large group performances taking up to 15 minutes. In these performances, hundreds of male and female gymnasts exercise together on the stadium area being watched by hundreds of spectators on the stands. Our large group performances prepared in the Czech Association Sport for All (CASfA) have been gaining long-term appreciation by both spectators and experts contributing significantly to the global development of physical-educational performances.

The CASfA large group performances for the World Gymnaestrada are created as a movement education programme for adult gymnasts of Gymnastics for All (Ahlquist et al., 2010). The participation in movement compositions is favoured by a certain type of gymnasts, particularly women, who like performing group gymnastic exercises with music. For a large part of the gymnasts, the rehearsal of movement compositions and their presentation to the public become repeatedly a long-term physical exercise programme. The offered group exercise programme with music must be composed and implemented by the authors to be attractive, to cultivate in an interesting way the gymnasts' physical performance, satisfy their physical, social and psychological needs, bring them some health benefits, motivate them for long-term physical activity (Novotná et al., 2011) and to positively affect their overall quality of life (Novotná et al., 2012).

The preparation for the Gymnaestrada is a several-year process of movement education and physical preparation culminating by a performance at an international event. The four-year preparation between Gymnaestrada events is focused on acquiring the optimal content of gymnasts'physical literacy (Whitehead, 2010; Šimůnková et al., 2010) adequate for their age, on training new gymnastics skills and developing the necessary level of physical fitness.

Several surveys investigating the opinions on both the personal evaluation of the long-term preparation and performance and on the effectiveness of the physical-educational programme have been conducted over the years of preparation for Gymnaestrada events since 1991, e.g. Čechovská et al., (2006) and Novotná et al. (2011). The research focusing on various aspects of motivation (Gillernová et al., 1995) for selected types of physical activity and education took place in the context of the preparation for the 15th World Gymnaestrada held in Helsinki in July 2015. 344 gymnasts volunteered to participate in a large group performance, of them 64% of women and 69% of men were senior gymnasts aged 50-80 years.

A questionnaire survey was chosen for the investigation of their motives leading to their participation in the selected movement education programme. None of the existing standardized questionnaires offered surveying the physical activity of seniors, such as Leisure Time Exercise Questionnaire - LTLQ; Physical Activity Survey for the Elderly - PASE (Mudrák et al., 2013; Mudrák et al., 2014;) provided the necessary specific information which could encompass specific motives for the selection of the above gymnastics programme. Therefore, a survey questionnaire was designed whose results could be partially compared with previous studies (Čechovská et al., 2006; Novotná et al., 2011) and which could demonstrate and assess the importance of individual motivation components for a given activity. The starting point for the formulation of questions was the model of needs represented in Maslow's hierarchy of needs at the level of higher order needs (Maslow, 1943; Maslow, 2014). The questions were focused on social needs (Slepička et al., 2008), the need for solidarity and sharing the experience of a movement composition, on physical and psychological satisfaction with the activity and on aesthetic self-actualization. We assumed that the designed composition, the training process implementation and the performance itself in a specific environment would reflect the lifestyle needs of the gymnasts.

Methods

The age group of senior gymnasts aged 50-80 years was represented by 141 women and 40 men. The participation in the study was voluntary, and the obtained data were processed in a way ensuring the respondents' anonymity. Descriptive statistics was used for the description of the surveyed group. The motivation for the given movement education was identified through a questionnaire survey.

The questionnaire included 12 question areas. The initial questions were directed to the identification of age and sex, the number of repeated participations in Gymnaestradas, the training method and financial demands for the participation. The following 8 questions were devised by the application of individual components of Maslow's hierarchy (social needs, need for recognition and respect by others, need for self-actualization). Women and men were divided into groups in the interval of five years of age. The respondents replied to individual questions according to the degree describing their opinion on a five-point scale. The highest agreement was rated level 5, low significance level 1, and rating 0 meant insignificance (it was not recorded in the results). In each group, the average value – score was calculated from the frequency of responses (see Table 1). For each type of motive, an average score was calculated, separately for women and men (Table 1, last column). For all types of motives, the resulting average score was calculated, together for women and men (Table 2).

Results and Discussion

The questionnaire was filled in by 65% of the approached respondents. All the average resulting opinions expressed a high level of agreement with the wording of individual questions. It was only in the group of men aged 50-54 years that a partial score of 3.5 appeared in three cases (motives 3 "atmosphere", 4 "beauty" and 5 "self-actualization") and once in the group of women (motive 7 "composition rehearsal"). The gymnasts in the age category of over 70 years in most cases chose a rating within the maximum of 4-5 showing the highest agreement with the content of the question, expressed satisfaction with both the physical activity programme and their participation.

Tab. 1 Resulting answer scores in age groups and the average score of motives

motive	**age - women**	50 - 54	55 - 59	60 - 64	65 - 69	70 - 74	75 - 80	*average*
number		score	score	score	score	score	score	*score*
1.	motive "representation"	4.42	4.43	4.60	4.52	4.56	5.00	*4.58*
2.	motive "team"	4.38	4.63	4.64	4.69	4.89	5.00	*4.70*
3.	motive "atmosphere"	4.50	4.53	4.74	4.69	4.89	5.00	*4.73*
4.	motive "beauty"	4.03	4.37	4.51	4.43	4.78	5.00	*4.52*
5.	motive "self-actualization"	4.42	4.63	4.71	4.65	4.78	5.00	*4.70*
6.	motive "programme"	4.15	4.23	4.37	4.39	4.67	5.00	*4.47*
7.	motive "composition rehearsal"	3.49	4.26	4.31	4.43	4.89	5.00	*4.40*
8.	motive "joy"	4.38	4.40	4.63	4.52	4.89	5.00	*4.64*
	age -men							
1.	motive "representation"	4.00	4.80	4.42	4.70	4.56	5.00	*4.58*
2.	motive "team"	5.00	4.80	4.08	4.70	4.67	5.00	*4.70*
3.	motive "atmosphere"	4.00	4.40	4.33	4.90	4.67	5.00	*4.55*
4.	motive "beauty"	3.50	4.40	4.17	4.80	4.33	5.00	*4.37*
5.	motive "self-actualization"	3.50	4.60	4.67	4.50	4.56	4.50	*4.39*
6.	motive "programme"	3.50	4.60	4.50	4.10	4.00	4.50	*4.87*
7.	motive "composition rehearsal"	5.00	4.20	4.50	4.50	4.33	4.50	*4.51*
8.	motive "joy"	5.00	4.60	4.50	4.80	4.44	4.00	*4.56*

Some very interesting differences in the motivation were revealed between men and women (Table 1, last column). The biggest difference was in motive 6 "programme", where the men's rating was by 40 hundredths higher. On the contrary, women reached an average score in motive 5 "self-actualization" by 31 hundredths higher and a significantly higher score in motives 3 "atmosphere" and 4 "beauty". The results imply that women are motivated by the very participation in the selected programme finding a high degree of satisfaction of their needs in it; for them, movement compositions represent a long-term physical activity affecting their lives. For men, the specific content of the physical exercise programme and its rehearsal appear more important.

Tab. 2 Resulting combined score for women and men split into individual motives

motive number	1.	2.	3.	4.	5.	6.	7.	8.
resulting score (women and men)	4.58	4.70	4.64	4.44	4.54	4.33	4.43	4.60

According to the results of the average combined score (sc.), the most significant motive for the participation most often chosen by the gymnasts was the answer: I like group exercises with music, I enjoy the atmosphere of this exercise (the highest rating for 8 groups; sc. 4.64; motive 3 "atmosphere"). The close second answer was: I like exercising in a large group performance, I feel good in a friendly team of fellows gymnasts (the highest rating for 7 groups; sc. 4.70; motive 2 "team"). The third highest rated question was: Participation in the preparation process for a performance at WG mostly brings me joy and pleasant experiences (sc. 4.60; motive 8 "joy"). In the fourth

place, there were responses to the question: It is an opportunity to participate actively in an international event, successfully represent the Czech Republic at WG (sc. 4.58; motive 1 "representation"). The fifth highest rated response was agreement with the statement: Performance in a composition brings me physical self-actualization and relaxation from everyday worries (sc. 4.54; motive 5 "self-actualization"). In the sixth place, there was a positive answer to the question: I enjoy sharing the discipline of rehearsing a composition, perceiving the beauty of movement and choreography (sc. 4.44; motive 4 "beauty"). The seventh came the opinion: I like the way and the atmosphere of rehearsing a composition represented by the authors (sc. 4.4; motive 7 "composition rehearsal"). In the eighth place, there was a confirmation of the statement: I was motivated for participation by the offered physical activity programme, I like learning something new (sc. 4.33; motive 6 "programme").

The obtained results are largely consistent with the results of previous studies. The most significant motives for the participation in the respective programme are the possibility of sharing group movement with music, building up friendships with fellow gymnasts and preparing for a performance in a team. A significant drop against the results of studies from the 1990s was only demonstrated in the evaluation of the motive of representation at an international event, which had been new and attractive for the majority of gymnasts then.

Tab. 3 Number of respondents' participations in World Gymnaestradas

Participation in WG	6x	5x	4x	3x	2x	1x	0	sum
women	7	20	10	18	39	30	17	141
men	4	7	7	9	2	5	6	40

The high number of participations in WG showed that some gymnasts had participated in more Gymnaestradas since 1991 (Table 3). This means that they repeatedly chose the rehearsal of a musical movement composition as their favourite long-term physical activity, maintaining their social belonging to a team which altered only partially. Their motivation is supported by repeated good experience gained from their previous successful participations in Gymnaestrada events, by positive perceptions of personal experiences in exercising with motivating music and shared experiencing the given skills as well as the whole composition, both at the stadium with other fellow gymnasts and with applauding audiences on the stands. The course of the performance rehearsal stimulates the growth of cooperation and solidarity among the gymnasts, who gradually adopt the composition as "their own". At the same time, they assume joint responsibility for its good presentation. The success of the composition is perceived by each gymnast as their own success which enhances the feelings of joy and satisfaction. The feeling of representing one's own country also

becomes an unforgettable experience and a powerful incentive for their participation in the next Gymnaestrada event.

Conclusions

Based on the evaluation of the results, we can conclude that the participation in the preparation and public presentation of a large group performance at the World Gymnaestrada is not only a movement education programme for the gymnasts, but it also satisfies their social need, a possibility of making new friends and the feeling of belonging to the selected group. Cooperation among the gymnasts during the composition satisfies their need for recognition and respect by others, satisfaction with their own mastering specific physical tasks and skills. Another significant aspect is the stated agreement with satisfying the needs for self-actualization and with the opinion that each gymnast contributes to the success of the performance by their own positive creative physical performance. It is evident that the composition of a large group performance for the World Gymnaestrada and the preparation process for the performance may be a suitable incentive for the movement education of senior gymnasts bringing the gymnasts physical, psychological, social and aesthetic satisfaction of their needs.

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ANALYSIS OF FITNESS LEVEL OF SCHOOL-AGE CHILDREN IN THE CZECH REPUBLIC

Tomáš Perič
Faculty of Physical Education and Sport, Charles University in Prague, Czech Republic

Abstract

In connection with the Sazka Olympic multi-event competition there was implemented nationwide testing of more than 40,000 children at the age of 6-15 years in the school year 2014/2015.

Physical fitness was assessed through 8 motor tests and somatic characteristics with 2 indicators (body height and weight). Results were analyzed in three main areas:

1. Comparison of fitness development - boys vs. girls
2. Comparison of small and large settlements (less than 20,000 vs. above 50,000)
3. Comparison of regions

In the first area girls exceed boys more in the following events: stork stand (balance) and a sit and reach (flexibility), boys exceed girls in the other abilities: T-Run (agility), 60 m run (speed), basketball throw (explosive power), long jump (explosive power) 500/1000 m run (endurance). For power endurance – truncated sit-ups in the first grade girls exceed boys and in the second grade the ratio is reversed.

In the second area the level of fitness by children living in the big cities was significantly higher in comparison with children from the small municipalities.

In the third area we found significant differences in fitness between individual country regions.

Keywords: *testing, small and large settlements, boys vs. girls, comparison of regions*

Introduction

Nowadays we have the broad spectrum of possibilities of using leisure time. Movement activity in any form should be integral to everyday human life. Nevertheless the amount of performed movement activities is permanently decreasing. Bunc (2011) mentions about 30% decrease in two last decades. The use of movement activities not only in area of health support and disease prevention, but also socialisation and formation of attitudes of children and youth has the irreplaceable importance.

Despite the known benefits of movement activities for human health there recently appear many children that move only during school lessons of physical education.

Researches show that 70% of school children and youth spend more than four hours a day of their leisure time by sitting by computers, surfing the Internet, watching TV, playing computer games and distraction with mobile phones. Only every third pupil is engaged in regular organised movement activity.

The studies show that spontaneous activity decreases in period of adolescence, mainly by girls after their 14 years of age and by boys between 16 and 18 years of age (e.g. researches of Sigmundová, Suchomel, Rychtecký and the like). The comparison of results from monitoring of the work and rest regime, which was conducted in years 1999 and 2012, showed that pupils spend nowadays less time outdoors. While in the year 1999 almost 80% children, both from the cities and villages, mention that they spend more than two hours a day outdoors, in the year 2012 it was only 30,4% of city children and 60,5% of village children. These findings document the negative trend in lifestyle of current children and youth (Bunc, 2011).

Socioeconomic status

Socioeconomic status strongly correlates with range of indicators of personality, performance, career self-promotion and life success rate (also school one). Its base is formed by social class into which the individual belongs, mainly on the basis: his/her job prestige, income (wealth), education (Helus, Z., 2007). Mota & Esculcas (2002) mention that prevalence of overweight together with unhealthy lifestyle connected with lack of movement activity are higher by children from families with lower socioeconomic status, while children from families with higher socioeconomic status have positive attitudes to performing movement activities, higher level of fitness and higher share in organized movement activity. This is also confirmed with the result of the Hanson – Chen (2007) study. Authors pointed out that lower socioeconomic status is connected with worse eating habits and lower amount of performed movement activity.

Infrastructure for movement activity

Researches prove (Sallis, Story, & Lou, 2009) that environmental conditions, mainly in place of residence and attended school, can influence movement habits of a child and also the amount of performed movement activity. Also Sallis – Prochaska – Taylor (2000) confirmed positive correlation between accessibility of sport facilities and playgrounds with performance of movement activity by children and youth.

The facts mentioned above show that there exist many confirmed findings about low level of performance of movement activity by current population of children and youth, but only general assumptions about the important influence of socioeconomic status of the family and sport infrastructure for encouraging to performance of movement activities of children.

Methods

In connection with the Sazka Olympic multi-event competition there was implemented the nationwide testing of more than 40,000 children at the age of 6-15 years in the school year 2014/2015. Physical fitness was assessed through 8 motor tests and somatic characteristics with 2 indicators (body height and weight). Results were analysed in three main areas:

1. Comparison of fitness development - boys vs. girls
2. Comparison of fitness among individual regions
3. Comparison of small and large settlements (less than 20,000 vs. above 50,000)

The research was implemented at elementary schools in the Czech Republic in period from September 2014 to December 2014. More than 200,000 children were involved in the research; all data (8 motor tests, 2 somatic indicators and 2 geographical indicators) were gained from 50,404 school-age children. Specific age and gender cohorts are presented in table 1.

Tab. 1 Age and gender distribution

	Age												
	5	6	7	8	9	10	11	12	13	14	15	16	Total
Boys	16	1 307	2 955	2 999	2 935	3 114	3 010	2 862	2 661	2 623	1 489	78	26 049
Girls	21	1 563	2 761	2 768	2 783	2 908	2 702	2 670	2 584	2 476	1 050	69	24 355

Note: Only children at age 6-15 years were involved in the research

The measurement was carried out during lessons of school physical education by teachers of physical education. The involvement to the research was for the individual schools (teachers) and probands (pupils) voluntary - within the program of the Sazka Olympic multi-event competition. When they got involved in the program the individual teachers got instructions about the organization, timetable and test evaluation via instructing videos. In case it was not clear the teachers could visit instructing seminar that took place in every region.

Data structure

We divided the research data gained from the individual probands to four basic groups:

1) **Identification data** – ID of the child, age and gender
2) **Somatic parameters** - Body height and weight
3) **Fitness tests** - stork stand, sit and reach, truncated sit-ups, T-Run, 60m run, 500m run (6-11 years old) /1000m (12-15 years old) run, long jump (6-11 years old) / triple jump (12-15 years old), basketball throw
4) **Geographical data** - Place of residence – region, size of the settlement

Results and Discussion

Comparison of fitness development – boys vs. girls

When evaluating development of fitness we worked with arithmetical means of the individual age and gender cohorts and we compared them in graphs. The results from the individual test items are presented in tables 2 – 9. The difference is achieved by subtraction of results of girls from results of boys.

Tab. 2 Development of the performance in the Sit and reach test

Age		6	7	8	9	10	11	12	13	14	15
Sit and reach /cm/	Boys	1.6	1.3	1.1	0.7	0.0	-0.5	-1.1	-0.8	-0.4	1.3
	Girls	4.1	4.3	4.6	4.2	4.7	4.9	5.8	7.1	8.2	8.1
	Difference	**-2.5***	**-2.9***	**-3.5***	**-3.5***	**-4.7***	**-5.5***	**-6.9***	**-7.9***	**-8.6***	**-6.8***

Note: Higher values mean better result, * girls achieve better results

Tab. 3 Development of the performance in the T-run test

age		6	7	8	9	10	11	12	13	14	15
T-run /s/	Boys	20.3	19.7	18.6	17.5	16.7	16.0	15.2	14.5	14.0	13.6
	Girls	21.0	20.2	18.9	17.9	17.0	16.2	15.6	15.3	15.2	15.3
	Difference	**-0.6**	**-0.5**	**-0.3**	**-0.3**	**-0.3**	**-0.2**	**-0.4**	**-0.8**	**-1.2**	**-1.7**

Note: Lower values mean better result

Tab. 4 Development of the performance in the Truncated sit-ups test

age		6	7	8	9	10	11	12	13	14	15
Truncated sit-ups /n/	Boys	18.0	21.0	26.7	31.8	37.1	40.7	45.9	51.7	55.3	57.4
	Girls	18.5	21.7	27.5	32.4	37.5	41.8	46.0	49.9	50.8	50.0
	Difference	**-0.5***	**-0.7***	**-0.8***	**-0.5***	**-0.4***	**-1.1***	**-0.2***	**1.8**	**4.6**	**7.4**

Note: Higher values mean better result, * girls achieve better results

Tab. 5 Development of the performance in the Stork stand test

age		6	7	8	9	10	11	12	13	14	15
Stork stand /s/	Boys	7.9	8.8	9.5	11.5	13.5	14.3	15.2	16.9	17.3	17.5
	Girls	9.5	10.7	12.2	14.6	16.5	18.3	19.0	20.5	21.7	22.0
	Difference	**-1.5***	**-1.9***	**-2.7***	**-3.1***	**-3.0***	**-4.0***	**-3.8***	**-3.7***	**-4.4***	**-4.5***

Note: Higher values mean better result, * girls achieve better results

Tab. 6 Development of the performance in the 60m run test

age		6	7	8	9	10	11	12	13	14	15
60m run /s/	Boys	13.7	13.2	12.6	12.1	11.7	11.3	10.8	10.3	9.7	9.2
	Girls	14.1	13.6	12.9	12.4	11.9	11.4	11.0	10.7	10.5	10.5
	Difference	**-0.4**	**-0.4**	**-0.3**	**-0.3**	**-0.2**	**-0.1**	**-0.2**	**-0.4**	**-0.8**	**-1.3**

Note: Lower values mean better result

Tab. 7 Development of the performance in the 500/1000m run

age		6	7	8	9	10	11	12	13	14	15
500/1000m run /min:s/	Boys	02:57	02:52	02:43	02:35	02:35	02:55	05:04	05:15	05:02	04:52
	Girls	03:08	03:02	02:52	02:44	02:41	03:15	05:37	05:46	05:43	05:50
	Difference	**- 0 :11**	**- 0 :10**	**- 0 :09**	**- 0 :09**	**- 0 :06**	**- 0 :20**	**- 0 :33**	**- 0 :31**	**- 0 :41**	**- 0 :58**

Note: Lower values mean better result

Tab. 8 Development of the performance in the Long jump/triple jump test

age		6	7	8	9	10	11	12	13	14	15
Long jump/triple jump (standing) /cm/	Boys	113	119	128	137	144	191	450	537	576	613
	Girls	106	111	120	128	136	206	448	490	495	494
	Difference	**7**	**8**	**8**	**8**	**8**	**-15**	**2**	**47**	**81**	**120**

Note: Higher values mean better result

Tab. 9 Development of the performance in the Basketball throw test

Age		6	7	8	9	10	11	12	13	14	15
basketball throw /cm/	Boys	260	287	334	378	422	466	533	615	700	769
	Girls	232	257	301	341	389	437	492	537	563	568
	Difference	**28**	**29**	**33**	**37**	**33**	**29**	**42**	**78**	**137**	**201**

Note: Higher values mean better result

The results of the individual tests show that girls **exceed boys more in the following events**: stork stand (balance) and sit and reach (flexibility); **boys exceed girls in the other abilities**: T-Run (agility), 60m run (speed), basketball throw (explosive power), long jump (explosive power) 500/1000m run (endurance). For **power endurance – truncated sit-ups** girls exceed boys in the first stage of elementary school (1^{st} – 5^{th} grade) and the ratio is reversed in the second stage of elementary school (6^{th} – 9^{th} grade).

Results in most tests correspond to presumptions of gender differentiation between boys and girls – girls are better in balance and flexibility, boys in speed, strength and endurance. It was quite surprising that girls below the age of 12 years achieved better results in truncated sit-ups and boys start to be dominant in this test just after the age of 12 years. This result is more interesting because of the boys in all age categories are better in other test items concerning strength abilities (basketball throw and long jump/triple jump). In this context we have not found out the explanation of this result yet. It will be surely interesting, if we find out similar results in following years of the research.

Evaluation of fitness level in the individual regions of the Czech Republic

In connection with results from evaluation of fitness level we conducted also the analysis of fitness level in connection with geographical distribution of the Czech Republic to higher administrative units – regions. To be able to compare results in the individual test items (and in individual age and gender cohorts) we transformed them to normative score (T-scores) and the individual regions were compared through the total sum of all eight test items. On this basis we made the arithmetical mean of the individual regions and compared mutually all of them. The results of the mean value of the individual regions are presented in table 10.

Tab. 10 Regions ranking according to the fitness level

REGION	Total score
Liberec	407
Zlín	406
Prague	402
Vysočina	402
Pardubice	401
South Bohemia	401
South Moravia	400
Moravia-Silesia	400
Hradec Králové	400
Central Bohemia	399
Ústí nad Labem	398
Karlovy Vary	396
Olomouc	396
Plzeň	391

The very interesting finding out was the comparison of fitness level and BMI values in the individual regions. They are in inverse proportion in the graphical illustration (higher fitness level evidences lower BMI and on the contrary higher BMI supports lower level of fitness – see Figure 1.

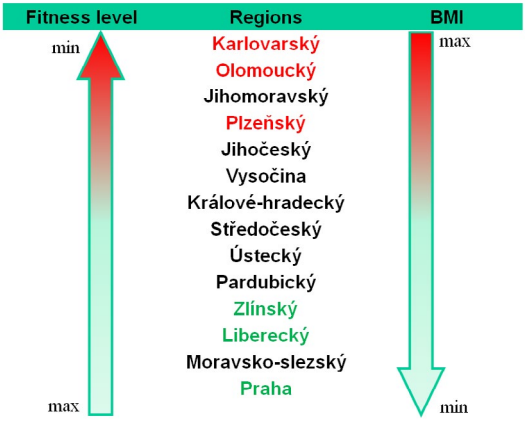

Fig. 1 Comparison of the overall fitness level and the level of BMI in regions

Explanatory note: Red colour – regions with the highest BMI, green colour – regions with the highest level of fitness

The very interesting result was also the comparison of development of fitness in the individual regions. In the individual age categories the arithmetical mean from

the total fitness level (standardized T-scores) was calculated and the means were combined to three age categories: 6-9 years, 10-12 years and 13-15 years. The results are presented in Figure 2.

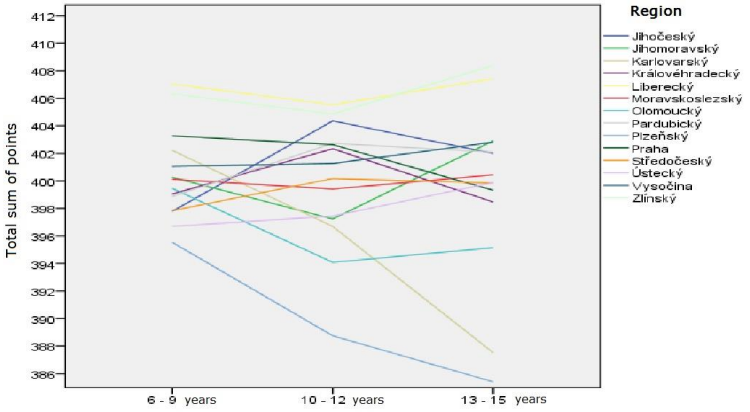

Fig. 2 Comparison of regions according to scores and age categories

The graph shows several findings out. The region with the highest increase of fitness level is South Bohemia. On the contrary the biggest decrease of fitness is in Plzeň and Karlovy Vary region. The most interesting fact is the relative diversification of fitness level in connection with increasing age of probands. In the age group of 6-9 years was the difference between the best and the worst region 11 T-scores, in the age group of 13-15 was this difference twice a big – 22 T-scores. The essential question arises there, how much the level of fitness is influenced by social and economic status and infrastructure for movement activity.

Comparison of small and large settlements (less than 20,000 vs. above 50,000)

In connection with the analysis of fitness the evaluation of the total level of fitness was realised in connection with the size of place of residence of the individual probands. It was divided to 5 size categories (to 5,000 inhabitants, 5,001 – 10,000 inhabitants, 10,001 – 20,000 inhabitants, 20,001 – 50,000 inhabitants, 50.001 – 100,000 inhabitants and over 100,000 inhabitants). Within this paper this number was reduced to two size categories – to 20,000 and over 50,000 inhabitants. The results of comparison of development of fitness in small and large settlements are presented in figure 3.

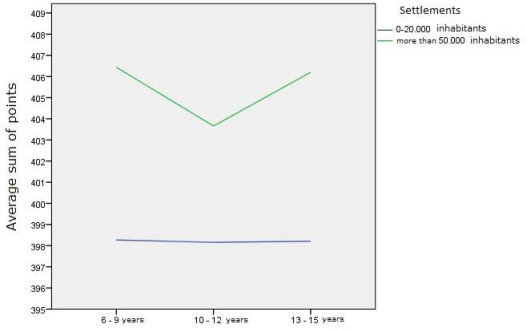

Fig. 3 Comparison of development of fitness in small and large settlements (boys and girls)

Note: differences in individual age categories are statistically significant on the level of significance p=0.01.

The graph shows that fitness level of children living in large cities is significantly higher than in small settlements. Even if in professional population is said for years that "village children" are more skilful than "city children", our research showed the opposite trend. Of course there is a question, what is the cause of these differences – where it is possible to put among the main causes the accessibility of sport facilities/ clubs, size of family incomes, social possibilities and so on.

Conclusions

The analysis of fitness level of school-age children in the Czech Republic brought range of interesting findings and data. In connection with following funding and data collection it will be interesting to compare results in particular years and also in the longitudinal context. High number of probands and broad focus on socio-cultural area give good preconditions for finding other connections with development of fitness level of school-age children.

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PHYSICAL DEVELOPMENT AND GENERAL MOTOR PERFORMANCE OF PRESENT PRIMARY SCHOOL BOYS POPULATION IN RUZOMBEROK

Peter Krska, Jaromír Sedláček, Andrej Hubinak, Jan Kostial, Maria Teplicancova
Faculty of Education, Catholic University in Ruzomberok, Slovakia

Abstract

In 2014-2015 there were tested in several Ruzomberok schools children from maternity, primary and secondary schools. This contribution deals with boys from primary schools (age 6 – 11). We used two somatic tests body height (BH) and body weight (BW) and reduced Eurofit test battery for general motor performance level evaluation: sit and reach (SR), standing broad jump (SBJ), sit-ups in 30 s (SU), bent arm hang (BAH), shuttle run 10 x 5 m (10x5), endurance shuttle run (ENDU) and 2 kg medicine ball throw (MBT). These parameters we compared with Slovak population results mostly from former period 1994-95 and 1987 in case of MBT. Differences were evaluated by parametric un-pair test on 1% and 5% significance level. There were involved 469 boys from Ruzomberok 1st to 5th classes. In somatic parameters we learned that in test BH present Ruzomberok schools boys are on 1% significantly smaller level than former populations. In case of BW there were mostly found none significant differences with former populations; it seems that Ruzomberok boys are slightly of higher BW. In tests of general motor performance can be seen that there is a great difference between former populations comparing present Ruzomberok boys. Only in test BAH are Ruzomberok boys slightly better in all classes. In all other tests are better former population boys, mostly on 1% significance level. The greatest difference seems in the test endurance shuttle run.

Present researchers often confirm these results that in physical development stopped so called secular trend. Present boys are smaller, but their BW is the same or slightly higher. So they must have higher body mass index. It is sure that negative trends in somatic parameters also influence negatively general motor performance. Present Ruzomberok boys level in motor performance is far worse from former Slovak populations.

Keywords: *primary school, physical development, general motor performance*

Introduction

Movement and sport activities help us to increase human physical fitness, performance, labour readiness and generally can positively improve also health of

man. Movement activities have mainly among children and youth very important position that cannot be substituted with anything else at forming generally developed personality. In many researches there is shown that most of present young generation do not perform adequate quantity of movement activities, there is also low quantity of compulsory physical education lessons in schools; in such a way exists disharmony between movement disposition development possibilities with real presented motor tests results. It is a pity that only small part of our school population posses permanent, positive relationship towards active movement in the frame of recreational movement activities and sport. It courses quantity increase of weakened and disabled young individuals with very often body overweight or obesity. This worse results and habits are transmitted in adulthood and these factors influence directly health status of each individual, not only physical, but also psychological and that results to lower work activity and people are not able to live in the society as actively as it could be (Simonek sn. 2000; Bebcakova et al 2015; Zvonar 2015).

In former Czechoslovakia, as well as in Slovakia there were watched somatic parameters with physical fitness performance level of school children since 60-iest of the last century. So we have relatively good possibilities for comparing present and former population samples of school children and youths. Since 60-ties there were found trends that each 10 – 15 years younger generation was taller and heavier. This also influenced regular positive increase in physical fitness level. This secular trend had been watched both in groups of boys and girls till 90-ties. At this time are several measurements and research works (Moravec et al 1990; Moravec – Kampmiller – Sedlacek, 1996; Moravec 2008; Sedlacek 2009; Zvonar – Balint – Balint, 2015) which inform us about slowing down these positive trends, even some authors point out on stopping or decrease in several somatic (Cacek – Grasgruber – Hlavonova, 2014; Kunesova 2006; Kasovic – Zvonar – Sebera, 2014), motor as well as kinematic parameters (Zvonar et al 2014).

Parents, teachers and other adults should know that children and youths need regular and daily movement activities in order to secure their not only physical development, but through these activities to gain many further inevitable benefits for the whole productive and post-productive life. In this sense physical activity cannot be substituted with anything else.

Period of younger school age (6 – 10/11 years) is considered like the most proper time for general motor development and is presented by the level of motor abilities. They form dispositions for movement activities familiarization. The basic objective of school physical and sport education is to increase functional and motor performance level of pupils and to form their positive and long-term relationship towards movement activity. Dominant role by this aim realization have movement games. They contribute to harmonic development of individual and to general skills

and customs improvement and in large scale by playing form they develop children motor abilities and their‘ creative thinking in permanently changed situations (Krska – Adamcak, 2008).

Objectives

The aim of this research is to monitor physical development and motor performance level of Ruzomberok primary school boys in age 6 – 11 years and make comparison with former Slovak (Czechoslavak) populations differences.

Methods

Measurements were done in years 2014-15 in several Ruzomberok primary schools. Average decimal age, numbers of boys and somatic parameters can be seen in table 1.

Tab. 1 Age intervals, number of tested boys, average decimal age and somatic

RK Boys		Dec. Age		BH		BW	
Age Int.	N	x	s	x	s	x	s
<7.50	91	7.01	0,25	123.7	5,97	25.5	6,31
7.51-8.50	109	7.93	0,27	127.8	5,88	27.7	5,40
8.51-9.50	97	8.95	0,29	134.4	6,12	32.0	5,64
9.51-10.50	117	9.94	0,27	139.6	6,91	35.1	9,06
10.51>	55	11.02	0,40	145.9	6,90	41.0	9,41

We applied reduced test battery Eurofit plus test Medicine ball throw. There were applied these tests: Body height (BH), Body weight (BW), Sit and reach (SR), Standing broad jump (SBJ), Medicine ball throw (MBT), Shuttle run 10 x 5 m (10x5), Bent arm hang (BAH), Sit-ups in 30 s (SU) and Endurance shuttle run (ENDU). Pupils performed tests in stated sequence. Gained results were basis for our further statistic work. Comparison between groups of boys and former population norms were evaluated by parametric in-pair t-test. Differences are evaluated on 1% (**) and 5% (*) significant levels. Results can be seen in tables. Pedagogical interpretation with description was done by fundamental logical methods, mostly comparison and generalization.

Results and Discussion

Tab. 2 Significance of differences between Ruzomberok and population somatic parameters

Body height [cm] - Boys					Body weight [kg] - Boys				
Ruzomberok		Population			Ruzomberok		Population		
x	s	x	s	t-test	x	s	x	s	t-test
123.7	5.97	127.67	5.85	**	25.5	4.89	26.29	4.93	n
127.8	5.88	133.60	6.80	**	27.7	5.62	29.20	6.64	**
134.4	6.12	137.81	6.14	**	32.0	8.47	31.52	5.52	n
139.6	6.91	143.52	7.97	**	35.1	8.02	36.35	9.82	n
145.9	6.90	150.43	6.79	**	41.0	9.32	40.85	8.88	n

*Legend: * p>0.05; ** p>0.01; yellow highlighted: better performance of Ruzomberok boys compared to previous population*

Tab. 3 Significance of differences between Ruzomberok boys and former population: a) Parameters SR and SBJ

Sit and Reach [cm]					Standing Broad Jump [cm]				
Ruzomberok		Population			Ruzomberok		Population		
x	s	x	s	t-test	x	s	x	s	t-test
14.9	10.63	19.85	5.01	**	108.6	19.10	132.52	16.38	**
17.0	7.12	18.85	5.49	**	116.7	20.69	136.22	15.24	**
15.6	7.95	20.19	5.54	**	126.0	19.91	149.30	17.87	**
18.1	8.71	18.14	5.67	n	140.4	20.27	160.85	18.69	**
17.9	8.96	16.27	6.30	n	141.0	25.51	167.52	19.42	**

*Legend: * p>0.05; ** p>0.01; n=none sign.; yellow highlighted: better performance of Ruzomberok boys compared to previous population*

b) Parameters MBT and 10x5

Medicine Ball Throw [m]					Shuttle Run 10 x 5 m [s]				
Ruzomberok		Population			Ruzomberok		Population		
x	s	x	s	t-test	x	s	x	s	t-test
200.5	49,85	262	65	**	26.01	2,99	24.20	2.71	**
238.2	48,15	301	62	**	24.73	2,83	23.42	2.50	**
280.6	56,97	351	72	**	23.76	2,46	22.73	2.38	**
332.4	64,55	401	90	**	22.44	2,29	21.17	1.78	**
363.0	70,75	450	78	**	21.97	2,14	21.13	2.24	**

*Legend: * p>0.05; ** p>0.01; n=none sign.; yellow highlighted: better performance of Ruzomberok boys compared to previous population*

c) Parameters BAH and SU

Bent Arm Hang [s]					Sit-Ups during 30s [1]				
Ruzomberok		Population			Ruzomberok		Population		
x	s	x	s	t-test	x	s	x	s	t-test
14.7	11.35	9.90	10.33	**	12.7	5.65	19.01	5.09	**
16.4	13.07	13.10	10.38	**	15.7	4.83	20.26	5.38	**
20.4	17.30	19.17	14.38	n	17.8	6.05	21.28	5.23	**
23.4	17.90	21.64	17.67	n	20.1	5.02	23.27	3.92	**
23.2	23.32	25.76	20.06	n	20.8	4.98	23.36	4.45	**

*Legend: * p>0.05; ** p>0.01; n=none; sign yellow highlighted: better performance of Ruzomberok boys compared to previous population*

d) Parameter ENDU

Endurance Shuttle Run [1]				
Ruzomberok		Population		
x	s	x	s	t-test
16.1	8.21	31.70	11.11	**
18.6	8.77	33.41	13.91	**
24.3	12.92	43.88	14.60	**
29.6	13.43	43.56	16.26	**
27.4	12.22	44.51	16.09	**

*Legend: * p>0.05; ** p>0.01; n=none sign.; yellow highlighted: better performance of Ruzomberok boys compared to previous population*

In table 2 can be seen that in the parameter BH reach clear higher levels former population measurements in each of the age intervals. All differences are significant on 1% levels. It leads us to a deduction that either the former secular trends in parameter BH has changed to its opposite, or the Ruzomberok present boys population is smaller like population norms of Slovakia. In the second somatic parameter BW can be seen that results are far more equable like are in BH. In three of age intervals reach higher values former populations (one time on 1% significance level) and two times possess higher values Ruzomberok boys. Important seems fact that four times there is none significance difference. Together with clear higher values of BH parameter of former population there is evident that present Ruzomberok boys population must have far higher body mass index. This correspond with often present stated measurements, which show permanent increase of overweight and obesity among school children.

In test Sit and Reach can be seen higher values of former populations in age 7, 8 and 9 years. Differences are on 1% significance level. In years 10 and 11 is

situation more equal. Differences are not significant and in age 11 are slightly better Ruzomberok boys (tab 3a).

In test Standing Broad Jump we can see clear higher level of performance of former population. Differences are all on 1% significance level (tab 3a). Similar situation can be also seen in further tests: Medicine Ball Throw, Shuttle Run 10 x 5m, Sit – Ups in 30s and Endurance Shuttle Run. Differences are in all tests on 1% significant level in all age intervals. In several tests are results of former population so better by comparing present Ruzomberok boys that it courses wonder or evoke some further questions (tests SBJ, MBT, ENDU): what are reasons that these differences are so high, what courses it, etc.

The only one motor test in which can be present Ruzomberok primary school boys considered of higher level is Bent Arm Hang (tab 3c). In age 7 and 8 years are differences in favour of Ruzomberok boys on 1% significance level, than in 9 and 10 years are Ruzomberok still better though there is not any statistical difference. Only in age about 11 years the former population is slightly better, but without any statistical significance.

From former researches we know that physical development influences general motor performance mainly in groups of younger schools boys (Pavek, 1977; Moravec et al, 1990; Moravec – Kampmiller – Sedlacek, 1996). In case of our watched probands of Ruzomberok pupils it helps us to understand better why we measured such a results. Relatively smaller growth with higher body height influence negatively performance results in most motor tests. Relatively higher body weight courses lower performance from the point of single motor abilities, mainly in speed, speed strength, explosive strength, endurance and in agility, too. In such a way can be explained these results from measurements in Ruzomberok primary schools boys.

It is shown that secular trends in somatic parameters turned to opposite, when BH decreases while BW either stagnate or increase. This also with some more factors (low volume of movement recreational activities) forms negative trends of present school population in the level of general motor performance (mostly statistically significant decrease).

Conclusion

1. Former secular trends in somatic parameters changed. Parameter body weight is stagnating, while parameter body height changed to opposite.
2. Present Ruzomberok primary school boys reach lower general motor performance comparing former populations.

3. Negative trends in physical fitness tests are undoubtedly coursed by negative changes in somatic parameters, when present boy generation in Ruzomberok seems to be relatively of higher body weight.
4. In general lower quantity of movement activities of present young generation also negatively influences either somatic parameters as well as general motor performance, too.

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PHYSICAL ACTIVITY OF ADOLESCENT GIRLS IN DIFFERENT TYPES OF HIGH SCHOOLS

Pavel Trochta, Dita Hlavoňová
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

The thesis deals with the physical condition of the adolescent girls and their attitudes towards the physical activity on different types of secondary schools. The research focuses on attitudes of adolescent girls to physical activity at school and during their leisure time. 12 high schools from Zlín region got involved in this study. High schools were divided into 3 groups. Grammar schools, schools specialized in business and schools specialized in health. Each group is characterized by similar types of school. All groups were represented by 4 particular high schools from Zlín region. A structured questionnaire was designed at first. To determine relative and absolute rate of attitudes obtained results were analysed. The research reveals that 42% of all involved adolescent girls are dissatisfied with contents of physical education. Most of adolescent girls simultaneously agree and understand that physical education should be part of curriculum. The most preferred physical activity is fitness training. 82% of all participants responded that fitness training should be more often included into contents of physical education. Outdoor and alternative activity together with ball games tend to be very popular too. It´s also obvious that popularity of particular sport is connected with individual motivation of participants. This research shows that the most of adolescent girls do sport or physical activity because of the fun or because of their desire to have better physical condition or nicer body. These 3 motivation factors achieved on average 79% from all types of high schools and are the most significant. In short results suggest that adolescent girls understand the benefits and importance of physical activity. The research also reveals girl´s dissatisfaction with form of physical education. It could be claimed that solution is inclusion of fitness training into contents of physical education. This type of activity tend to be close to adolescent girls and corresponds to their lifestyle.

Keywords: *adolescence, physical education, school environment, motivation, feminity, masculinity, female sports*

Introduction

In my opinion physical activity still belongs into the group of typical characteristics which participate on formation of culture. It is probable that preferred physical

activity can reflects interests and attitudes of people on particular place while different places are connected with different preferences. From historical point of view it´s obvious that women and girls had very limited possibilities to do sport or other organised physical activities. Nowadays it seems to be different situation. But if we look at female sport preferences and try to compare it with male ones we discovered that realization of female sport needs is sometimes disregarded especially at school age.

Sport is one of the most widespread physical activity all over the world. It is universal in all its consequences. It´s not just specific activity focused on reaching maximal physical performance in competitions. It´s also physical activity aimed on cultivation of our human nature (Gréxa, 2007, p. 5). Sport is social phenomenon. It helps us to understand values and our relationship in the world. Sport is one of the ways how to integrate sportsmen into society (Sekot, Leška, Oborný & Jůva, 2004, p. 9).

It´s likely that two way influence exists - sport having strong effect on shape of society and on the other hand society which reflects itself into the sport. This influence is various because society is consisted of men and women although their needs and preferences are different. Despite mass popularity of women sport today J. Hargreaves claims that there is still much more public attention in male sports compared to female ones (2001, p. 1).

This research deals with physical activity of adolescent girls in different types of high schools in Zlín region. J. Hargreaves in her study describes crucial matters connected with adolescence in life of young women. Adolescence is life period when girls are getting really mature. It´s certain that during adolescence crucial changes appear in female body and it could be difficult for young women to retain current physical abilities and skills which gained before. J. Hargreaves continues and explain how society and public opinion causes much bigger obstacles to girls than the physical factor of activity. The reason is social a cultural tradition which expects typical woman sexuality and feminity. It increases demands on their self-confidence. In fact adolescent girls are usually not satisfied with their bodies. Therefore young women can suffer from this social expectations. This is also reason why women prefers these physical activities which are focused on enhancing their body shapes (2001, pp. 155 – 156). Considering this characteristic background and important variables this research tries to find some typical trends in physical activity of present adolescent girls.

Methods

Research characteristics

12 different high schools were examined. 365 female respondents were tested. High schools were divided into 3 groups – Grammar schools, medical schools and

business schools. Grammar schools were represented by 117 respondents. Medical schools were represented by 105 respondents and finally business schools were represented by 143 respondents.

GRAMMAR SCHOOLS:

- Masaryk Grammar School, High Medical school and Higher Vocational School Specialized in Healthcare Vsetín
- Jan Pivečka Grammar Schools Slavičín
- Grammar School Rožnov pod Radhoštěm
- Grammar and Vocational School Staré Město

MEDICAL SCHOOLS:

- High Medical School and Higher Vocational School Specialized in Healthcare Zlín
- Masaryk Grammar School, High Medical school and Higher Vocational School Specialized in Healthcare Vsetín
- High Medical School Kroměříž
- High Industrial, Hotel and Medical School Uherské Hradiště

BUSINESS SCHOOLS:

- Business Academy and Higher Vocational School Valašské Meziříčí
- Business Academy Kroměříž
- High Fashion School and High School of Service Trade Vizovice
- High Industrial, Hotel and Medical School Uherské Hradiště

Instrument description

The data were obtained through questionnaire. To eliminate defects of questionnaire a pilot study was conducted. Questionnaire was divided into 3 manor parts and 3 minor parts and it´s completion takes 15 minutes overall. Manor parts consist of *general opinions of adolescent girls towards physical activity and sport, condition of physical activity of adolescent girls during their leisure time* and *Attitudes of adolescent girls towards physical activity and sport organised by their high school.*

Data collection

The data were collected personally and were gained in first quarter of the year 2015.

Data preservation and analysis

The data were divided into groups according to the type of particular high school. Data from these groups were used in appropriate tables which were constructed for specific research needs. Then the data were analysed.

Data evaluation

Absolute and relative rate method was used to evaluate data. Relative rate method was used in conjunction with absolute quantity and particular type of high school.

Results

General opinion of adolescent girls towards physical activity

At first we asked if physical activity plays important, secondary or meaningless role in the life of adolescent girl. There were no significant differences between types of school. Only exception were medical high schools. Physical activity plays there rather secondary role. If we count all schools together we discovered that for **184** respondents plays physical activity secondary role while 162 respondents considered it important. In short we can claim that physical activity of adolescent girls in Zlín region has some importance.

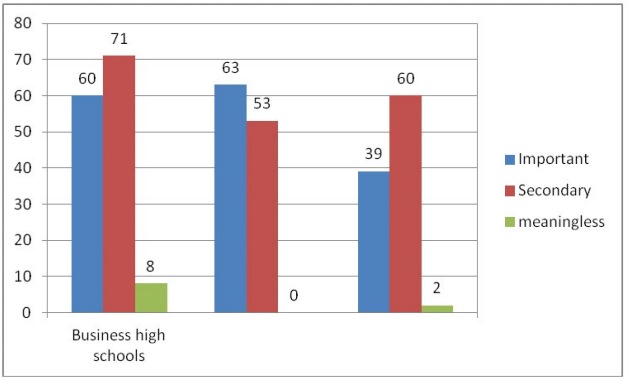

Fig. 1 General opinions

Participation on physical activity and sport

This part of research shows if adolescent girls in Zlín region do physical activity and sport at school, during their leisure or not. **241** adolescent girls answered that they do sport activity in the school but even during their leisure time. This corresponds with 66% of total number. Also in this case all particular types of high schools were represented by the same kind of answer. Only medical high schools had 31 (almost 30%) respondents who does sport only during their leisure time.

Satisfaction with contents of physical education

Another part of research revealed 42% of all involved participants are rather or totally dissatisfied with contents of physical education. Although there is quite high number of those who are generally satisfied we considered **42% (153 respondents)** as relevant quantity. Moreover even in this case adolescent girls answered similarly in all types of high schools in Zlín region. The number was around 40% again.

Attitudes to obligation of physical education

Adolescent girls generally agreed also in this case. They understand physical education as essential. **267 (more than 73%)** of them agreed that physical education should remain as a part of curriculum. 50 (13.7%) of them disagree. It is question of individuality if it´s remarkable. The rest of respondents didn´t answered or didn´t know.

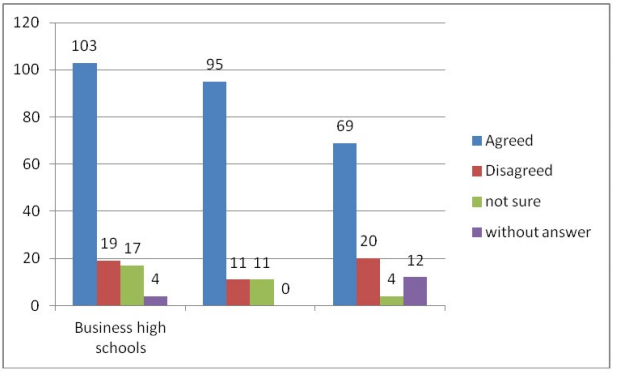

Fig. 2 Attitudes to obligation of physical education

Physical activity preferences within physical education at high schools

We asked adolescent girls if they would prefer more of the particular physical activity in their schools. In this case a positive message has appeared. The research reveals that adolescent girls from Zlín region would accepted more of all preselected physical activities. The only exception was gymnastics and athletics. These two sports are considered to be the least popular at grammar and business high schools. 42.7% (52.4%) of all adolescent girls from business high schools would rather avoid athletics (gymnastics). Numbers are also very similar at grammar schools. 44.8% (50%) of girls are against gymnastics (athletics). Our research also shows that at business schools is sport (physical activity) the least popular overall. But still the most favourite **is fitness (79%) and ball games (67.1%).** Adolescent girls from grammar schools preferred more of fitness **(82.9%), ball games (71.8%), dancing (70.1%) and outdoor activities (68.4%).** And finally girls from medical high schools preferred more of **fitness (86.7%), ball games (76.2%) and outdoor activities (72.3%).** The rest of results are not considered to be sufficiently significant.

Motivation to physical activities

The question of motivation was positively responded. We found out that adolescent girls from Zlín region are generally not motivated by **parents (76.4%)**. On the other hand the most frequent and important reason why do sport or physical activity was **vision of nice body (77.3%), better physical condition (79.7%), positive effects on health (75.1%) and fun factor (75.3%).** Other motivational factors are considered to be less significant.

Discussion

J. Hargreaves (2001) deals with women and sport from historical point of view. She describes different historical periods in women sport in he book. There are also some words about development of particular age periods of women and their options to do sport. One of these age periods is adolescence. L. Fialová (2010) and V. Vilímová (2009) are both interested in issues of adolescence but they discover only general regularities. There is no adequate source of motivation of adolescent girls (especially during late adolescence which is important period for this research) to physical activities. A. Sekot (2006) is another author who is also interested in this issues. He is mainly focused on professional sport of women from social and cultural point of view. K. Frömel, J. Novosad & Z. Svozil (1999) reveals more specific information. They focused on physical activities of boys and girls at elementary schools, high schools

and universities. They included section which is connected with attitudes of boys and girls towards physical activity in their research. Besides they discovered that athletics and gymnastics belongs between the least popular activities which is consistent with results of this research.

One of the first steps of this research was to contact selected high schools. Another step was explanation of meaning of research. Reactions were very positive. Directors or representatives of high schools asked for results soon. Sometimes they asked for results before it was offered. It seems that the topic of adolescent girl´s attitude to sport and physical activity is very actual.

Research reveals also some specialities. Some of the adolescent girls responded that they are interested in sport during their leisure time. These girls simultaneously don´t exercise during physical education. Dianne, Ward, Ruth, Saunders & Russell claims that sports offer is very influential in local communities because it usually takes place during leisure time. It means after school, during weekends, during holidays etc. In these cases sport activity is more available and required by girls and boys (2007, p. 46). But there is different question. How and why is possible that girls (boys probably too) can do sport in their free time but on the other hand physical education seems to be not so obligatory. We understand that sometimes it´s hard for girls to submit to ideas of teacher. But this problem should be solved by schools and not by individual´s avoidance.

Another phenomenon has appeared in Zlín region. The most of adolescent girls (more than 73%) agreed that physical education should be part of curriculum which means to stay obligatory. On the other hand 153 (42%) of them are generally dissatisfied with contents of physical education. It´s apparent that girls are dissatisfied with form of physical activity. In my opinion it´s certain that adolescent girls in Zlín region have positive attitude to sport overall but situation at high schools could be simply unfortunate for them. It´s up to management of particular high schools to handle it.

Conclusion

The research deals with physical activity of adolescent girls in different types of high schools. We found out that for the most of adolescent girls from Zlín region is physical activity either **important** or **secondary**. The difference is not significant. Results from next part of research shows that **42%** of all girls are **generally dissatisfied** with form of physical education. On the other hand more than **73%** of them agreed that physical education should be **part of curriculum.** And finally **79 – 86.7%** of adolescent girls would preferred **more of fitness activities** at their high schools.

Besides this kind of activity corresponds with their needs. For instance **77.3%** of girls wants **nicer body**. **79.7%** of them wants to **improve physical condition.**

All in all we can´t say that adolescent girls generally don´t like sport or physical activities. They are simply dissatisfied with the form of activity. But 79 – 86.7% of all adolescent girls from Zlín region would preferred more of fitness. Even though this kind of activity has some limits, practising more fitness could be a way how to attract even more adolescent girls to physical activities and strengthen their attitude towards sport.

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SPORT MANAGEMENT

CONCEPTS OF OPEN INNOVATIONS AND ABSORPTIVE CAPACITY AND THEIR INFLUENCE ON HUMAN RESOURCES REQUIREMENTS IN SPORTS ORGANIZATIONS

Jana Nová
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Concepts of open innovation and absorptive capacity are based on the use of purposive inflows and outflows of knowledge in order to accelerate internal innovation. To assure the innovative spirit in sports organizations the implementation of the human resources recruitment policy based on these concepts is needed. Therefore, this article investigates using the Atlas.ti software and coding techniques, to what extent the various sports organizations in Australia and New Zealand seek in their recruitments the human resources equipped with sensitivity, skills or predispositions towards the innovations and how these requirements are formulated in relation to the different management job positions.

Keywords: *open innovations, sports organizations, HRM, innovation, absorptive capacity*

Introduction

Cohen and Levinthal (1990) defined absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it and apply it to commercial ends". Innovation is generally understood as the introduction of new products or new technologies, but according to the Chesbrough (2003) the process of innovation means also knowledge flow and he puts emphasis on external knowledge within the open innovation model. In accordance with this logic, the concept of absorptive capacity in the process of innovation (Cohen and Levinthal, 1990) and relationship between the human capital and innovation (Almeida et al., 2014) should be acknowledged as well. According to Nová (2015a) in sport organizations the systematic approach is needed for assessing innovation in sport that provides opportunities for business development in all sports sectors. In sports management there is a lack of the studies that would explore the relationship between the absorptive capacity, innovation and Human Resources Management policies and practices. Therefore, this paper explores to what extent the concept of organizational absorptive capacity influences the recruitment of human resources in sport management. This is studied from the

acquisition perspective (Zahra & George, 2002) using empirical data from the portal where sports management jobs in Australia and New Zealand are advertised.

Literature review

The concept of absorptive capacity represents according to Cohen and Levinthal (1990) the ability of a company to use the knowledge that exists outside of the company and it depends on the ability of the organization to recognize the value of new information, integrate it and use it for commercial purposes. It is a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability", which is "pertaining to knowledge creation and utilization, which enhances a firm's ability to gain and sustain a competitive advantage. The capability of an organization to exploit external information – absorptive capacity – is considered as a key component of innovation capability (Lane et al., 2002). Zahra & George (2002) identified four dimension of absorptive capacity: acquisition, assimilation, transformation and exploitation and Daghfous (2004) argues that the degree of absorptive capacity in the organization is dependent on ability to transform and implement external knowledge within the company so as to enhance its core competencies. Van Den Bosch et al. (2005) state, that absorptive capacity is based on three crucial components: the capacity to recognize the value of external knowledge, the capacity to assimilate it and the capacity to apply it for commercial purposes. The importance of human resources, involved in this process has been stressed by many scholars (Mangematin and Nesta, 1999; Vinding, 2006; Kneller and Stevens, 2002) and as suggested by Murovec and Prodan (2008) if an organization uses different external sources of knowledge for innovation, it can be assumed that it possesses a certain absorptive capacity and an organization that has the ability to use external knowledge, also has the ability to identify and assimilate this knowledge. These thoughts influenced our approach towards examining recruitment policy as a part of the Human Resources Management in sports organizations with regard to the concepts of open innovation and absorptive capacity.

Methods

The qualitative investigation is based on the concept proposed by Zahra & George (2002) which distinguishes between potential (acquisition and assimilation of knowledge) and realized (transformation and exploitation) absorptive capacity. Acquisition is defined as being the capacity to recognize, understand the importance

of, and acquire the external knowledge needed for the operations of an organization. Therefore, the thematic analysis of the promoted vacancy advertisements (job and person specifications) placed on the Clearinghouse portal in Australia and New Zealand (https://secure.ausport.gov.au/clearinghouse/) in various sport organizations over the 8 months' period (January – August 2015) has been conducted. This geographic area has been chosen bearing in mind the fact, that the Australian and New Zealander sports labour market can be considered as the one which is well developed due to the implementation of the wide range of measures stemming from consolidated and sustainable national policy in sport (Hoye et al., 2012). Coding method (Strauss a Corbin, 1998) was used so to provide the overview of the most required skills related to the innovation. The 253 advertisements have been analysed using the Atlas.ti software. Open coding was applied based on the theoretical framework of the Competencies for Entrepreneurship as presented in Nová (2015b) so the analysis concentrates on the occurrence, frequency and the context of the words innovative and innovation.

Results

The content analysis of 253 advertisements (Primary Documents for Atlas. ti) using the coding technique revealed that the word innovative occurred in 44 advertisements (17, 39%). The list of job positions and the frequency of the word innovative is presented as the visual output form Atlas ti. (Figure 1). The majority of the advertisements came from national sport bodies such as Australian Sports Commission, Australian Institute of Sport, various sports associations (skiing, rowing, softball, tennis, gymnastics, swimming, cricket, cycling, football, goalball, triathlon, taekwondo, netball, athletics) and non- governmental institutions as well as particular sport clubs. When it comes to the context in which the word innovative occurs the following classification can be applied:

- Innovative as personal characteristics
- Innovative as ability
- Innovative as expectation
- Innovative as approach

This classification has been used in order to create the family codes in Atlas .ti so to select the collocation related to the family code. This allowed to create the visualization of the collocations as displayed in Figures 2- 5, using the the Network View tool from in Atlas ti.

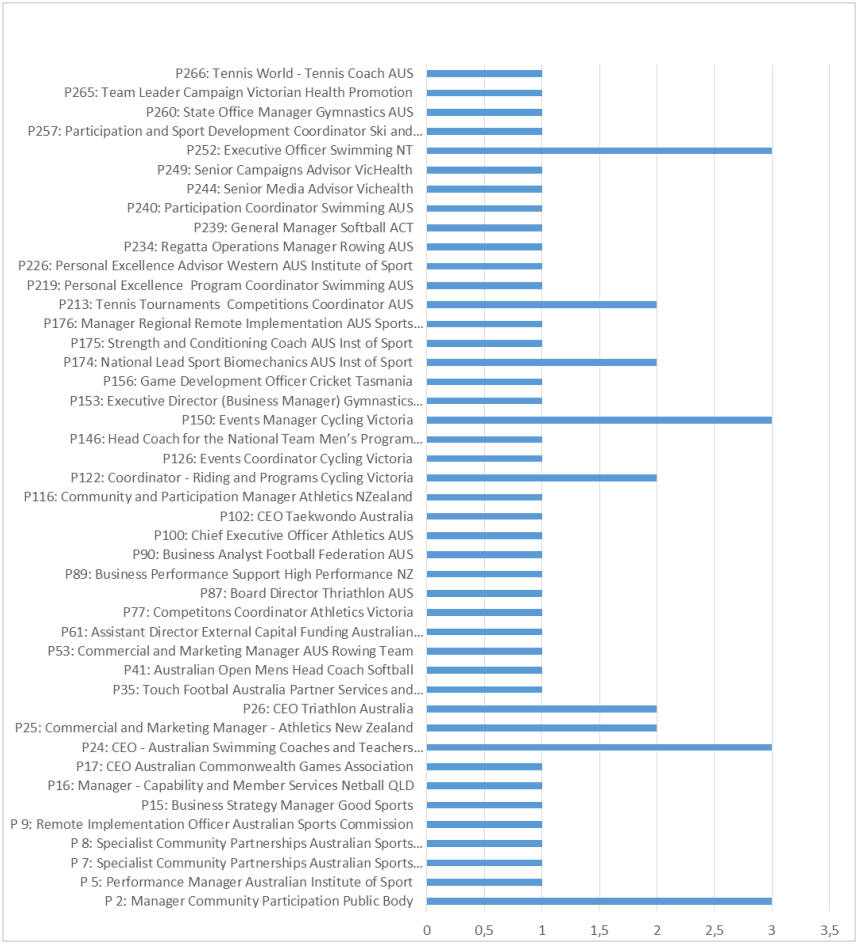

Fig. 3 Innovative Ability Family Network View , Atlas.ti Source: Own elaboration

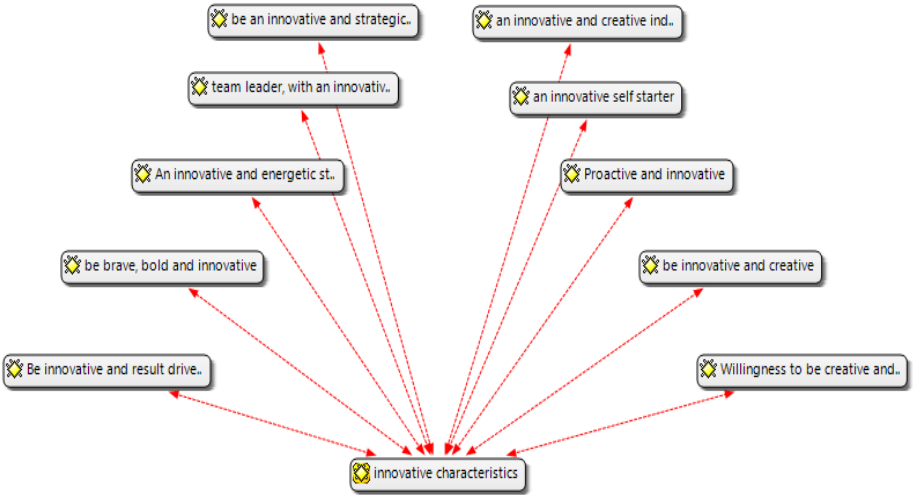

Fig. 2 Innovative Personal Characteristics Family Network View , Atlas.ti Source: Own elaboration

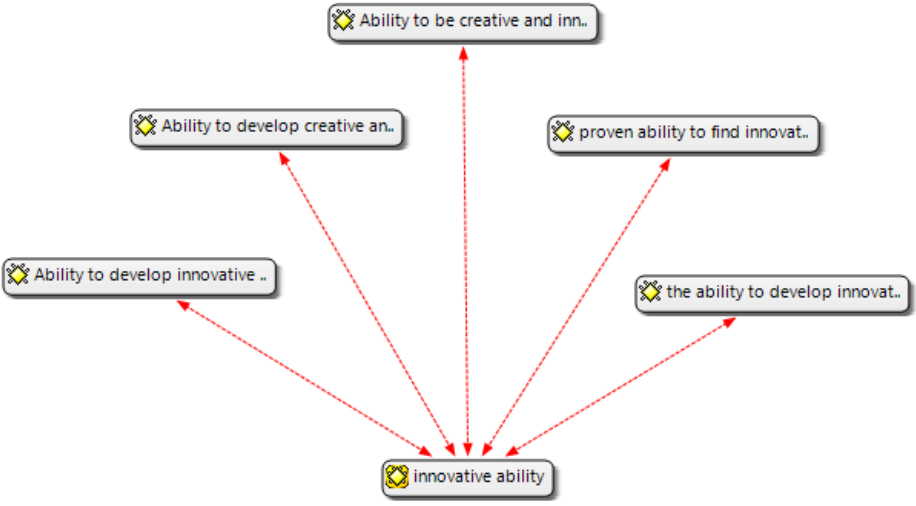

Fig. 3 Innovative Ability Family Network View , Atlas.ti Source: Own elaboration

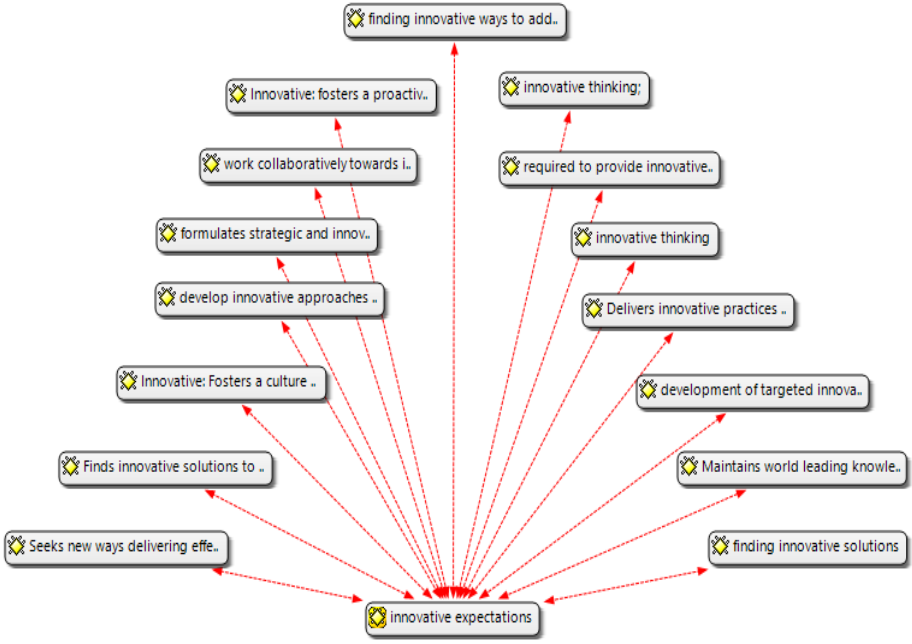

Fig. 4 Innovative Expectations Family Network View , Atlas.ti Source: Own elaboration

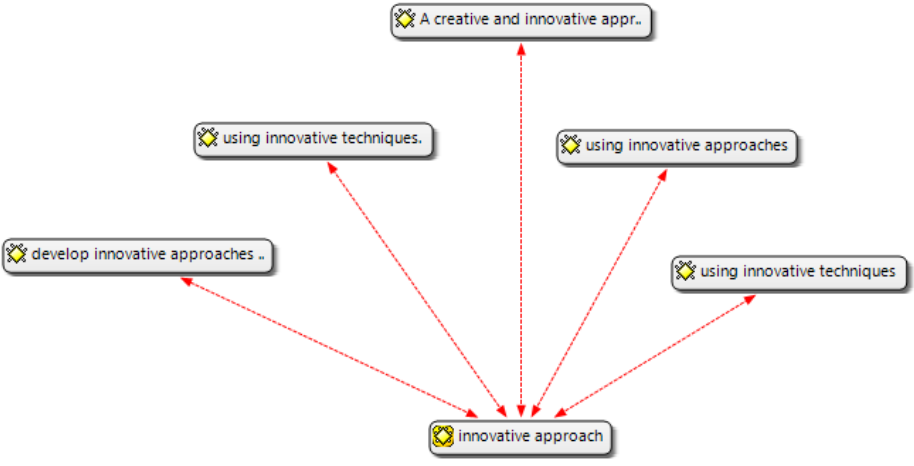

Fig. 5 Innovative Approach Family Network View , Atlas.ti Source: Own elaboration

The word innovation was used in 25 advertisements (9, 98%) and there are just 7 advertisements in which both the word innovative and innovation were used. The contextual collocations of the word innovation are as follows:

- Express the values of the particular organization
- Express the responsibilities of the job
- Express the key performance drivers of the job
- Express the expected personal skills

The results from thematic analysis indicate that the content of the job advertisements for jobs in sports management is influenced (although maybe indirectly) by the need of the various sports organizations for the acquisitions of the knowledge and skills possessed by the candidate in relation to the open innovation framework as defined by the Cohen and Levinthal (1990) and Zahra and George (2002). The employers expect to recruit and employ the candidate equipped with the knowledge, skills, ability and approaches with regard to innovations of the sports products, services and processes capable to implement the innovative approaches and techniques at strategic as well as operational level. Clear articulation of these factors in job and person specification description enable focusing the selection process on the candidates who show the favourable attitudes towards innovation which are seen as key managerial determinant of innovations in sports organizations (Hoeber and Hoeber, 2012).

Discussion and Conclusion

Theoretical perspective of the concepts of open innovation and absorptive capacity is covered sufficiently, but in sport management there is lack of studies of how to operationalize them especially when it comes to human capital and human resources management. An organization that wants to make effective use of the sources that can boost its absorptive capacity needs to focus strongly on the communications interface between the external environment, the company as a whole and its constituent units (Cohen & Levinthal, 1990). This is also relevant for the Human Resources Strategy in recruiting and selecting policies. As the results of the study showed the Australian and New Zealand sports organizations in their vacancy advertisements pay a due attention to the precise and well-structured description of particular job and subsequently person specifications'. Thus majority of the advertisements contains also the well-defined requirements in terms of skills and abilities to innovate the field where the job is organizationally located. As it is presented in the results, the requirements related to the innovations and innovative approach are present mainly in positions which are advertised by national sporting bodies and sports governing bodies, or

special professional agencies. This is linked to the mission and strategies of these sports organizations as far as most of them are at the forefront when it comes to the promoting and applying the innovative approaches. These organizations are able to articulate at the very early stage of recruitment process the requirements in terms of the person skills in relation to the innovations and innovative approach they expect from future employees. The sound articulation of the needs for innovative skills enables later on selection of the human resources for different position who would assure the realized absorptive capacity of the sport organizations. This paper has the theoretical as well as practical implication. In terms of the theoretical contribution the paper offers enrichment of the classification criteria for implementing the open innovation and absorptive capacity concepts in recruitment process of sports organizations. For sport management practitioners offers the useful collocation with regard to the job description and person specification process which is considered to be of the utmost importance when it comes to the rest of the Human Resources Management functions and policies.

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GRASSROOTS TRANSPARENCY: TRANSPARENCY AND ATTITUDES TOWARDS TRANSPARENCY IN LOCAL VOLUNTARY SPORT ORGANIZATIONS

Pavel Král, Lucie Stejskalová
Faculty of Management Jindřichův Hradec, University of Economics, Prague, Czech Republic

Abstract

Transparency has been gaining attention both in the profit and non-profit sectors. In the non-profit sector and particularly in sport, most studies focus on large organizations with international or national impact. The aim of this paper is to explore transparency in grassroots sport organizations and this aim is broken down into two objectives. The first objective is to find out what information is published by grassroots organizations and how their transparency meets the criteria of codes of good governance and legal requirements. The second objective is to explore the attitudes towards transparency and identify possible opportunities for increasing transparency and barriers to transparency. A survey design of the research was carried out in two phases. In the first phase, document analysis of websites and social networks was conducted. In the second phase, semi-structured interviews were carried out with representatives of six organizations. The results show that almost 70% of grassroots organizations have their own website, which is a significant increase in comparison with previous studies. However, the prevalence of a website itself does not ensure transparency and generally low transparency was classified. Particularly, financial transparency is lower than in previous studies. Social network activity was also analysed because in many cases, a social network (mainly Facebook) is the main communication channel of an organization. The role social networks play in transparency is scarce. Interviews revealed two main clusters of motives for publishing governance information (external pressure and direct benefit) and two main clusters of obstacles for disguising information (inertia and fear). Thus, this study shows the development of transparency in the civil society and it also enriches the theory on transparency by studying the determinants of grassroots transparency.

Keywords: *Grassroots, transparency, attitudes towards transparency, local voluntary sport organizations*

Introduction

Grassroots organizations are defined as "locally based and wholly volunteer non-profit organizations" (Smith, 1997, p. 269). They are predominantly membership-based civil organizations and most of operations of the organizations are run by volunteers. In spite of their small size and local impact, grassroots organizations have a significant impact on society, as they are comprised of social, economic and health benefits (Smith, 2000). The growing importance of grassroots organization for sport participation is acknowledged generally (Phillpots, Grix, & Quarmby, 2011) and also in the Czech Republic (Numerato & Flemr, 2013). The sport environment in the Czech Republic underwent significant changes in governance after 1989 and the speed of changes caused many governance problems. For example, due to failures in governance and low transparency, Czech sport lost about 13% of the revenues (Král, 2012; Numerato & Flemr, 2013). Thus, transparency has become topical not only for national sport organizations but also for grassroots organizations.

Transparency has been gaining attention both in the profit and non-profit sectors. The latest studies have focused on transparency as a general term with the aim of conceptualizing transparency (e.g. Auger, 2014; Schnackenberg & Tomlinson, 2014). Studies in the non-profit sector either assessed the level of transparency (e.g. Bachmann, 2012; Schmitz, Raggo, & Bruno-van Vijfeijken, 2011), or searched for determinants of transparency (e.g. Behn, DeVries, & Lin, 2010; Zainon, Atan, & Wah, 2014). With regards to sport organizations, most studies have focused on governance or transparency of large organizations with international or national impact (e.g. Chappelet & Mrkonjic, 2013). However, the applicability of these studies on local voluntary sport organisations (grassroots organizations) is not proven and thus our study focuses on the grassroots organizations.

Transparency of grassroots organizations has not been researched enough. Most of the studies in the non-profit sector have rather focused on larger organizations (Behn et al., 2010; Zainon et al., 2014). On the other hand, there is a study focusing on transparency in non-profit organizations in the Czech Republic conducted in 2011 (Bachmann, 2012). The sample of the study were 469 non-profit organizations of all kinds (e.g. culture, social, environmental, sport, etc.) with their own website. A hundred and fifty-five of them were sport organizations, which comprised 33% of the sample and thus made sport organizations the prevalent type of organization within the study. Therefore, our paper contributes to the study of Bachman in three ways. First, we conducted interviews as the follow-up phase of the research, which allows us to assess the attitudes towards transparency, and also identify possible barriers or facilitators of transparency. Second, due to the difference of four years in

data collection, we provide valuable evidence of the development of transparency in the Czech Republic. And finally, we added an analysis of social networks (specifically Facebook) to reveal the role of social networks in promoting transparency.

The aim of this paper is to explore transparency in sport grassroots organizations and this aim is further broken down into two objectives. The first objective is to find out what information is published by grassroots organizations, and how their transparency meets the criteria of codes of good governance and specifically, requirements on transparency. The second objective is to explore the attitudes towards transparency and identify possible facilitators or opportunities for increasing transparency and barriers to transparency.

Studying grassroots transparency is valuable for several reasons. First of all, transparency is the most prevalent principle of good governance (Chappelet & Mrkonjic, 2013). Transparency also helps to protect against clientelism or misuse of power, and these aspects negatively affect the sport environment in the Czech Republic (Numerato, 2009) or in other transitional countries (Erturan-Ogut & Sahin, 2014). Grassroots organizations are receivers of public subsidies and they also have tax allowances and transparency can assure public control of using the subsidies or possible misuse of legal form. Finally, development of transparency in voluntary sport organizations can indicate the development of an entire society.

Methods

A survey design of the research was carried out in two phases. A content analysis of websites and Facebook profiles of selected organizations was carried out in the first phase. Follow-up interviews with representatives of six organisations of different sizes comprised the second phase.

The sample for the website analysis was comprised of all organizations associated by the regional governing body Czech Union of Sport (CUS) in the Olomouc Region (n=183). These organizations are focused on participatory sport and competition sport in lower leagues or competitions. They associate over 30,000 members of which over 23,000 are adults and over 7,000 are youth members. The majority of the organizations focus on a single sport (n=131) and the rest (n=52) are registered in more than one sport, which are called multisport. The sample was divided into three clusters according to size and the sample consisted of 81 small organizations (less than 70 members), 68 medium-sized organizations (70 to 200 members) and 34 large organizations with membership over 200. Interviews with representatives of six organizations were conducted subsequently and purposive sampling was used to

select six organizations. We aimed to have representatives of all sizes and thus two small, two medium-sized and two large organizations were selected. The presence of a website was the auxiliary criterion and thus two organizations without a website and four organizations with website were included what is in accordance with results of the first phase because 70% of organizations have the website. Also, two of the organizations are multisport and four of them are focused on individual sports (squash, handball, skiing and athletic).

The structure of data required for the website and Facebook analysis reflects Bachman's criteria of transparency (Bachmann, 2012, p. 50). The criteria [and coding of variables acquired] were 1) presence [not present=0 / present=1] and updates of websites [year], 2) mission (written declaration of an organization's core purpose and focus that normally remains unchanged over time) and vision (what an organization would like to achieve or accomplish in the mid-term or long-term future) of the organization [both 0/1], 3) elementary information about the organization, such as presence of statutes, list of board members, contacts and annual report [all variables 0/1], 4) list of donations [0/1], and 5) financial reports [0/1]. This list also reflects commonly used codes of good governance for voluntary organizations (National Council for Voluntary Organisations, 2005) or sport organizations (Australian Sports Commission, 2005) and coding corresponds to usual coding of transparency variables in previous studies (Bachmann, 2012; Rodríguez, Pérez, & Godoy, 2012; Zainon et al., 2014). Semi-structured interviews with representatives of six organizations focused on deeper understanding the results from the first phase and to reveal the attitudes towards transparency. The structure of the interview was based upon criteria for the website analysis and the representatives were asked about their attitudes towards publishing particular information. Other aspects of interviews covered legal requirements, interaction with stakeholders, acquiring public subsidies, and dealing with sponsors.

The data acquired in website and Facebook analysis were processed using descriptive statistics and contingency tables. The significance of differences was tested using inferential statistics. The transcripts of the interviews were analysed by use of thematic analysis (Sparkes & Smith, 2014). First, initial codes were generated and then codes were gathered into broader levels of themes. After further revision of the themes and their relation to codes, the final themes were refined.

The list of organizations for website and Facebook analysis was acquired directly from the regional governing body database (CUS, 2015). Since the website addresses are not included in the official list of CUS, the websites were searched manually using their official name, identification number and contacts stated in the list.

The representatives interviewed were contacted by phone first and then the researchers conducted the interviews, which took from 30 minutes to an hour. The interviews were transcribed for the purpose of thematic analysis.

Results

The results chapter starts with an assessment of criteria of transparency and structure of the assessment reflects Bachman`s criteria (2012). The presence of a website and their updates was the first criterion of transparency evaluated. Websites of 129 organizations were found, making up 70.5% of the sample. Considering the size, the larger the organization is, the higher the probability of having a website is. Only 52% of small organizations have the website, while the medium-sized organizations have the websites in 81% of cases and large organizations in 94% of cases. Thus, the size of an organization makes a significant difference in the presence of websites (χ^2=26,186; p<0,001). Overall assessment of updating shows that 65% of organizations updated their website in the recent year, 19% updated their website in the previous three years and the rest (16%) of website did not display the date of update. Table one shows the proportion in updates and there are no significant differences in relation to the size of an organization (χ^2=4,917; p=0,654).

Tab. 1 Presence and updates of the websites

	Presence of the websites	Updates (counted from the sample organizations having websites; 42 small, 55 medium, 32 large)			
		updated before 2013	updated in 2013 – 2014	updated in 2015	update unidentified
Small (n=81)	51.9%	9.5%	16.7%	59.5%	14.3%
Medium (n=68)	80.9%	11.5%	5.8%	65.4%	17.3%
Large (n=34)	94.1%	3.6%	7.1%	71.4%	17.9%
Total (n=183)	64.8%	9.0%	9.8%	64.8%	16.4%

Vision and mission statement forms the second group of criteria of transparency and this assessment revealed the low presence of such statements and totally different views were provided by the representatives of the clubs. Over 75% of organizations did not have their mission stated on the website. Moreover, it was often difficult to find the mission, and the statement of mission was rarely included on the home page or in the section with information about the club. Again, larger organizations were more likely to present the mission statement. Vision was present in only 11.6% of the cases and was presented only by those organizations which had the mission statement. On the other hand, 94% of the websites dealt with history of the organization.

The interviews explain the low presence of mission and vision statements. The representatives of both small and both medium-sized organizations were obviously taken by surprise and they struggled to state their mission or vision. Moreover, the representatives of two small organizations were not able to state the mission and vision at all. Deeper analysis revealed that their main activity of both small organizations differs from what is perceived as the activity of non-profit organizations. Their main focus was not aimed at the members and can be perceived as for-profit activity (e. g. paid coursed for public or running commercial sport facilities). After brief consideration, the representatives of the two middle-sized organizations stated the purpose of the organizations and general aims they are working to achieve. The representatives of larger organizations were more aware of these statements. Both of the large organizations state their mission on the websites because they "want to be visible for the potential members" and they also perceive the statements important for promotion of the organization.

Tab. 2 Presence of strategic direction statements

	mission/purpose	vision
Small (n=42)	16.7%	9.5%
Medium (n=55)	21.8%	12.7%
Large (n=32)	40.6%	12.5%
Total (n=129)	24.8%	11.6%

Elementary governance information is the third criterion of transparency. In total, 75.2% of the organizations provided at least club e-mail address and a club e-mail. Analysis of the presence of lists of governance organs brought distinctly lower numbers which are presented in table three. Low numbers in the auditing body column is probably caused by the fact that smaller organizations usually do not have an auditing body. The interviews confirm that only large organizations interviewed had an auditing body.

Only 11.6% of organizations published their statutes, which is very low number considering that statutes are an elementary governance document of an organization. When asking to provide statutes during the interviews, five of the representatives refused to provide the statutes. One of the representatives preconditioned providing the statutes on the approval of the general meeting and four other perceived statutes as a private organizational document. One representative expressed suspicion and fear of an official inspection. On the other hand, a representative of a large organization said that they [their organization] were going to put the statutes on the Internet "because it's fashionable now".

The presence of information about the activities was even lower. Only a single annual report was published on a website. None of the organizations interviewed elaborates on an annual report and generally, they do not perceive a serious reason why to elaborate on an annual report because it is useless. Organizations are obliged to have an annual meeting every year and thus, the presence of annual meeting reports was hoped to bring higher numbers. Ultimately, the result was very similar because only two other organizations presented an annual meeting report.

Tab. 3 Presence of elementary governance information about the organization

	Statutes	President	Board members	CEO (general secretary)	Auditing body	Annual report
Small (n=42)	9.5%	9.5%	4.8%	0.0%	4.8%	0.0%
Medium (n=55)	10.9%	36.4%	23.6%	5.5%	9.1%	0.0%
Large (n=32)	15.6%	28.1%	25.0%	0.0%	28.1%	3.1%
Total (n=129)	11.6%	25,6%	17.8%	2,3%	12.4%	0.8%

Over 50% of the organizations provide some evidence that they have a sponsor or a donor. However, they generally show only the sponsor's logo. Half of these organizations also provide the name of their sponsor(s) but only four organizations present the sponsor's contacts or links and none of the organization presents the amount of the sponsorship or gifts.

The last criterion of transparency is the disclosure of financial reports. None of the organizations presented any financial results even as a part of annual report or as a part of annual meeting report. The representatives in the interviews were also asked to provide their financial data. Five of them provided the total amount of revenues and their proportional structure and one representative provided the proportional structure of revenues only (without saying the amount of the budget). Paradoxically, the representatives perceived financial information less confidential than statutes.

Additional part of the study was analysis of the Facebook pages of the organizations. A Facebook profile was found and analysed in 52 organizations. The trend is opposite to the presence of websites and generally higher activity was assessed in smaller organizations. Facebook pages were generally used for communication about day-to-day activities (such as trainings, competitions) or information on managing events. On the other hand, no data relating to analysis of transparency were found on Facebook pages apart from a few contacts. Thus, the result tables would not be influenced by incorporating analysis of Facebook pages.

Exploring the attitudes towards transparency and identifying the motives and barriers of transparency was the second objective of the research. The motives of the transparency can be divided into two main clusters. The first cluster of motives is

connected with external pressures. The majority of the representatives stated that if there was a legal requirement under sanctions they would publish all required information. Actually, in some other cases they just comply with the rules only if there is a sanction. The first example of such behaviour is in sending the required documents to sport governing bodies or municipalities, because there is usually a sanction (or loss of the support) if they fail to provide required information. The second example is connected to requirements of the new Civil Law (Civil Code 89/2012) according to which all civil associations must adjust their official name and statutes. All the organizations have not still met the requirements and they reputedly plan the adjustments at the last moment allowed by law. In other words, they postpone the duty until it is necessary to do so. The second cluster of motives is formed by direct benefits. The organizations publish only the information they perceive important for attracting new members, sponsors, or for satisfaction of current members, and information on governance is clearly not perceived as such kind of information.

We also identified two clusters of transparency barriers. The first cluster is connected with inertia. Most of the representatives do the work in the way their predecessors did. Their predecessors did not provide or publish the information and they do not see a reason to change it. Also, the demand of stakeholders (e. g. members, sponsors, officials) for the governance information has been changing very slowly and often stated was that no one cares about it. The second cluster is connected with the fear of transparency. First of all, they expressed the fear of revenue authorities or the possibility to loose government or municipal subsidies. Second, there is a fixed idea that governance documents of civil associations are strictly internal and should be confidential.

Discussion

The previous studies in the Czech Republic (Bachmann, 2012; Rohrbacher, 2007) found that about 25% of non-profit voluntary organizations had their own website. More precisely, Rohrbacher found the presence of websites in 25.1% (344 out of 1368) civil associations in 2007 and Bachmann figure of 24.9% (469 out of 2000) in 2011. Our results differ from these figures and the presence of websites in over 70% organizations makes a significant increase. On the other hand, there is no significant contribution of the higher presence of websites to transparency. The relative numbers of the presence of elementary governance documents are lower in most cases, and for example financial transparency was lower than in all previous studies. To demonstrate this, no organization from our sample published any financial data while Rohrbacher stated the figure of 7.3% and Bachmann 7.9%. The presence of annual reports brings similar results; 7.0% in Rohrbacher's study and 7.9% in Bachmann's study,

in comparison with 0.8% in our study. Thus, our findings challenge the research that proves the positive role of the Internet in transparency (e. g. Rodríguez et al., 2012). We also argue that social networks (particularly Facebook) cannot replace websites in online transparency. Although studies in the public sector identified possible positive effects of social networks on transparency (e.g. Bertot, Jaeger, & Grimes, 2012; Bonsón, Torres, Royo, & Flores, 2012; Jaeger & Bertot, 2010) our findings suggest that using social networks does not improve the availability of governance information for stakeholders. Social networks rather play a role as a communication tool for daily routines and for non-formal communication. In certain cases, social media may be a way publicity can offset transparency (Zhuang, Saxton, & Wu, 2011) because stakeholders may perceive an organization publishing a lot of information as more transparent regardless the content. Another argument why social media is not a good tool to ensure online transparency is the structure of the pages which is very dynamic, timely linear, and older posts are very difficult to find.

The qualitative part of the survey was focused on barriers of and motives for transparency. We revealed a fixed idea that governance documents are not intended to be published. This idea will be difficult to overcome. Nevertheless, we identified that external pressure is a strong motivator for changing attitudes or behaviour. Based on our findings, we suggest that policy makers at governmental and local level should condition the subsidies and grants by publishing elementary governance information. This rule could be unpopular on one side, but on the other side, it would also be educational because it would disprove the notion that governance documents are confidential. On the other hand, educational opportunities could overcome inertia in managing grassroots organizations. In addition, we identified that low transparency may disguise the activity of the organisation. Thus, higher governance transparency could eliminate the misuse of legal form.

Conclusion

Our study presents the current situation of transparency of Czech sport grassroots organizations. In comparison with previous studies by Bachman (2012) or Rohrbacher (2007), there is a general increase in usage of websites by grassroots organizations from 25% to 70%. However, the impact on transparency is questionable because relative figures of organizations providing assessed information on their websites are lower. Very important is the fact that transparency in key areas (such as a decrease in financial transparency from 7% to 0% or a decrease in the presence of annual reports from 8% to less than 1%) is significantly lower than in previous studies. In addition, the trend of using social networks (Facebook) has no significant impact on transparency

at all. This finding indicates that the sport environment is the least transparent sector in civil society. Upon the findings from the qualitative part of the survey, two ways of overcoming low transparency can be suggested. First, transparency could increase due to external pressure from policy makers and second, inertia could be overcome by educational stimuli for volunteers operating grassroots organizations.

The study also identifies questions for future research. The results reveal very low awareness of transparency what could be one of the main causes of low grassroots transparency. Future research could focus on perceptions or knowledge of transparency of representatives of grassroots organizations, which could both enrich the theory of transparency and help to find ways of ensuring reasonable transparency by grassroots organizations. Considering the opposite point of view, future research could also focus on the perception of transparency by stakeholders of particular organizations. Finally, our findings about the role of social network in transparency proved diverging results from previous studies. Hence, future research should focus on the means of online transparency and the optimal blend of social networks and websites for transparency and governance overall.

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COMPETITIVE BALANCE IN PROFESSIONAL SPORTS LEAGUES AND HIS INFLUENCE ON ATTENDANCE

Robert Kuchar
Faculty of Business Administration, University of Economics, Prague, Czech Republic

Abstract

The paper deals with the competitive balance in professional sports leagues. It focuses on the comparison of two systems: open European and closed North American. Aim is to analyse competitive balance in selected leagues. Open system is represented by the top football league Premier League plus Czech Republic and closed by NHL. It specifies what regulatory instruments are adopted. The paper also tries to find answer to question whether competitive balance influences the average attendance.

Keywords: *Competitive balance, sports leagues, league system, Premier League, NHL*

Introduction

The benefits of professionalism in sport are widely known – the introduction of money into sport was an incentive to players and teams to maximize their achievements and to give athletes the best resources to perform at the very best of their ability. However, although professionalism can increase the spectacle, the impact of money can also undermine the competiveness of competitions. Several studies have shown that professional sports are burdened by what Neale (1964) termed the 'peculiar economics of sport'. In particular, the problem of money plagues the industry, to the point that it has become a moderating factor. It is evident money and the wealth of people plays an increasingly important role in sport. In the context of professional football or ice hockey, the wealthy have the ability to purchase international rugby clubs and to have the luxury of being able to afford the top international players. In competitions where there is an imbalance of wealth across teams, money has the effect of reducing the distribution of player talent and effectively creating uneven teams (McMillan, 1997). As a result, sporting competitions require some restraints on economic competition to create competitive balance as well as to encourage sustainability.

The question of how the expected demand for sporting events depends on the probability of the teams wins, sport economists have addressed from the outset of this scientific discipline. In the 50s and 60s of the 20th century came to the view that heavy

dominance destroys interest and reduced demand. The result was that consumers demand uncertainty and the result of increasing demand uncertainty increases. This assumption became the basis for many of the recommendations in this area.

Competitive balance refers to the balance in sport capabilities of teams (Michie et al., 2004). Uncertainty in sports results are investigated by various methods, but Szymanski (2003) identifies three kinds of uncertainty:

a) Match uncertainty which refers to the uncertainty about the result of a special match (between two teams)
b) Season uncertainty which refers to uncertainty about the matches of a season
c) Championship uncertainty which refers to the dominance of a limited number of teams over the league in consecutive seasons (Szymansky, 2003).

However, any attempt to increase attention and the audience and as a result competitiveness may seem inappropriate from the viewpoint of a special club or fans, especially when they believe that the possibility of winning the game is high (Jennett, 1984). If a game result is predictable, people will be more worried than when the game starts soon. Therefore, football league committees should provide appropriate grounds to increase competitive balance (Koning, 2000). It is clear that sport leagues need a certain degree of competitive balance to survive and improve quality. Without competitive balance, the games are easily predicted and as a result they lose their attractiveness. Lack of competitive balance means that the number of spectators (those who go to the stadiums as well as those who watch the game on TV) is not maximized (Michie et al., 2004). Quirk and Fort (1992) asserted that one of the reasons why people love team sports is the excitement resulted from the uncertainty about the results of league competitions. To attract fans' interest, strengths and weaknesses of all league teams should be considered so that the uncertainty can exist for the results (Quirk et al., 1992). Competitive balance is important due to the fact that if other factors are considered to be similar, the uncertainty about the results will increase fans' interest and the need to watch games (either in stadiums or on TV). If a league is not balanced, it cannot earn revenues from the spectators and viewers. Therefore, it is important to increase and maintain competitive balance in order to maximize demand for a clubs, and the league's, product. This is an important business reason why sport leagues adopt disciplined regulations so that they can distribute revenues again and increase the balance. Competitive balance results in a balanced league as well. Imbalanced leagues face threats such as bankruptcy or threat to bankruptcy, weak clubs (retrograde), threats of competing leagues, a big gap in the intra-league (among league teams) and inter-league (among the teams of various leagues) revenues so that the teams which are selected for champions league and premier league can reach high revenues. Therefore, competitive balance is important for league certainty (Michie et al., 2004).

Match uncertainty

Impact match result uncertainty in demand and interest in this battle is being studied mainly through two characteristics. These are the number of spectators at the stadium and the TV audience. The level of outturn uncertainty match can be measured in several ways. Currently, the most used pre-match odds betting, which are generated in a competitive market and reflect the likelihood of match result uncertainty. But this is not completely smooth. One of the drawbacks is that the classes are created in a moment in time than that when viewers are buying tickets available. Empirical studies that examine this issue, however, the hypothesis of great interest and attendance at the great uncertainty in the results do not confirm much. On the contrary, many of them show that audiences want to see his primary victory of the home team, so number of spectators is higher if the home team is the favourite high price. So the theory of outturn uncertainty does not match up to the same weight as previously thought. More recently, however, it examines how a match uncertainty impact on the audience viewing transmissions on television. Viewers, who watch matches at home, are not as interested in the outcome of the match and prefer mainly viewing experience transfer. In this case, the results may be wrestling uncertainty analysis of the relationship and the TV audience different than it is in attendance.

League uncertainty

Theory uncertainty league results described it, what is the probability that one team or group of teams have dominated the competition in a particular season or over several seasons. League is a long-term competition and so there is no need independent variable, such as odds betting, which defines the level of uncertainty league results. The key question is what should be the division victories for items between teams in order to maximize overall attendance of league. Does the controversy whether increasing uncertainty league results has resulted in an increase of the total viewing attendance? The issue was or it currently spends time many sports economists and empirical studies associating attendance at matches and won the teams, but do not always have identical results. Some studies even show that less balanced competition can achieve higher overall spectator attendance as balanced competition.

From the above information indicates that there is no clear answer as to whether the increasing uniformity and increasing insecurity is increasing interest and demand for sports competition.

Salary Cup

The salary cap is defined as a form of wage maxima, which may be imposed on total payments to players of a club or the league as a whole (Dabscheck, 2004). "Effectively, a salary cap restricts how much teams can pay their players, ultimately preventing the inflation of salaries" (Staudohar, 1999: 3). The idea of salary caps was introduced by Rottenberg (1956) who anticipated salary caps "as a possibility, let teams bid for players and players accept offers, subject only to the constraint that a ceiling is imposed on the salaries that may be paid to individual players" (256-257). It was proposed that the salary cap allowed a team to assemble a more competitive roster paying less than the maximum. As mentioned above, the rising salaries are having huge consequences on the success of sports competitions and the salary cap is a way to limit its effect.

The salary cap is designed to ensure that all teams are spending equal amounts on player salaries, so that money cannot be used by wealthy teams to stock their teams with the all the best players. Ideally, if all teams are spending under the salary cap and have somewhat equal resources in terms of coaches and management, the competition should be fairly balanced. Furthermore, the appeal of the cap to owners is that it is a way to control salary costs. Vrooman (2000) also suggests salary caps act as a binding rule and restrict the mobility of professional players as well.

In conclusion, competitive balance has been investigated in world leagues and in various years. The present study attempts to investigate the competitive balance between the Premier League, Synot Legaue CZ and NHL from 2000-2014 and compare them.

Methods

This study is descriptive and the data are secondary and were collected from valid documents and league tables. This study aims to investigate competitive balance between to leagues. Premiership with salary cup regulation and Super Rugby, with no regulation in 1996-2014 seasons and compare them. Five models were used in this study:

1. The Three and Five-Club Concentration Ratio (C3 and C5) and the C3 and C5 Index of Competitive Balance (C3ICB, C5ICB)
2. Standard deviation wins
3. Relative standard deviation (RSD)- The ratio of actual and ideal standard deviation wins

The above models were used in many researches (Dejonghe, 2006; Novotny, 2006; Szymanski et al., 2006; Feddersen, 2006; Tenreiro, 2006; Brunelli, 2006; Gouget et al., 2006; Michie et al., 2004, 2005). As these models were economic and mathematic indexes, it was not necessary to approve their validity and reliability.

1. In a totally balance league, **C3ICB and C5ICB** always equals 100 (Michie et al., 2004). An obtained C3ICB and C5ICB>1 shows a lower balance in that league. Index is an indicator of the static competitive equilibrium. C3 and C5 in a totally balanced league changes by a change in the number of teams and as the leagues of this study consist of 12, 14 and 15 teams:

C3= 0.25 in a 12-team league C3=0.214 in a 14-team league C3=0.2 in a 15 team league
C5=0.416 in a 12-team league C5=0.357 in a 14-team league C5=0.333 in a 15-team league
C3/C5 ratio= total points won by the top five clubs/total number of points won by all clubs
C3/C5 Index of Competitive Balance= C3 or C5 / (3 or 5/n) * 100

Where n is the number of teams in the league. If the obtained C5 is more than the above scores, that league enjoys lower balance (Michie et al., 2004).

2. **Standard deviation victories** show us how to win in the league diverted from the league average. In the case of competition where matches cannot finish in a draw the league average of 0.5.
3. **RSD** - the ratio of actual and ideal standard deviation extends the previous indicator of relationship to the situation which would occur in ideal distribution victories. It allows us to compare the actual deviations from the ideal state. Standard deviation in the ideal state in the tender without draws calculated as: $\sigma i = 0.5 / n$, where N is the number of matches that each team plays.

Results

Open model (European Football League)

England - Premier League

C5ICB vs. attendance

The following chart shows that the development of values C5ICB had not a direct impact on the average attendance at Premier League matches. Annual increase (or. decrease) imbalances and conflicting attendance movements can be seen, only six season (03/04-06/07, 10/11-11/12), but not really strong.

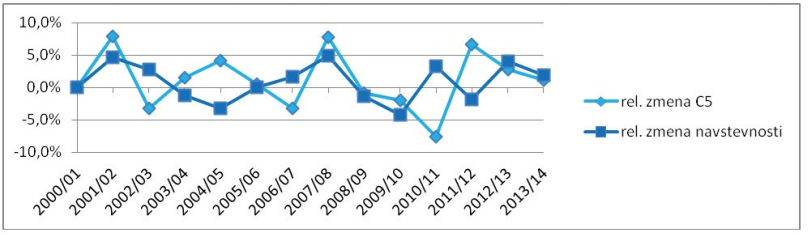

Fig. 1 Comparison of the index and C5ICB avg. attendance in Premier League
Source: author

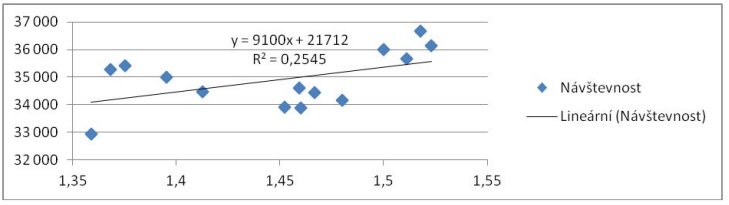

Fig. 2 Dependence of the attendance on the index C5
Source: author

The above chart shows the variation in attendance on competitive balance index change. The graph is observed very low leakage, respectively, a linear relationship of the two variables. It is the expressed values of the coefficient of determination (0.2545) In the case of removal of the first extreme value specified by the output reaches even lower leak. But it can gently suggest that some effect of improving competitive balance has an impact on attendance, but not strong enough to serve as an argument.

Czech Republic – Synot League

C5ICB vs. attendance

Czech Football League has inherently a long way in comparison with the English Football League, but in this case, when comparing the influence of attendance to balance competition, this comparison can be used. It shows that the attendance change is very flowy from year to year even if there is only small changes in competitive balance.

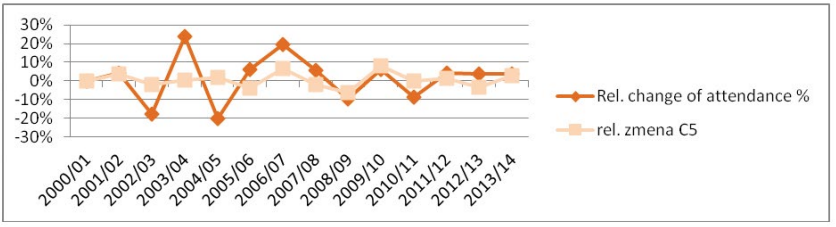

Fig. 3 Comparison of the index and C5ICB avg. attendance in Synot League
Source: author

The graph shows the dependence, respectively independence of average attendance on league balance. The graph is observed very low leakage between dependent and independent variables, so we can quite clearly say that the balance of competition in the Czech league does not have influence on the decisions making of people if they will go or not at the match.

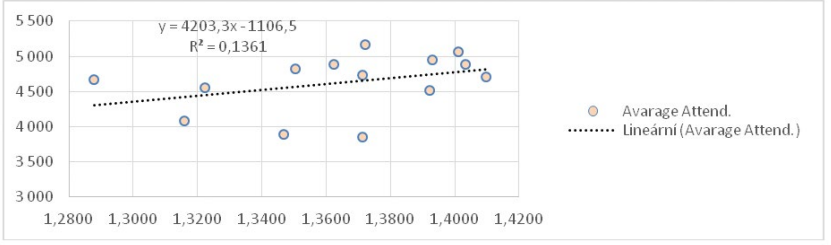

Fig. 4 Dependence of the attendance on the index C5
Source: author

Closed North American model

NHL

The development of the standard deviation percent of wins before and after the adoption of the salary cap

To examine the competitive balance was used standard deviation victories. Although the NHL used in determining the order of the points system, this was changed in the period since the disturbing draw. The 2012/13 season was a shortened version of the season and so was the absolute points lower. Therefore, this indicator has been chosen so that it can be compared to the ideal value and development Ratio indicator.

Competitive balance vs. Attendance

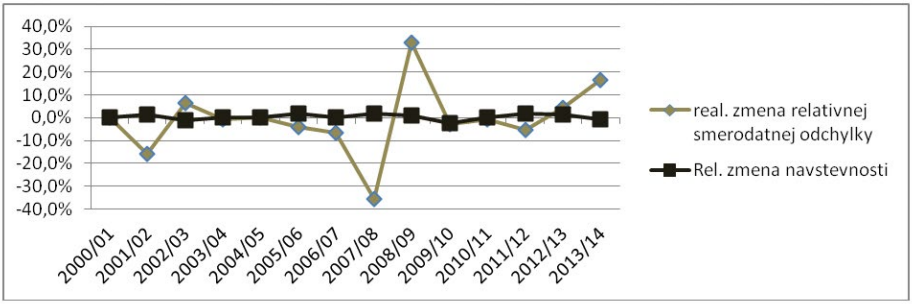

Fig. 5 Development of relative changes in attendance on competitive balance in the NHL
Source: author

Like the football leagues in Europe and in the NHL it was examined whether a change in the competitive equilibrium represented by the relative change in the ratio of actual and ideal standard deviation wins clubs impact on attendance. Since the year 2000/01 without major moving average attendance, no relative change ratio of the actual and ideal standard deviation were in some seasons marked. However on the average number of viewers it did not work.

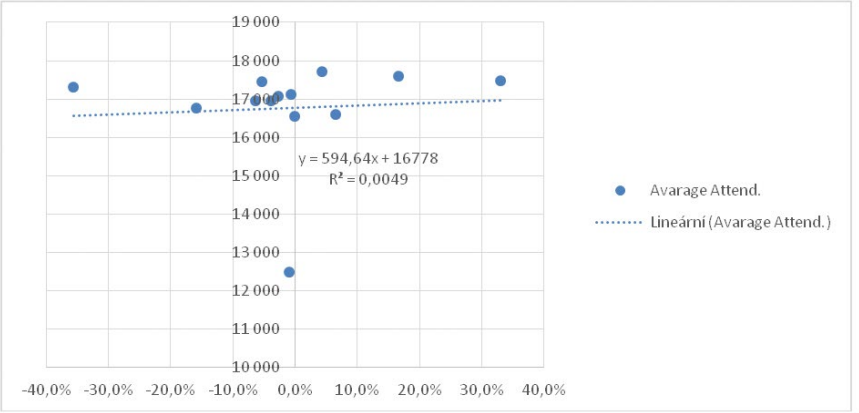

Fig. 6 Dependence of the attendance on the relative standard deviation
Source: author

Correlation dependence between investigating variables is in this case minimum and therefore absolutely unprovable dependence attendance on competitive balance.

Conclusion

Objective analysis in the form of competitive balance in selected professional leagues has been successfully implemented in this paper. The main building block of this section was to compare the closed and open system of the professional leagues. The space was dedicated to examining the impact of the CB and attendance, which brought interesting results. England football league and Czech football league has been analyzed with the index C5 and the NHL were used relative standard deviation. Emphasis was placed on the adoption of a hard salary cap and its impact on competition and CB.

The result did not improve that the better competition balance has fluent on average attendance, but this work showed that the difference between perceived competitive balance in North America and Europe will be gradually reduced. Personally, I believe that the issue of competitive balance in the near future gets even more to the fore in the world of professional sports leagues.

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THE LEGACY OF MAJOR INTERNATIONAL SPORTING EVENTS IN THE CZECH REPUBLIC

Jiří Novotný
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

The aim of this paper is to compare legacy of two winter major sporting events that were hosted in the Czech Republic as were FIS Nordic World Ski Championship Liberec 2009 and IBU World Championships Biathlon 2013 Nové Město na Moravě and find what link left in the region and the state. Theoretical background. Several scholars have been studying by the phenomenon of the impact of sport on the society and by the legacy of major sporting events in terms of economic effects mainly from USA. This paper is based on the work of European authors, especially Holger Preuss and Arne Solberg. Problem legacy of sporting events is part of the EU Strategy for the European sport. Emphasis is placed on the fact that investments in mega sports events has a legacy as particularly positive effects of tangible and intangible factors both in the region and locally. Methodology which is based on the relation as a comparison between positive and negative effect of these mega sport events in the sphere of social, economic, including environmental protection. The results of the study show that is positive legacy of the biathlon, especially in the areas of the social dimension, where started the huge positive publicity in the Czech. In contrast of it, as was the Nordic World Ski Championships in Liberec where the Czech public was under influence of a negative media campaign about the championship and the result was discrediting of the reputation of the city and region.

Keywords: *biathlon, legacy, ski, sport event, world championship*

Introduction

At present the views of the EU tends that is more profitable to follow what is called as the legacy of major sport events than to observe the impact of sport event on economics. The measuring of the impact of the sport on the economics is very difficult and in a small state like is economy of the Czech Republic it is extremely difficult for several reasons. First, the Czech Republic is an unitary state and the tax collections are saved to the ministry of finance and secondary are redistributed to the municipalities and regions. Second reason is that all major sports events are strongly dependent on the subsidies from the public budgets. From a purely economic point of view sport events are the unprofitable business in the case when we must invest to modernization

or constructions new sport facilities. Still something remains in the host country and in the city which has benefits for residents in next years after the event.

What is the legacy? One definitions "*Legacy is planned and unplanned, positive and negative, intangible und tangible structures that were/will be created through a sport event and remain after the event*." (Preuss 2006).

In accordance with the statement published in the aftermath of the "Education, Youth, Culture and Sport" Council Meeting of May 20th-21st, 2014 the definition is: *"The organisation of major sport events has a mixed record of results over the past 40 years. In the current situation of economic and financial crisis, the question rises on how to improve the cost-benefit ratio of hosting major sport events in Europe. The lasting, long term benefits of these events should include not only economic, but also sociocultural and environmental aspects."* Another definitions were presented on European Commission - DG Eurostat Expert Group "Economic Dimension" (XG ECO) meeting 06-07/10/2015 in Luxembourg.

The definition of the major sporting event. It is organized by one or by several host countries, regions or cities, and attended by different international delegations with the aim of practicing one or several sports branches. Such events are characterized by major technical and logistic challenges (the construction and development of venues, public transport, safety and security, etc.), have a high media profile, welcome thousands of people including supporters, journalist, technical teams and officials, and are organized consecutive days[1]. It is apparent that legacy of the major sporting event includes all its lasting impacts, i.e. what remains of the event after it ends. As a rule, it is not possible to arrive at an overall assessment of the legacy, which instead of it should be evaluated with given to its diverse forms. These may be positive or negative, tangible/quantifiable or intangible planned or unplanned, and short-, medium- or long-term effects. The result of this evaluation depends on a stakeholder's perspective and his or her interests.

Such a notion corresponds to the Czech Republic two major international sports events about which have more information. It is the FIS Nordic Event World Championship 2009 in Liberec and the IBU Biathlon World Championship 2013 in Nové Město na Moravě.

[1] Seminar on the environmental sustainability of major sport events organized by the French Sports Ministry (25/09/2014); Summary of discussions and recommendations for institutional sport and sports movement stakeholders.

Methods

I compare the legacy of two mega sports events in winter outdoor sports branches such as are the Nordic ski disciplines and the biathlon it is ski running and shooting. Mostly is used description of phenomena. Compilation is mainly in the socio cultural phenomena and the economic dimensions as the budget of events. Third dimension of the impact of the environmental dimension is not important, because the organizer has to comply with protection requirements of the nature and avoids of conflicts here. If we include the media to the environment of society we find their strong influence there. Started from diploma thesis of Eliáš (2014), Pavouková (2015) and the bachelor thesis Kožíšková (2009) processed ex post after sporting events. Assessed the positive and negative externalities and the results of cost-benefit analysis for the championship in biathlon, was followed by the recommended methodology.

Results

Legacy in the Sociocultural Dimension

In this dimension, I will try to describe the lasting legacy of sporting events to residents of the city and the region, sports federations and sports clubs in the city, the public sector, the state and the private sector.

Liberec

Legacy for citizens

The citizen's pride and honour that his city and county were able to create conditions for the organization of an international successful World Championship. In foreign countries, it has been also evaluated positively. What will remind to him from this World Championships and if it will be able to use in future years is not so positive information. Liberec is a city with a developed transport infrastructure and with easy access to the capital city.

In some parts of roads it was repaired surfaces and newly constructed the driveways roads to ski-jumping and cross-country areas. An average citizen was not touched by this. Here were made some urgent repairs of road surfaces. Rapid access to Liberec from the capital is only on roads by cars and buses, trains are used minimally. Nothing else was changed for the citizen, only for the duration of MS was partially limited individual transportation within the city. Modernized were area for ski jumping and

ordinary citizens will use this facility only if they take place on the World Cup ski jumping. For training it can only use by young jumpers, and it is a very small group of people from the town with 100 000 inhabitants.

Vesec-Nordic ski zone is on the southeastern outskirts of Liberec, the treeless land elevation is over 410 - 460 m above sea level. Tracks are very demanding and suitable only for physically able-bodied athletes. After World Championships there were taken away all technical facilities, i.e. changing rooms, toilets, refreshments, etc., so just the tracks remained. The average citizen and recreational skier do not use this facility. Reconstruction of the college dormitory of the University of Liberec was appreciated by students, but it has been irrelevant for ordinary citizens. Public opinion in Liberec has been negatively affected by the dismissal of the Chairman of the Organizing Committee of Championships Mr. Roman Kumpošt forced by the Minister of Education. To protest with him retired out most of the members of the organizing committee, which adversely affected future work of the new management committee. All residents of the Liberec region will remember that in the Organizing Committee of the Championship became something that was not fair play.

Legacy for athletes

The newly built sports facilities are suitable for competitive athletes, the resort for ski jumping is the second best in the Czech Republic and is also suitable for holding the World Cup in ski jumping. The Area Vesec began new post event period without a technical background and for normal training and clubs is not suitable for these reasons. Recreational skiers with performance skiers will prefer the nearby Jizera Mountains. All Czech skiers of the Nordic disciplines have individual pleasures from the fact that they had the opportunity to attend as spectators and see with their own eyes the best skiers in the world.

Legacy for Public sector

By the successful holding of World Championships were created further potential for hosting major international sports events in the Nordic ski in the Czech Republic. The city before public eye showcased itself as an attractive place to live and new houses were built in preparation in frame for sporting events has attracted new residents.

Legacy for Private sector

In the private sector taking away a legacy of unfulfilled accommodation capacities, the loss of customers in restaurants, including fast food stands. It was the consequence

of a reduction in number of visitors and the departure of some city residents outside of the city.

Legacy for ski associations

The Association gained dignified sports area for ski jumping and Nordic skiing which can quickly put into operation and can apply it for top world competitions. Certainly it was increased publicity of Nordic skiing events among the Czech citizens. The Association demonstrated in the international field that it could ensure organizes the top world sports competition. Unfortunately, also received a lesson that the organizing committee cannot be changed during the preparation of the event and the application of unexpected personnel changes can have unpleasant economic consequences for the entire association.

Nové Město n M.

Legacy for citizens

Legacy for all the citizens of the Nové Město n. M. area is the improvement of the road infrastructure, it is the improvement of the D1 highway exit, road surfaces around the Vysočina Aréna and stop way roads for accommodation guest houses. In Nové Město n. M there was modernized the train station and bus stations in the city Žďár n. S. and in Nové Město n. M. too. The multifunction and modernized Vysočina Arena allows sports physical activities for recreational athletes both in winter and in summer, mountain biking, inline skating and walking. The sport facility complex is equipped with all the social and technical backgrounds. In all around the area have increased full-year capacity to accommodate guests in pensions, lot of new jobs and lot of temporary jobs were created.

Legacy for athletes

Athletes can utilize quality training conditions they have their own individual experiences, where they may well train in the environment that has the world level. They have other individual benefits from the possibility of having the contact with foreign athletes, etc. Analogical feeling have also volunteers who have contributed to a good thing and something new learned and especially they have a sense of inner satisfaction that they were right participants in major sporting events.

Legacy for Public sector

It managed to more visualize Nové Město n. M and Vysočina Region in the Czech Republic and Europe. It offers the possibility for investors for Nové Město manufacture of skis, investment in leisure activities, of which could create new job opportunities. The successful holding of World Championship create further potential for hosting major international sports events in biathlon, but also cross-country skiing and in summer for cycling. These entire sporting events animate the whole region and into the city's treasury as revenue can come from recreational fees, etc. Increase of tax collection can only occur with a growth in tax revenue from real estate taxes, the rest is collected centrally and in a particular region to recognize their higher incomes.

Legacy for Private sector

Expectations of the private sector was filled only dissatisfied were several of small merchants on the main square in the city, which was closed to cars for the championship for the reasons of medal ceremonies.

Legacy for Sports Association

The Association received a decent sport facilities; it may seek the top world sport competition, increased promotion of the biathlon and to clubs come new primarily young members.

Legacy in the Economics Dimension

In this dimension, we will try to describe the lasting legacy of the economic dimension special if the planned budget will finish with deficit or surplus. The impact will fall on economy of national sport associations, municipality, region and government.

Economics of major sports event must be seen from two aspects of expenditure. Firstly, there are expenses associated with the financing investments into sport and transport infrastructures. The finance instruments are the investment budget or indirect costs. Secondly, there are expenses associated with the operation of the organizing committee of sporting events and equity financing during sporting events, this are direct costs. Instrument of financing is the operating budget.

Liberec

Championships in Nordic skiing events were organizationally and economically more challenging already from that point of view. The competitions took place in two different sports facilities and the cost was too high. The original budgeted amount

for planned investment budget was 1.5 billion CZK. Ski Jump Area Ještěd it was necessary to reconstruct. The Nordic Ski Cross-Country Area Vesec it was completely newly construct. The Committee and the city invested into accommodation capacities in university dormitories, the construction of houses and finally to the so-called metropolitan area networks. The investment budget was overdrawn by CZK 524 million into two sports arenas. In connection with the construction appeared scandals on overpriced building plots and speculations with them. Another scandal which general public perceived was associated with a tender procedure for suppliers for the reconstruction of student dormitories, but the budget was not exceeded. The actual investment budget was amounted to 1 950,281 million CZK. If Area Ještěd over the next few years will be utilized, with the Nordic Ski Cross-Country Area Vesec with costs over 594.4 million CZK is very problematic. It seems that this is the "White Elephant" of public expenditure in the country. The amount of nearly 2 billion CZK was financed from public funds, both by the Czech government so regional and municipal too. Whether participated in the construction private investors, it is not know from documents of the organizers of the championship. The operating budget in the planed amount of 593,5 million CZK of the organizing committee of the event finished with the significant deficit. The reason was mainly decrease of revenue from the entrance fee of viewers 42.7 million CZK and from the VIP clientele of 28.5 million CZK. The third reason was the unexpected appreciation of CHF against the CZK; decrease in revenue to budget for the payment from FIS was minus 9.1 million CZK. The income of the budget was ended with a deficit of CZK 86,963 million. To the total deficit of the budget of the Committee should have the effect of increase in the costs of several items. These were mainly higher infrastructure costs in Vesec about 8,056 million. CZK and the area Jested 9.8 million CZK, in Marketing of 9.78 million CZK and Security of 4,918 million CZK, although the Catering saved 2,768 million of CZK. So was the total cost overruns of budget amounted to 29,709 million CZK. After counting of the amount for exceeding of costs and total non-fulfillment of revenues, the budget of the organizing committee ended with deficit of 116.672 million CZK.

The cause of such a high deficit of the budget was primarily the pricing policy of the organizing committee, which discouraged primarily domestic visitors. Prices were high relative to average incomes of Czech households. Kožíšková (2009, p. 32 - 33) states in her bachelor thesis that ticket prices were higher than in Oberstdorf, Germany in 2005. For example, the price of the Package Type 1 was high about 1, - EUR, for Package Type 2, it was already high about 17 euro. In Liberec it was more expensive than Oberstdorf. The price of Package 1 was in Czech crowns 18 250.00 CZK and it presented at that time, net monthly income, on which did not

reach 2/3 of the employees. Generally organizers were expecting slightly lower visit than at the previous championships in Oberstdorf, i.e. around 300 thousand spectators (in Oberstdorf, this number was 360 thousand). This idea, however, was not nearly fulfilled and the Championship reached around 173 thousand spectators. This number may actually be even lower because it is only the value of number of the passes through the turnstiles of areas.

After the end of the championship were entered eight creditors for their claims against the Organizing Committee with the requirement of 319 261 303 CZK. Legal disputes have been probably taking place until today, to all creditors will not be the claim accorded. Recognized debt are estimated at around 115-116 million CZK and it was divided between the Ski Association of the Czech Republic, Liberec County and the city of Liberec. This is the negative economic legacy that left over for the Czech Republic and the Liberec Region from the World Championship in Nordic skiing in 2009

Nové Město na M.

IBU Biathlon World Championship 2013 Nové Město na M. was smaller than the FIS Nordic Ski Championship 2009 Liberec. The total amount of money spent on the organization of the championship in biathlon was CZK 465 million. The budget of the Organizing Committee was 190 million CZK as direct costs. The investment real budget was CZK 275 million, as indirect costs of the event. Sources of funding were from the public sector as were the European Union, the Czech government: Ministry of Education and Ministry of Transport, County Vysočina and the municipality Nové Město. Private source were entry fee from visitors. Planned budget has ended with surplus of 1 230 130,00 CZK. On investment costs were saved 31 million CZK. (Pavouková 2015, p. 60)

On the overall positive legacy was involved by very good marketing that ensured a relatively small agency from the city Třebíč. Pricing policy was very real, which correspond to the income situation of Czech households. The final attendance was higher than expected and the number of visitors was higher than in the much larger Liberec.

The Organizing Committee has stabilized and there were no scandals as in Liberec. Pavouková (2015, p. 43 - 85), who ext post cost benefit analysis prepared for this event and proved that conditions for the organization of the event were very real and recommendations for implementation of action was confirmed by the analysis. Economic legacy for this event was highly positive.

Legacy in the Environment Dimension

From the viewpoint of nature conservation during implementation of the sport event were respected requirements for Nature Conservation. More unfortunately it suffered Liberec, who had to move the cross-country skiing area on a place which is not very suitable location, thus it got into the position of a White Elephant. In the Novém Městě were not such problems.

If we include this dimension of the media environment, where badly ended Liberec after exchange of the Organizing Committee when started very negative media campaign against Championships. Eliáš (2014 p. 82) listed 13 negative reports in the newspapers, which had a very significant impact on public opinion and thus negative legacy of Championship and were damaged the public reputation of the city Liberec.

Conclusions

If compare the legacy of two major sports events in the Czech Republic, it definitely better ended up the event in Nové Město n. M. It shows that an extremely strong factor may be negative media campaign and Liberec paid for the sport event very much. Another major negative factor is the wrong economics of the Organizing Committee. The public wrongly perceived when the budget of the Organizing Committee finishes with the high deficit and with high exceeded investment costs into sports facilities. If comparing championships in Liberec and Nové Město n. M. then far better is the legacy for the Nové Město n. M. where the budget ended with a surplus and investments costs were lower than planned budget. Great significance for the economy of events has high attendance and revenue from entrance fees. Liberec paid the high price, which had result in significantly lower attendance of visitors, which strongly influenced the revenue of the Organizing Committee and its budget deficit. For legacy event it is very important how the public perceives the subsequent use of the sports facilities for training and for other sporting events in the future. There is the legacy better for Nové Město. During the processing of this paper it turned out that this area is not processed in the particular methodology for the intangible benefits of sport events. For the successful organization of events it shows that are necessary preparations before the event with a feasibility study, pre ante cost benefit analysis, etc. Public sector bodies that provide financial subsidies should always require such studies from candidates of major sport events.

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ANALYSIS OF HUMAN MOVEMENT

PHYSICAL ACTIVITY VS INACTIVITY, MUSCLE VS FAT MASS IN ELDERLY

Rado Pišot, Armin Paravlić, Uroš Marušič, Matej Plevnik, Dorjana Zerbo Šporin, Saša Pišot, Boštjan Šimunič

Institute for Kinesiology Research, Science and Research Centre, University of Primorska, Slovenia

Abstract

The aim of present study was to investigate the influence of the level of physical activity, both extremely active (Most Active-MoA) and extremely inactive (Less Active-LA) subjects, on body composition parameters and strength, with special emphasis on the relationship of muscle mass (MM) and fat mass (FM) in the elderly. We used a data from two separated studies, both in the framework of the EU project PANGeA: Physical Activity and Nutrition for Quality Ageing. First was aiming to monitored the quantity of PA with GPAQ in three Slovenian towns using a sample of 446 subjects [women *N* = 284 (64.7 %), age 66.8 ±5.1 years, men *N* = 162 (36.3 %), age 68±5.5 years]. The subjects were divided by METs and age on three (Less Active, Moderate Active and Most Active), respectively (<=64, 65-70 and 71+ years) groups. Second study, from which we used a data, was an experimental bed rest. With two weeks complete inactivity we cause an acute inactivity period for group of elderly subjects (*N*= 16; 59.6 ± 3.4 years). LMM and FM in both studies were measured with bioimpedance. We found that MoA71 + (*M* = 32.95; *SD* = 6.70; *t* (87) = 2.04, *p* <0.05) group had a significantly lower values of FM% by 1:09 times or 9.83% compared with LA64 (*M* = 36.19; *SD* = 7.73). A significant difference were showed in LA64 (*M* = 37.56; *SD* = 9.43) and LA71 + (*M* = 32.29; *SD* = 8.30; *t* (101) = 2.996, *p* <0.01) which indicates that LA71 + has for (16.29%) weaker grip strength than LA64. The results of experimental study have shown that acute inactivity increased a fat mass before bed rest (BBR)/(*M* =22:38;*SD*=5.726) until after bed rest (ABR)/(*M*=24.69;*SD* =6.620),*t*(15)=2.911; p<0.01) and same changes, have occurred in the reduction of MM, BBR (*M*=39.81,*SD*=6.75) respectively ABR (*M*=37.49, *SD* = 5.15),*t*(15)=3.122;*p* <0.01) The level of physical activity has definitly a big impact on body composition and strength as the important factors and indicators of health. The detrimental effect of inactivity on muscle mass in elderly as it emerges from the present work represents a reason to suggest an active life style to the elderly and to avoid or to minimize the period of inactivity during hospitalization. We need to facilitate the introduction of the necessary adaptations to the environment and create the incentives required to help elderly population to be more active and increase the quality of their lives.

Keywords: *elderly, physical activity, morphological characteristic, health, independence*

Introduction

It is well known that regular physical activity has a great positive impact on wide array of physical (Thompson, Buchner, Piña, Balady, Williams, et al. 2003; Pollock, Franklin, Balady, Chaitman, Fleg, et al. 2000) and mental (Yaffe, Barnes, Nevitt, Lui, & Covinsky, 2001; King, Taylor, Haskell & DeBusk, 1989; Dischman, 1992) health. Physical activity is an important contributor to a healthy lifestyle in the prevention of non-communicable chronic disease as cardiovascular diseases (Tanasescu, Leitzmann, Rimm, Willett, Stampfer, et al. 2002; Wannamethee, Shaper, Walker, 1998; Bassuk & Manson, 2005), diabetes melitus type 2 (Manson, Stampfer, Colditz, Willett, Rosner, et al, 1991; Eriksson & Lindgärde, 1991), osteoartritis (Martin, Kuh, Harris, Guralnik, Coggon, et al. 2013) and other important functional and metabolic changes influence large spector of Non-Communicable Diseases (NCDs) (Lee, Shiroma, Lobelo, Puska, Blair, et al. 2012; Morley, Abbatecola, Argiles, Baracos, Bauer, et al. 2011).

On the other side, the same effects are established with regard to physical inactivity but in the diametrically opposite direction when we considered the outcomes. With great certainty we can say that physical inactivity, caused by overall or habitual inactivity (Slentz, Aiken, Houmard, Bales, Johnson, et al. 2005, Tremblay, Colley, Saunders, Healy & Owen, 2005), by bed rest (Rittweger, Simunic, Bilancio, De Santo, Cirillo, et al. 2009; de Boer, Seynnes, Di Prampero, Pišot, Mekjavić, et al. 2008) or even microgravity (Caiozzo, Baker, Herrick,Tao & Baldwin, 1994; Fitts, Riley & Widrick, 2000) could represent the important factor of many non-communicable chronic diseases. Physical inactivity is an increasing health problem that has marked a negative impact not only on muscle structure (Rittweger, et al. 2009; de Boer, et al. 2008) and function (Berg, Larsson, & Tesch, 1997) but affects also other subsystems of human body, such as cardiovascular (Blomqvist, Buckey, Gaffney, Lane, Levine, et al. 1994; Perhonen, Franco, Lane, Buckey, Blomqvist, et al. 2001; Traon, Sigaudo, Vasseur, Maillet, Fortrat, et al. 1998), and skeletal (Leblanc, Schneider, Evans, Engelbretson, & Krebs, 1990; Rittweger et al., 2009) with some evidence of potential deficits on brain functioning (Marusic, Meeusen, Pisot, & Kavcic, 2014) and/or even cognition (Ioseliani, Narinskaia, & Khisambeev, 1985; Lipnicki & Gunga, 2009). Sedentary living is estimated to be responsible for approximately one third of deaths due to coronary heart disease, colon cancer, and type 2 diabetes (Powell & Blair 1994). It is also well known that hospitalization has a negative impact on the health of elderly people (Solomon, Wang, Freeman, Vos, Flaxman, et al. 2012). However, aging itself, is associated with a decline in physical activity level (Caspersen, Pereira, & Curran, 2000; Pate, Pratt, Blair, Haskell, Macera, et al. 1995; Black, Coward, Cole, & Prentice, 1996; Roberts & Dallal, 2005). This may be partly due to the change in their life habits (Caspersen, et al., 2000) but it is definitely due to a large extent to the limitations in physical activity.

Muscle mass and strength decrease with age in older adult men and women. This loss may accelerate after the age of 65 years (Baumgartner, Stauber, McHugh, Koehler &Garry, 1995). Mankowski, Anton & Aubertin-Leheudre (2015) noted that unhealthy changes in body composition can contribute to a decline in motor function and significantly increases the risk for disability, thus, this changes are associated with increased fat depots within the muscle as well as a loss in muscle strength and muscle power. Decline in strength is associated with loss of muscle mass and motor units, altered hormonal, insulin, and growth factor secretion, and other changes (Metter, Talbot, Schrager & Conwit, 2002). Physiological aspects that occurred within those changes are explained by declining hormonal and growth factor secretion with decreasing muscle protein metabolism which altering of muscle tissue function and mass (Sonntag, Lynch, Cefalu, Ingram, Bennett, et al. 1999).

The maintenance of muscle strength and the prevention of sarcopenia, are extremely important for older adults to be able successfully perform physical tasks, and exercise including daily activities like walking, showering and caring for one's personal needs (Jones, Stephenson, King, Knight, Marshall, et al. 2009). It is important to determine whether performing regular physical exercise throughout life may help maintain muscle strength and mass of a 70- or 80-year-old adult (Evans & Campbell, 1993).

The question is whether increasing the level of physical activity in old age can reduce the above-mentioned consequences and thus improve the situation, accompanied by the reduction of functional autonomy, and physical independence and thus generally reducing the quality of life of the elderly.

The main aim of present study was to investigate whether the physical activity level, both extremely active and extremely inactive subjects, is associated with body composition parameters and strength with special emphasis on the relationship of muscle mass (MM) and fat mass (FM) distribution in the elderly. Another research question issue that we ask ourselves through this study, which could give us an one more argument to the importance of physical activity for human health, is that the least hypothetically possible to compare the results of two completely different studies by design, cross sectional and experimental study, hipothetically speaking. These results will give us the answers, regarded to inactivity, about the degree of degradation of the above mentioned variables through biological aging and degradation caused them by acute inactivity, in 14 days bed rest controlled longitudinal interventional study.

Methods

The study is a part of the project PANGeA: Physical activity and nutrition for great ageing which was co-financed by the Crossborder Cooperation Programme Slovenia- Italy 2007-2013. Data were collected the measurement and bed rest study

in the framework of PANGEA project. The lead partner of the project was Institute for kinesiology research, Science and research centre, University of Primorska.

Sample of Subjects

Cross sectional (mass measurements) study

Eligible subjects were 446 subjects (women N = 284 (64.7%), age 66.8 ± 5.1 years, BMI = 26.8 ± 4.2kg/m^2; men N = 162 (36.3%), age 68 ± 5.5 years, BMI = 27.7 ±3.3 kg/m^2], from three Slovenian towns: Koper, Ljubljana and Kranj. Basic parameters are reported in Table 1.

The inclusion criteria for mass measurements study were: age limit (60 to 80 years of age), health status in a way that s/he is able to walk 2 km without support, and completing and submitting the Questionnaire. The questionnaire was divided in several different parts to cover general health status, well-being and lifestyle (physical activity (PA), nutrition and health-risk behaviors) of older adult population.

Tab. 1 Subjects characteristics (M±SD), Cross Sectional Study and Experimental Study

Cross sectional study			**Experimental study**		
Gender	Men	Women	Men	BBR	ABR
N	162	284	16		
Age	68±5.5**	66.8 ±5.1	59.6 ± 3.4		
BH	173.8 ±5.9**	161.0 ±5.9	1.73 ± .05		
BW	84.1 ±10.2**	69.9 ±12.0	79.9 ± 12.3		
BMI	27.7 ±3.3*	26.8 ±4.2		26.6 ± 4.4	25.8 ± 1.4
FM	29.1 ±4.5**	38.1 ±6.5		22.3±5.7	24.7 ±6.6**
MM	31.5 ±3.8**	19.2 ±2.5		39.8 ±6.7	37.5 ±4.8**
GSt	46.9 ±7.5**	30.5 ±5.2			
tMETs	5248.2±4237.6	4389.8±3413.3			

BH- Body Height (cm); **BW**-Body Weight (kg);
BMI- kg/m^2; **FM**-Fat mass(%); **MM**-Muscle Mass(kg);**GSt-** Grip strength(kg); **tMETs-** total METs**; BBR**-before bed rest; **ABR**-after bed rest
***p<0.05;**p<0.01**

Experimental (Bed Rest) Study

Twenty-three healthy men, of which 7 young (YM; aged 18-30 years) and 16 older adults (aged 59.6 ± 3.4, BMI = 26.6 ± 4.4) were recruited for the study. All participants underwent medical examination and routine blood and urine analysis. For the purpose of this research question and article, we will only present the data from older participants. Basic parameters are reported in Table 1. Exclusion criteria were: smoking; regular alcohol consumption; ferromagnetic implants; history of deep vein thrombosis with D-dimer > 500 μg•L-1; acute or chronic skeletal, neuromuscular, metabolic and cardiovascular disease conditions; pulmonary embolism. Participants were informed of the purpose, procedures and potential risk of the study before signing the informed consent. The study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and was approved by the National Ethical Committee of the Slovenian Ministry of Health on April 17, 2012 under the acronym: IR-aging 1200, with the obligation of maximum rehabilitation of participants after the study period. The study design and detailed experimental study protocol is described in Marusic et al., (2015) and Pisot, Marusic, Biolo, Mazzucco, Lazzer, et al. (submitted).

Measurements

Physical activity level

Physical activity level was described using the GPAQ (General Physical Activity Questionnaire, WHO) as a suitable and acceptable instrument for monitoring physical activity in population health surveillance systems (Bull, Maslin, & Armstrong, 2009). The study design and detailed cross sectional study protocol is described in (Pišot, S., & Marušič, 2015).

Anthropometrics and body composition

A trained staff person of the same sex as the study participant conducted the anthropometry.

Body weight (BW) was measured to the nearest _ 0.1 kg with an electronic scale (LIBELA ELSI TPT5N, Slovenia) and body height was measured to the nearest _0.1 cm with a wall-mounted stadiometer (Stable stadiometer Seca, Birmingham, UK). Body mass index (BMI) was calculated as weight divided by height squared (kg/m2). Muscle mass (MM) and fat mass (FM) were measured with bioimpedance method (Maltron BioScan 916S, UK) like elswere (Cankar et al. 2009; Palombo 2015).

Grip strength measurement

The portable Jamar hydraulic hand dynamometer (Sammons Preston, Rolyan, Bolingbrook, IL, USA) was used, with the second handle position for all subjects. The presented scores are expressed in kilograms.

Test procedures

The National Medical Ethics Committee approved the protocol. ? All participants gave written informed consent. The Jamar dynamometer was placed in the right or left hand randomly and was held loosely around the readout dial by the examiner to prevent dropping (Mathiowetz et al., 1984). In alternating order, three maximum voluntary GS contractions were taken for each hand. The mean value of each hand was used for analysis (Mathiowetz, 1990). All participants were examined in a standardized position (American Society of Hand Therapists, 1992) like is noted (Peters 2011).

Statistical Analysis

The 446 subjects were classified into three symmetric groups: LA group (Less active or <=2790 METs), MdA (moderate active or <2791-5097 METs) and MoA (most active or 5098+ METs), taking a cut-off value of 33.33 and 66.66 tertiles of the independent variable obtained by means of the total weekly metabolic equivalent index value (MET) as mantioned in Maciel, Vilarta, Modeneze, Sonati, Vasconcelos, et al. (2013). We considered the all three groups for statistical analysis with special emphasys on the two extremely groups, the LA (the first tertile 33.33) and the most active (the third tertile 66.66) which totaled 298 subjects of both gender.

By the study sample we divided participants on three groups according to tertile distribution were defined in each different age (<=64 y, 65-70 y, and 71+ years).

Descriptive statistics were run on all variables to check for the assumptions of normality and homoscedasticity. After forming the groups, these were subjected to statistical tests to detect differences between the averages of the independent variables. Data are presented as mean±standard deviations (M+SD). For Cross sectional study Student's independent test for unpaired samples (two-tailed) were used to evaluate differences between groups of subjects considering the gender. To evaluate the effects size between differences in variables between groups were used equation:

$$\text{Eta Square} = \frac{t^2}{t^2 + (N1 + N2 - 1)}$$

Using the Pearson linear correlation coefficient we investigate a relationship between continuous variables.

For Intervention Bed Rest study Student's t-test for paired samples (two-tailed) were used to evaluate differences before and after intervention. We calculate the strength of correlation by Cohen (1988): small r=0,10-0,29, moderate r=0,30-0,49 and strong r= 0,50 - 1,0

For calculation differences in procents we used equation:

$$\frac{mean\ difference}{mean} \text{ x } 100$$

The effect size (ES) presented through Eta Square, between post and pre training was calculated using equation:

$$\text{Eta Square} = \frac{t^2}{t^2 + (N - 1)}$$

in order to verify the magnitude of the differences, where an ES of 0.01–0.059 was considered as small, 0.06–0.137 as moderate, and >0.138 as large (Cohen, 1988).
IBM SPSS Statistics 20.0 software (SPSS, Inc., Chicago, Ill, USA) was used for all statistical procedures, statistical significance was set at the level of $p < .05$.

Results

Cross sectional study

Physical characteristics and body composition

The age, number of participants , physical and body composition characteristic of participants categorized by gender are presented in Table 1. There is a significant difference (p<0,01) between man and women for all variables. Significant difference (p<0,05) was found also for BMI (p<0.05).

Body composition and physical activity level regarded to age differences

With T test for independent samples were compared the results of %FM, MM and GSt between the two groups LA64 and MoA71+. Significant difference was observed when compared %FM in LA64 (M = 36.19; SD = 7.73) and MoA71 + (M = 32.95; SD = 6.70; t (87) = 2.04, p <0.05), suggesting that MoA71 + has to 1:09 times (9.83%) less body fat than LA64, Eta Square = 0.045. We were not found significant differences when compared this groups based on MM and GSt, also no significant differences were showed comparing the groups of LA64 and MdA71+; LA64 and MdA65-70, and LA64 i LA65-70 for all three variables. Significant differences were found compared LA64 and MoA 65-70 in the %FM. Between LA64 (M = 36.19; SD = 7.73) and MoA65-70 (M = 32.34; SD = 6.35; t (107) = 2.845, p < 0.01), respectively MoA65-70 group has to 1.11 times (11.77%) less body fat than LA64 group. Comparing these

two groups for MM were also recorded significant difference LA64 (M = 22:56; SD = 5.4) and MoA65-70 (M = 25.95; SD = 7.23; t (107) = 2.755, p<0.01), which indicates that MoA65 -70 group has 1.15 times (15.2%) more muscle mass in relation to LA64. In GSt no significant differences were showed between the those groups. A significant difference were showed in LA64 (M = 37.56; SD = 9.43) and LA71 + (M = 32.29; SD = 8.30; t (101) = 2.996, p <0.01), which indicates that LA71 + has for (16.29%) weaker grip strength than LA64, Eta Square = 0.08 (moderate impact). No significant differences were showed in comparison this two groups by FM% and MM. The result are shown in Table 2.

Tab. 2 Student's Independent t-test for comparing groups by METs regarded to age.

METs	***Less active(LA); n/(53, 47, 50)***			***Moderate active(MdA); n/(54, 50, 44),***			***Most Active (MoA); N (56, 56,36)***		
	FM%	MM(kg)	GSt (kg)	FM%	MM(kg)	GSt (kg)	FM%	MM(kg)	GSt (kg)
<= 64	36.1 ±7.7**◆	22.5±5.4	37.5 ±9.4	35.4 ±7.3	23.5 ±6.7	36.6 ±10.3	33.3 ±7.4	23.9 ±7.2	37.2 ±9.2
65-70	35.1 ±7.2	23.2 ±6.1	35.4 ±9.7	35.1 ±7.2•	23.2±6.1**°	35.4 ±9.7	32.3 ±6.3*•	25.9 ±7.2	40.5 ±10.8
71+	36.7 ±7.1	22.4 ±6.5	32.3 ±8.3	35.7 ±7.7	23.8 ±7.1	34.9 ±9.6	32.9 ±6.7*+	24.7 ±7.0	37.2 ±10.1

***P <0.05:**

****P<0.01:**

+ Significant difference were showed in comparison of LA64 i MoA71+ in FM%

· Significant difference were showed in comparison of LA64 i MoA65-70 u FM%

° Significant difference were showed in comparison LA64 i MoA65-70 u MM

[u] Significant difference were showed in comparison LA64 i LA70+ u GSt

Correlations

Using the Pearson coefficient of linear correlation, we explored the link between continuous variables: the percentage of fat mass (FM%), muscle mass (MM) and grip strength (GSt).

We conducted preliminary analysis in order to prove satisfying assumptions of normality, linearity and homogeneity of variance. Moderate to strong negative correlation is measured between the mean of % FM and MM, r= -0,491, n=446, p<0,001, where high levels of percent of body fat monitor low levels of muscle mass (Figure 1.). Correlations between FM% and GSt is large and has a negative direction, r= -0,546, n=446, p<0,001, where high levels of percent of body fat monitor low levels of grip strength (Figure 2.)

Correlation between MM and GSt is very large and has a positive direction, r = 0.789, n = 446, p <0.001, with high levels of the percentage of muscle mass accompanied by high levels of grip strength (Figure 3)

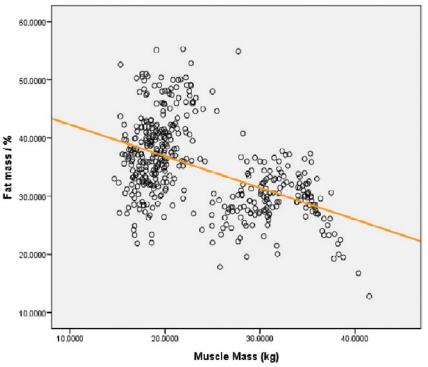

Fig. 1 Correlation between FM% and MM

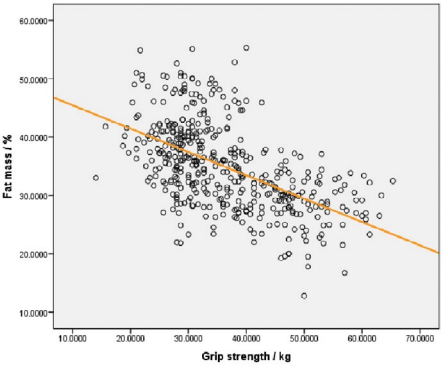

Fig. 2 Correlation between FM% and GSt

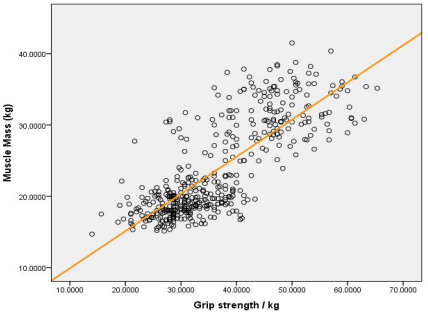

Fig. 3 Correlation between MM and GSt

Experimental study

Body composition

The age, number of participants , physical characteristics and body compositions of participants are presented in Table 1. Analyzed by Student's test for paired samples the significant difference (p<0.01); (two tailed) were showed between two periods, pre (BBR) and post (ABR) intervention.

Fat mass

A significant increase was found in %FM from time 1 (BBR) (M =22:38;SD=5.726) until the time of 2 (ABR) (24.69;SD =6.620), t (15) = 2.911; p <0.01). The average increase in %FM was 2.31% while the CI95% extends from -4.006 to -0.619. The value of Eta Square (0.36) shows that the impact of the intervention was great, respectively after treatment the increase in the %FM was by 1.1 time (10.3%) compared to the period before treatment.

Muscle Mass

A significant reduction of the MM from BBR (M=39.81,SD=6.75) up to the ABR (M=37.49, SD = 5.15), t (15) = 3.122; P <0.01. The average reduction values of MM was 2.32 kg, while the CI95% extends from 0.738 to 3.912. The value of Eta Square (0.39) shows that the impact of the intervention was a big. Difference between the mean values before and after treatment was - 6.2%.

Discussion

There is a few major findings that emerge from this study: (1) We showed a significant difference by extremely active group, MoA71+ years, and extremly inactive goup LA64 years, with regard to total body fat percent %FM. We also detected difference between this two groups in regard to total body muscle mass (MM), but with no statisticaly main significance and same for GSt (2) There is a big, significant difference between gender and body anthropometrics, body measurements: body weight, body height and body composition and also in strength. (3) If we could dare to compare means of two different study design, we could conclude that habitual higher activity levels at elderly 71+ could suppress the effects of aging on FM% accumulation that occured in acute physical inactivity like bed rest (controlled hospitalization conditions) at elderly 59.6 ± 3.4. The increase of %FM after 14 days bed rest was (by 1.1 time or 10.3%) and lower fat level (1:09 times or 9.83%) of MoA71+ compared to LA64. (4) Corellations showed us that FM% and MM has a moderate to strong negative direction, FM% and GSt link is strong and has a negative direction, MM and GSt correlation is a very strong and has a positive direction with statistical significance (p>0.01). Correlation between Total METs and age, like GSt and Age were correlate in negative direction but without significance difference within.

Our finding suggest that we can fight against biological aging with higher level of physical activity. If we compare results between three age groups we could say

that both older 64-70 and 71+ most active groups have a lower levels of FM than LA64 (11.77% and 9.83% respectively). Regard to this results there is a posibility of decrease FM until 70 years and after that regardless to physical activity level (PAL) we have lower chance and posibility to maintain that level of FM regard to age (Kyle, Genton, Hans, Karsegard, Slosman, et al., 2001). Haight, Tager, Sternfeld, Satariano, Van der Laan, et al. (2005) conclude that higher levels of physical activity appeared to reduce the risk of future functional limitation conditionl on the level of functioning established early in the disablement process by muscle mass:fat mass ratio. Average means of MM in groups which we compared hasn't achieved statistical significance which means that most active elderly have the same level of muscle mass compare with less active, but MoA 71+ has a lower level of fat mass. Based on this we can infer that we could hipothetically suppress ratio of MM and FM and therefore functional inability that occured with it. Promising results could occured with this findings if we accept the conclusion from Beccket, Brock, Lemke, de Leon, Guralnik, et al. (1996) which states that some subjects recovered from disability even at the oldest ages and that the decline in mean level of physical function in their elderly subjects did not imply that all subjects followed a steady course of decline.

The average reported age-related decreases in strength are on the order of 20-40%. In general, similar declines in strength have been reported for proximal and distal limb muscles, including the ankle plantar and dorsiflexors, elbow flexors and extensors, and hand grip (Doherthy, 2003). With regard to this our findings sugest that, for habitual MoA elderly 71+ compared with LA elderly <64, there is no significant decline in GSt with age, but when we compared this two groups with same amount of PAL, respectively the LA of booth, we have the decrease of GSt in LA 71+ by 16.29% compared to LA64. That is steal less than 20% as Doherthy, (2003) stated. Reason for that as we suposed is a higher activiy level in base line of our participants on average mean (4701.6 ± 3751.9) than some of suggested population of elderly (2114.5 ± 3191.07) (Maciel, et al. 2013). One of the conclusion of Metter, et al. (2002) was that although muscle mass and physical activity are important, they do not completely account for the impact of strength and changes in strength in elderly. Our findings suggest that we have opposite results and that muscle mass correlate positively strong with grip strength, which is validate measure for total body strength (Newman, Kupelian, Visser, Simonsick, Goodpaster, et al. 2005; Winsdor & Hill, 1988). Our results may can be axplained by the same fact of higher base line of physical activity than normal population of elderly. So we can conclud that higher level of physical activity, more than it's recomended by IPAQ (HEPA active= of at least 3000 METs on weekly level) has a greater health beneffits and our findings agree with Hupin, Roche, Gremeaux, Chatard, Oriol, et al. 2015.

It is important to keep in mind when interpreting the results of the present study that the data are cross-sectional and do not provide direct evidence of cause and effect or changes with age, in other case it's needed to be cross sectional longitudinal study with waves on many years for collecting date on the same participants.

Conclusion

The level of physical activity has definitely a big impact on body composition and strength as the important factors and indicators of health. The detrimental effect of inactivity on muscle mass in elderly as it emerges from the present work represents a reason to suggest an active life style to the elderly and to avoid or to minimize the period of inactivity during hospitalization. We need to facilitate the introduction of the necessary adaptations to the environment and create the incentives required to help elderly population to be more active and increase the quality of their lives.

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TREND OF ADAPTATION TO TREADMILL WALKING DURING DIFFERENT PHASES OF PREGNANCY MEASURED BY GROUND REACTION FORCE AND STRIDE DURATION

Marta Gimunová
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Treadmill and overground gait are from the mechanical point of view considered to be equivalent. Previous studies show that treadmill walking, as an unusual experience, requires one to six minutes of familiarization in young healthy subjects. Treadmill walking may be therefore used in studies of adaptation to unfamiliar gait environment. Pregnancy influences an array of factors affecting gait parameters. As pregnancy progresses altered balance and higher risk of falling were reported. Purpose of current study was to compare the trend of adaptation to a treadmill walking at three pregnancy stages measured by ground reaction force at maximal weight acceptance and push-of phases and by the stride duration. In this study six pregnant subjects participated at three pregnancy stages. Two hundred step cycles measured by Pedar Insole System were obtained from the five minute long treadmill walking at the velocity of 3 $km.h^{-1}$. These step cycles were divided into five subgroups of forty step cycles, each subgroup was corresponding approximately to one minute of treadmill gait. To assess differences between step subgroups of each measurement Kruskall Wallis test followed by post hoc testing was used. The level of significance was set to 0.05. Statistically significant changes in subgroups of analysed force and time variables were observed during all pregnancy stages, especially between first, second and fifth minute of walking. These trends are highlighted in the third trimester of pregnancy where statistically significant changes from the first to the second, third, fourth and fifth subgroup were more evident. Results of current study show altered process of familiarization to the treadmill walking in advanced phases of pregnancy. However, during all pregnancy stages individual human movement variability has a huge impact on statistically significant changes between analysed step groups during the five minute long walking.

Keywords: *Adaptation, Gait, Ground Reaction Force, Pregnancy, Treadmill*

Introduction

Treadmill walking is commonly used in biomechanical and clinical studies (Savelberg et al., 1998). Differences between treadmill and overground walking were previously reported (e.g. van Ingen Schenau, 1980; Strathy, Chao and Laughman, 1983) and made the extrapolation of results from treadmill to overground walking limited (Savelberg et al., 1998). Treadmill gait was characterised by faster cadence, shorter stride length and by the displacement of the head, hip and ankle in the saggital plane compared to overground walking (Murray et al., 1985). However, from the mechanical point of view treadmill and overground gait are considered to be equivalent (van Ingen Schenau GJ, 1980) and it has been proved that long-range autocorrelations of human gait are maintained during treadmill locomotion (Bollens et al., 2010). Treadmill walking is used to keep the subjects' safety and to maintain experimental control of the speed, as the speed affects the force and foot pressure distribution (Cavanagh et al., 1997; Hessert et al. 2005).

Previous studies show that treadmill walking, as an unusual experience, may require 4 to 6 minutes of familiarization at the beginning for young healthy subjects (Matsas et al., 2000). Treadmill walking may be therefore used in studies of gait adaptation to new environments (Shimada et al., 2013). The range of time provided in previous studies for familiarization to the treadmill range from 1 to75 minutes (Matsas et al., 2000).

Human gait is a complex process. It is based on automated and reflexive spinal programs under the control of supraspinal centres in the brainstem, basal ganglia, cerebellum, and cerebral cortex (Shimada et al., 2013). The walking rhythm characterised by stride duration, the time between two heel contacts of the same foot, is one of the final outputs of the locomotor system, as it relies on central and peripheral inputs and feedback, and forms the basis of gait analysis (Bollens et al., 2010; Hausdorf et al., 2001; Psalman et al., 2014). More accurate analysis of gait is represented by ground reaction force (GRF) measured by insole systems or force plates (Bollens et al., 2010; Hausdorf et al., 2001). GRF reflects foot loading pattern and shows no significant differences during non-pathological human gait (Giakas and Baltzopoulos, 1997; White et al., 1999; Dosla et al., 2013).

Pregnancy produces increased biomechanical demands affecting gait parameters. The most apparent are weight gain, approximately 12 kg, musculoskeletal changes, hormonal changes and change of the centre of gravity. Change of the centre of gravity associated with the ventral growth of the uterus and deepening lordosis of the lumbar spine affect the balance and gait (Ribas and Guirro, 2007). More than 50% of pregnant women report altered balance (Ponnapula and Boberg, 2010), the risk of falling is prevalent in 25% of pregnant women (Vullo et al., 1996).

Purpose of current study was to compare the trend of adaptation to treadmill walking at three pregnancy stages measured by ground reaction force at maximal weight acceptance and push-of phases and by the time of stride duration.

Material and Methods

Six pregnant subjects of the mean age 31.83 years (SD 2.19) and mean high 173.17 cm (SD 4.34) participated in this study at three pregnancy stages. First collection session took place at the 15.69 (SD 3.38) gestational week, when the mean body mass of subjects was 74.32 (SD 12.96) kg. Mean body mass at the second measurement, which took place at the 28.55 (SD 1.65) gestational week, was 82.85 (SD 12.65) kg. Last measurement took place at 38.31 (SD 1.53) gestational week when the mean body mass was 86.57 (SD 12.20) kg.

Informed consent was obtained from all subjects at the first measurement session. Study was approved by Ethical Committee of FSpS MU.

Collection sessions took place at the campus of Masaryk University of Brno, Czech Republic. Pressure distribution during the gait was measured by Pedar Insole System (Novel GmbH, Munich, Germany) using 99 capacitive sensors with a sample rate of 100 Hz, connected to a small portable data acquisition device fastened by a belt on the subjects' waist. To account for differences in foot size, insoles of European sizes 36-37, 38-39 and 40-41 were used.

The gait on a treadmill (Katana Sport 400 V, Lode, Groningen, Netherlands) was measured for 5 minutes at the velocity of $3 km.h^{-1}$, which is manageable during last trimester of pregnancy when the self-selected gait velocity is slowing (Forczek and Staskiewicz, 2012). For further analyses 200 steps cycles were selected from steady data segment of desired walking speed. To assess the trend of adaptation to treadmill walking these step cycles were divided into five subgroups of forty step cycles, each subgroup was corresponding approximately to one minute of treadmill gait.

Low-pass filter with a cut-off frequency of 50 N was applied for the data processing and GRF at maximal weight acceptance and push-of phases and time of stride duration (Figure 1) were determined by a self-developed algorithm for selected 200 step cycles. Forces of maximal weight acceptance and push-of phases were normalized to body mass. Microsoft Office Excel 2007 (Microsoft Corporation) was use for the data processing. For following statistical analysis data of the right foot were used.

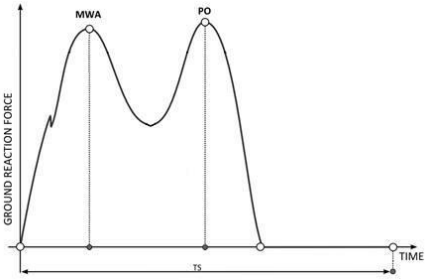

Fig. 1 Graph representing the ground reaction force during step cycle with analyzed variables - ground reaction force in maximal weight acceptance (F_{MWA}); in push-off phase (F_{PO}); and time to reach end of the step (T_S).

Statistical analysis

To assess differences between step subgroups of each measurement of each subject Kruskall-Wallis test was applied. Post hoc testing was used to determine the exact location of statistically significant changes from the first to the fifth minute of walking. The level of significance was set to 0.05. All statistical analyses were conducted using IBM SPSS Statistics software.

Results

Means and standard deviations of analysed variables of each subject are shown in Table 1. Table 2 shows incidence of statistically significant differences between step groups.

Tab. 1 Means and standard deviations of analysed variables of each subject.

Subject		StepGroup	F_{MWA} 1	F_{MWA} 2	F_{MWA} 3	F_{PO} 1	F_{PO} 2	F_{PO} 3	T_S 1	T_S 2	T_S 3
1	**mean**	1	9.03	8.16	8.64	8.85	7.63	10.08	1.22	1.27	1.23
	SD		0.26	0.39	0.18	0.78	0.95	0.21	0.03	0.02	0.03
	mean	2	8.88	8.17	8.64	8.72	7.68	10.14	1.24	1.27	1.26
	SD		0.20	0.29	0.15	0.62	0.70	0.16	0.02	0.02	0.01
	mean	3	8.86	8.15	8.65	8.96	7.71	10.00	1.23	1.29	1.26
	SD		0.24	0.29	0.14	0.61	0.56	0.20	0.01	0.01	0.01
	mean	4	8.75	7.88	8.67	8.91	7.31	9.99	1.22	1.29	1.25
	SD		0.21	0.33	0.17	0.76	0.67	0.17	0.02	0.02	0.01
	mean	5	8.74	7.99	8.62	9.04	7.63	9.92	1.23	1.28	1.25
	SD		0.17	0.31	0.17	0.56	0.69	0.23	0.02	0.01	0.02
2	**mean**	1	11.09	10.71	10.01	11.41	12.98	13.42	1.31	1.31	1.32
	SD		0.24	0.25	0.47	0.31	0.41	0.84	0.02	0.02	0.02
	mean	2	11.10	10.63	10.05	11.16	12.82	13.56	1.33	1.34	1.35
	SD		0.21	0.25	0.42	0.31	0.46	0.52	0.02	0.02	0.03
	mean	3	10.91	10.66	10.10	10.75	12.80	13.69	1.32	1.33	1.36
	SD		0.21	0.43	0.46	0.21	0.47	0.39	0.03	0.03	0.02
	mean	4	10.73	10.56	10.10	10.59	12.86	13.40	1.32	1.33	1.35
	SD		0.25	0.24	0.39	0.29	0.43	0.43	0.02	0.02	0.03
	mean	5	10.57	10.44	9.97	10.27	12.58	13.05	1.32	1.32	1.35
	SD		0.22	0.30	0.37	0.30	0.44	0.48	0.03	0.02	0.02
3	**mean**	1	7.26	5.98	6.,45	8.19	6.58	7.17	1.33	1.36	1.36
	SD		0.15	0.12	0.18	0.22	0.17	0.25	0.05	0.03	0.03
	mean	2	7.29	5.90	6.45	8.13	6.62	7.00	1.35	1.36	1.34
	SD		0.23	0.18	0.17	0.28	0.22	0.18	0.05	0.03	0.02
	mean	3	7.10	5.99	6.40	8.08	6.60	6.93	1.35	1.36	1.35
	SD		0.16	0.11	0.17	0.19	0.22	0.26	0.02	0.02	0.02
	mean	4	7.15	5.90	6.30	8.16	6.52	6.93	1.34	1.35	1.34
	SD		0.16	0.16	0.14	0.18	0.24	0.25	0.02	0.02	0.02
	mean	5	7.00	5.82	6.26	8.08	6.46	7.02	1.32	1.33	1.33
	SD		0.16	0.12	0.17	0.20	0.19	0.26	002	0.02	0.02
4	**mean**	1	9.53	9.57	9.29	10.68	10.32	10.21	1.25	1.18	1.26
	SD		0.31	0.30	0.31	0.39	0.15	0.24	0.02	0.02	0.02
	mean	2	9.55	9.28	9.22	10.82	10.32	10.23	1.26	1.16	1.25
	SD		0.32	0.30	0.34	0.38	0.29	0.24	0.02	0.02	0.02
	mean	3	9.41	9.17	9.02	10.89	10.47	10.21	1.26	1.18	1.24
	SD		0.21	0.29	0.30	028	0.19	0.26	0.02	0.01	0.02
	mean	4	9.42	9.19	8.91	10.97	10.45	10.21	1.22	1.18	1.24
	SD		0.24	0.31	0.31	0.36	0.21	0.18	0.02	0.02	0.02
	mean	5	9.27	9.12	8.83	11.01	1057	10.12	1.22	1.19	1.23
	SD		0.22	0.32	0.23	0.33	0.25	0.23	0.03	0.02	0.02

5	**mean**	1	8.65	8.14	6.92	10.10	9.36	8.62	1.38	1.36	1.40
	SD		0.31	0.16	0.21	0.16	0.25	0.24	0.03	0.02	0.03
	mean	2	8.70	8.05	6.72	983	9.19	8.23	1.36	1.35	1.37
	SD		0.15	0.16	0.26	0.22	0.29	024	0.03	0.03	0.02
	mean	3	8.59	7.92	6.63	9.50	9.14	8.20	1.35	1.35	1.37
	SD		0.20	0.18	0.24	0.28	0.23	0.28	0.03	0.03	0.02
	mean	4	8.47	7.85	6.58	9.63	9.12	8.07	1.36	1.35	1.38
	SD		0.19	0.14	0.28	0.22	0.21	0.33	0.02	0.03	004
	mean	5	8.41	7.90	6.47	9.49	9.17	8.01	1.36	1.34	1.37
	SD		019	0.17	0.29	0.28	0.21	0.24	002	0.02	0.02
6	**mean**	1	7.98	9.44	9.75	8.55	10.68	12.50	1.24	1.28	1.30
	SD		0.30	0.40	0.55	0.68	0.60	0.29	0.04	002	0.03
	mean	2	7.77	9.43	9.99	8.45	10.81	12.22	1.23	126	125
	SD		0.33	0.43	0.55	0.66	0.47	0.31	003	0.02	0.02
	mean	3	7.65	9.79	10.19	8.44	10.69	12.02	1.28	1.26	1.25
	SD		0.35	0.45	0.46	0.75	0.61	0.32	0.04	0.02	0.02
	mean	4	7.90	9.35	9.60	8.78	10.58	11.91	1.28	1.25	1.25
	SD		0.38	0.30	0.49	0.51	0.51	0.25	0.03	0.02	0.02
	mean	5	8.10	9.38	9.34	8.79	10.60	11.80	1.24	1.26	1.25
	SD		0.33	0.43	0.47	0.49	0.55	0.32	0.04	0.02	0.01

Tab. 2 The incidence of statistically significant changes during five minutes of walking at three collection sessions during the pregnancy.

	1-2	**2-3**	**3-4**	**4-5**	**5-3**	**5-2**	**5-1**	**4-2**	**4-1**	**3-1**
$F_{MWA}1$		33.33	33.33	16.67	66.67	100.00	83.33	50.00	50.00	33.33
$F_{MWA}2$	16.67	33.33	50.00		50.00	16.67	66.67	33.33	66.67	50.00
$F_{MWA}3$	16.67		16.67		50.00	66.67	66.67	50.00	33.33	66.67
$F_{PO}1$	16.67	33.33			16.67	33.33	50.00	33.33	50.00	33.33
$F_{PO}2$		16.67			16.67	33.33	50.00		16.67	33.33
$F_{PO}3$	33.33	16.67			33.33	66.67	66.67	33.33	50.00	50.00
T_S1	50.00	16.67	16.67	33.33	50.00	50.00	33.33	5.,00	50.00	50.00
T_S2	50.00	33.33		16.67	16.67	50.00	50.00	3.,33	33.33	33.33
T_S3	83.33			16.67	16.67	16.67	100.00		83.33	83.33

Incidence	**%**
1	16.67
2	33.33
3	50.00
4	66.67
5	83.33
6	100.00

Force of maximal weight acceptance phase

The common tendency of statistically significant changes is mostly apparent in the first trimester of pregnancy, where the first, second and third minute statistically significantly differs from the fifth minute of walking. Statistically significant changes in following trimesters of pregnancy tend to be more individual.

Force of push-of phase

Changes in force of push-of phase during five minute long walking are very individual (Table 2). Apparent tendency was found in the statistically significant change from the first and the second minute to the fifth minute of walking during the last trimester of pregnancy, these two changes were found in 4 from 6 tested subjects.

Temporal measurement

Stride duration time is statistically significantly changing during the five minute long walking during all phases of pregnancy. The common trend of tested subjects is revealed entirely in the third trimester where the first minute is significantly different from the second, third, fourth and fifth minute of walking in 83,33 to 100% of subjects.

Discussion

Purpose of current study was to compare the trend of adaptation to the treadmill walking at three pregnancy stages. As pregnancy progresses women commonly complain on altered balance and gait (Ribas and Guirro, 2007; Ponnapula and Boberg, 2010). Therefore we hypothesised that longer time for familiarization to treadmill walking will be necessary at advanced phases of pregnancy.

Results of current study show that the most evident adaptations to treadmill walking occur during the first and second minute of walking in all pregnancy stages. Therefore it is recommendable to provide this time for familiarisation. There is no consensus in the time needed for familiarisation to the treadmill walking in previous studies. The adequate time of familiarisation is necessary to obtain reliable and valid data from treadmill walking as the treadmill is not a familiar type of locomotion (Matsas et al., 2000; Shimada et al., 2013). In previous studies subjects were provided with 1 to 75 minutes to familiarise, long times for familiarisation may influence consequently obtained data of the gait pattern by subject fatigue. On the other hand, significant differences were found between treadmill and overground gait in studies with short time (1 to 2 minutes) of familiarisation. (Matsas et al., 2000)

The adaptation process during different pregnancy stages is complex and with individual differences. Higher incidence of statistically significant changes of analyzed force variables was found between the first, second and fifth minute of walking. For F_{PO} and T_S a higher incidence of statistically significant changes was found in the last trimester of pregnancy indicating altered process of familiarization to the treadmill walking in the last collection session.

The limitation of our study was a low number of participants and analysing intra-individual data. At the last trimester, where the changes were expected to be more obvious, subjects participating in current study already had the experience with treadmill walking from the previous collection sessions, which may had an influence on results.

Another factor having an influence on the significant differences between step groups may be the human movement variability. Every time, when the same movement is performed in subsequent repetitions, a certain variation may be observed (Preatoni et al., 2013).

The most evident adaptations to treadmill walking in this study occur in all pregnancy stages during the first and second minute of walking. To obtain reliable and valid data from treadmill walking is recommendable to provide subject two minutes for familiarization.

Conclusion

During all pregnancy stages statistically significant changes between analysed step groups of the five minute long walking were found in current study. In the last trimester of pregnancy results show altered process of familiarization to the treadmill walking, especially evident in the time of stride duration and GRF of push-of phase. In all pregnancy stages the most evident adaptations to treadmill walking occur during the first and second minute of walking. To obtain reliable and valid data providing two minutes of familiarization to treadmill walking is recommendable in treadmill studies of GRF, but a consequent study of differences in treadmill to overground walking is needed.

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DIAGNOSTICS OF PLANTAR PRESSURE IN PREGNANT WOMEN

Ondřej Mikeska, Kateřina Kolářová, Martin Zvonař
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Pregnancy is a specific phase in the course of women's lives, which has a considerable influence on the distribution of plantar pressures which are influenced by several factors: the increasing weight gain, changes in the distribution of body mass, changes in walking stereotype, the shape of the foot. The purpose of this research was to demonstrate and measure changes in plantar pressures, particularly the changes in the values of the maximal pressures and the changes in the values of the total load in selected areas of the foot during and after pregnancy. The article is focused on plantography and its application in a research on the influence of pregnancy and postpartum weight loss on changes in the distribution of plantar pressure during walking. The aim of the study is to identify (diagnose) the development of plantar pressures during pregnancy and after childbirth, demonstrate and characterize changes in load and feet, which are manifested by changes in the values of the maximal pressure and the time integral of pressure in different areas of the foot. The research was designed as a case study. Six pregnant women took part in the research. They used plantographic emed-at platform to monitor the changes in selected plantographic parameters in ten areas of the foot (the hind foot, the midfoot, from the first to the fifth metatarsal, the thumb, the forefinger and other fingers) during pregnancy and after childbirth. The first measurement was carried out as a part of the research into the 15th week of pregnancy. The second measurement was carried out in the period between the 25th and 26th week of pregnancy. The third measurement took place about 14 days before a month when the childbirth was expected. The fourth measurement took place six months after the childbirth. For a description and comparison of the measured values between the measurements of each participant we used histograms and then we analyzed the measured values of the effect size of Cohen's d coefficient. The results show that during pregnancy the load on the medial part of the metatarsal area and under the thumb, also under the hind foot and in midfoot increases. The increased load of the midfoot causes a decrease of the longitudinal arch. The overall dynamic pattern of gait became slower in case of all participants, this corresponds to the changes of the measured values. During the measurement, a certain part of the load moved from the rear part of the foot forward when in the phase of the reflection at the metatarsal region its medial parts are more involved. In the reflective phase of a step there are more involved metatarsal heads and thumbs (fingers have rather negligible roles). In the impact phase of a step is the hind foot and the midfoot are significantly loaded.

Keywords: *pregnancy, plantography, plantar pressure*

Introduction

Pregnancy is a specific phase in the period of women's lives, which has a considerable influence on the distribution of plantar pressures. Characters of changes of plantar pressures during pregnancy are various, because they are individual. This fact is explained by several factors: increasing weight gain, changes in the distribution of body mass, changes in walking stereotype, the shape of the foot, the age of women, health, injuries, shoes etc

Plantography is one of methods, which examines changes of plantar pressures, in this case, during pregnancy. Plantography tries to evaluate the load of the foot during walking or standing in various modifications and point out the potential structural or functional abnormalities in the shape and the position of the foot. Then, this diagnostic method gives us measured values, which are examined, e. g.: the maximal pressure, the time integral of pressure, the area of the foot. The system, which is used for this diagnostic method, is called Emed. Emed is a sophisticated software analyzing many measured values, which are then evaluated and processed. The article is focused on plantography and its application in research on the influence of pregnancy and postpartum weight loss on changes in the distribution of plantar pressure during walking. The aim of the study is to identify (diagnose) the development of plantar pressures during pregnancy and after childbirth, demonstrate and characterize changes in the load on feet, which are manifested by changes in the values of the maximal pressure and the time integral of pressure in different areas of the foot.

Methods

In the research, which is designed as a case study, there were involved 6 women at the age from 30 to 34 years. The research was realized with the pedobarographic platform emed and we focused mainly on the pressure distribution on planta pedis while walking. We used the third step method and we averaged five attempts for each participant's foot (figure 1). Then, the averaged data were processed in the program *multimask evaluation*, which divided values to pre-defined ten areas of a foot: MO1 - hind foot, MO2 - mid foot, M03-M07 - 1. - 5. metatarsal head, MO8 - thumb, MO9 -forefinger, M10 - other fingers (figure 2).

The first measurement was realized in the fifteenth week, the second between the twenty-fifth and twenty sixth week, the third one 14 days before a month when the childbirth was expected. Last measurement was realized six months after the childbirth.

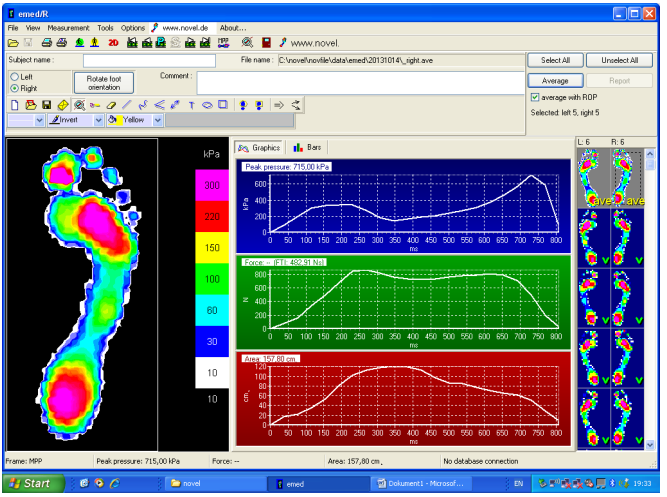

Fig. 1 Average of five attempts from both participant's feet

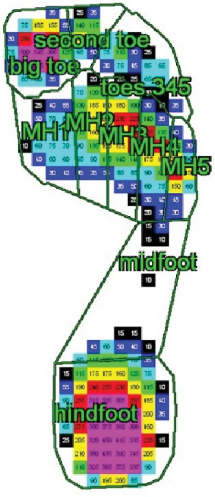

Fig. 2 Ten pre-defined areas of a foot by multimask evaluation

Results and Discussion

From the measured values we compared the differences in changes of the maximal pressure and the time integral of pressure between the first and the third trimester and

between the third trimester and the postpartum measurement - there was observed a return to the original values in some areas.

The results were processed with the help of Cohen's d coefficient, whose values are: for a small effect size d > 0.2, for a medium effect size d > 0.5 and for a large effect size d > 0.8 (table 1). The calculation of Cohen's d coefficient was performed from the averages and standard deviation of the first, third and fourth measurement of each participants.

Tab. 1 Key for values of effect size

d > 0.2	Small effect size
d > 0.5	Medium effect size
d > 0.8	Large effect size

Tab. 2 Expression of the effect size of changes maximal plantar pressures of pregnant women between the first and the third trimester

	MO1	MO2	MO3	MO4	MO5	MO6	MO7	MO8	MO9	M10
Left foot: 1. - 3. measurement	0.16	1.44	0.01	0.51	0.68	0.48	0.21	0.07	0.42	0.06
Right foot: 1. - 3. measurement	0.14	1.31	0.38	0.25	0.12	0.65	0.13	0.07	0.56	0.26

In table 2 we can see some important changes in maximal plantar pressures between the first and the third measurement. We can register an increase of maximal plantar pressure especially in the area of transverse arch (M04, M05) of the right foot and (M06) of the left foot, then in the area M09 (forefinger) of the right foot. It can mean, that a part of the load has moved to the front part of the foot. The most significant change can be seen in the area (M02). It is probably caused by the decrease of the longitudinal arch in conjunction of the increase body weight and hormonal changes.

Tab. 3 Expression of the effect size of changes time integral of plantar pressures of pregnant women between the first and the third trimester

	MO1	MO2	MO3	MO4	MO5	MO6	MO7	MO8	MO9	M10
Left foot: 1. - 3. measurement	1.57	1.39	0.38	0.48	0.69	0.46	0.13	0.36	0.44	0.23
Right foot: 1. - 3. measurement	1.35	1.04	1.28	0.55	1.02	0.59	0.1	0.25	1.15	0.33

In table 3 we can see changes in time integral of the plantar pressure. Time integral of the plantar pressure expresses the total load on a foot. Each area of a foot has a different total load during walking across Emed system. Values of middle effect size can be found in areas (M04, M06) of the left foot and (M05) of the right foot. This confirms values from table 2 (the part of the load has moved to the front part of the foot). The most significant changes can be found in areas of the hind foot (M01) and the mid foot (M02) for both feet, then in areas (M03, M05, M09) of the right foot. This confirms again the decrease of the longitudinal arch, then a bigger part of the load is on the hind foot after an impact of the feet. It can mean, that walking during pregnancy becomes slower and unsteady. We can tell there was an increase of total load in most areas of the foot during pregnancy.

Tab. 4 Expression of the effect size of changes maximal plantar pressures of pregnant women between the first and the fourth trimester

	MO1	MO2	MO3	MO4	MO5	MO6	MO7	MO8	MO9	M10
Left foot - 1. a 4. measurement	0.16	0.6	0.05	0.37	0.57	0.45	0.61	0.07	0.62	0.05
Right foot - 1. a 4. measurement	0.07	0	0.56	0.31	0.29	0.14	0.47	0.01	0.62	0.52

In table 4 we can assess the return of original values of the maximal pressure after childbirth. We can see there was a return of some values, but there are changes in distribution of the plantar pressure. The changes can be registered mainly in the area of the transverse arch (M03, M03, M05, M06, M07) and in the area of the forefinger (M09) of both feet in general, and other fingers (M10) of the right foot.

Tab. 5 Expression of the effect size of changes time integral of plantar pressures of pregnant women between first and fourth trimester

	MO1	MO2	MO3	MO4	MO5	MO6	MO7	MO8	MO9	M10
Left foot - 1. a 4. measurement	0.21	0.18	0.2	0.16	0.28	0.18	0.33	0.31	0.2	0.51
Right foot - 1. a 4. measurement	0.97	0.07	0.31	0.13	0.37	0.2	0.37	0.15	0.57	0.15

In table 5 we can assess the return of original values of time integral of the plantar pressure after childbirth. We can see some changes of time integral of plantar pressure in the area of the hind foot (M01), mainly for the right foot, then in areas (M05, M07, M08, M10) of the left foot and in areas (M03,M05, M07, M09). We can see a small and middle effect size there, so there was a return to original values approximately. The most significant change can be seen in the area (M01) of the right foot. It can mean that a bigger part of the load stays on the hind foot during the first contact of the foot with the ground, it could be caused by change stereotype of gait.

Conclusion

From the detected changes of values of the maximum pressures and time integrals pressures we can see, that pregnancy has an influence on a distribution of plantar pressures. Based on this research we can tell that during pregnancy certain a part of the load was moved to the front of the foot, mainly in the central region of metatarsal heads. There was average increase of the load about 12,7% (at the end of the third trimester) for both feet. It is caused by the increase of the body weight, changes in the centre of gravity and changes in body mass. At the end it causes decrease of the transverse arch. Next significant changes of the pressure can be found in the area of the longitudinal arch, it means it was decreased too. There was average increase of the load about 35% during the third trimester. Some interesting changes of plantar pressure can be found mainly in the area of the thumb of the right foot. It can mean, the thumb is more loaded during the last contact with the ground.

It can be related with to the move of the centre of gravity forward. After childbirth most of the values were returned to the original state. However, we can find some areas where changes of plantar pressure remained, it means six months after childbirth. There are some changes of stereotype of the gait. The gait is rather slower, unsteady and uncertain during pregnancy, but it is individual for each participant.

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JOURNAL KINESIOLOGY: INTERNATIONAL JOURNAL OF FUNDAMENTAL AND APPLIED KINESIOLOGY: THE POSITION AND VISIBILITY IN INTERNATIONAL ENVIRONMENT

Marijana Briški, Dragan Milanović, Daniel Bok
Faculty of Kinesiology, University of Zagreb, Croatia

Abstract

The aim of this paper is to assess the quality of journal *Kinesiology* by relying on common quantitative and qualitative indicators and to position the journal in regional and international environment. Criteria refer to editorial and publishing policy, coverage by abstracting and indexing services, and high frequency of citation. *Kinesiology*, although being published for more than 40 years now, has achieved a recognizable level of international visibility in past several years. Although certain improvements can and will be made, like indexation in more databases, *Kinesiology* shows stable and secure growth making its way in worldwide scientific community.

Keywords: *scientific journals, kinesiology, journal quality*

Introduction

The quality of scientific journal is important to many parties: to librarians for building their library collection, for academics to publish their results, for editors to acknowledge the best editorial and publishing practices, for funding agencies to have their money invested in good research. When evaluating a journal, all those different points of view must be taken into account. According to Rosseau, Zwemer published list of characteristics that constitute a good journal. Criteria refer to editorial and publishing policy, coverage by abstracting and indexing services, and high frequency of citation. However, he points out that not only citation matters but also how often a journal is read because many scientists read journals not just to produce new papers i.e. to cite them but also to be up to date with recent scientific activities. Board of experts sometimes assesses the quality and establishes a ranking list of papers. This is useful in social science and humanities which are less present in international databases because of their local and regional subject coverage. There are other indicators that can help in assessing the quality: subscription rates, quality of the paper used, quality of the illustrations, reputation of publisher, especially for new papers (Ronald, 2002).

We will discuss the quality of journal Kinesiology by three main criteria: editorial and publishing policy and some other qualitative indicators (reputation of publisher, quality of illustrations and paper), coverage by databases and citation analysis.

Editorial and publishing policy and some other qualitative indicators

Faculty of Kinesiology has been publishing *Kinesiology: International Journal of Fundamental and Applied Kinesiology* since 1971. Reputation of publisher being one of indicators in assessing journal quality, we will say few words on the Faculty of Kinesiology. The Faculty of Kinesiology is an academic, educational and research institution of higher education in the Republic of Croatia, one of the younger members of the University of Zagreb. It educates teachers in physical education and according to their elective module, students also obtain an additional competence for working in one of the fields of applied kinesiology: education and sports, physical recreation, kinesitherapy, sports management. For the past 40 years, Faculty has been organizing postgraduate studies in kinesiology. The coach education and training department is an organizational unit of the Faculty, which organizes and conducts the coach education professional course and a specialist graduate study for coach education, while it develops and performs scientific and professional work in the field of kinesiology and its related scientific disciplines. Board of experts, appointed by Agency for science and higher education, visited Faculty in the academic year 2013/2014. Based on internal documents, reports and meetings with representatives of management board, students, professors and other professionals, the Board expressed positive opinion on scientific and expert work, quality of study program, mobility and international cooperation.

Kinesiology is published twice a year with occasional supplements. Guidelines for contributors are available both on web page and in printed version and general editorial policy is available there: only manuscripts with topics appropriate for the journal will be accepted, if of course, they receive positive reviews, which are double-blinded. Manuscripts should contain relevant data and thus references generally should not be older than decade. The role of the Editorial Board is clearly stated; it comments on the form of the paper before its acceptance for publication, it categorizes manuscripts in accordance with suggestions of reviewers. When accepted for publication, authors must sign that manuscript has not been submitted or published elsewhere, that is original work and that experimental research conforms to the highest standards of safety and ethics and that are in accordance with laws of a country in which work took place and that the informed consent has been obtained. Editorial Board has international members and there are section editors, experts for specific field (sport and sports activities, physical education, recreation/leisure, kinesiological anthropology, training methods, sports medicine and physiology of sport, biomechanics, history of sport, book reviews). Tome and Lipu (Tome & Lipu 2004) argue that peer review is one of two main indicators of journal quality, although there are some weaknesses: peer review depends on experience, knowledge and possible ignorance of reviewers and there are differences in the level of rigour (Ronald, 2002). Since 2009. a list of

peer reviewers has been published every year, the last one in 2013. Most of peer reviewers come from institutions worldwide and their expertise can easily be checked on websites. Also, the same authors say that there are two major tools used to identify peer-reviewed journals: DEST's Register, a list of journals assessed by Australian Government, Department of Education, Science and Training and Ulrich's, product of ProQuest company (Tome & Lipu, 2004). *Kinesiology* is currently listed in Ulrich's, which is confirmed by official communication with Ulrich's employer (E.Czegledi, personal communication, July 20, 2015).

As stated, the indicator of journal quality is promptness of publication; it usually takes seven to nine months for paper to be published upon receipt. Depending on the quality of paper and necessary recommendations for improvement, communication between author(s), editor(s) and peer reviewers can take a longer period of time and that is way the Editorial Board is not obliged to publish papers in chronological sequence, as stated in Guidelines. This is the reason why papers are sometimes published after longer period of time that is, after nine months.

All papers from *Kinesiology* dating from 2004 onwards are available for free on *Hrčak*, central portal of Croatian scientific journals. This supports Open Access initiative and provides the public with unrestricted, free access to scholarly research.

Coverage by databases

The journal is indexed in *Journal Citation Report*, database that gives overview and evaluates world's leading journals with quantifiable, statistical information based on citation data. There are two basic editions of *Journal Citation Report*; *Science Edition* which covers over 8,400 leading journals and *Social Sciences edition* - which covers more than 3,000 leading journals. *JCR* covers over 2,550 publishers in approximately 232 disciplines from 83 countries (Essential Science Indicators & Journal Citation Reports, c2014). *Kinesiology* is indexed in both *Science Edition* and *Social Science Edition*. In both editions, journals are categorized according to subject category and ranking in each category is based on Impact Factor (IF).

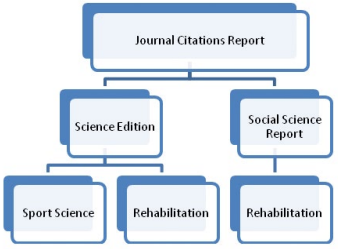

Fig. 1 *Kinesiology* in Journal Citation Report

In *Science Edition, Kinesiology* is categorized in *Rehabilitation*, which covers resources on therapy to aid in the recovery or enhancement of physical, cognitive, or social abilities diminished by birth defect, disease, injury, or aging. It is also categorized in *Sport Science*, which covers resources on the applied physiology of human performance, physical conditioning for sports participation, optimal nutrition for sports performance, and the prevention and treatment of sports-related injuries and diseases. It also covers papers on sport psychology and sociology. In *Social Science Edition*, *Kinesiology* is also placed in *Rehabilitation*, which includes papers on therapeutic approaches for the treatment of mental, speech, hearing, visual, and other physical disabilities. The great difference between *Rehabilitation* in *Science Edition* and *Rehabilitation* in *Social Science* edition is that this one also includes studies in music, art, dance, and occupational therapy. For the purpose of this paper, only data from *Sport Science – Science Edition* will be analyzed because according to journal's Guidelines for contributors, this category best covers topics presented in the journal.

There are 81 journals in the *Sport Science* category, both definition and data collected from JCR in July 2015 (Journal Citation Report, 2015). To show the importance of being indexed in *JCR*, the following chart represents geographical coverage of journals in *Sport Science* category.

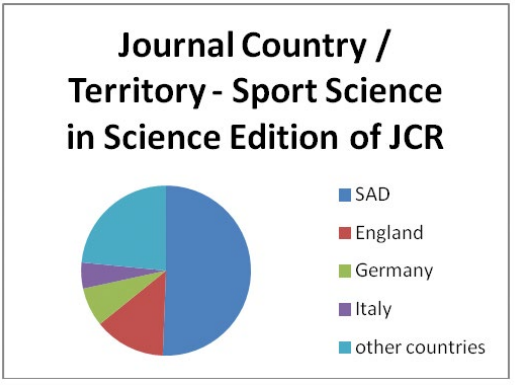

Fig. 2 Journal Country / Territory – Sport Science in Science Edition of JCR

In *Sport Science* category, journals published in USA are dominant; there are 41 journals published by prestigious publishers like Lippincott Williams & Wilkins, Sage Publications, Human Kinetics, and are followed by journals published in England (11),

Germany (6), Italy (4), Netherland (3), People's Republic of China (2), Poland (2). There is one journal from each country indexed in *JCR*: Canada, Ireland, Wales, Sweden, Australia, Turkey, Brazil, Spain, Denmark, France, New Zeland and finally Croatia. This makes the journal *Kinesiology* the only journal from SE Europe, along with Turkish *Journal of Sports Science and Medicine*, indexed in *JCR*.

Most of these journals are published in English, as Kinesiology is too. This makes scientific communication easier and the journal itself more visible in international environment. English has become *lingua franca* for science today: conferences, projects, web pages – all is written in English. Research has shown that, in some fields, almost 90% of papers are written in English. This is especially true for life science because social sciences and humanities often refer to phenomena that occur in specific geographical and social environment (Jokić, 2005).

Kinesiology is indexed in Web of Science Core Collection (also Thomson Reuters database), Scopus database, Academic Search Complete (by EBSCO host), and finally Ulrich's, which was already mentioned as reference point for checking that articles are peer reviewed.

Citation analysis

Knudson mentions following databases and their indicators as relevant in bibliometric and journal influence field: Journal Citation Reports 2-year impact factor, Scopus 3-year SCI Imago Journal Rank and the Google Scholar Metrics 5-year Hirsch index (Knudson, 2015).

IF is probably the most popular quantitative tool for ranking, evaluating, categorizing, and comparing journal and can have many applications: in the management of library journal collection, in the process of academic evaluation, in market research for editors and publishers. However, the usage of data must be informed and careful. It is important to keep in mind that different disciplines have different ranges of impact factor (Garfield). For example, basic life research journals have the highest mean impact factor and are followed by clinical medicine, pharmacology, and biological sciences. This is because some research can have great commercial value, like cancer treatment, and continuous efforts are made in those fields so new papers are published (Triaridis & kyrgidis, 2010). Also, some fields are generally less cited because there are relatively a large number of subfields and branches and only a few people are working in each branch and because the subject matter is not interested to general public and papers are hard to read and understand, e.g. mathematics. So, to properly position the journal *Kinesiology* in *Sport Science* category, it is necessary to have understanding of this category. There are 81 journals

in Sport Science, the highest IF is 5.038 and the lowest one is 0.146, median IF is 1.534. The distribution of IF is: the majority of journals (33) have IF ranging from 1.017 to 1.970, 15 journals have IF ranging from 2.017 to 2.896, 12 journals ranging from 0.585 to 0.984 and finally there are 11 journals ranging from 0.146 to 0.488. *Kinesiology* has IF 0.585, along with 11 other journals ranging from 0.585 to 0.984[1]. It has been indexed in *JCR* since 2010 and has showed stable IF ranging from 0.238 for 2011 to 0.585 for 2014, always remaining in Q4 quartile.

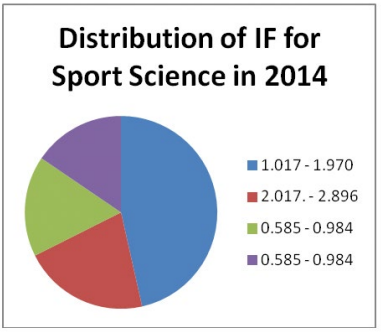

Fig. 3 Distribution of IF for Sport Science in 2014

Also, as Triaridis and Kyrgidis mention, publishing a larger percentage of review articles over less-cited articles, is one way of manipulating IF. Review articles are usually cited more often because they generally contain an overview of literature. It is therefore important to mention that almost all papers published in *Kinesiology* are original scientific papers: in the period from 2011 to 2014, 112 original papers and only four reviews were published.

SCImago Journal Rank is another bibliometric indicator whose value is calculated not only on the number of citations but on the importance of citations. Citation from a journal which is highly cited itself is regarded as more significant (Brajenović – Milić, 2014). The indicator was developed from algorithm Google PageRank and shows visibility of journals in Scopus database from 1996. According to SCImago Journal Rank, journals are ranked in Quartiles - Q1 means highest values and Q4 lowest values (SCImago Journal and Country Rank). *Kinesiology* is categorized in *Health Professions* subject area, in *Physical Therapy, Sports Therapy and Rehabilitation* and *Sport Science* category. *Kinesiology* is in this database since 2009 and from that year on, up to 2014, it has always been ranked in Q4 quartile for *Sport Science* category. In *Physical Therapy,*

[1]Data collected for 2014. from JCR
[2]Year: 2014.

Sports Therapy and Rehabilitation category, only in 2009 was ranked in Q4 and since 2010 it has been ranked in Q3 quartile. To compare, there are 165 journals in this category, by 41 in Q2, Q3, Q4 quartile and 42 in Q1 quartile. In *Sport Science* category, there are 129 journals, by 32 in Q2, Q3, Q4 and 33 in Q1 quartile[2].

Finally, the last indicator suggested by Knudson as relevant in bibliometric and journal influence field is Google Scholar Metrics 5-year Hirsch index. According to explanation on Google Scholar, *the h-index of a publication is the largest number h such that at least h articles in that publication were cited at least h times each*. This index was first introduced by J.E. Hirch who tried to overcome limitations of existing bibliometric indicators. It should be used for comparison of scientists at similar career stage and in the same research field. The same applies to journals. The advantages of H-index are that it is not sensitive to extremes – from articles with no citations to articles with great citations, and it combines impact and productivity (Jokić, 2009). The h-index for *Kinesiology* is 11, however, current transfer to Open Journal Systems can improve technical requirements and eventually lead to higher h-index.

Conclusion

Kinesiology, although being published for more than 40 years now, has achieved a recognizable level of international visibility in past several years. Also, the editorial policy, since the very beginning, has fostered multidisciplinary approach: in the period from 1990 – 1999, three research areas are recognizable in the papers: the research of characteristics of a sport activity, the research of the dimensions of athletes and the analysis of performance factors (Jaklinović – Fressl et al., 2000). As mentioned, the journal covers topics from physical education, kinathropology, recreation, sport history with special emphasis on biomechanics and training methods. With this policy, we try to promote kinesiology as multidisciplinary and interdisciplinary scientific discipline with all its complexities and within this lies the quality of the journal. Although certain improvements can and will be made, like indexation in more databases, *Kinesiology* shows stable and secure growth making its way in worldwide scientific community.

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KINEMATIC AND DYNAMIC ANALYSIS OF SWIMMING TECHNIQUE OF CZECH NATIONAL TEAM IN YEARS 2009-2015

Jaroslav Motyčka, Jan Šťastný, Miloslav Pašek, Hana Lepková, Michaela Bátorová
Centre for Sport Activities, Brno University of Technology, Czech Republic

Abstract

The objective of research conducted by Brno University of Technology (BUT), Centre for sport activities (CESA) from 2009 until now is to successfully implement a kinematic and dynamic analysis of top-level swimming; to increase the efficiency of swimming technique in the Czech Republic to reach the world leading level. Twice a year we measure the speed of swimming of Czech national team using two tachographs (inventions of BUT). Measurements are evaluated by computer software. We synchronously record the movement of measured swimmers by three underwater camcorders. The analysis of speed and acceleration is printed out. We also print out the erroneous body positions and erroneous strokes by arms and legs while swimming. We provide the results of complete measurement on DVD. The results of measurements (DVD) are forwarded to the coaches of national teams and to the measured individuals. Twice a year we issue the tables of kinetic and dynamic analysis of swimming, which refer to the swimmers with the highest efficiency of swimming technique in the Czech Republic. Every six months the coaches and swimmers are provided with "Tables on statistical analysis of swimming of Czech national team". The research team of CESA BUT is the only one (according to the available literature), which calculates, on the basis of measurements of swimming speed, the efficiency of swimming technique and the variation coefficient – a sensitive indicator of swimming technique.

Keywords: *swimming, analysis, speed, acceleration, efficiency*

Introduction

In the last few years, national swimming associations, both in Europe and worldwide, have built the Olympic sites for their talents to ensure better conditions for top-level training. For those countries in Europe and worldwide where so far the proper conditions for training have not been provided, the associations have offered their swimmers in Olympic preparation to be trained anywhere worldwide in the form of long-term preparation trainings. This form of preparation has also been selected by the Czech Association of Swimming Sports.

At the World Swimming Championship in Kazan in August 2015, eight world records and four world records in the relay were broken. In the preliminaries and semi-finals, Czech swimmers broke six individual national records and one Czech

record in the medley relay. Závadová Barbora was qualified for the final of the World Championships. Within a heavy competition, she ranked the fifth in the 400m individual medley. In the preliminaries and semifinal, Závadová Barbora broke three Czech records - twice in the discipline of 200m individual medley (2:13.12 and 2:11.97 min.) and once in the 400m individual medley (4:35.60 min.). Kolářová Anna improved Czech records in the disciplines of 100m (0:55.26 min.) and 200m crawl (2:00.24 min.). Šefl Jan set a new Czech record in the discipline of 200m butterfly (1:57.63 min.). Baumrtová Simona, Chocová Petra, Svěcená Lucie and Kolářová Anna set a new Czech record in the discipline of 4 x 100m medley relay (4:03.44 min.).

Since the previous World Championship, the national teams of participating countries have unprecedentedly grown in the number of starters and also in their performance. It would be unfair if our public, affected by this fact, underestimated the success of our national team at this World Championship. In the past, our national team never broke seven Czech records at the World Championship. Behind this success, enormous and undervalued work in swimming clubs of the Czech Republic has been hidden, where these swimmers were discovered and trained and also the successful work of the University Sports Centre of Ministry of Education, Youth and Sports in Prague (VSC MŠMT), which led the preparation of our national team for the World Championship in Kazan in 2015.

In 2009, CESA BUT started their research work on the analysis of swimming technique. Annually, we conducted research measurements of Czech national teams, the junior teams (junior and senior) and the senior national team. Most attention was paid to male and female swimmers selected for the Olympic preparation. In order to assist the selected elementary and sports grammar schools and secondary vocational schools in the Czech Republic, CESA BUT integrated the swimmers of these schools into their research. The schools concerned provide teaching, education and also the top-level training in swimming. Every year we organize research measurements for swimming teams of these schools in the Czech Republic; these measurements are assessed and the newly acquired significant information is forwarded to the teachers and coaches of swimming teams of these schools to work with them.

Methods

In our research work devoted to swimming, we start from the following definitions and hypotheses:

Extremely important is a kinematic and dynamic analysis of research related to the swimmer's movement. Neither the coach nor the swimmer can see the movements of

the body, underwater performance of arms and legs. Coaches and swimmers usually do not know sufficiently, or just estimate, how much force the swimmer must exert to overcome the water resistance to reach the necessary speed.

The analysis of swimming speed and acceleration (by arms, legs, interplay) is considered to be an objective benchmark of technique.

The smaller is the variation in speed and acceleration of the swimmer (by arms, legs, interplay) during each stroke, the more perfect his/her technique is.

Water resistance depends on speed and acceleration, and inertia force on acceleration. Speed and acceleration are valuable information about the swimmer's technique.

Path, speed and acceleration are interconnected with the relationships known in kinematics; water resistance, inertia force and driving force are interdependent under the laws of hydrodynamics.

Theoretical approaches to measurement evaluation with notes.

Speed and acceleration of swimming, time or path are measured by two tachographs of our own design and production (invention BUT, number 2012/178). Recordings of these variables are associated with synchronous video recordings of swimmer's underwater movement provided by three camcorders (a device for measuring the speed of linear movement of the object or individuals with synchronous video recording, (invention BUT, number 2012/179).

Computer software evaluates the following statistic variables:

- Mean speed ($m \cdot s^{-1}$)

Mean speed affects all the measured variables. Before starting the measurement, the swimmers concerned are asked to ensure the mean speed for each measurement (arms, legs, interplay) as high as possible to be close to or exceed their racing speed.

- Standard deviation ($m \cdot s^{-1}$)

Standard deviation is an indicator of deviation from the uniform speed and should be as low as possible.

- Coefficient of variation (%)

Coefficient of variation is the ratio of mean speed and standard deviation expressed in %. Due to its large range in each swimming stroke and element, it is a very sensitive indicator of swimming technique. Variation coefficient should be as low as possible.

- Variance ($m^2 \cdot s^{-2}$)

Variation informs about expenditure of energy needed to maintain the uniform speed. The higher is the variance, the more energy must be exerted by the swimmer to maintain the mean speed. This data is particularly significant for long-distance swimmers and should be minimized.

- Efficiency of swimming technique (%)

Efficiency of swimming technique is calculated from the work done while swimming. It is the work at uniform speed divided by actual work corresponding to the measured actual variable speed. In each measured element (legs, arms, interplay), it should be as close as possible to 100%).

We also measure and evaluate the speed of dolphin crawl across the entire 25m lane in four positions - on the chest, on the back, on the right and on the left side. For each measured swimmer, we measure and evaluate the instantaneous speed after the turn, and after completing 15 meters under water. By observing our swimmers, we found out that they do not have control of underwater dolphin crawl. To reach the permitted 15 meters under water in the crawl, backstroke and butterfly after the start and after each turn, the Czech national team loses up to two meters for world top swimmers.

After the measurements in the swimming pools, CESA BUT evaluates these measurements. Out of 25m recordings of speed and acceleration, we print out that section of swimming where the speed and acceleration of the swimmer were not affected by the increased speed after the take-off from the pool wall. The header of this protocol refers to all the necessary data about the measured individual, the assessed technical data, mean speed ($m \cdot s^{-1}$), standard deviation ($m \cdot s^{-1}$), variation coefficient (%), effectiveness of swimming technique (%), variance ($m^2 \cdot s^{-2}$), accomplished percentage of personal maximum speeds (records) and a description of what has been tested (legs, arms, interplay). We print out a selected portion of speed recordings (Fig.1). It is followed by a synchronous graphic recording of acceleration, which was obtained using speed derivations (Fig.2). The acceleration recording provides a wide range of information. It shows what swimming technique was used; the smaller is the variation in acceleration, the better the swimming technique is. A calculation of dynamic forces, positive or negative inertial force obtained by multiplying the acceleration (at the selected point of recording) by mass of the swimmer, informs about the size of inertia force in newtons (N). The third print out is a protocol from the video-recording of the measured individual at the moment when his/her lowest speed was recorded (the most serious error in the technique of swimming). We print out underwater dolphin swimming in four body positions and dolphin crawl up to 15 meters. DVD recordings of the entire measurement are provided. All of these materials are forwarded to coaches within the shortest possible time.

Every six months we evaluate and print out "Tables on statistical analysis of swimming of Czech national team." The listed swimmers achieved the highest efficiency of swimming technique in interplay in the Czech Republic or in more swimming styles. Each category has its own table; junior juniors, senior juniors and seniors (male and female). The last line of each table lists the medians in the monitored variables of statistical set of national swimming team of the Czech Republic regardless of age category (Table 1, 1-8). These prove that Czech coaches devote the necessary attention to the swimming technique. Each line of the table is able to give the significant information on each measurement.

Based on the order of VSC MŠMT in Prague, we analyzed the swimming technique of the Czech national team (3/2/2015), who was in preparation for the World Championship 2015 and is under preparation for the Olympic Games in 2016.

Results

National team swimmer Z. B.

Z.B. had the largest range of speed measurement. We measured her swimming speed by two tachographs and analyzed four swimming styles - butterfly, backstroke, breaststroke and crawl. First she swam in elements, i.e. only leg strokes, then only arm strokes, and finally the interplay. The analysis of her swimming technique proved that in the interplay of all four swimming strokes she approached the highest measured efficiencies of swimming technique for women in CR. Z.B.'s measured efficiency of swimming technique was as follows: breaststroke swimming style 79.55% (the highest measured efficiency is 83.20%); this is by 3.6% lower efficiency. Z.B.'s efficiency in backstroke swimming style is 96.81% (the highest measured is 99.49%); this is by 2.7% less than the highest measured. The measured effectiveness in butterfly was 96.87% (the highest measured is 97.44%), this is by 0.6% lower. In crawl, Z.B. reached the swimming technique efficiency of 98.81% (the highest measured is 99.56%); this is by 0.7% lower than the highest measured.

National team swimmer V. M.

When measuring the Czech national team (3/2/2015), we measured and evaluated V.M.'s 4 x 25m crawl. He was swimming the first 25m with breaths on the left, the second 25m with a right breath, the third 25m with alternating breaths on the left and right, and the fourth 25m without breaths. After evaluation, we received the following table (Tab.9). The maximum mean speed reached by V.M. when swimming the 25m section without breaths was 1.81 $m \cdot s^{-1}$, the highest efficiency of swimming technique was measured with right breaths (99.31%). The most perfect technique of V.M. (variation coefficient of 4.81%) was achieved with right breaths (Tab.9). A surprising

finding is that V.M. has the highest efficiency in crawl swimming technique with breaths on the right and not when swimming without breaths.

National team swimmer E. M.

We were asked to try to find the difference between the two techniques of crawl swimming. Different should have been the work, length of arm stroke. In the first attempt, the arms ended up their stroke in a perpendicular position under the body; in the second attempt, the arms continued their stroke along the curve as close as possible to the knees. E.M. had been using the first technique since her childhood; she was practising the other technique of swimming for several months. A numerical evaluation yielded the following results:

Attempt No. 1: Stroke of arms in crawl only perpendicularly under the body.

Mean speed: 1.63 $m \cdot s^{-1}$. Standard deviation: 0.071 $m \cdot s^{-1}$. Variation coefficient: 4.17 %. Efficiency: 99.43 %.

Attempt No. 2: Stroke of arms in crawl along the curve up to the knees.

Mean speed: 1.59 $m \cdot s^{-1}$. Standard deviation: 0.14 $m \cdot s^{-1}$. Variation coefficient: 8.87 %. Efficiency: 97.72 %.

A brief evaluation of acceleration recording:

Attempt No. 1: Stroke of arms in crawl only perpendicularly under the body.

Graphic recording for the assessed section, time from 4.11 to 11.42s, confirms 8 strokes by the right arm and 8 strokes by the left one. Positive acceleration increased eight times to the size of 3-4 $m \cdot s^{-2}$. The size of positive inertia force was 3-4 x 61 kg = 163-244 N in absolute values. Negative inertia force is of the same size as the positive inertia force.

Attempt No. 2: Stroke of arms in crawl along the curve up to the knees.

Graphic recording for the assessed section, time from 4.11 to 11.42s, confirms 8 strokes by the right arm and 8 strokes by the left one. Positive acceleration increased once to the size of 8 $m \cdot s^{-2}$and seven times to 6 $m \cdot s^{-2}$. Negative acceleration decreased to -5 and -6$m \cdot s^{-2}$. The size of positive inertia force was 6 – 8 x 61 kg = 366 – 488N. The size of negative inertia force was 5-6 x 61 kg = 187 – 366 N.

The above-described results of swimmer E.M. and the related discussions are presented in the annexes in the form of graphs and video recordings (Figures 1- 6). The annexes also contain Tables 1-8 under a comprehensive title Tables on statistic analysis of swimming of Czech national team, Table 9 entitled Breaths in crawl

swimming style of swimmer V. M. and Table 10 describing Development of efficiency of swimming technique in crawl swimming style 2009-2015 (swimmer V.M.)

Discussion

National team swimmer Z. B.

It is a known fact that human population can either master a breast stroke swimming style, and then, poorly, swimming styles using legs in crawl, backstroke and butterfly, or they have an innate predisposition to swim well using legs in crawl, backstroke and butterfly and no disposition to swim well using legs in breast stroke. A 400m medley swimming race must be regarded as the toughest one in terms of the swimming technique from among all the announced races. The national team swimmer Z.B. has innate predispositions to master the techniques of all four swimming styles. During preparation she must swim up to four times more kilometres than the swimmers preparing to master one swimming style. She must cope with daily biphasic swimming training. The above figures on efficiency of swimming technique show that the largest reserve is in the technique of breast stroke, then in the backstroke, crawl and butterfly.

National team swimmer V. M.

We present an analysis of the highest measured efficiency of swimming technique (99.80%) reached by the swimmer V.M. (16/ 5/ 2013) during measurements of the Czech national team in Brno. V.M. has competed for the Czech Republic especially in the disciplines of 50m and 100m crawl at all European and World Championships since the year 2000 and also at the Olympic Games. He qualified for the finals. The swimmer V.M. has genetic predispositions for the top level crawl. He is 194.5 centimetres tall and has a constant weight of 91.5 kg. He has an excellent feel of water resistance.

Table 10 has a great predictive value. V.M. reached the maximum mean speed (1.91 $m \cdot s^{-1}$) in 2010 and 2011. The lowest standard deviation of V.M. (0.05 $m \cdot s^{-1}$) was in 2013. A conveniently lowest variation coefficient (2.56%) was calculated in 2013, as well as the highest efficiency of swimming technique, the highest ever measured (99.80%). The swimmer V.M. works very well with crawl legs, efficiency (98.9%), and has excellent work of crawl arms (99.77%). Based on these values, it was then possible to achieve an incredible efficiency in crawl interplay (99.80%).

Some corrections to errors in swimming technique can be performed immediately after their revelation; serious changes in swimming technique require years of work and our cooperation with each measured person. In the measurement results, especially in variation coefficient (%), and the effectiveness of swimming technique (%), all the

changes in swimming technique saved by the coach and realized by the swimmer are carefully recorded.

National team swimmer E. M.

A brief commentary on the numerical evaluation: Decrease in speed in the second measured section highlights the fact that the second interplay of E.M. in the crawl has not been mastered. An undesirable increase in the second standard deviation confirms that the new technique of arm stroke in crawl is not constant and is disadvantageously greater than in the first attempt. Variation coefficient confirms very significantly a miscontrol of technique within the arm stroke up to the knees in the second attempt. An undesirable increase in variation coefficient is by 4.71%. A decrease in efficiency of swimming technique in the second section by 1.71% is for the Czech national team swimmer, who has been swimming competitively for 10 years, too high. It also confirms that the new technique of arm stroke in the crawl interplay has not been yet mastered. The analysis of the videorecording proves that E.M. irregularly alternates the length of arm strokes. A conclusion consistent with numerical evaluation is given by graphic recordings of speed and acceleration, and videorecordings.

We assume that E.M., after full mastery of technique with extended stroke of her arms, will have an opportunity to work her way up to the European and world top swimmers in 50m, 100m, 200m crawl. Our research measurements and observations of world competitions confirm that the world leaders in crawl swim with arm strokes along the curve up to the knees.

Unsolved problems.

A significant decline in the efficiency of swimming technique between the individual measurements observed with each measured swimmer can indicate, both for us and for the coaches, great stress, fatigue, overtraining, a developing, previous or undertreated disease, undertreated musculoskeletal injury, current low fitness, current state of mind. Conversely, based on the low value of variation coefficient (dimensionless relative number) and the increased percentage of efficiency of swimming technique (the ratio of two works - work at uniform speed divided by work at variable actual speed), we can also detect physical and mental well-being, favourable euphoria, high fitness, instantaneous ability of the body to minimize water resistance. All of the above information is taken into consideration; we tolerate the negatives and help the swimmers to overcome them. However there is no deeper involvement in these issues.

Conclusion

The tachographs developed and used by our research team allowed us to measure the speed of swimming for six years without defects. Elaborated software evaluates the monitored technical variables. In addition to the extensive baseline measurement, the CESA team of BUT is able to deal with and evaluate each individual problem in the swimming technique.

The methodology of measuring the speed of swimming, evaluated results, a contribution of significant information to the gains of efficiency of swimming technique proved the validity of hypotheses.

Thanks to the research measurements carried out and delivery of significant information and conclusions to the coaches, the Czech national team reached the leading world standard in swimming technique. A significant growth in the efficiency of swimming technique from 2009 to 2015 in all age categories and in all four swimming styles allows the Czech national team to deal with the quantity and intensity of swimming training with the aim to reach the level comparable with world champions in swimming.

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Annexes

Swimmer: E.M. 1993
Date/time: 3.2.2015, 11:18
Style: freestyle
Efficiency: 99.43 %
Variation coeffcient: 4.3736 %

Club: Loko Trutnov
Pool: Ponávka
Length: 25.0 m
Mean speed: 1.635 m/s
Variation: 0.0051 (m/s)2

Address: Trutnov
Protocol: 1
Test: both
Percentage of max speed: 86.669 %
Standard deviation: 0.0715 (m/s)

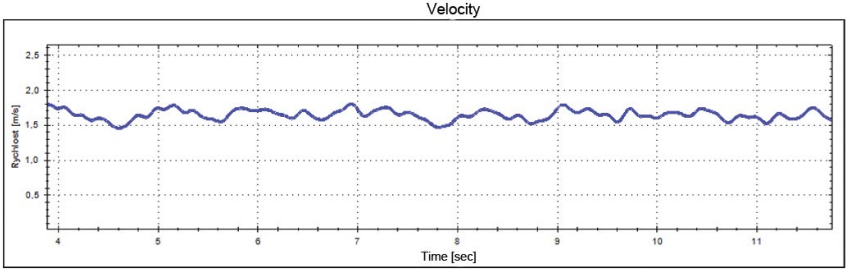

Fig. 1 Speed of E.M.

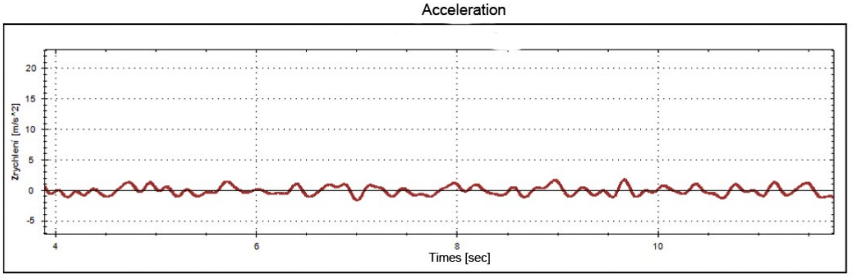

Fig. 2 Acceleration of E.M.

Fig. 3 Video recording of E.M.

Swimmer: E.M. 1993
Date/time: 3.2.2015, 11:18
Style: freestyle
Efficiency: 98.30 %
Variation coeffcient: 7.5927 %

Club: Loko Trutnov
Pool: Ponávka
Length: 25.0 m
Mean speed: 1.608 m/s
Variation: 0.0149 (m/s)2

Address: Trutnov
Protocol: 2
Test: both
Percentage of max speed: 85.239 %
Standard deviation: 0.1221 (m/s)

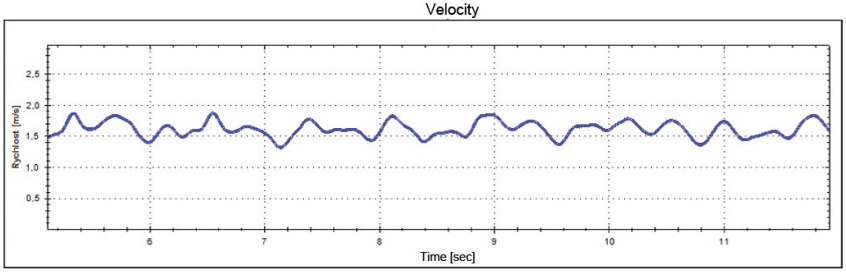

Fig. 4 Speed of E.M.

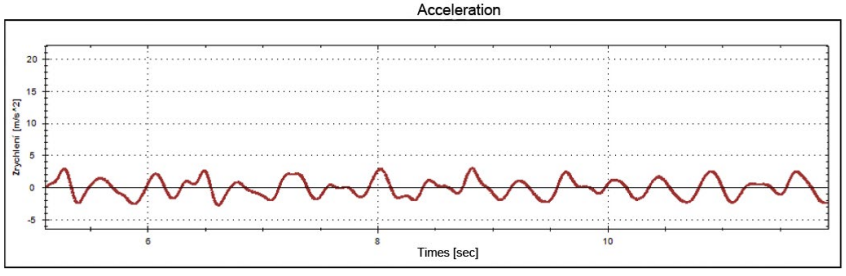

Fig. 5 Acceleration of E.M.

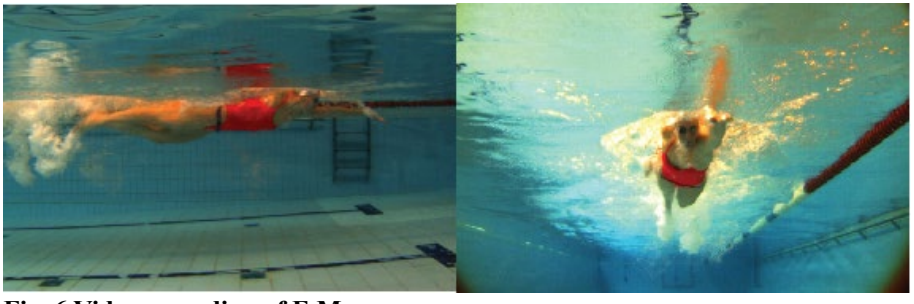

Fig. 6 Video recording of E.M.

Tables on statistic analysis of swimming of Czech national team (30/6/2015)

Tab. 1 Swimming style crawl - men

Category Name (year of birth) Swimming club, school Date of measurement	Mean speed ($m \cdot s^{-1}$)	Standard deviation ($m \cdot s^{-1}$)	Variation coefficient (%)	Efficiency of swimming technique (%)
Senior **Verner Martin** (1980) Kometa Brno 16/ 5/ 2013	1.86	0.047	2.54	99.80
Senior Junior **Podzemný Matěj (1997)** PK Nový Jičín 22/ 4/ 2014	1.60	0.077	4.83	99.31
Junior Junior **Sazovský Jan (2001)** PK Nový Jičín 22/ 4/ 2014	1.43	0.076	5.31	99.16
Median 52 swimmers	1.676	0.133	8.224	98.01

Tab. 2 Swimming style crawl - women

Category Name (year of birth) Swimming club, school Date of measurement	Mean speed ($m \cdot s^{-1}$)	Standard deviation ($m \cdot s^{-1}$)	Variation coefficient (%)	Efficiency of swimming technique (%)
Senior **Pechancová Aneta** (1992) Lok. Trutnov 2/ 12/ 2010	1.61	0.062	3.82	99.56
Senior Junior **Chudárková Gabriela (1997)** ZPK Zlín 14/ 10/ 2014	1. 63	0.055	3.38	99.66
Junior Junior **Trnková Michaela** (1999) Motorlet Praha 21/ 9/ 2014	1.53	0.077	5.07	99.24
Median 44 swimmers	1.456	0.133	9.169	97.60

Tab. 3 Swimming style butterfly - men

Category Name (year of birth) Swimming club, school Date of measurement	Mean speed ($m \cdot s^{-1}$)	Standard deviation ($m \cdot s^{-1}$)	Variation coefficient (%)	Efficiency of swimming technique (%)
Senior **Havránek Tomáš** (1994) Bohemians Praha 3/ 2/ 2015	1.41	0.226	15.97	93.05
Senior Junior **Maluš Jan** (1996) ZPK Zlín 24/ 10/ 2013	1.51	0.162	10.74	96.60
Junior Junior **Pošmourný Matěj (1998)** SG Kladno 14/ 10/ 2014	1.28	0.147	11.47	96.14
Median 18 swimmers	1.57	0.316	19.40	89.73

Tab. 4 Swimming style butterfly - women

Category Name (year of birth) Swimming club, school Date of measurement	Mean speed ($m \cdot s^{-1}$)	Standard deviation ($m \cdot s^{-1}$)	Variation coefficient (%)	Efficiency of swimming technique (%)
Senior **Kulišťáková Natalie (1995)** PK Nový Jičín 22/ 4/ 2014	1.45	0.136	9.34	97.44
Senior Junior **Kopřivová Věra** (1995) SG. Ostrava 23/ 2/ 2012	1.38	0.175	12.67	95.39
Junior Junior **Nováková Renata** (1997) SG. Pardubice 17/ 10/ 2013	1.31	0.127	9.73	97.26
Median 12 swimmers	1.32	0.351	23.64	86.09

Tab. 5 Swimming style breaststroke - men

Category Name (year of birth) Swimming club, school Date of measurement	Mean speed ($m \cdot s^{-1}$)	Standard deviation ($m \cdot s^{-1}$)	Variation coefficient (%)	Efficiency of swimming technique (%)
Senior **Bartůněk Petr** (1991) Chemička Ústí n. Labem 23/5/2013	1.30	0.332	25.26	83.56
Senior Junior **Tobiáš Jakub** (1995) SG. Brno 13/ 10/ 2011	1.18	0.325	27.52	81.67
Junior Junior **Černý Filip (1998)** PK Nový Jičín 22/ 4/ 2014	1.26	0.344	27.33	81.60
Median 16 swimmers	1.22	0.655	50.00	58.35

Tab. 6 Swimming style breaststroke - women

Category Name (year of birth) Swimming club, school Date of measurement	Mean speed ($m \cdot s^{-1}$)	Standard deviation ($m \cdot s^{-1}$)	Variation Coefficient (%)	Efficiency of swimming technique (%)
Senior **Moravčíková Martina (1988)** VSC. MŠMT. Praha 22/ 4/ 2014	1.24	0.326	26.21	83.20
Senior Junior **Štěpánová Monika (1997)** SG. Brno 22/ 4/ 2014	1.11	0.339	30.45	78.58
Junior Junior **Pučanová Aneta** (1997) SG. Pardubice 17/ 10/ 2013	0.94	0.295	31.34	78.01
Median 13 swimmers	1.11	0.434	42.10	63.51

Tab. 7 Swimming style backstroke - men

Category Name (year of birth) Swimming club, school Date of measurement	Mean speed ($m \cdot s^{-1}$)	Standard deviation ($m \cdot s^{-1}$)	Variation Coefficient (%)	Efficiency of swimming technique (%)
Senior **Verner Martin** (1980) Kometa Brno 16/ 5/2013	1.65	0.113	6.87	98.60
Senior Junior Podzemný Matěj (1997) PK Nový Jičín 22/ 4/2014	1.46	0.073	4.99	99.27
Junior Junior **Širocký Tomáš (2000)** PK Nový Jičín 22/ 4/2014	1.28	0.068	5.30	99.16
Median 22 swimmers	1.49	0.209	13.09	95.17

Tab. 8 Swimming style backstroke - women

Category Name (year of birth) Swimming club, school Date of measurement	Mean speed ($m \cdot s^{-1}$)	Standard deviation ($m \cdot s^{-1}$)	Variation Coefficient (%)	Efficiency of swimming technique (%)
Senior **Baumrtová Simona (1991)** Slavie Chomutov 6/ 5/ 2014	1.52	0.063	4.15	99.49
Senior Junior **Indráková Michaela (1997)** PK Nový Jičín 22/ 4/ 2014	1.31	0.080	6.06	98.91
Junior Junior **Vybíhalová Petra** (1997) Zlínský plavecký klub 25/ 10/ 2012	1.22	0.078	6.37	98.80
Median 10 swimmers	1.33	0.180	14.40	94.20

Brno University of Technology, Centre for sport activities, Motyčka J. 30/ 6.

Tab. 9 - Breaths in crawl swimming style
V. M. Measurement - 3/2/2015 Brno. Influence of breathing on the efficiency of swimming technique.

Breaths	$\bar{v}$ ($m \cdot s^{-1}$)	s ($m \cdot s^{-1}$)	C (%)	η (%)
left	1.75	0.14	8.02	98.11
right	1.77	0.08	4.81	99.31
alternating left and right	1.77	0.12	7.00	98.55
no breaths	1.81	0.09	5.14	99.11

Tab. 10 – Development of efficiency of swimming technique in crawl swimming style 2009-2015
V. M. Year of birth 1980

Date	$\bar{v}$ ($m \cdot s^{-1}$)	s ($m \cdot s^{-1}$)	C (%)	η (%)
23/3/2010	1.91	0.13	6.58	98.72
13/10/2011	1.91	0.07	3.70	99.59
5/9/2012	1.84	0.15	8.07	98.10
16/ 5/2013	1.86	0.05	2.56	99.80
3/2 /2015	1.81	0.09	5.44	99.11

EVALUATION OF SPORT TECHNIQUE IN TENNIS BASED ON 3D KINEMATIC ANALYSIS

Pavel Mudra[1], Vladimír Psalman[2]
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic[1]
Faculty of Education, University of South Bohemia in České Budějovice, Czech Republic[2]

Abstract

Sport technique in tennis represents one of the most important factors of sport performance. This study deals with 3D kinematic analysis of tennis shots and with an evaluation of sport technique. The aim of this research was to use 3D kinematic analysis and obtain precise kinematic characteristics in chosen phases of tennis shots which are required for an evaluation of tennis technique. A male tennis player has been tested for the purposes of this case study in thirty attempts in standard conditions. Three most interesting forehand shots have been analysed in detail. The same ball velocity and the same place were generated by the tennis machine. The tested person A.P. was 15 years of age. We focused on key time moments in the performance of motion during repeated forehand strokes. The first moment was when the time of maximal acceleration of upper tennis racket occurred, the second moment was the time when maximal speed of upper tennis racket was recorded, the third moment occurred at the time of contact between the tennis racket and the ball, and finally the highest and lowest values of kinematic parameters of all segments of dominant upper extremity (right) were taken into the consideration. The following kinematic parameters have been chosen: velocity, acceleration of dominant upper extremity, centre of gravity and upper racket, height, lateral and forward-backward distance of centre of gravity, angles in both knees, elbows and body bending. The highest values of acceleration of upper racket during stroke are achieved when the whole kinematic chain of body segments are finished. The best attempt was represented by the highest values of velocity and acceleration of upper racket. The achieved values are: 19.744 m/s and 206.520 m/s^2. The contact between the racket and the ball should happen a moment later. We believe that the most important segment of tennis player system is the upper racket location which is responsible for the quality of tennis shot. Many velocity, acceleration and angle parameters have been measured, but for the evaluation of tennis technique have been chosen only those which achieved required values and forehand shot was successful. However, the positive results of some of the shots parameters were achieved due to decelerations of some other segments of dominant upper extremity just before the contact with the ball. The moment of maximal velocity of upper racket occurred nearly at the same time as the contact of the racket with

the ball. Acceleration of upper racket at this moment was lower than maximal acceleration recorded little bit sooner. Movement of the centre of gravity must be smooth enough and in a sufficient range. This study also brings specific values for classification of forehand shots and it confirms that optimal kinematic chain determines the quality of tennis techniques. These objective results can be helpful for tennis coaches and support their subjective expert evaluation.

Keywords: *sport technique, tennis, 3D kinematic analysis*

Introduction

Sport technique in tennis represents one of the most important factors of sport performance. This study deals with 3D kinematic analysis of tennis shots and with an evaluation of sport technique.

Aim

The aim of this research was to use 3D kinematic analysis and obtain precise kinematic characteristics in chosen phases of tennis shots which are required for an evaluation of tennis technique.

Methods

A case study of a young male tennis player hitting thirty balls in standard conditions has been performed. Three most interesting forehand shots have been analysed in detail. The same ball velocity, the same rhythm of shots (every 2.9 second) and the same location of shots (back forehand quarter of the tennis court) were generated by the tennis machine – tennis Tutor Pro Lite. The following testing protocol was applied: 3 times 10 forehand cross court shots (from the right side to the left opposite side of the tennis court). During the whole test the US Open tennis ball have been used.

The tested person A.P. was 15 years of age, and he is currently a member of tennis club TK Tesla Brno. His national ranking went up from second half of four hundredth in year 2013 to first third of two hundredth in year 2015. Training load of the player was 8 hours of tennis per week. It consisted of two 60-minute trainings with the coach, two 90-minute trainings with the coach and another young tennis player and two 90-minute trainings against suitable sparing partners. Besides these tennis trainings the tested person did short fitness training in duration of 30 minutes five times per week aimed at the core training. Additionally, the tested player participated in 47 single games and 39 double games matches in national tournament last tennis season.

We focused on key time moments in the performance of motion during repeated forehand strokes. The first moment was when the time of maximal acceleration of upper tennis racket occurred, the second moment was the time when maximal speed of upper tennis racket was recorded, the third moment occurred at the time of contact between the tennis racket and the ball, and finally the highest and lowest values of kinematic parameters of all segments of dominant upper extremity (right) were taken into the consideration. The following kinematic parameters have been chosen: velocity, acceleration of the dominant upper extremity, centre of gravity and its movements in forward-backward, lateral and horizontal directions, angles in both knees, elbows and body bending. With the help of 3D kinematic analysis and Simi motion software all needed parameters of the body and tennis racket have been recorded by synchronized cameras and sport technique has been evaluated by tennis experts and biomechanics.

Results and Discussion

Three best attempts seemed nearly perfect without any mistakes. However, a more careful kinematic analysis allows more precise view which is very helpful in an evaluation of every single shot. Certain anomalies appeared which confirmed that kinematic chain of dominant upper extremity is not completely correct. The timing of some segments was imprecise in preparation phase (t=0.603s). There are following velocities: 2.516 m/s – shoulder, 2.110 m/s – elbow, 1.908 m/s - wrist and 4,666 m/s – upper racket. Both sides extremes are visible (shoulder is very fast in this moment which is not useful for this moment and the same is valid for upper racket). Also, movements in elbow and wrist have opposite velocity tendency (Fig. 1).

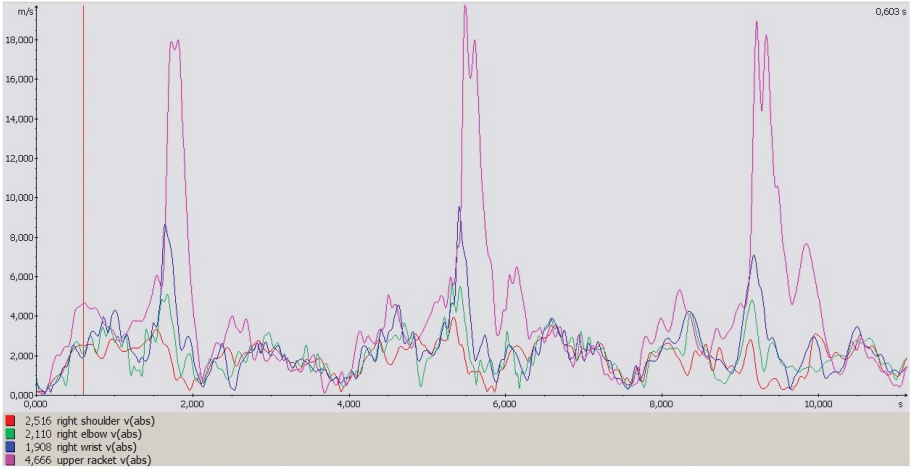

Fig. 1 Velocity of shoulder, elbow, wrist and racket (right side) – example for anomalies

The forehand shot in the first attempt achieved maximal velocities in these moments: maximal velocity of the right shoulder was in t=1.541s which is correct and after this moment the next actuated joint should be elbow, then wrist and finally tennis racket. However, in this case the second wrist was active sooner than elbow and its maximal velocity occurred in time t=1.650s (too late) followed by elbow (t=1.679s). Finally, in time t=1,729s upper racket achieved maximal velocity (17.937 m/s) which is quite high but could be higher and as a result this forehand shot was not optimal.

On the other hand, minimal velocities were achieved between first and second forehand shot in time t=3.941s and values were: 0.477 m/s – shoulder, 0.444 m/s – elbow, 0.853 m/s – wrist and 0.752 m/s – upper racket. In this moment the player is waiting for his second shot, feeling relaxed and velocities are significantly lower. One exception is the highest velocity in the right wrist which is no mistake but it indicates a slightly faster movement than other segments of the dominant upper extremity. It may be a relaxation of wrist before the next hitting activity (Fig. 2).

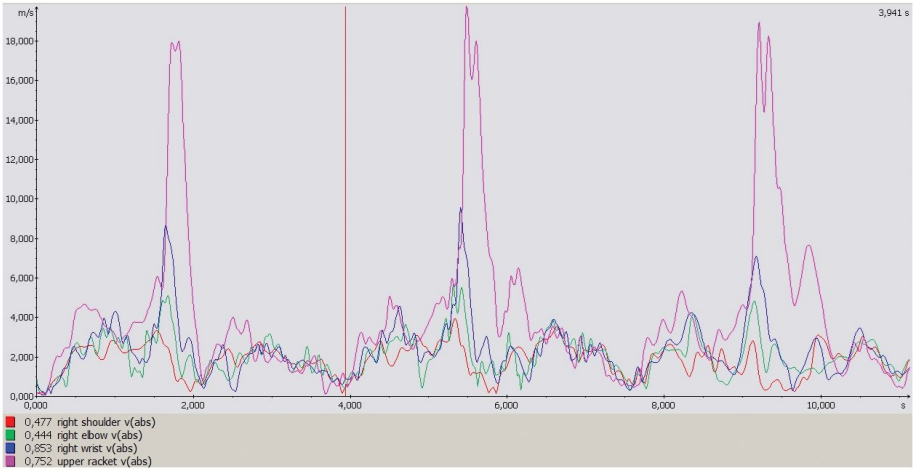

Fig. 2 Minimal velocities of right upper extremity in time t=3.941s

The best forehand shot was the second one in which the player achieved maximal velocities for shoulder (3.925 m/s in time t=5.334s), elbow (5,655 m/s in time t=5.314s), wrist (9,547 m/s in time 5.403s) and upper racket (19.744 m/s in time t=5.482s). Value of maximal velocity 19.744 m/s was the highest of all performed attempts and for the age of 15 seems to be sufficient. To improve more sensitivity is needed in certain time moments with the aim to avoid useless changes in time continuity (time moment for shoulder is too late and this signalizes a small movement correction).

Between the second and third forehand shots we mentioned a specific situation which represents very good preparation for the attempt number 3. Its velocity peaks before the main peak. In this moment t= 8.218s we recorded sufficient values of velocities (from medial to distal end of the movement chain: 1.828 m/s, 2.270 m/s, 2.896 m/s and 5.317 m/s). This progressive increase of velocity confirms the optimal kinematic chain.

Regarding acceleration, the first attempt was technically best with optimal following accelerations: 6.322 m/s^2 in time t1=1.482s in shoulder, 37.450 m/s^2 in time t2=1.571s in elbow, 74.428 m/s^2 in time t3=1.600s in wrist and even 153.327 m/s^2 in time t4=1.669s in upper racket. All these values confirm the optimal tennis technique, perfect timing in acceleration and excellent time series progress. The best acceleration was recorded in the second forehand shot in which the value was 206,520 m/s^2 (Fig. 3).

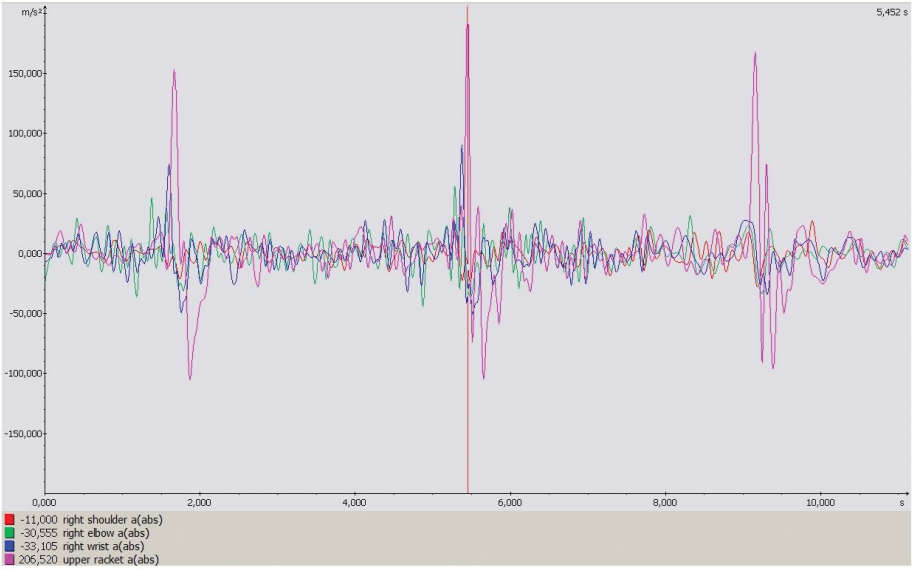

Fig. 3 Maximal acceleration of upper racket in time t=5.452s

Very high value of 206.520 m/s^2 represents successful end of acceleration process but there is some room for additional improvement. This value was achieved due to deceleration in all other segments of the dominant upper extremity. Values -11.000 m/s^2 for shoulder, -30.105 m/s^2 for elbow, -33.105 m/s^2 for wrist are extremely low and there is a small time gap for contact between the racket and ball which is at the moment of 5.552s. The biggest deceleration occurred mostly at the same time, it is the moment when the shot is finished but swing is continuing and deceleration of upper racket is reaching values very close to – 100 m/s^2.

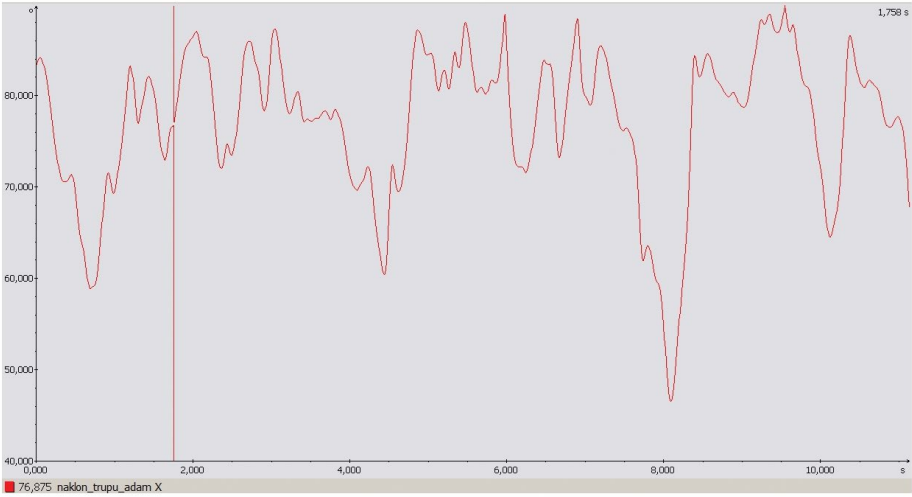

Fig. 4 Values of angles represent different body position and bending trunk in forward-backward direction

The range between flexion and extension of the trunk varied between 46.7 and 89.4 degrees. At the exact time of contact between tennis racket and the ball (t=1.758s) the body of tennis is bent at an angle of 76.875° which means more than 13° forward (measured from vertical axis, Fig. 4).

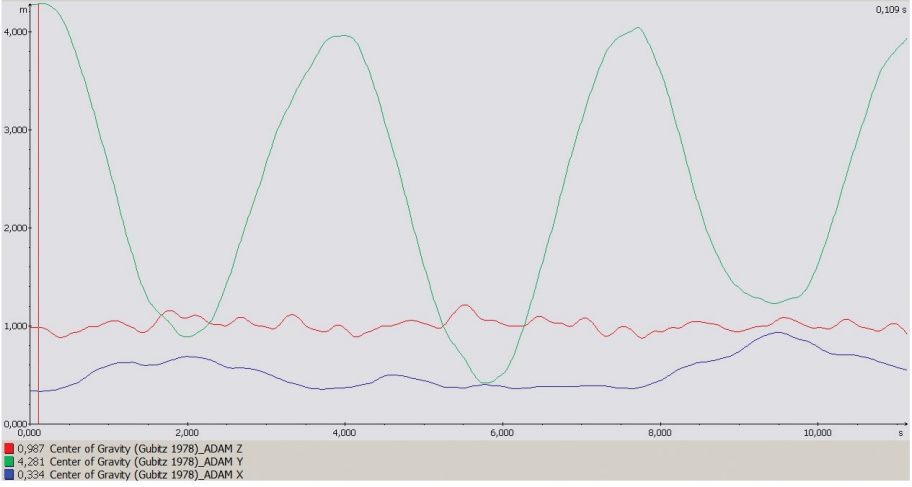

Fig. 5 Centre of gravity and its movements in forward-backward, lateral and horizontal directions

The most important seems to be vertical movement which should be very sensitive. During the best tennis shot attempt the vertical movement of COG (centre of gravity) varies in the range of 0.327m. The maximal value of COG is just a few milliseconds after hitting the ball with value 1.213m. The maximal extension in knees before the contact phase (between racket and ball) determines minimal high (0.886m). Forward-backward movement is slightly bigger than in vertical direction with values up to 0.5m. This precise distance influences the quality of timing which is essential for the whole tennis technique. Very long movement trajectory occurs in lateral direction and it depends on the placement of the ball in the court but in our case, based on testing protocol, lateral movement achieved values around 3.5m, with a maximum of 3.639m (Fig. 5).

Movements of COG seem to be fairly important and in our tested player we found some disadvantages especially in vertical direction which means the player makes too big movements in knee joints (great flexion and extensions).

Conclusion

An evaluation of sport technique in tennis can be realised very precisely using 3D kinematic analysis. This case study also shows which specific values may be used for the classification of forehand shots and it confirms the validity of optimal kinematic chain which determines the quality of tennis techniques. These objective results can be helpful for tennis coaches and support their subjective expert evaluation.

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ANALYSIS OF MAXIMUM AND RELATIVE STRENGTH LEVELS OF JUNIOR MALE AND FEMALE TENNIS PLAYERS

Jiří Pačes[1], Jiří Zháněl[1], Miroslav Černošek[2], Tomáš Vodička[1]
[1]Faculty of Sports Studies, Masaryk University, Brno, [2]TK Plus Prostějov, Czech Republic

Abstract

The issues of the significance of strength capabilities in sport and tennis are dealt with by many authors. In tennis, the strength of the playing arm primarily manifests in the speed of serve. In the researched age range, major inter-individual and inter-sexual differences were observed and confirmed. Boys exceed girls in somatic and motoric characteristics. Research shows close relation between body weight and physical strength. In junior age this aspect may affect the athletes' performance due to the different progress of their ontogenetic evolution. For objective comparison of inter-individual differences in strength levels, relative strength calculation is used (physical strength/bodyweight ratio). The goal of this paper is level analysis of maximum strength of players' playing hand, comparisons and evaluation of intersexual differences of somatic (body height and weight) and motoric (maximum and relative strength of playing hand) characteristics, and determining the correlation between maximum and relative strength of playing hand and body weight. The research sample (acquired by method of intentional selection) consists of Czech junior male tennis players (n=157) and female players (n=163) in the ages between 13.0 and 14.9 years. The data for this research were gathered during 2000-2010 period by regular testing using hand dynamometer (Grip D, Takei, Japan) within Czech tennis association project. Analysis of acquired data shows normal distribution characteristics (verified by Kolmgorov-Smirnov test). Values of measured statistic characteristic variables in the set of male tennis players (n=157, body height: V=169.79 9.27, body weight: H= 57,05 ± 9.26, strength of playing hand: SH=34,64±7.53, relative strength of playing hand: RS= 0.61±0,10) and female tennis players (n=163, body height: V=164.93 ± 5.80, body weight: H=53.57± 6.31, maximum strength of playing hand: SH=29.09±3.84, relative strength of playing hand RS= 0.55±0.06) are characterizing sets of players in terms of levels of somatic and strength characteristics. Using t-test, major statistically relevant intersexual differences between male and female players were proved in all monitored variables. Using value of Cohen's d, a major effect was proven in case of maximum strength of playing hand (d=0.94), relative strength of playing hand (d=0.73) and body height (d=0.63); a medium effect was found in body weight (d=0.44). Statistically significant relation was proven between the strength of playing hand in a set of male players (r =0.80, r^2 = 0.64, i.e. medium effect) and

female players (r =0.55, r^2 = 0.30, i.e. low effect). Relation between body weight and playing hand was not proven in the set of male players (r =0.05, r^2 = 0.00), in the set of female player statistically significant negative correlation was found (r =-0.36, r^2 = 0.13, i.e. low effect). In the researched age range 13.0 – 14.9 years, the results show significant intersexual differences between male and female players in all monitored variables. These found facts need to be respected in the training process. A significant relation between body weight and maximum playing hand strength was proven also in sets of both male and female players. These facts combined with low (female players) respectively none (male players) relation of relative strength and body weight prove the suitability of using relative strength as objective evaluation of strength potential in tennis players and in athletes in general.

Keywords: *Hand dynamometer, intersexual difference, maximum strength, relative strength, tennis*

Introduction

The tennis played in the last decade has become significantly more dynamic, powerful and faster. This has been influenced by both the development of new technologies used in manufacturing racket frames and strings and the stress put on physical side of players' training. In today's tennis, according to authors Roetert and Kovacs (2011), there are far more winners played from open position, which presents the players with much tougher strength requirements connected with much higher joints and muscles strain. The role of muscles in tennis apart from generating power is also the consequent eccentric slowdown in the final stage of individual shots. Modern tennis rackets allow for much bigger ulnar and radial deflections, which result in wrist injuries occurring more frequently. Therefore, balanced strengthening of extensors and flexors is absolutely essential. According to authors Reid, Crespo and Quinn (2003), strength capabilities in tennis generate speed and power of individual shots; it is hence impossible to have speed, anaerobic energy system and flexibility without well-developed strength capabilities. Players who are able to utilize their strength capabilities hit their shots and serve with more power. Different surfaces present players with different challenges for their strength capabilities. Hard surface demands elasticity and reactional strength, acceleration and de-acceleration of the body. The characteristic of clay surface are high demands on stability, isometric and eccentric muscle contraction. Similar demands are posed by grass surface, where the body is exposed to larger scope of movements and better dynamics is required (Reid & Schneiker, 2008).

The development of strength capabilities plays a vital role in the advancement of a competitive player for two reasons:

1. It reduces the risk of injuries and prolongs players' careers
2. It improves players' performance and hence increases career productivity. Reid, Crespo and Quinn (2003)

The research of the role of strength in various sports has been dealt with by many authors (Innes et al., 1999; Reid et al., 2003; Reid & Schneiker, 2008). An often used practical research method for measuring the maximum hand strength level is using handheld dynamometers. As stated by Innes (1999), handheld dynamometers can be hydraulic (Jamar, USA), pneumatic (Tekdyne, USA) or mechanical (Takei, Japan). The maximum strength level is an important indicator not only in sport, but also to measure overall physical condition, and is often used to evaluate the efficiency of rehabilitation procedures and the overall physical health of a population (Massey-Westrop et al., 2004).

Methods

The research was carried out in junior tennis players in the period of 2000-2010 as a part of a project of the Czech Tennis Association for regular testing of performance prerequisites. Testing of the maximum hand strength level is one of the tests of the test battery TENDIAG 1 (Zhanel et al., 2000). In this research we were finding out the maximum hand strength level in Czech junior male (n=157) and female players (n=163) in the age of 13.0 – 14.9 years using handheld dynamometers (Grip D, Takei, Japan). The results are recorded in kiloponds (kp, 1 kp = 9.80665 N). The relative strength was calculated as the ratio between maximum strength and a kilogram of bodyweight. Two attempts were carried out in standing position (arms stretched down along the body without touching it) and the best result was recorded.

By conducting this research, we wanted to answer the following questions:

1. What is the maximum hand strength level in junior tennis players at the age of 13-14?
2. Are there inter-gender differences in the hand strength level?
3. Is it possible to prove a relationship between maximum and relative hand strength level and bodyweight?

Research aims:

1. To find out the maximum strength level of the tennis players using statistical analysis of the research data, and compare those with the data on record.

2. To find any inter-gender differences between the sets of male and female tennis players of the same age.

3. To assess the importance of the relation between strength (maximum and relative) and bodyweight.

The normality of the research data has been verified using the Kolmogorov-Smirnov test. It has been established that the data has been collected from both male and female junior tennis players, with normal distribution. Basic statistical characteristics of both sets of male (n=157) and female (n=163) tennis players are included in Table 1.

Tab. 1 Basic statistical characteristics of the observed variables

Category	Male players (n = 157)				Female players (n = 163)			
Variables	M	DD	min	max	Mean	DD	min	max
Age	13.90	0.58	13.00	14.90	13.90	0.58	13.00	14.90
Height (cm)	169.79	9.27	148.00	192.00	164.93	5.80	152.00	179.00
Weight (kg)	57.05	9.26	33.00	78.00	53.57	6.31	37.00	71.80
MHSL	34.64	7.53	18.80	50.00	29.09	3.84	20.30	39.00
RHSL	0.61	0.10	0.40	0.90	0.55	0.06	0.39	0.73

Legend:
M …mMean
DD … determinative divergence
MHSL …maximum hand strength level
RHSL … relative hand strength level

The results of the calculations of the basic statistical characteristics of individual variables observed characterize the research categories from the point of view of somatic (male players: height = 169.79 +- 9.27 cm, weight = 57.05 +- 9.26 kg; female players: height = 164.93 +- 5.80 cm, weight = 53.57 +- 6.31 kg) and strength variables (male players: hand strength = 34.64 +- 7.53 kp, relative hand strength = 0.61 +- 0.10; female players: hand strength = 29.09 +- 3.84 kp, relative hand strength = 0.55 +- 0.06).

It is clear from the results shown in Table 1 that, in all measured variables, male players reach higher average figures than female players of the same age (13-14 years). On top of that, in the male players' category, a higher variability of the categories has been recorded in all the variables, which consequently affects both the level of the

determinative divergences and the differences between the maximum and minimum levels.

Tab. 2 Inter-gender differences in observed variables – importance assessment

Category	Male	DD	Female	DD	Cohen´s d
Height (cm)	169.79	9.27	164.93	5.80	0.63 (medium)
Weight (kg)	57.05	9.26	53.57	6.31	0.44 (small)
MHSL (kp)	34.64	7.53	29.09	3.84	0.94 (large)
RHSL	0.61	0.10	0.55	0.06	0.73 (medium)

The assessment of the importance of differences in medial figures (Mean) in both male and female players in individual variables using the Student's t-test showed statistically significant differences in all variables. Interpretation of the values of Cohen's d proved a huge difference in inter-gender differences in the cases of maximum hand strength (d=0.94), median difference in relative hand strength variables (d=0.73) and body height (d=0.63). Small difference was observed in body weight (d=0.44). Differences in maximum hand strength levels between male and female players are shown in Fig. 1.

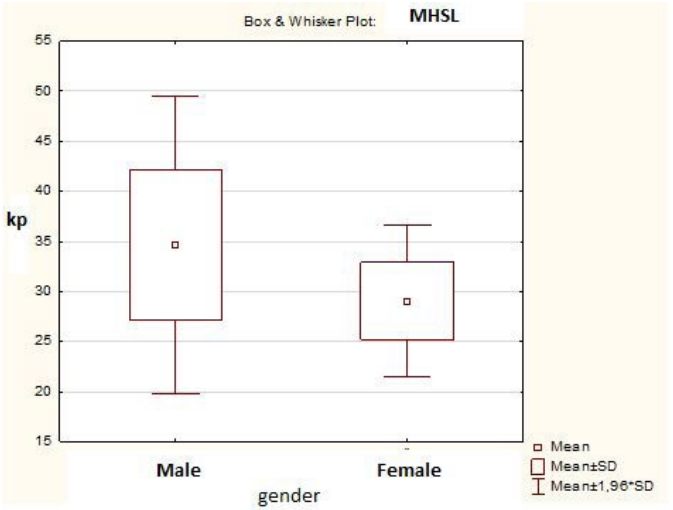

Fig. 1 The level of maximum force game hand male and female players

Relations between observed variables (weight, maximum and relative hand strength) was (taking into consideration the proven normality of the research data)

researched using Pearson's correlative coefficient, whose values are shown in Table 3. Factual dependency importance was assessed using the value of determination coefficient r^2.

Tab. 3 Correlative coefficient values – assessment of factual dependency

Category	MHSL	r^2	RHSL	r^2
W (male)	0.80	0.64***	0.05	0.00
W (female)	0.55	0.30**	-0.36	0.13*

Legend:
W … weight
r^2 … coefficient of Determination
*** … hight efect
** … medium efect
* … smalll efect

Table 3 shows that a high factual dependency was proven between maximum hand strength and bodyweight in male players (r=0.80, r2 = 0.64, high effect); in female players a median level of factual dependency was proven (r=0.55, r2 = 0.30, medium effect). Dependency between relative strength and bodyweight in male players was not proven (r=0.05); in girls this dependency was proven to be very low or negative (-0.36, low effect).

Discussion

There have been not many research studies allowing for comparing maximum hand strength measured by a handheld dynamometer in a population or tennis players of the same age. Reid et al. (2003) states that for the age of 13-14 the median value level of hand strength in male players is in the scope of 24-33 kp (median of 29 kp), in female players in the scope of 25-30 kp (median of 27.5 kp). The players we observed exceed these values by 5.64 kp in male players and 1.59 kp in female players. The Takei company manual (the manufacturer of Grip D dynamometer) states the following values for male and female players at the age of 13-14: M= 33.3 kp and F = 25.3 kp, which differs by 1.34 kp and 3.79 kp respectively from the category of tennis players. Beck and Bos (1995) present the following values for males and females: M = 34.13 kp and F = 28.75 kp, which are values just 0.51 and 0.34 lower. Carrasco et al. (2010) state the following values in Spanish table tennis players at the age of 11-13 (a year younger): M = 27.44 kp, F = 20.6 kp, which means a substantially lower level. The relative hand strength values in male (0.61) and female players

(0.55) show that male players are capable of generating a higher level of strength per a kilogram of bodyweight. The proven very low dependency between relative hand strength and bodyweight (in female players) and none whatsoever (in male players) supports the premise of some authors (Zatsiorsky & Kraemer, 2014) that it is a better suited characteristic for evaluating the strength level.

Inter-gender differences are affected by both different physical constitution and different ontogenetic development. According to Riegerova et al. (2006), pubescent growth acceleration in girls is more intensive and shorter, ending at about 13 years of age, while boys have not peaked at the same age. Girls may surpass boys due to earlier start of puberty, around the age of 11-12. As our research has shown, at the age of 13-14 it is vice versa, with male players being significantly taller (by 4.86 cm), while in the area of weight the difference is relatively small in favour of the boys (3.48 kg). This relates to the higher level of maximum hand strength in male players (by 5.55 kp). The level of maximum strength hugely affects overall tennis performance not only because it allows for more powerful and direct shots. A stronger and more stable wrist means more control over the racket and hence more accurate shots, which is very important in the fast and attacking style of play nowadays. This fact can also be observed in professional players who have their forearm muscles very well developed (*flexor carpi radialis, m. flexor carpi ulnaris*). Reid et al. (2003) state that the level of strength capabilities should be in harmony with technical, tactical and psychological dispositions of a player. Zatsiorsky and Kraemer (2014) confirmed that the correlation of maximum strength and bodyweight in a sport-active person is always very close, which our research proved for both male (r=0.80) and female players (r=0.55). From this data, it is plausible to conclude that, especially in junior male players (and partly also in female players) the taller the players are combined with their bodyweight, the higher a chance of the players reaching the maximum strength, which may affect their sporting performance. The values of relative hand strength in male (0.61) and female (0.55) show that male players are capable of generating more power per a kilogram of bodyweight. Carrasco et al. (2010) state that the maximum strength level measured by a handheld dynamometer is higher in the dominant hand, both in right- and left-handed people. According to Hanten et al (1999), men reach higher level than women, which was also proven by our research in junior tennis players.

Conclusion

The results of research of the maximum hand strength in male and female players at the age of 13-14.9 showed significant inter-gender differences in all variables observed; this fact has to be taken into account for future trainings. At the same time, a significant dependency was proven between bodyweight and maximum hand

strength in both sets of players. These facts – together with low (female players) and virtually no (male players) dependency of relative strength and bodyweight – confirm the viability of using the relative strength values for an objective assessment of strength potential in tennis players and athletes in general.

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RUNNING ECONOMY AT HABITUALLY FOREFOOT AND HABITUALLY REARFOOT RUNNERS

Vladimír Pospíchal, Jan Novotný
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

The research focused on changes in running economy – minute oxygen uptake, heart rate. We have compared forefoot run and rearfoot run at habitually forefoot runners and habitually rearfoot runners.

The research attended sixteen healthy, injury free, amateur distance runners, eight habitually forefoot runners and eight habitually rearfoot runners. The research conducted in laboratory condition on the treadmill. Testing speed was set at 12 kilometers per hour. Duration of the test was 2x12 minutes. Athletes ran one test with impact on the toe and one test with impact on the heel.

Oxygen uptake: Median habitually FFS – test forefoot: 3.156 ± 0.38 ; test rearfoot: 3.017 ± 0.42 . Median habitually RFS – test forefoot: 3.323 ± 0.31 ; test rearfoot: 3.106 ± 0.35 . Heart rate: Median habitually FFS – test forefoot: 146.10 ± 8.88 bpm; test rearfoot: 144.75 ± 11.62 bpm. Median habitually RFS – test forefoot: 170.87 ± 17.28 bpm; test rearfoot: 167.99 ± 16.20 bpm.

Habitually forefoot runners has higher oxygen uptake, when they run forefoot. Difference at habitually forefoot runners between rearfoot and forefoot is 0.139 . The proponents of rearfoot running advocate that human feet are born to run rear on the ground because our ancestors ran for thousands of years.

Keywords: *Running technique, foot strike pattern, minute oxygen uptake, heart rate, treadmill, laboratory condition*

Introduction

Running is a worldwide activity. Distance amateur running is one of the most popular activities. Running is a simple, cost efficient solution for many who wish to lose weight or improve fitness level. The popularity of long distance running has increased over the years.

Santos-Concejero et al. (2014), investigate the relationship between stride angle and running economy in athletes with different foot strike patterns. Their research focused on biomechanical variables like stride angle, swing time, contact time, stride length and frequency. Santos-Concejero et al. used optical measurement system and

oxygen uptake below the lactate threshold to calculate running economy. Running economy has been proposed as a primary determinant of competitive long distance running. Running economy is partly responsible for the vast differences in performance between athletes with a relatively high peak oxygen uptake and lactate threshold (Dallam et al., 2004). Foot strike patterns are defined as the rear foot strike pattern, in which the heel impact on the ground firstly. The forefoot strike pattern, in which the ball of the foot impact on the ground firstly. Liebermann et al. (2010) discovered that forefoot may decrease the probability of injuries. Compared to rearfoot, the proposed benefits of forefoot include decreased energy absorption at the knee, better running economy and better running performance (Landreneau et al., 2013). Humans usually run barefoot using a forefoot and run shod using a heel strike (Shih et al., 2013). Shih et al. compare 12 habitually shod runners. Barefoot running with a forefoot strike, barefoot running with a rear strike, shod running with a forefoot strike and shod running with a rear strike. The results showed a higher muscle activity in the gastrocnemius when athletes run forefoot (Shih et al., 2013).

The aim of the study is to compare forefoot run and rearfoot run at habitually forefoot runners and habitually rearfoot runners.

Methods

We used a comparative study of distance amateur runners.The research attended sixteen healthy, injury free, amateur distance runners. Eight men habitually run forefoot and eight men habitually run rearfoot. All runners were experienced long distance runners, who run no more than 3 times a week, maximally 60 minutes per one training lesson.

The test subjects completed two tests. One test ran with impact on the forefoot and the second test with impact on the rearfoot. Four habitually forefoot runners began with impact on the forefoot and four habitually forefoot runners began with impact on the rearfoot. Four habitually rearfoot runners began with impact on the forefoot and four habitually rearfoot runners began with impact on the rearfoot

The research conducted on the treadmill LODE Katana. We used MetaLyzer 3B-R2 for measuring cardio-respiratory data. For evaluating data we used software Cortex MetaSoft Studio, Microsoft excel 2010 and Statistica 12. For evaluating data we used last 5 minutes of the test period, when runners achieved steady state. We have created box graphs and data verified Wilcoxon paired test ($\alpha = 0.05$).

The research conducted in the laboratory condition on the treadmill. Duration of the test was 2x12 minutes. Testing speed was set at 12 kilometres per hour, without increasing treadmill. Athletes ran one test with impact on the forefoot and one test with impact on the rearfoot. We filmed runners on the camera to validate running

technique. The research conducted in one laboratory, at the constant temperature and same laboratory devices.

The average age of habitually forefoot runners is 25.25 ± 3.31 years, mean body height is 185.75 ± 5.19 cm, mean body weight is 76.75 ± 4.87 kg and mean BMI is 22.23 ± 0.72. The average age of habitually rearfoot runners is 26.50 ± 2.87 years, mean body height is 179.25 ± 2.77 cm, mean body weight is 72.50 ± 3.61 kg and mean BMI is 22.56 ± 0.82.

Cardio-respiratory parametres of running economy:

- Minute oxygen uptake – $\dot{V}O_2(1.min^{-1})$
- Heart rate – rate – HR ($^{b}\cdot min^{-1}$)

Results

Oxygen uptake – $\dot{V}O_2(1.min^{-1})$

If forefoot runners change their habitual running technique from forefoot to rearfoot, they have better running economy when impact on the ground rearfoot. It is demonstrated decreased of oxygen uptake when run rearfoot (Fig. 1)

The statistical analysis of foot strike pattern a significant interaction between forefoot and rearfoot strike at habitually forefoot runners (p=0.02).

Analysis of oxygen uptake at habitually rearfoot runners has better running economy when run rearfoot (Fig. 1). Wilcoxon test revealed significant interaction at habitually rearfoot runners when impact on the ground forefoot and rearfoot (p=0.00).

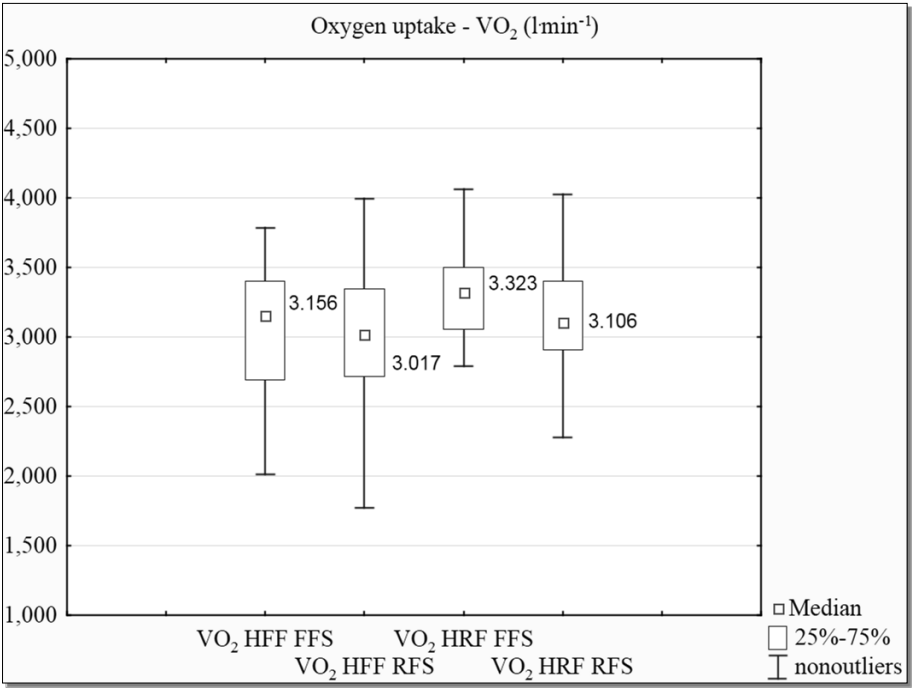

Fig. 1 Oxygen uptake at HFF and HRF runners

Legend: VO_2 - oxygen uptake, VO_2 HFF FFS – oxygen uptake at habitually forefoot runners when run forefoot; VO_2 HFF RFS – oxygen uptake at habitually forefoot runners when run rearfoot; VO_2 HRF FFS – oxygen uptake at habitually rearfoot runners when run forefoot; VO_2 HRF RFS – oxygen uptake at habitually rearfoot runners when run rearfoot

Heart rate – HR ($b \cdot min^{-1}$)

Habitually forefoot runners have lower heart rate when run rearfoot. Forefoot run is more economical when athletes run rearfoot in both groups. Difference heart rate between forefoot and rearfoot run at habitually forefoot runners is 1.35 $b \cdot min^{-1}$ (Fig. 2). Significant difference between habitually forefoot runners when run forefoot and habitually forefoot runners when run rearfoot is p=0.00. Difference heart rate between forefoot and rearfoot run at habitually rearfoot runners is 2.88 $b \cdot min^{-1}$ (Fig. 2).

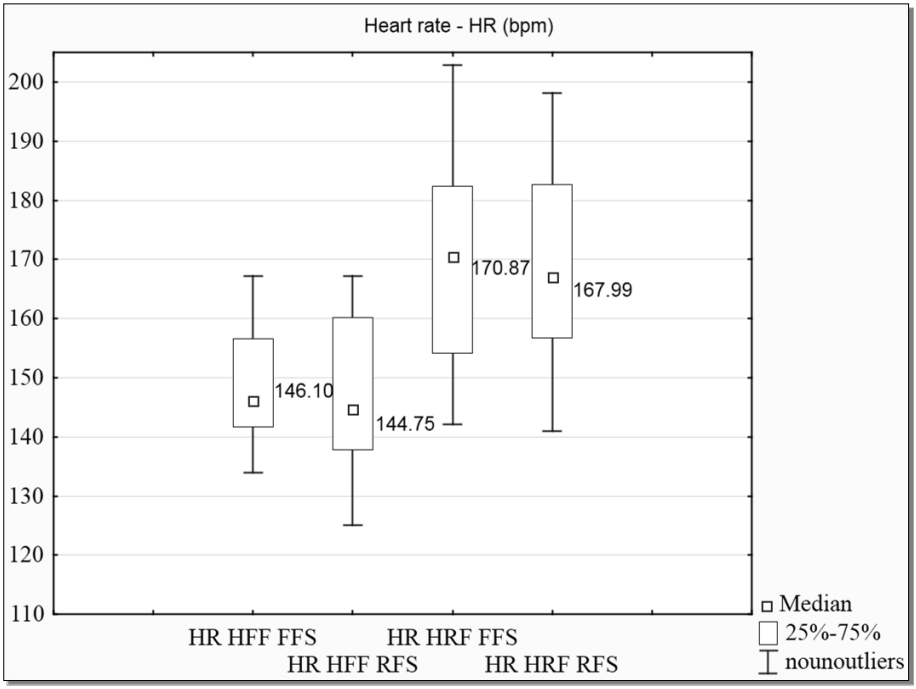

Fig. 2 Heart rate at HFF and HRF runners
Legend: VO_2 - oxygen uptake, VO_2 HFF FFS – oxygen uptake at habitually forefoot runners when run forefoot; VO_2 HFF RFS – oxygen uptake at habitually forefoot runners when run rearfoot; VO_2 HRF FFS – oxygen uptake at habitually rearfoot runners when run forefoot; VO_2 HRF RFS – oxygen uptake at habitually rearfoot runners when run rearfoot

Discussion

In the study we assumed that habitually impact on the ground affect cardio-respiratory rate. We assumed that habitually forefoot runners will have better running economy when they run forefoot. Habitually forefoot runners has higher oxygen uptake, when they run forefoot. Difference at habitually forefoot runners between rearfoot and forefoot is 0.139 $1.min^{-1}$

The proponents of rearfoot running advocate that human feet are born to run rear on the ground because our ancestors ran for thousands of years without high-technology sports shoes, which were not invented until 1970s. The proposed advantages of

rearfoot running include gait changes resulting in a lower collision force, a reduction in running economy, and an increase in movement perception and muscle strength (Shih et al., 2013). In the study of Boyer et al. (2014), more than 75% of runners said they were interested in running rearfoot, primarily to reduce chance of injuries in the future. From a biomechanical viewpoint, the most difference between running performance is the landing pattern. Forefoot or midfoot are considered less efficient running because the centre of pressure trajectory of these running technique goes backward after impact on the ground and subsequently goes forward if the centre of pressure trajectory of the rearfoot goes forward directly after landing. Forefoot resulted in decreased effective mass in the lower extremities and decreased collision force during running (Shih et al., 2013). Boyer et al., (2014) states that 11 of 15 habitually forefoot runners impact on the middle foot. When habitually forefoot runners ran rearfoot, habitually forefoot runners landed farther back on their heel (Boyer et al., 2014).

Almeida et al., (2015) determine the distribution of the foot strike patterns among amateur shod runners and to compare the individual training characteristics between runners with different foot strike patterns. 514 amateur shod runners older than 18 undergo cross sectional study. Runners were instructed to run 25 m laps on the track and run back to the start. The participants were instructed run at a comfortable speed that was measured. 95.1% of the runners were rearfoot runners, 4.1% were midfoot runners and 0.8% were forefoot strikers (Almeida et al., 2015).

Limitation of this study may be running speed. We set running speed 12 km. $^{h-1}$. The idea of running speed was to achieve steady state. In the beginning of the study we tried running speed 14 kilometers per hour as Noakes (2003). Noakes (2003) discovered relationship between running economy and oxygen uptake at professional athletes. Running speed Noake´s study was 14.5, 16.1 and 17.7 km. $^{h-1}$ Difference in running economy at different speed presented Helgerud et al., (2010). Fifteen well-trained distance runners completed 5 min runs at speed ranging from 8 to 17 km, $^{h-1}$ representing intensities ranging from 60 to 90% of maximal oxygen uptake. Helgerud et al,. (2010) means that running economy measured at submaximal speed are representative for running economy at race speed for distance above 10.000, for most runners. Running speed 14 kilometres per hour was for our study inadequate. Amateur distance runners achieve anaerobic threshold. They didn´t achieve steady state.

I think that athletes may run rearfoot at slower running speed regardless they are habitually forefoot or rearfoot runners. When distance runners increasing running speed, foot strike pattern may change from rearfoot to midfoot and at race speed run forefoot. This study follows up cost of energy and doesn´t deal biomechanics of running. Biomechanics of running may be in conflict with running economy. If we want to run for a long time, in steady state, without wasting energy it is preferable run rearfoot at individual running speed.

Conclusion

We can assume from obtained results that habitual running doesn´t influence running economy. Lower indications oxygen uptake has runners with impact on the ground forefoot. But if we are interested in habitual foot strike, forefoot runners has better running economy when run rearfoot. They have lower value oxygen uptake and heart rate at rear foot strike.

Rearfoot strike is likely to be more economical but the forefoot strike appears to be more desirable (Santos-Concejero et al., 2014).

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RELIABILITY ANALYSIS OF THE 94 FIFTY SMART SENSOR BASKETBALL

Tomislav Rupčić, Ljubomir Antekolović, Damir Knjaz, Bojan Matković, Vjekoslav Cigrovski
Faculty of Kinesiology, University of Zagreb, Croatia

Abstract

The 94Fifty Smart Sensor Basketball, manufactured by InfoMotion Sports Technologies, Inc., allows measurement of certain kinematic parameters in the process of shooting the ball (the speed of performing the shot; the angle at which the ball enters into the basket; and the rotation of the ball during the shot), as well as in the process of dribbling the ball (the number of dribbles and control of the ball). This Smart Sensor Basketball is equipped with a number of sensors inside the ball which allows the user direct monitoring of the results on a computer in an appropriate programming interface connected via a Bluetooth connection. To be more precise, the aim of this study was to compare the results obtained from a 94Fifty Smart Sensor Basketball with the results obtained by video analysis (a DMC-FZ200 Panasonic camera operating at 100Hz; Kinovea software 0.8.15) while examining the following two parameters: the speed of performing the shot and the angle at which the ball enters into the basket. For the purpose of this study, a total of 80 shots were taken; 40 three point shots and 40 two point shots. The results (ANOVA) indicate that there are no significant differences (angle: p=0,10; speed: p=0,08) in the obtained values for the examined parameters in relation to the manner the results were produced - by video analysis or by using the Smart Sensor Basketball. In addition, there is a statistically significant correlation between the two methods of determining the above parameters (angle: 0,98; p<0,05; speed: 0,96; p<0,05). Based on the results of this study, the conclusion can be made that the 94Fifty Smart Sensor Basketball has a practical value as it allows obtaining the results in real time, which ultimately provides coaches with an objective confirmation of their subjective assessment. Likewise, the 94Fifty Smart Sensor Basketball can be used for certain scientific research which can ultimately improve basketball practice as such.

Keywords: *basketball, jump shot, angle, speed*

Introduction

The jump shot can be defined as one of the more complex elements of basketball technique (Okazaki and Rodacki, 2005).

A quality technique of performing a jump shot requires that a player has an excellent coordination of movements - the coordination between the lower and upper extremities; a good preparatory phase which will enable him a less difficult transformation of positional (horizontal) movement into vertical movement (a low position of the body's gravity centre); a good position of balance; a correct grip on the ball; with eyes on the basket (Ripoll etal., 1986), a proper and aligned semicircular lifting of the ball to the central position for the jump shot; directing the elbow of the shooting hand towards the basket while it is in central position, shooting the ball at a proper angle (Fontanella, 2006; Satti, 2004), releasing the ball using the wrist of the shooting hand (Palubinskas, 2004), the last contact with the ball being with the middle finger and the index finger, etc.

Nowadays, modern technology allows us to conduct training processes for more complex motor movements, such as after all is the jump shot in basketball, which are more reliable and accurate in order to avoid that any individual mistake during the training process is adopted on such a level that it is hard to ever correct afterwards. Basketball coaches very often use various forms of modern technology for the purpose of adopting and improving certain technical and tactical skills or for the purpose of correcting them.

It is precisely this type of modern technology that the InfoMotion Sports Technologies, Inc., invented and patented as the 94Fifty Smart Sensor Basketball (Crowley, 2011).

This measuring instrument is actually a regular basketball of standard basketball dimensions, in other words, of circumference between 749-780 mm and weighing between 567-650 grams (Official Basketball Rules, 2014), which allows measuring certain essential parameters which determine a player's situational efficiency during a game from the shooting aspect. The mentioned parameters are the following: the angle at which the ball enters into the basket, the speed of performing the shot and the number of the ball's rotations around the horizontal axis. In addition to the mentioned parameters, the 94Fifty Smart Sensor Basketball also has the option of measuring certain parameters from the aspect of ball dribbling, such as control of the ball and the number of iterations.

The Smart Sensor Basketball has previously been used for certain scientific research. In 2015, Dobovičnik and ass., attempted to measure if players perform the three point jump shot within the values which are suggested by the manufacturer as ideal for a correct shooting technique (the angle at which the ball enters into the basket = 42-48 degrees; the speed of performing the shot = < 0.7 seconds; the number of rotations around the horizontal axis = 130-150 rotations per minute). This study was performed on a sample of 52 basketball players, aged between 18 and 19, and the obtained results were lower than the values suggested by the manufacturer. This

led the authors to the conclusion that either the manufacturer suggested the incorrect criteria or that the examined sample of basketball players demonstrated a poorer shooting technique.

This was precisely the objective of our study - to establish the accuracy of the obtained results for the two kinematic parameters measured by the 94Fifty Smart Sensor Basketball: the angle at which the ball enters into the basket and the speed of performing the shot, by comparing the obtained values with the results which were received by means of video analysis.

Methods

For the purpose of this study the 94Fifty Smart Sensor Basketball was used, manufactured by InfoMotion Sports Technologies, Inc., (Figure 1.), as well as a DMC-FZ200 Panasonic camera operating at 100Hz. In order to conduct the video analysis later on and to compare the obtained results, the Kinovea software, version 0.8.15, was also used for this study.

The research was conducted in the following manner - one examinee performed a series of 40 jump shots from a distance of 6 m (two point shot) after which he performed a series of 40 jump shots from the distance of 6.75 m (three point shot).

After recording the results received from using the 94Fifty Smart Sensor Basketball, video analysis of the identical jump shots was conducted (Kinovea, 0.8.15) with the common objective of determining the values of the previously mentioned kinematic parameters.

By applying the statistical programme package STATISTICA, ver. 12, the attempt was made to establish correlative connections, as well as the possibility of certain statistically significant differences (ANOVA) between the two different methods of determining the obtained values between the two kinematic parameters which were analysed.

Fig. 1 The 94Fifty Smart Sensor Basketball (www.94fifty.com)

Results and Discussion

Upon analysing the obtained results it was clear that there are no statistically significant differences between the results received after using 94Fifty Smart Sensor Basketball and the video analysis of the jump shots (Table 1.). On the contrary, correlative connections were found between the two methods of determining the mentioned kinematic parameters (Table 2. and Table 3.).

Tab. 1 Univariate analysis of variance – determining statistical differences between the two methods of measuring the speed of performing the shot and the angle at which the ball enters into the basket (94Fifty Smart Sensor Basketball/video analysis)

Var.	Multiple R	Multiple R2	Adjusted R2	SS Model	df Model	MS Model	SS Residual	df Residual	MS Residual	F	p
SPEED	0.13	0.01	0.01	0.04	1	0.04	2.43	158	0.01	3.02	0.08
ANGLE	0.12	0.01	0.01	24.80	1	24.80	1443.93	158	9.13	2.71	0.10

Tab. 2 The correlation between the 94Fifty Smart Sensor Basketball and video analysis - variable „SPEED“

	Marked correlations are significant at p < ,05000; SPEED			
Variable	Means	Std.Dev.	94Fifty	Video analysis
94Fifty	0.82	0.11	1.00	0.96
Video analysis	0.78	0.13	0.96	1.00

Tab. 3 The correlation between the 94Fifty Smart Sensor Basketball and video analysis for the variable „ANGLE“

	Marked correlations are significant at p < ,05000; ANGLE			
Variable	Means	Std.Dev.	94Fifty	Video analysis
94Fifty	42.28	3.09	1.00	0.98
Video analysis	43.07	2.94	0.98	1.00

Many authors consider that the mentioned kinematic parameters - the angle at which the ball enters into the basket and the speed of performing the shot, are extremely important for the situational efficiency of a player (Okazaki and Rodacki, 2012).

The speed of performing the shot (the time between catching the ball until releasing it towards the basket) is very often described as an important factor of

a player's shooting efficiency, which makes sense, as the shorter the time interval is between the moment of receiving the ball until the moment of releasing it towards the basket, the harder it is for the defensive player to defend the jump shot (Fontanella, 2006; Rojas, 2000). The speed of performing the shot, besides a proper technique of shooting the ball, strongly depends on the preparatory phase for the jump shot. In other words, it is generally considered that if a player does not utilize well the ground reaction force, he will have more difficulties with transforming the horizontal movement into a vertical one, which will in the end reflect on the speed of performing the shot due to the consequential relationship of lowering the ball in the moment of receiving it. In order to perform a jump shot quickly and well enough, a player should be positioned in a lower position of the body's gravity centre with slightly bent lower extremities just before receiving the ball (Krause, Meyer, Meyer, 2008).

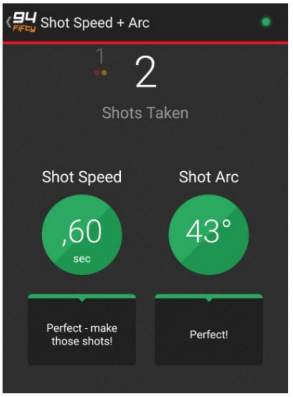

Fig. 2 An illustration of kinematic parameter results for the speed of performing the shot and the angle at which the ball enters into the basket obtained by using the 94Fifty Smart Sensor Basketball (software 94 fifty)

The angle at which the ball enters into the basket is closely related with the angle at which the ball is released (Okazaki, 2015) and it is also defined as an important factor for a player's situational efficiency during the game (Okazaki and Rodacki, 2012). A higher angle at which the ball enters into the basket enables the player to be more precise as in that case the ball has more space for passing through the basket (Fontanella, 2006). Especially among younger players, attention should be paid to this parameter as it is very often that the ball demonstrates a lower parabolic trajectory due to certain mistakes in the motor execution of the shot such as: a poor use of the ground reaction force, not directing the elbow of the shooting hand in the direction of

the basket when in the central position for the jump shot, a disrupted coordination - alignment of movements, etc.

It is very important to state that this "device" has a wide range of use in practice, that is, in training of young players as it enables feedback in real time which makes it possible to immediately apply certain corrections in performing the shot. However, it is also essential to emphasize that it can primarily be used as an objective confirmation of a coach's subjective evaluation as it is precisely the coach's knowledge and experience which are most important in the process of interpreting the results, all for the purpose of producing a high quality player (Erčulj, Marković, Broder, 2014).

Conclusion

The results obtained during this study indicate that it is possible to use the 94Fifty Smart Sensor Basketball for practical purposes, but also for scientific reasons in view of the accuracy of the obtained results.

Scientific applicability of this measuring instrument is manifested in the possibility of receiving feedback which are important for the improvement of the overall basketball training process, all with the purpose of "producing" top quality players or results.

Practical applicability comes into the picture in the process of adopting and perfecting the shooting technique in young players, as it is precisely at a younger age that it is essential to acquire the correct motor movements which will later on become automatic.

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CHANGES IN EFFICIENCY AND SPEED OF FRONT CRAWL SWIMMING TECHNIQUE OF JUNIOR SWIMMERS AGED BETWEEN 14 AND 19 YEARS OLD – A CASE STUDY

Jan Šťastný, Jaroslav Motyčka, Michaela Batorová, Miloslav Pašek
Centre for Sport activities, Brno University of Technology, Czech Republic

Abstract

In our study we focused on evaluating the results of long-term measurements of swimmers in junior categories. We have used the results of swimmers who were measured repeatedly three times during a period of measurement with at least one year delay between the measurements. We had a sample group consisting of 5 women aged between 14 and 17 years and 4 men aged between 14 and 19 years. We expected that with increasing age the swimmers will increase their speed (H1) and improve their efficiency (H2) as a result of better efficiency of swimming technique. We were also assessing the differences between men and women. In the case of women we confirmed that both the hypothesis H1 and H2 were correct, whiles in the case of men sample the hypothesis of H1 showed to be correct; however the hypothesis H2 was inconclusive. Therefore it was not possible to confirm the hypothesis H2.

Keywords: *long-term, swimming, speed, efficiency, freestyle, tachograph*

Introduction

Since 2009, our research team has been concerned with measuring the changes in the speed of swimmers. These measurements are performed primarily by competitive swimmers of junior and senior categories. So far, we have focused on the analysis of individual shots, sections, or comparisons with other swimmers. During our measurements, the selected swimmers were measured repeatedly.

In our study we focused on evaluating the results of long-term measurements of swimmers in junior categories. In this age group, we expect major changes of swimming technique and an increase of power capability of swimmers. This stage is important for successful entry into the senior category. Our question is how the variables of speed and efficiency change in junior categories over the years. What is the relationship between these variables? We expected that with increasing age the swimmers will increase their speed and improve their efficiency as a result of better efficiency of swimming technique (Šťastný, & Motyčka, 2012). We were also assessing the differences between men and women. The results of the study are important for long-term monitoring of athletes and the quality of their training.

Methods

The results were obtained using a measuring system tachograph developed by our research team. These results were subsequently processed with the help of software Swim Data Viewer. In this software, the section unaffected by push-off and touch of each swimmer was selected - after the start and the first swimming cycle (the second shot of the arm above the surface). The interval ends 2 m before the end of the section.

SW SwimdataViewer calculates results with the use of formulas shown in Fig.1.

mean speed ($m*s^{-1}$) :

$$\overline{v} = \frac{\sum_{i=1}^{n} v_i}{n}$$

efficiency of swimming technique (%) :

$$\eta = \frac{work\ at\ uniform\ speed\ (lower)}{work\ at\ real\ speed\ (higher)} = \frac{k\overline{v}^3 t}{k\Delta t \sum_{i=1}^{n} v_i^3}$$

Fig. 1. Formulas (Motycka & Stastny & Lepkova & Pasek, & Batorova, 2013)

Calculations show that:

"Efficiency of swimming technique is calculated from the work done while swimming. It is the work at uniform speed divided by actual work corresponding to the measured actual variable speed." (Motycka & Stastny & Lepkova & Pasek, & Batorova, 2013)

Swimming with minor variations in speed is less energy consuming (as less effort is needed), swimming technique is therefore more efficient.

In front crawl swimming style (the section performed by interplay of upper and lower limbs), a choice was made from among a total of 201 swimmers who underwent in total 480 separate measurements of crawl interplay.

We have used the results of swimmers who were:

1. measured for the first time at the age of 15 (±1) years
2. measured repeatedly at least three times,
3. period of measurement with one year delay between the measurements,

On the basis of selected criteria, we had a sample group consisting of 5 women aged between 14 and 17 years old +/- 1 year and 4 men aged between 14 and 19 years +/- 2 years.

In competitive swimming, the age categories are divided according to the following scale:

- younger juniors (14 - 15 years)
- older juniors (16 - 17 years)
- seniors (18 +)

All measurements are performed in the swimming pool of length of 25 m (Brno - Ponávka or SC Nymburk). We always evaluated the first section of the swimming track.

The study is limited by the following factors: the low number of swimmers and the fact that we only evaluated the first section of the track. We do not evaluate swimmers´ fitness, state of health and their level of motivation.

We set the following hypotheses:

H1) with increasing age, the swimmers will increase their speed

a) women
b) men

H2) with increasing age, the swimmers will improve their efficiency of swimming

a) women
b) men

Results

All evaluated women were measured for the first time at the age of 14. This corresponds to the category of younger juniors. The last measurement is at the age of 16 or 17 years.

Category women (fig. 2; fig. 3):

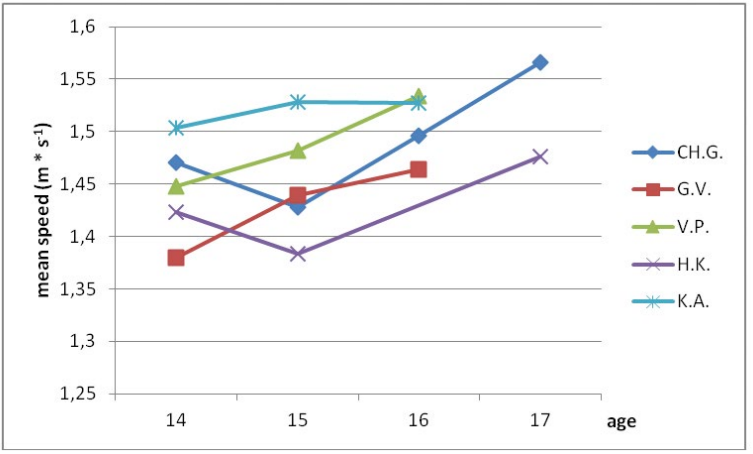

Fig. 2 Mean speed women

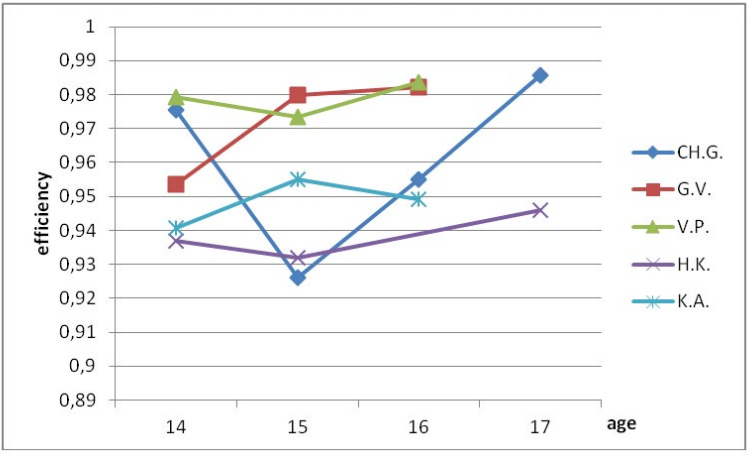

Fig. 3 Efficiency women

CH.G.

- The mean speed of swimmer during the reporting period was increasing. A decrease was reported at the age of 15.
- The effectiveness of swimming followed the development of speed. During the reporting period it was increasing; a decrease was also recorded at the age of 15.

G.V.

- The mean speed of swimmer during the reporting period was increasing.
- The highest increase of swimming efficiency was observed at the age of 15.

V.P.

- The mean speed of swimmer during the reporting period was increasing regularly. At the age of 16 it reached the highest value among all the observed swimmers.
- Efficiency of swimming during the reporting period increased only slightly. As early as at the beginning it reached the highest level among all the swimmers. A growth potential was low. We noticed a slight decrease at age of 15.

H.K.

- The mean speed of swimmer during the reporting period increased in total; a decrease was reported at the age of 15.
- Efficiency of swimming slightly increased with the exception of the age of 15. Among all the swimmers, it was the lowest achieved.

K.A.

- The mean speed of swimmer during the reporting period showed a continuous slight growth. She kept it at the highest level among all the swimmers.
- Efficiency of swimming increased slightly. At age of 15 it reached the highest level.

Category men (fig. 4; fig. 5):

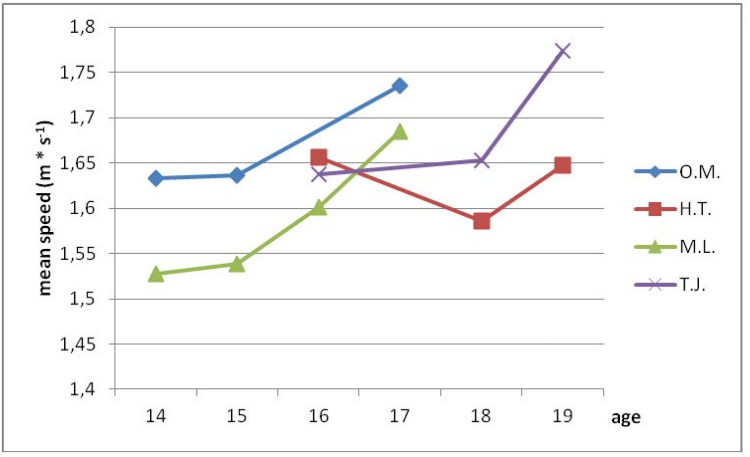

Fig. 4 Mean speed men

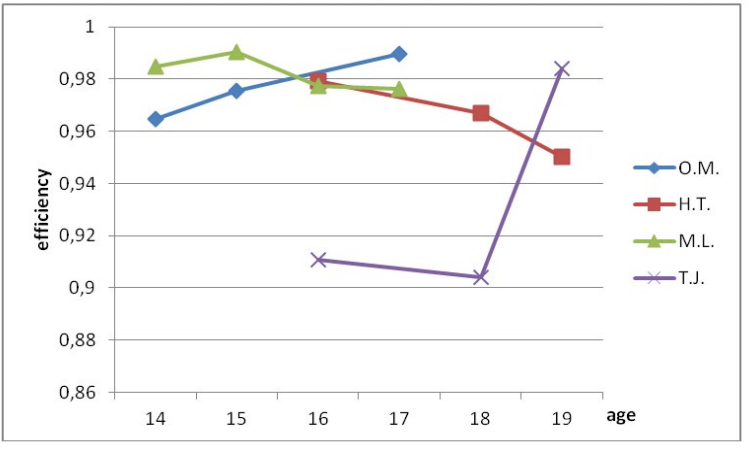

Fig. 5 Efficiency men

O.M.

- The mean speed of swimmer during the entire reporting period was increasing. At the age of 17, he reached the highest value among all the swimmers.
- Effectiveness of swimming followed the speed development. Between the age of 14 and 17, the swimmer reached the highest values among all the swimmers.

H.T.

- The mean speed of swimmer during the reporting period was decreasing. It reached the lowest value at the age of 18.
- Effectiveness of swimming was decreasing during the entire reporting period.

M.L.

- The mean speed of swimmer during the reporting period was increasing regularly (the highest values among all the measured swimmers.
- Efficiency of swimming during the reporting period decreased slightly. However it was kept at high level.

T.J.

- The mean speed of swimmer during the reporting period was increasing; most between the age of 18 and 19 years.
- Efficiency of swimming during the reporting period increased. A slight decrease was recorded at the age of 18, followed by a significant growth at the age of 19.

Discussion

In the women's category we were able to take the results of the group, which is more homogeneous than in the men's category. For men, the age range is wider and therefore less representative.

Our objective for the future is to measure and evaluate a broader sample of swimmers. The aim is to determine the manner of how their swimming speed and efficiency are developed during the transition from the junior category to the category of seniors. For many swimmers, observed for a longer period, some of the conditions for selection have not yet been met. Along with other measurements the number of persons meeting the criteria will be expanded.

In the senior category, we expect that changes in the values will fluctuate according to the current fitness and state of health of swimmers.

We attach a table of mean values of efficiency and mean speed of swimmers of the Czech Republic in tab 1.

Tab. 1 Mean values of speed, efficiency (Šťastný, & Motyčka, 2014)

category	mean speed ($m*s^{-1}$)	efficiency
men + women (N=96)	1.568	0.972
men (N=52)	1.662	0.974
women (N=44)	1.457	0.970

Category women:

A graphical representation of the results of swimming efficiency of all swimmers followed the graph of mean speed. With increasing efficiency, the increase in mean speed was recorded in most cases. However it was not true that the fastest swimmers should always be more effective than the swimmers with a lower mean speed.

The speed and efficiency of swimming of all women increased during the period.

For measured women we expect a further increase in the mean speed during the transition to the senior category.

Category men:

A graphical representation of the results of swimming efficiency with a half of recorded men copied the graph of mean speed; the other half showed the results independent of each other.

In 3 out of 4 men swimming speed grew in the monitoring period , but efficiency did not follow this trend.

Swimmer H. T. - In the case of this swimmer, the measured decrease in mean speed did not match a gradual increase in the best results of the competitions. A deviation may be caused by the first measurement when, in terms of percentage, the swimmer was very close to his best performance achieved at the age of 17.

Conclusion

In category of women, with increasing age swimmers in all the cases increased their mean speed of swimming and their efficiency of swimming during the recorded period.

Both hypotheses H1a) and H2a) are confirmed.

Category of men - with increasing age the swimmers in 3 out of 4 cases increased their mean speed of swimming. In one case, the speed was almost unchanged; however, in the last measurement it showed an upward trend.

The hypothesis H1b) is confirmed.

In two cases, the efficiency of swimming increased during the recorded period; in other two it decreased.

The hypothesis H2b) is not confirmed.

At this stage we are considering to extend the study using a larger sample group over a longer period of time. As a result we will be able to confirm more firmly how the aspects of H1 and H2 impact the men and women swimmers.

Furthermore, we are planning to evaluate more swimming sectors, not only the first one.

In the case of women sample it was confirmed that both hypotheses H1 and H2 were correct, whiles in the case of men sample, the hypothesis H1 showed to be correct; however the hypothesis H2 was inconclusive. Therefore it was not possible to confirm the hypothesis H2.

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PLANTOGRAPHY OF CHILDREN OF PRIMARY SCHOOL - COMPARING OF PLANTOGRAMS

Jaroslav Vrbas, Lenka Máčková
Faculty of Education, Masaryk University, Brno, Czech Republic

Abstract

The goal of the research is to find out if plantogram formed by putting colour on foot (a terrain method) is comparable with plantogram formed on podoscope (a laboratory method). Five chosen terrain methods Mayer´s mothod, Method segments, Method index, Chippaux – Šmiřák method, Clark angle (Vařeka, 2009), The visual – range of Klement in Urban (2000) were used in solution of diagnostics of a state of foot arch and visual range created by Josef Klement. I had compared results of individual terrain methods and visual range of plantogram formed by putting colour on foot with results of individual terrain methods and visual range of plantogram formed by podoscope. More than 63% of similarity between these two differently formed plantograms (a similarity in results of terrain methods and visual range) as a result of measuring and more than 73% of plantograms was identical in visual range (the most important accordance is in shape of plantogram). The main finding is that plantograms have the same shape in more than 70 % and also that plantograms formed by putting a color on a foot partly don´t show or don't show high foot. Both types of plantograms were tested on 30 children (of fifth grade). Five terrain methods (Chippaux–Šmiřák, Method of index, Method of segments, Mayer´s method, Clark´s angle) and visual range of Josef Klement were used to find a solution. The results of terrain methods and visual range of plantogram formed by podoscope were compared with the results of terrain methods and visual range of plantogram formed by putting colour on foot. Accordance between these two differently formed plantograms is expressed in percentage.

Keywords: *Flat foot, normally arched foot, foot arch, plantogram, terrain methods, podoscope.*

Introduction

The fallen arches (flat feet) are one of the most frequent defects of the foot. According to the data of orthopaedic surgeons, about 80% of our population suffer from the wrong construction of the foot (Zvonař, 2009).

Although the problem of the fallen arches is widely known, the seriousness of this disease is still underestimated. The change in the function of the foot can affect the physical activity of a human, therefore fatigue or depressions may occur (Véle, 2006). After previous experience especially with softer surfaces there can be expected negative effects on the foot arch and influence on plantar pressure distribution during normal walking (Zvonař, 2012).

A human does on average 100,000 km in their life, i.e. 8,000-10,000 steps per a day; therefore, we should take great care of our feet (Jaroslav, 2006).

The fall of the foot arch is possible to be recognized as early as at the age of four according to some authors addressing the issues of the fallen arches; the others say it is possible at the age of six or seven. According to Přidalová (2006), the forming of the foot arch is finished at the age of about six and from this age, the foot should function in the same way as the foot of an adult.

In any case, we should monitor the growth and forming of child's foot, which grows in steps, regularly, because the consequences of damages to the feet in childhood may manifest themselves in 30 or 40 years. Children have a reduced pain threshold, therefore they do not usually complain about small shoes that pinch (Přidalová, 2006).

To be able to monitor the formation and growth of the feet of primary school children regularly, we need to know the way to get footprints (plantograms) and to evaluate the condition of the foot soles.

The aim of this paper is to find out whether the footprint created by application of paint to the foot is of the same quality as the one created by a plantograph, to be specific by a static plantograph-podoscope, and which of five field methods with a visual scale is the most suitable for the diagnostics of the foot arch for primary school educators.

Due to the fact that we created the plantograms using the application of paint to the foot in September 2014 and March 2015, the changes to the pupils' feet can be compared.

Methods

The footprint or the plantogram can be obtained by various methods; using the plantographs (static, dynamic) or by application of paint on the foot.

The plantograms were obtained in September 2014 and March 2015. The footprints were provided by the total of 33 pupils attending the fifth class in September 2014 and 30 pupils of the fifth class in March 2015 (classes of 5. A and 5. C) of the Elementary School and Kindergarten Chalabalova 2, Brno. To compare the two differently created plantograms, we used five field methods together with the visual scale by Josef Klementa (1987). We chose these methods since they are often used

in practice to evaluate the condition of the foot sole by various physiotherapists addressing the issues of the fallen arches. The methods include Chippaux-Šmiřák, the Clark angle, the Mayer method, the index method and the segment method. We compared the plantograms using the five various methods as none of them is generally accepted as the totally suitable and flawless one. For more objective assessment of the plantograms, we used results of multiple field methods. The visual scale by Josef Klementa was chosen for the assessment of plantograms for the reason of graphical representation of individual grades of the high-arched foot. To compare the accuracy of individual methods, we measured the probands (respondents) also by a laboratory apparatus – a podoscope, and we compared the created plantograms with the field methods.

The basic descriptive statistics were used for the mathematical expression.

Results

We compared 30 plantograms created by paint on hard paper, the A3 format, and 30 plantograms made using the podoscope. The plantograms were compared both visually and according to the results of five various measurement methods. We took the sharpness and the clarity of the plantograms into consideration in the results.

Out of 30 plantograms, 19 were identical in the overall result (63.3%) Although the plantograms were not completely identical, they featured the same result of measuring for each method - the fallen arches or the normally arched foot (the minimum match of 3 field methods out of 5). The most important criterion was the match of the podograms with the visual scale since the visual scale is the measure for orthopaedic surgeons as well as for physiotherapists and it is the most frequent way to recognise the fallen arches, the normally arched foot or the high-arched foot.

In the remaining 11 cases, the plantograms were inconsistent in the overall evaluation, mainly due to bad representation or none representation of the high-arched foot on the plantograms created by paint. Out of 11 cases, the high-arched foot was badly depicted or was not depicted at all in the colour plantogram in 8 cases (26.7 %), therefore the results of measuring of both the types of podograms did not match in multiple field methods and the visual scale.

In the remaining three cases, the measuring results of both the plantograms did not match in the field methods either, but they featured the same results of the evaluation using the visual scale. The plantograms created using the podoscope have a similar shape to the shape of plantograms created by the application of paint on the foot and they match the visual scale in 22 out of 30 cases (73.3%).

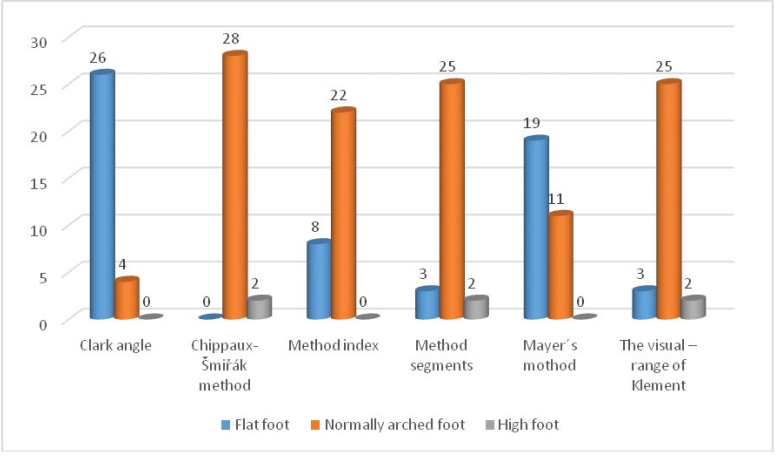

Fig. 1 The evaluation results plantogram left foot

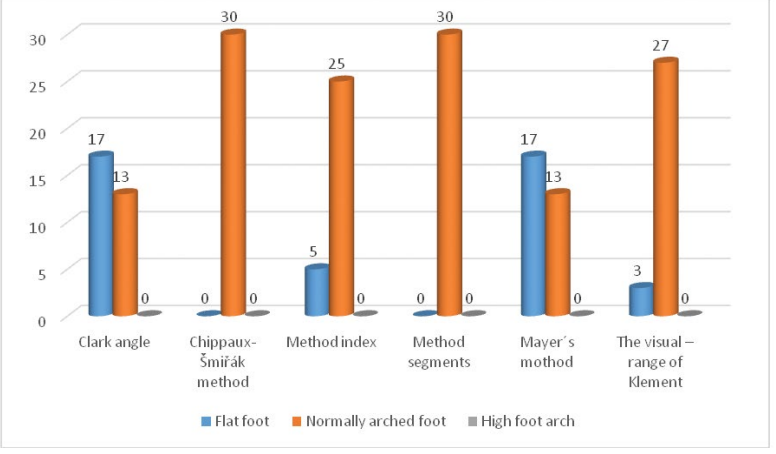

Fig. 2 The evaluation results plantogram right foot

The plantogram which was created by paint on hard paper, is, in our opinion, as reliable as the plantogram created by the podoscope. Various types of foot deformation were shown both in the colour plantogram, and in the plantogram from the podoscope. Unfortunately, the colour footprint does not show the high-arched foot or its representation is not fully accurate. However, this type of footprint is more

suitable for counting and evaluation of each field method (better quality footprint in terms of clear/sharp edges without the need for additional adjustments).

Discussion

With respect to the measured results, we can conclude that the segment method and the Chippaux-Šmiřák method match the visual scale most. The index method does not match the visual scale in most cases and the method of the Clark angle and the Mayer method show results totally different from the results of the visual scale by Josef Klementa. The best utilizable method in practice is the segment method followed by the method Chippaux-Šmiřák. With regard to the simplicity of each measurement, we prefer the segment method more; the pupils do not have to count anything, they simply draw the basic geometric formations.

The results of the segment method are closest to the visual scale by Josef Klementa. That is why we believe that the segment method is the most reliable out of the five field methods (the segment methods, the Chippaux-Šmiřák method, the index method, the Clark angle and the Mayer method). The segment method suits the practice most even in terms of demands on primary school pupils.

Conclusions

The aim of the contribution was to determine the similarity of the plantogram created by the application of paint to the foot with the static plantogram created using the plantograph (podoscope). To solve the issue, we used footprints (plantograms/ podograms) of 30 pupils which were measured and evaluated using five various field methods and the visual scale of Josef Klementa.

Both the types of plantograms were compared in terms of their mutual match in results of five various field methods and the visual scale. It was also evaluated how the both the kinds of plantograms match in the visual scale for the reason that the match in the shape of both the plantograms is the most important criterion for the evaluation of the quality of the plantogram created by the application of paint to the foot.

The research set consisted of 30 probands, therefore the results cannot be generalized. It was found out that the plantogram created by the application of paint to the foot is as good as the plantogram created using the podoscope on the basis of the similarity of the shapes of two differently created plantograms. In most cases, the shapes of plantograms were similar (in the visual scale) - in more than 73 %.

In the cases when the shape of the plantogram created by the application of paint to the foot was not similar to the shape of the plantogram created on the podoscope - more than 26 % - is caused by the failure to show or by incorrect representation of the

high-arched foot. On the podoscope, the high arches were always shown, unlike the application of paint to the foot, when the high arches were not shown.

In terms of the plantograms created by the application of paint to the foot, I highly appreciate the clear edges and readability. The plantogram which is created with the podoscope, must be further corrected and the edges are unclear and fuzzy.

Due to the fact that the foot, like the entire individual, develops continuously (it arose from the measuring results that, on average, pupils' feet grew by 3.9 mm in 6 months), it is advisable to create this plantograms and to assess them with pupils more often, so that we can monitor the forming and the growth of the foot.

Recommendations for the Theory

Due to the small number of probands in the research sample, this result cannot be considered generally applicable. It is necessary to measure and evaluate the plantograms of much larger research sample, so that we can be sure that the plantogram created by the application of paint to the foot is comparable with the plantogram created by the static podograph (podoscope).

Recommendation for Practice

Primary school pupils must be appropriately motivated to create the plantograms to evaluate the condition of the foot sole (foot arch). Pupils like creating prints of their limbs (often in the art class). The pupils must be informed about the issues of the flat feet, so that they are willing to know the condition of their own feet (e.g. using measuring). We recommend that the issues of feet are introduced to various primary school subjects. The right motivation and the active approach of teachers can help many pupils to deal with the issues of the fallen arches in time.

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SOME BIOMECHANICAL CHARACTERISTICS OF SLALOM TURN DURING RACE OF ELITE ALPINE SKIERS

Ljubomir Antekolović, Vjekoslav Cigrovski, Antonio Horgas
Faculty of Kinesiology, University of Zagreb, Croatia

Abstract

The aim of this study is to determine the relationship between speed of passing through ski gates and variables of geometry of skiers' body during slalom race for the top alpine skiers. The parameters were recorded at the World Cup Race Snow Queen Trophy on 30 top alpine skiers participating in the second run. The Ariel Performance Analysis System was used to calculate the 3D kinematic data. We determined the distance of elite skiers' lines of skiing from the fall line and tried to establish whether the competitors with a shorter line of skiing in the gate setting achieve higher velocities and consequently better race results. The most significant correlation (r=0.95) was observed between the distance of outside ski boot and ski gate and projection of center of gravity to outside ski boot distance. Mentioned correlation is a result of skiers' effort to find an optimal position between outside ski and projection of center of gravity relative to the ski gate. Statistically significant and positive correlation (r=0.65) observed between distance of skiers' center of gravity and ski gate and distance between center of gravity and outside ski boot explains how greater distance of outside ski boot from ski gate required greater deflection of skiers' body toward center of turn in order to optimize the trajectory passing through the gate. Correlation of skiers' speed at gate and investigated variables of geometry of skiers' body was not overall statistically significant. The absence of significance between position of center of gravity, ski boots and velocity might be explainable by undemanding configuration of ski slope at filmed slalom turn and superb technical performance of investigated alpine skiers. Use of more advanced technology might be more appropriate for the investigation of subtle differences in the race performance among top alpine skiers.

Keywords: *slalom discipline, kinematic indicators, center of gravity*

Introduction

Past years in alpine skiing were marked by significant changes brought on by improvements in racing equipment, which, through impact on velocity, acceleration, forces and vibrations led to new technique development. Today, only subtle differences, measured in fractions of a second discriminate the best ranked skiers, so one of the main topics of both scientific and expert debates in alpine skiing is

which technique and racing turn is better in specific conditions and might affect the ski success (Supej et al., 2005). Ski turn during specific conditions of ski racing is a complex interaction between skier on one side with his technique and tactics, and on the other side equipment and ski trajectories (Haugen et al., 2010). During slalom ski racing, the technique and the strategy of choosing the right trajectory between the gates are of utmost importance, while mistakes in technique lead to loosing speed (Federolf et al., 2013). This is the reason why alpine ski coaches focus tactics on the timing and placement of the line important for the gaining and loosing speed (Sporri et al., 2010). Many authors advocate the direct trajectory as an optimal one, but others also emphasize the importance of vertical dynamics (Moger et al., 2007). Equally important is maintaining high velocity and at the same time an optimal trajectory, which can produce high centripetal force acting on the body's center of mass (Pozzo et al., 2010). During a competition, each turn must be performed technically perfect in order for a skier not to lose speed. Many studies tried to identify the phase of ski turn during which acceleration leads to better performance (Haugen et al., 2010). For this reason, advanced video analysis or 3D kinematic analysis analyses are used (Hraski & Hraski, 2007). They enable detection of precise position of specific points and segments of the body in time and space during ski turns (Lešnik & Žvan, 2007). Interestingly, published data mainly describe the results of kinematic analyses during simulated sky polygons while there were only few reports on movement kinematics during actual ski competition (Pozzo et al., 2010). In the present study, we aimed to establish the differences in the choice of the line of skiing between 30 competitors of the Zagreb World Cup slalom. Moreover, we determined the distance of elite skiers' lines of skiing from the fall line and tried to establish whether the competitors with a shorter line of skiing in the gate setting achieve higher velocities and consequently faster sliding among the slalom gates.

Methods

The sample of participants consisted of 30 slalom racers (aged 27.12±1.15) participating in the 2nd run of 2009 Snow Queen Trophy World Cup slalom (Sljeme, Croatia). Each competitor of the 2nd slalom run was filmed with four DV cameras (Sony HDR-HC9E) operating at 50 fps with shutter speed of 1/500 sec. The space calibration was done with cube (180 cm x 180 cm x 180 cm) filmed after competition on the position of analyzed slalom turn.

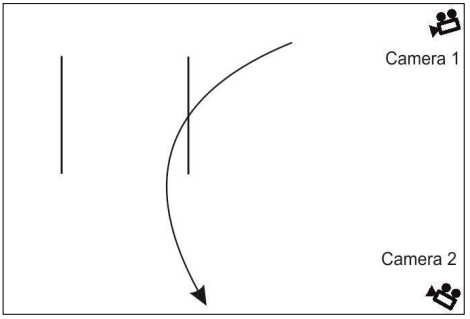

Fig. 1 Camera positions

The Ariel Performance Analysis System (APAS, Ariel Dynamics inc., USA) was used to calculate the 3D kinematic data. The kinematic variables used to describe observed slalom turn were average velocity (v) from the beginning to the end of slalom turn (Supej et al., 2003), height of center of gravity (hcg) at the moment parallel to the ski gate, center of gravity to gate distance (dcg) calculated as a horizontal distance from projection of CG to the ski gate at the moment parallel to the ski gate, inside ski boot to the gate distance (dibg) as a distance from inside ski boot to the gate, outside ski boot to the gate distance (dobg) as a distance from outside ski boot to the gate and projection of center of gravity to outside ski boot distance (dcgob) as a distance from CG projection to the outside ski boot. The Statistica ver. 7.1 (StatSoft, Inc., 2006) was used to calculate descriptive statistics and correlation.

Results and Discussion

Skiers' average speed during analyzed turn was 12.74 ms^{-1}, ranging from 12.11 ms^{-1} to 13.26 ms^{-1}. The results were similar as reported in other investigations (Lešnik & Žvan, 2007). Projection of center of gravity (CG) was 8.17 cm from pole to the center of turn, which is used as a sign of efficacy during slalom turn. Average distance between outside ski boot to the gate measured 67.71 cm. The height of center of gravity averaged to 44.03 cm (Table 1), which is compatible to results of similar studies (Schiefermuller et al., 2004).

Tab. 1 Descriptive statistics

variable	N	Mean	Min	Max	Std.Dev.
v (ms^{-1})	30	12.74	12.11	13.26	0.29
hcg (cm)	30	44.03	37.81	47.73	2.71
dcg (cm)	30	-8.17	-26.99	16.30	11.49
dibg (cm)	30	21.35	1.78	54.99	14.28
dobg (cm)	30	67.71	41.41	103.49	19.03
dcgob (cm)	30	55.62	17.16	94.51	21.69

Legend: v - average velocity; hcg - height of center of gravity; dcg - center of gravity to gate distance; dibg - inside ski boot to the gate distance; dobg - outside ski boot to the gate distance; dcgob - projection of center of gravity to outside ski boot distance

Correlation of skiers' speed at gate and investigated variables of geometry of skiers' body was not statistically significant (Table 2), mainly explainable by sample's homogeneity and subtle results variance. Important correlations are between position of center of gravity, ski boots and gates. Statistically significant and positive correlation (r=0.65) observed between distance of skiers' center of gravity and ski gate (dcg) and distance between center of gravity and outside ski boot (dcgob) explains how greater distance of outside ski boot from ski gate required greater deflection of skiers' body toward center of turn in order to optimize the trajectory passing through the gate.

Tab. 2 Correlation between analyzed variables

variable	**v**	hcg	dcg	dibg	dobg	dcgob
v	1.00	-0.23	-0.11	-0.19	-0.14	-0.09
hcg		1.00	-0.12	-0.05	0.03	0.00
dcg			1.00	0.40*	0.50*	0.65*
dibg				1.00	0.84*	0.75*
dobg					1.00	0.95*
dcgob						1.00

Legend: v - average velocity; hcg - height of center of gravity; dcg - center of gravity to gate distance; dibg - inside ski boot to the gate distance; dobg - outside ski boot to the gate distance; dcgob - projection of center of gravity to outside ski boot distance; * - significant at p=0.05

The most significant correlation (r=0.95) was observed between the distance of outside ski boot and ski gate (dobg) and projection of center of gravity to outside ski boot distance (dcgob). Mentioned correlation is a result of skiers' effort to find an optimal position between outside ski and projection of center of gravity relative to the ski gate (Tudor et al., 2009; Flores at al., 2013). From the set point of ski technique, good ski result is a consequence of best possible relationship between speed of skies and choosing a best trajectory during ski turn, with respect to terrain configuration and position of gates (Schiefermuller et al. 2005; Lešnik & Žvan, 2007). The absence of significance between position of center of gravity, ski boots and velocity might be explainable by undemanding configuration of ski slope at filmed slalom turn and superb technical performance of investigated alpine skiers.

Conclusion

In the present investigation we found no overall significant correlation between position of center of gravity, ski boots and velocity most probably explainable by undemanding configuration of ski slope at filmed slalom turn and superb technical performance of investigated alpine skiers. We did notice significant correlations between the distance of outside ski boot and ski gate and projection of center of gravity to outside ski boot distance as well as the correlation observed between distance of skiers' center of gravity and ski gate and distance between center of gravity and outside ski boot. It is possible that use of more advanced technology such as high speed video cameras, adequate application etc. might be more appropriate for the investigation of subtle differences in the race performance of top alpine ski racers.

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MARTIAL ARTS AND COMBAT SPORTS

THE MEANING OF SELF-DEFENCE: AN EXPERT DEFINITION. A CONTRIBUTION TO THE THEORY OF SELFDEFENCE AND COMBAT

Wojciech J. Cynarski
University of Rzeszów, Rzeszów, Poland

Abstract

The theoretical perspective outlined is taken from the Humanistic Theory of Martial Arts and the anthropology of martial arts. The aim of this study is to describe and attempt to explain the rapid growth in self-defence arts in the West today and to consider the forms in which they are manifested. Three complementary qualitative research methods were used: long-term participant observation, a content literature analysis, and that of competent judges/expert courts. These were considered along with a broad thematic discourse of sources and studies. There was only one question put to the self-defence experts: What is the meaning of self-defence, its substance and manifestation in Western countries today? Responses came from three European experts two are the holders of 10 dan the highest rank in *goshinjutsu* (the art of self-defence), and the third has wide experience as a bodyguard. Direct quotations are included, as are an analysis of sources (books, videos, organizational documents), and scientific studies. The results are presented in three parts: definitions; experts' opinions, and discussions. The basic canon of real combat, self-defence techniques, and tactics used by participants are used. Experts point to the need for specialist training. The effectiveness of self-defence requires: fairly high versatility in training in, and selection of, really effective techniques; appropriate teaching methods, and psychological knowledge. Only the ability to fight a variety of distances and positions, and the selection of appropriate techniques can ensure victory in actual combat (a real fight).The meaning of self defence is recognized in a variety of ways and it manifests itself differently. The extreme commercialized version of this is often the only product for sale. This is sometimes the main understanding of martial arts training as well.

Keywords: *fighting skills, self-defence, jujutsu, effectiveness, real fight*

Introduction

The Humanistic Theory of Martial Arts takes into account the cultural context, as it relates to the art of self-defence. Security culture is a fundamental concept of the science of safety. In military cultures, like those of medieval Japan, this was relatively highly developed.

There are current and ongoing attempts to determine and describe these models [*cf*. Cooper, 2000]. There seems to be most interest in the particular heritage of the countries and cultures of eastern and south-eastern Asia, and the studies also include the utilitarian value of the martial arts created there.

Juliusz Piwowarski and Vasyl Zaplatynskyi have formulated a definition of the culture of security/defence under discussion as follows: Security culture is the sum of the fixed, material and non-material achievements of mankind that serve their defence as understood both militarily and non-militarily. It is a trichotomy that consists of three streams: the mental and spiritual; the organizational and legal, and the material. A security culture allows mankind to achieve the following objectives:

- Maintaining and cultivating the state without danger, in relation to a certain individual and collective entity, or having efficient control over arising threats;
- Restoring security in situations where it is lost increase in particular threats towards the entity;
- Optimizing levels of multi-aspectual security of a particular entity (comprehensive security);
- Stimulating social and personal awareness of and belief in the need for self-improvement and three-part development on the personal and social scale, the creation of motivation and attitudes that result in individual and collective actions consistent with these beliefs, and an increase in the potential of autonomous defence of individual and the collective subjects of security [Piwowarski 2014: 449].

The art of **self-defence** (Jap. *goshinjutsu*) is a derivative of the fighting arts. It has changed over the years as threats in social life have modified. In the past, it would be an assault by stabbing or cold steel hence fencing skills determined survival. Nowadays, the term refers to hand-to-hand fighting, including using a staff and knife fighting, etc. However, the art of self-defence has its own characteristics; it is not merely the sum of the skills borrowed from *jujutsu*[1] or other martial arts/combat sports.

Self-defence is mentioned by many authors. They sometimes possess authentic, first-hand knowledge about the subject. Methods of teaching self-defence often pertain to reactions to common threats and types of assault. Course books and "teach-yourself" manuals based on *jūjutsu* have been published for more than a hundred years [André 1905; Cynarski 2008]. The theory of self-defence [Raczkowski 2008;

1 Self-defence (goshinjutsu) is a subsystem within the martial art of jujutsu. Some experts however identify jujutsu with self-defence

Cynarski 2009b] should refer to a selection of psychological, tactical and technical aspects of fighting. It may also contain information about the prevention of threats, crime statistics (types of assaults) and descriptions of legal aspects of self-defence. There is, for humanitarian reasons, the need to include first-aid pre-medical help in the course of learning. How therefore, to define self-defence? It can be assumed that it is "technical and tactical skills to avoid or fend off an attack and neutralize the attacker/s" [Cynarski, Skowron 2014].

These are the findings of the basic proposals. Self-defence and fighting tactics differ from combat sport tactics, which are adapted to particular sports regulations. There are, however, suggestions common to the different fighting arts. These include:

1) purposefulness and rationality of activities, an economical and planned way of conducting fights;
2) assessment of the situation – who the opponent is, his strong and weak sides and the conditions of the confrontation;
3) self-assessment of one's own abilities (predispositions and skills) and adapting them to the situation.

In a real fight one should take into consideration the following factors: the number of opponents, their weapons, terrain conditions (space, ground, lighting), the ability to use some objects for protection or for calling for help. There is a limited amount of time for reconnaissance and planning. A competitor is often forced to confine himself to his trained automatic reactions – the automatism of the chosen fight techniques. It is important for the fighter to position himself in such a way as to prevent an attack from the rear. If long range weapons are used by the rivals, barriers are used (walls, furniture). An attacker should be neutralised as fast as possible. If there is more than one attacker, it is crucial to avoid fighting from a prone position and to control the armed hand or weapon of the assailant. We should remember that a thug never plays fair.

A well-trained warrior should be able to fight with a simple stick, an umbrella, a walking stick or any other object. For instance, an arm wrapped in a jacket or a coat can be used for protection and to block knife stabbings. We should realise though, that in case of an assault by armed attackers, a successful defence is only possible in the movies in which heroes are bulletproof. It is sometimes better to retire from a confrontation if the odds of winning are non-existent, provided that it is not a struggle for honour and higher values. The warrior should be able to use proper tactics against a puncher and a catcher who tries to establish ground fighting; against an aggressive assailant and one who prefers to counter-fight; against a short or a tall one; against light and fast or heavier and stronger. It is sometimes more beneficial to delay action; at other times an immediate reaction is needed.

If the opponent is unknown to us, we have to establish his skills and preferred style of fighting. The boxer can be recognised by the guard position: the Thai boxer by a broad guard and the body balanced on the front leg: a wrestler by a low position (bent legs). The wrestler and *judoka* will aim for a grapple and contraction. Observation of the opponent's behaviour makes it possible to enforce one's own style. The rival should not be allowed to perform what he is very good at. That is why a boxer should be attacked with low-kicks at his normally-weighted front leg. One can use knees and high kicks always bearing in mind the high guard. A dangerous puncher should be taken down to ground fighting (joint locks and chokeholds), whereas a grappling attacker would be better kept at a distance (the use of counterattacks, escaping from grappling).

A more versatile warrior obviously has a bigger chance of coping in the fight as he possesses a wider spectrum of techniques and large range of possibilities with which to win the fight tactically. Nevertheless, it is often psychological resistance and self-confidence which decides the winner. If the rival gets scared, he has a less chance of winning; if he belittles the opponent, he will most likely make a mistake and lose. If his attempts are unsuccessful for some time, he will be helpless and this is the best moment to take the initiative. The experienced warrior does not get surprised or mistaken easily, he is constantly alert and careful. He saves his powers and follows his tactics, modifying them whenever the need arises.

Rhythmic breath is crucial for maintaining inner balance – deep diaphragm stomach breathing is better. This also is connected with the oxygenation of the organism. Avoiding fast and shallow breathing prevents stress from blocking our fighting skills. It is also important not to get hit when inhaling. Thus every technique is practised together with breath and muscle tension – *kime.*

Rhythm and timing are controlled over the length of the fight. Attaining these skills demands special training with a *sensei* or a trainer. An appropriate length of time means the time during which we manage to protect ourselves or attack and prevent a physical assault by the opponent. We are trying to impose our own rhythm on the fight. Having met an asynchronic contestant, one needs to be prepared for his changeable rhythm. At the same time, the right time to take the initiative ("timing") demands superb reflexes. Blocking also needs to be done on time, not too fast, not too late. Adapting timing and predicting the attack is surprising and often the most important element, allowing a fighter to win even over a couple of assailants [Sieber, Cynarski 2012].

Apart from the abovementioned rules, there are also those deriving from the general tactics and techniques of a particular method/martial art e.g. *jūjutsu* [*cf.* Cynarski 2009a: 122–124] or derived from an individual's predisposition, habits and consolidated movements. Therefore, people trained in kick-boxing, *kyokushin* karate, *teakwondo* WTF or a classical *kung-fu* style will fight differently.

Methods

Three complementary qualitative research methods were used: a long-term participant observation, a content literature analysis, and that of competent judges/ expert courts. These were considered along with a broad thematic discourse of sources and studies [Krippendorf 2004].

There was only one question put to the self-defence experts: What is the meaning of self-defence, its substance and manifestation in Western countries today? Responses came from three European experts (from Germany, Poland, and the UK), two are the holders of 10th dan the highest rank in *goshinjutsu* (the art of self-defence), and the third has wide experience as a bodyguard. All of them have over 40 years' experience in many martial arts, combat sports and self-defence systems. Direct quotations are included, as are an analysis of sources (books, videos, organizational documents), and scientific studies.

Quotes from specialists

Geoff Thompson (8 dan karate, 1 dan aikido, 1 dan judo) regards *judo* and wrestling to be effective only in combat/self-defence situations in close-range or tackles. In his view *aikido* also has very limited applicability in a real combat situation. Only masters of the martial art can cope in a real situation [Thompson 1999: 109]. It is about conventionality, "the conventions of attack and defence" in *aikido*.

Boxing is effective only at a distance determined by the range of arms and fists. But street fights frequently take place within fist distance rather than that of kicks, so boxing skills tend to be useful [Thompson 1999: 110-111]. It is not worth boxing with a boxer since that would be like kicking with a horse. The logic of a fight against a boxer is good tactical play during the confrontation. So we impose our own style to make use of the opponent's strengths and weaknesses. Similarly, we can fight against an assailant with a clear physical advantage (in this case not allowing ourselves to be caught).

Of course, you first need to have certain advantages. A person trained in martial arts should: be able to control the distance, timing and rhythm of combat; develop the ability to concentrate and function in difficult situations (psychological resistance); know the rules of self-defence (e.g. the struggle of several to one); use weapons (long and short weapons); hit or kick accurately, roll and use grips (leverage, strangling) and to perform *ne-waza*. The more versatile the fighter the more advantage he has.

What conditions determine successful self-defence? A successful fight depends on preparation: technical and tactical, physical and mental, knowledge and experience. Surely physical condition and intellectual potential play an important role? These

conditions refer equally to various forms of confrontation – whether boxing or in a street fight. As opposed to boxing, street fighting contains a number of important factors – surprise and the lack of limitations in terms of means and fighting techniques. That is why combat sports competitors do not generally perform well in real self-defence. Moreover the techniques of sports *judo* or any other combat sport are not suitable for training oriented to real fighting. The types of martial arts limited by sports or an idealistic code of convention (such as *aikidō aikikai*) should not therefore be associated with self-defence. This stance is expressed by distinguished experts in this field such as GM **Lothar Sieber**. He believes that *aikido* is not suitable for real combat, and that the people who practise this beautiful art of harmony in motion should practise running at the same time. He also identifies *jujutsu* as a hard, realistic self-defence system ("the safest self-defence" [Sieber L., Sieber H. 1986]). A Master's degree in this martial art is like a swimming certificate – it confirms that the holder is able to survive an attack on the street.

According to Sieber, *karate* and *taekwondo* were originally mostly martial arts (arts of self-defence) and real fighting. Matson [1963] uses the term *karate-jutsu*. Only regular exercising in self-defence, as in the style *Zendo karate Tai-te-tao*, provides real skills for this style there is a separate group of self-defence techniques on the curriculum [Sieber 2011]). In addition, one should practise responses to real attacks, rather than to classical or conventional ones. In *meijin* Sieber's school competitive sport is discarded and the training programme is aimed at fighting in a real situation [*cf*. Sieber L., Sieber H. 1986].

GM **Jan Słopecki** points to the fact that most common attacks are several-to-one. Thus there is no situation similar to a sports bout, but one where the attackers have a clear advantage. In addition the attacker might be bigger and stronger and often armed. Therefore, *gakari-dori randori* – coping with a fight against a group of attackers – should be practised [Słopecki 2008]. In self-defence the use of the multiple techniques from judo (a combat sport), which require grip is not feasible and this is particularly the case of some throws, which are dangerous both for the person thrown and the thrower. It is also unrealistic to take part in "fair" self-defence [*cf*. Harasymowicz, Kalina 2007; Słopecki *et al*. 2015].

Someone who does not know how to fight, has no "feeling of the enemy" nor of force or balance. In fighting at a distance there are also other elements such as: a sense of distance and rhythm; timing; anticipation of the opponent's actions and numerous tactical issues. You cannot learn these from books, or on short courses that are often a complete fraud. Słopecki, like Sieber, teaches modernized *jujutsu*, because the classic styles may not function quite so well in today's reality, and the effectiveness of self-defence is what is important here. *Jujutsu*, by teaching fighting at different distances and positions, provides a relatively wide repertoire of measures / fighting

skills. The holder of a master degree in *goshinjutsu* must be even more able to defend himself [IPA 2012; Cynarski, Słopecki 2015].

Discussion

In a more general sense, **self-defence** is understood as "all activities aimed at defending oneself from physical attack by an aggressor" [Wikipedia, 2015]. This can be achieved by many very different means. For example, Albrecht and Rudolph [2014] teach self-defence using classical *wushu*. The content of the various textbooks and guides to self-defence is varied. It is sometimes mainly first-hand knowledge (written by an MMA fighter or a policeman for example), but when it comes to self-defence, there are big doubts, for example when those authors suggest grabbing the attacker's sword with the hands [Forrest, Krauss 2012: 213]. Yet another author calls his programme a system of short *jujutsu* techniques for street fighting. But his programme also includes sports *judo* throws [Raffel 2012: 115, 133]. These throws are only acceptable as school-basic versions, useful at the stage of learning techniques.

In close combat a valuable discovery by the ancient masters and doctors were the vital points on the human body (Jap. *jintai kyusho)*. The application of this knowledge (of precise strikes and pressures) for the purpose of self-defence [Kogel 2006, 2008; Reinisch, Holler, Maluschka 2009] could allow the fighter to defeat a stronger opponent.

There are different combat systems with 'self-defence' in the name, such as *sambo* [Błach W., Cynarski, Błach L. 2006], which has both sport and combat versions. The combat version is a typical type of combat system to be used on the battlefield (the elimination of the opponent's manpower). Self-defence in war conditions is specifically just a struggle for survival or of the killing arts [*cf*. Fairbairn 1931; Echanis 1977].

Generally, every martial arts instructor should be able to defend himself and be able to teach real self-defence skills [Lee-Barron 2011]. In reality it can work out very differently. In reality even a specialized course for physical recreation instructors with a specialization in self-defence [Ambroży 2001, 2002-2003] does not guarantee high skills. It may however complement understanding, systematise knowledge, and check the basic skills acquired by the instructor. When similar courses are taken by people with many years' expertise in martial arts or combat sports, the effect is (in most cases) probably satisfactory.

The observations and advice from Alain Floquet, a master of martial arts and a retired police officer are interesting. He teaches self-defence and the defence of other people. Significantly, in his book on self-defence [Floquet 1984], while having 9 dan in *aikibudo*, he pictures his *jujutsu* 7th dan certificate in and a photo of *meijin* Minoru Mochizuki, who is very highly regarded in the international *jujutsu* environment.

In his second book Floquet added probably some new content covering emergency situations and the application of techniques, illustrated with photos [Floquet 2002: 241-313].

Roland J. Habersetzer [2007, 2008] an outstanding martial arts expert, recommends and teaches *karate, kobudo* (wielding weapons, such as sticks, *tonfa, nunchaku*) and *hojutsu* (shooting with firearms). Indeed it is possible that in the C21st these are the sum total of all the skills necessary for self-defence. Habersetzer generally recommends a return to what was indigenous in martial arts, namely teaching and learning real combat skills.

WingTsun kung-fu taught by GM Kernspecht [1988, 2014] also rejects sports competitions. It is strictly practised for self-defence. Teachers of this martial art focus attention on optimizing the activities related to taking the initiative in a struggle anticipating and overtaking. According to legend, the *WingTsun* style aimed to ensure that a petite woman could defend herself against a stronger attacker. Since traditional *WingTsun* imposes "system" limits, Kernspecht (10^{th} toan) introduces some innovations in his school. He does so on the basis of many years experience of practising various martial arts.

Blind or partially sighted people are offered such as activities as *WingTsun* / *Wing Chun kung-fu* [*cf*. Szuszkiewicz, Maleta 2007; Kohoutkova *et al*. 2015], where, by using the forearm contact techniques of the *chi-sao* exercises a practitioner can sense the direction of motion of their co-practitioner, who in a real combat situation would be the attacker. By controlling the arms (or legs) of the enemy, they are able to defend themselves whether in a dark room or because they cannot see.

On the basis of the rationale of humanity, GM Krzysztof (Christopher) Kondratowicz 12 dan described *jujutsu* as a noble art of self-defence, etc. [Kondratowicz 1991]. This trend fits the idea of "fair self-defence" [Harasymowicz, Kalina 2007]. However, there is a dilemma – whether self-defence against an aggressor should be effective or restrained. Should our primary stance be to defend ourselves while trying not to hurt the attacker? According to the author of this study anyone teaching the techniques of suicide bears more responsibility than someone who teaches people how to defend themselves effectively by neutralising the attacker/attackers. This does not however mean the acceptance of unnecessary brutality.

In 2003, during a scientific conference held at the Faculty of Physical Education at the University of Rzeszów in Rzeszow, Prof. Andrzej Szyszko-Bohusz expressed his criticism of the widely-used concept of "self-defence". He noted that the emphasis here is on one's own defence, which is somewhat selfish. Sometimes however it is someone else needs to be defended. But this type of self-defence can be understood differently thus: that you have to defend yourself without the help of state institutions (e.g. the police), or completely by yourself.

Can a practitioner's self-defence or previously-acquired skills be tested? There is currently ongoing research in this field [*cf*. Harasymowicz, Kalina 2005; Bugala *et al*. 2016]. This allows a practitioner's level of mastery of the course programme to be assessed. However, it seems that nothing can replace the expert judgment of a highly-experienced master.

Conclusions

The basic canon for real combat and self-defence, its techniques and the tactics to be used has been described. The author relied primarily on the teaching of *meijin* Sieber. However, all three of the experts quoted, as well as some of the experts cited in the discussion (Habersetzer, Kernspecht), point to the need for specialist training. Effectiveness in self-defence situations requires on the one hand quite high versatility in training and on the other, a selection of really effective techniques, as well as the use of relevant teaching methods. Furthermore, the knowledge must go beyond physical and technical training, as psychology plays an important role.

Słopecki draws attention to some fabrications in some works, including scientific ones. What is lacking is any literature describing self-defence in situations of several-to-one which is very frequently the case in assaults. Only the ability to fight at various distances and positions, and using a selection of appropriate techniques may ensure victory in an actual combat. Modern *jujutsu* contains a relatively rich repertoire of techniques, from mild to violent.

The meaning of self-defence is presented and manifests itself in a variety of ways. The extremely commercialized version is the only product on sale. However, for the experts mentioned above, self-defence is at the heart of martial arts training.

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FOUR-YEAR STUDY OF INJURIES IN POLISH SENIOR T'AEK-WŎNDO CHAMPIONSHIPS

Zbigniew Bujak, Dariusz Gierczuk, Jarosław Sołtan
Faculty in Biala Podlaska, University of Physical Education, Warsaw, Poland

Abstract

We analyzed types and frequency of injuries in Polish Senior T'aekwŏndo Championships in the years 2012-2015. Each physical trauma, which required care from medical personnel, was considered an injury. We analyzed medical documentation of four Polish Senior T'aekwŏndo Championships. Our analysis covered 394 sparring matches of 828 athletes exposed to injuries (A-E). Injury rate was calculated according to the following formula: *(# injuries / # athletes exposed to injuries) x 1,000 = # number of injuries per 1,000 athletes exposed to injuries*, *Confidence Intervals* (CI) – 95% considered. We recorded 106 injuries altogether in four years of our study. The minimal number of injuries, recorded in a single championship, was 13, whereas the maximal number of injuries, which we recorded in a single championship was 53. The total injury rate was 128.0/1,000 A-E (95%CI 120.8-135.2) (from 66.7/1,000A-E; 95%CI 64.1-69.3 till 217.2/1,000 A-E; 95%CI 210.4-224.0). Cases of epistaxis (43%) and contusions (33%) were the most frequent. We recorded only one case of concussion we recorded no cases of dislocations, twists and fractures. Head and neck (54%) as well as legs (24%) were the body parts which suffered the most. The vast majority of recorded injuries were minor, whereas major injuries, which could potentially cause prolonged disability, were recorded very rarely. Employment of headguards didn't reduce the number of injuries.

Keywords: *t'aekwŏndo, injuries, senior competitors*

Introduction

Popularity of combat sports generates interest in side effects of trainings and competitions injuries (Feehan & Waller 1995, Woodward 2009, Lystad et al. 2015). In order to be able to take preventive action one needs exact knowledge on types of injuries, their location, causes, and health effects, that knowledge is essential to make training process more safe and thus more efficient (Zazryn et al. 2003). According to ITF (International Taekwon-do Federation) t'aekwŏndo is a combination of self-defense (teaches how to overpower an opponent quickly) and a combat sport (scoring in sports competitions). There are five categories of competitions: patterns, sparring, special techniques, power test and pre-arranged free sparring (www.itfeurope.org).

Competitors are not required to take part in all of them. The most popular category in competition is sparring in 6 weight divisions (separate for males and females). Competitors' age is also taken into account. Sparrings are light-contact and competitors cannot attack opponent's legs. Some protective gear is compulsory and above that competitors are encouraged to wear optional protective gear to ensure their safety in the best possible way. T'aekwŏndo is a popular sport and World Taekwondo Federation (WTF) version is an Olympic sport. Research into injuries in the non-Olympic version of t'aekwŏndo has been scarce. Pappas (2007) points out that the incidence of injury in boxing and wrestling is higher compared to other martial arts (judo, t'aekwŏndo and tai chi). Woodward (2009) denotes only that there is a potential danger of injuries in martial arts. Burke et al. (2003) suggest that incidence of injury in t'aekwŏndo light contact sparrings is much lower than in other combat sports. While analyzing the incidence of injuries in t'aekwŏndo one should consider the following factors: rank of competition, age and gender of competitors, and their mastery level (Kazemi & Pieter 2004, Hssin et al. 2014, Bujak et al. 2015). T'aekwŏndo practitioners, who practice four or more times per week, spar for more than two hours a week, or have three or more years experience of taking part in competitions, are at increased risk of sustaining an injury (Covarrubias et al. 2015). Kazemi & Pieter (2004) note that the incidence of injury in t'aekwŏndo is, most often, lower than in other martial arts. Therapeutic properties of t'aekwŏndo training are highlighted by Cromwell, Meyers & Meyers et. al (2007) and Woodward (2009). Injuries are more often during competitions than during regular trainings (Kazemi et al. 2005). The following study is to determine the injury rates in senior t'aekwŏndo competitors during Polish National Championships in the years 2012-2015.

Methods

We considered an injury each physical trauma, which required care from medical personnel. We analyzed medical documentation of four Polish Senior T'aekwŏndo Championships. Our analysis covered 394 sparring matches of 828 athletes exposed to injuries (A-E). Injury rate was calculated according to the following formula: *(# injuries / # athletes exposed to injuries) x 1,000 = # number of injuries per 1,000 athletes exposed to injuries*, *Confidence Intervals* (CI) – 95% considered.

Results

We recorded 106 injuries altogether in four years of our study of Polish Senior T'aekwŏndo Championships (PSTCh), with an injury rate of 128.0/1,000 A-E (tab. 1).

Tab. 1 Injury rates in Polish Senior T'aekwŏndo Championships in the years 2012-15

Year of Polish Championships	Number of competitors	Number of injuries	Number of athletes exposed to injury	Injury rate per 1,000 athletes exposed (95%CI)
2012	103	26	206	126.2 (123.4-129-1)
2013	122	53	244	217.2 (210.4-224.0)
2014	105	14	210	66.7 (64.1-69.3)
2015	84	13	168	77.4 (73.2 – 81.6)
Total	414	106	828	128.0 (120.8-135.2)

The most frequent injuries were epistaxis (43%) and contusion (33%), whereas collapse, abrasions and concussions were the least frequent (tab. 2).

Tab. 2 Injury types and their rates

Injury type	PSTCh 2012	PSTCh 2013	PSTCh 2014	PSTCh 2015	Number of injuries	Percentage of all injuries
Epistaxis	11	24	9	2	46	43.40
Contusion	6	18	1	10	35	33.02
Sprain	7	11	3		21	19.81
Collapsed (conscious)			1		1	0.94
Abrasion	2				2	1.89
Concussion				1	1	0.94
Total	26	53	14	13	106	100.0

Taking into account body regions, the most frequently injured, were head and neck - 57 injuries (54.3%) and legs 25 injuries (23.6%) – table 3.

Tab. 3 Body regions injured

Body region	PSTCh 2012	PSTCh 2013	PSTCh 2014	PSTCh 2015	Total of all injuries	Percentage of all injuries
Head and neck	11	28	9	9	57	53.7
Upper extremities	4	4	0	0	8	7.6
Trunk	5	7	4	0	16	15.1
Lower extremities	6	14	1	4	25	23.6
Total	26	53	14	13	106	100.0

Discussion

The injury rate for seniors in four subsequent t'aekwŏndo championships was quite high 128/1,000 A-E compared to the results obtained by Burke et al. (2003) – 0.4/1,000 A-E with 2498 participants of various ranks of competitions. However, other studies (Pieter et al. 2012) show higher injury rates among the elite t'aekwŏndo practitioners from 20.6/1,000 A-E to 139.5/1,000 A-E, and from 25.3/1,000 A-E to 105.5/1,000 A-E for women. During Canadian Championships the injury rate reached 62.9/1,000 A-E (Kazemi & Pieter 2004), but during American Championships the injury rate (127.4/1,000 A-E) was similar to our findings. Championships in Greece were rather safe with a low injury rate of 20.6/1,000 A-E (Beis et al. 2001), unlike competitions in Africa – 86.6/1,000 A-E (Phillips et al. 2001). Thus, the incidence of injuries in t'aekwŏndo varies depending on the rank of the competition, the rank of the athletes (belt color), weight category, chronological age, professionalism of the judges, the degree to which rules are followed, and even the fact of rapid weight loss before the competition (Tsai et al. 2011, Altarriba-Bartes et al. 2014).

In 2014 obligatory headguards for seniors were introduced. Our analysis of Polish Championships in 2014 and 2015 show a decrease in injury rate, but it is difficult to conclude that the decrease resulted from employment of obligatory headguards. Hssin et al. (2014) and Hosseini & Hosseini (2010) stress the importance of using protectors in combat sports, moreover Kazemi & Pieter (2004) suggest that regulations should be changed so as to increase competitors' safety. Still other research results indicate low usefulness of headguards as a factor decreasing injury rate in t'aekwŏndo sparring (Birrer 1996, O'Sullivan et al. 2013).

We found epistaxis to be the most frequent injury (43%). Other authors do not record so many instances of epistaxis (Pieter et al. 2012). Since the rules allow competitors to attack head with hands and feet, the risk of epistaxis is quite high; which is also corroborated by research into the incidence of injury in boxing, kick-boxing and muay thai (Zazryn et al. 2003, Papas 2007). In our study contusions constituted 1/3 of all injuries. Similar results were obtained by Pieter et al. (2012), Phillips (2001) and Woodward (2009). Contusions are among the typical injuries in combat sports (Gartland et al. 2001, Pieter 2005, Lystad et al. 2009). Almost half of all the injuries sustained by Polish seniors were head injuries – this is a dangerous tendency because the long-term effects of such traumas are visible only after a few years after the trauma (Bailes & Cantu 2001, Forstl et al. 2010). Although ITF t'aekwŏndo follows the light contact rules, the number of head injuries calls for rethinking of the rules and further research into solutions to protect athletes' health (Macan et al. 2006, McIntosh & Patton 2015). It should be remembered that headguards do not protect from zygomatic bone fractures, which could have serious consequences. Findings of McIntosh &

Patton (2015) indicate that headguards can play an important role in reducing the risk of concussion and superficial injury in boxing competition and training in the range of punch speeds between 5 and 9 m/s. Headguards reduce the magnitude of angular head accelerations in impacts to the lateral jaw and in high-speed punches (>9 m/s) the headguard effects in terms of reducing the likelihood of concussion may be limited. T'aekwŏndo peak kick velocities have been measured to range from 13 to 18 m/s depending on the kicking technique (O'Sullivan et al. 2013). Basing on their own findings O'Sullivan et al. (2013) suggest that employment of headguards in full contact t'aekwŏndo is useless.

Conclusions

The overall number of injuries and the injury rate among the best Polish seniors does not diverge from the general tendency observed in t'aekwŏndo. Introducing obligatory headguards (helmets) don't reduce the number of injuries to the head. Research into the incidence of injury in t'aekwŏndo should be broadened by analyses of injury mechanisms, taking into account gender of athletes. Study results should be made widely known to t'aekwŏndo judges, coaches and competitors. The long-term effects of injuries should also be investigated.

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THE PEDAGOGICAL PROCESS OF TAEKWONDO

John A. Johnson
Humanitas College, Kyung Hee University, South Korea

Abstract

The purpose of this paper is to illustrate the three-stage, pedagogical process of Taekwondo education.Previous research on the Korean martial art concepts known as *musul* (무술; 武術; martial technique), *muyae* (무예; 武藝; martial artistry), and *mudo* (무도; 武道; martial way) were examined in Taekwondo literature. In addition, martial art educational literature revealed an overall stratified learning process for skills which correlates to this new etymological understanding of *musul*, *muyae*, and *mudo*. When approached etymologically, the terms also indicate a pedagogical process nearly identical to previous research on skill-based learning.The literature review of the Korean concepts of *musul*, *muyae*, and *mudo* were found to be esoteric and lacking in practical value to average Taekwondo practitioners. However, an etymological examination of the terms indicates that they illuminate the pedagogical process found in Taekwondo practice. The *musul-muyae-mudo* process is thus educative in nature and, like other attempts to describe and explain skill acquisition, elucidates how Taekwondo skills and knowledge are learned, adapted, and then adopted into daily life routines. This paper redefines the Korean terms *musul*, *muyae*, and *mudo* etymologically to elucidate Taekwondo pedagogy. By doing so, it illustrates the hierarchical development of Taekwondo education, and may be the first time the *musul*, *muyae*, and *mudo* concepts have been discussed without nationalistic intentions. It also explains why Taekwondo has more than one *Do* (도; 道; Dō), or "way," since the art can be approached from a plethora of viewpoints including–but not exclusive to–Taoist, Buddhist, or Confucian perspectives. Most importantly, Taekwondo education is demystified, so students can now comprehend what they are learning and how they are developing during practice.

Keywords: *Taekwondo, pedagogy, skill acquisition, musul, muyae, mudo*

Introduction

Despite being one of the most widely taught martial arts in the world, Taekwondo pedagogy is "overlooked" (Donohue. 2005, p. 8). To this point, the terms *musul* (무술; 武術), *muyae* (무예; 武藝), and *mudo* (무도; 武道) are well-known in martial art circles in Korea, but rarely mentioned internationally. Research to date has attempted to explain these concepts philosophically rather than defining them in the most obvious

manner: etymologically. Over sixty percent of the modern Korean language consists of vocabulary originating in *Hanja* (Chinese characters used in Korean writing before the 1990s) (Cho, 2013-07-03), and defining Korean words in this manner permits deeper insights into their denotations. Yet, no research has defined the terms according to their corresponding Chinese ideograms.

Musul, *muyae*, and *mudo* are herein defined according to their Chinese ideograms as *martial technique*, *martial artistry*, and *martial way*, respectfully. The newly coined definitions also correlate with the pedagogical processes discussed in martial art writings and modern analyses of skill acquisition. The purpose of this paper is therefore to illustrate the process of Taekwondo education by comparing it to accepted martial art pedagogical concepts and modern research into skill acquisition.

Methods

Historically, Taekwondo was conceived as a means of hand-to-hand combat for the South Korea military. Later, it spread to that nation's civilian populace for self-cultivation purposes (Choi, 2001, p. 248-9). It was then re-envisioned as a sport by the South Korean government (Kim et al., 2004, p. 363). As it has already been established that sport Taekwondo players cannot benefit to the same extent as individuals who engage in Taekwondo training for self-cultivation purposes (Lim, 2000, p. 223) and little research on Taekwondo as a martial art has been conducted, this paper considers Taekwondo's martial, rather than sportive, aspects.

Martial arts are a means of self-cultivation (Barczyński et al., 2009, p. 117-8) through "trials of intelligence and moral courage" (Draeger, 2007, p. 12). The rationale for defining Taekwondo in this manner is twofold. First, Taekwondo as a martial art predates its sporting component (Moenig et al., 2012, p. 1363), indicating its roots are grounded in similar pedagogies as other martial arts. Secondly, the World Taekwondo Federation (WTF), the governing body that regulates Taekwondo as a sport, considers it foremost a fighting system with the ultimate goal of physical, mental, and spiritual cultivation (WTF, 2013), which is in line with recent definitions of the term *martial art* (Johnson & Ha, 2015; Martínková & Parry, 2015, p. 9-11).

Nationalistic intentions have plagued academic research of Taekwondo for decades (Moenig, 2013, p. 332). With this in mind, potentially nationalistic viewpoints of *musul*, *muyae*, and *mudo* found in previous research were reviewed with skepticism. For instance, the prominent Taekwondo philosopher Yang (1999) states, "[*mudo*] signifies the Japanese culture of martial arts practice, while [*musul*] signifies the Chinese culture of martial arts practice" and "[*muyae*] in Korea signifies the concept for Korean practice of martial arts" (p. 27). However, these descriptions seemingly do not interpret the denotations of the *Hanja* and reveal nothing about Taekwondo

practice itself. This interpretation is also too esoteric to be of use to Taekwondo practitioners, the majority of whom lack education in East Asian studies. Similar findings were found with other authors' discussions on *musul*, *muyae*, and *mudo* (e.g., Lee, 2006, p. 46-7).

The Korean martial art concepts known as *musul*, *muyae*, and *mudo* were then defined based upon their meanings in *Hanja*. Previous research on these terms in Taekwondo literature were then examined and compared to historical literature on martial art education and modern research into skill acquisition.

Results

The *Hanja* for *musul*, *muyae*, and *mudo* were ascertained and compared to the pedagogical processes in martial art texts and modern research on skill acquisition. The *Hanja* for the *mu-* (무; 武) syllable in all three terms means *military* or *martial*. The ideograms for the syllables *-sul* (술; 術), *-yae* (술; 術), and *-do* (도; 道) were identified as *technique*, *artistry*, and *way*, respectfully. When understood as a process where one level is dependent upon other, the *musul-muyae-mudo* process is hierarchical in nature.

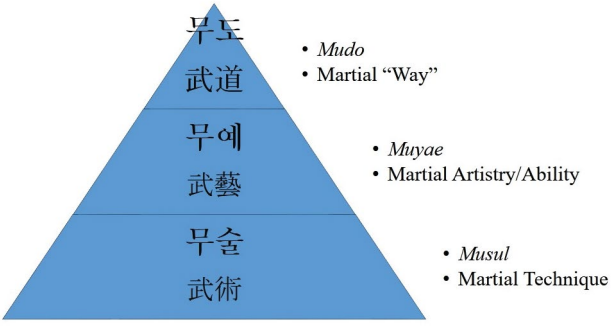

Fig. 1 Taekwondo pedagogical process depicted as a hierarchical structure.

From a pedagogical perspective, *musul* (martial technique) indicates Taekwondo's first stage of education. Students learn the art's fundamental and systematized physical skills (e.g., blocks, punches, kicks, and patterns/forms) from their first class. As *martial technique* implies, *musul* is when the fundamental physical lessons that define and exemplify Taekwondo are learnt. This Taekwondo knowledge must be learned in order for students experience Taekwondo, and the basis of all Taekwondo knowledge and experience is rooted within the learning and performance of these skills (Mayen et al., 2015, p. 25).

The next level of Taekwondo study is *muyae* (martial artistry), which students enter when they can adapt Taekwondo's physical skills in individualistic manners. Practitioners at this stage are capable of executing the art's fundamental techniques fairly much at will. They are still learning and refining those skills, but have begun to feel comfortable performing Taekwondo's physical techniques. Because they have long-practiced the art's fundamental techniques, they have experimented and most likely found their preferred techniques, established personal opinions about the art, and developed a unique fighting style. These adaptions are caused by a host of factors including body shape, personality, training goals, instructor methodologies, and personal preference of techniques. The ease that they perform techniques and movements indicates muscle memory has been acquired. Most importantly, students enter this stage when they have practiced Taekwondo to the point they can execute techniques without thought and with pleasure. The art has now become integrated into their physical bodies and consequently lives. *Muyae* is thus when a student has shown personal growth in the art. Practitioners at this level can thus be considered "artists" because of the self-expression Taekwondo affords them.

Mudo (martial way), the final level of Taekwondo study, can be interpreted in a variety of ways, since the *Do*/*Tao* concept has been interpreted by Taoism, Buddhism, and Confucianism. Nevertheless, the learning objectives of modern martial arts like Taekwondo tend to be Confucian in nature (Capener, 2005, p. 334-5; Donohue, 2005, p. 13; Watson, 2000, p. 21; Stevens, 2013, p. 25), because of the arts' emphasis on self-cultivation. The concept of *mudo* was thus newly defined as the stage in the Taekwondo pedagogical process that occurs after decades of study when a student incorporates their training into everyday life for personal, societal, or spiritual improvement purposes. To Japanese artists and subsequently Korean martial artists, *Do* is a methodology or "way" of doing something in which spirituality does not necessarily play a part. The cultivation of the spirit (i.e., *character* or *personality* rather than a religious *spirituality*) is the paramount educational objective. Taekwondo pioneers also believed their art should be used to cultivate students to become better members of their societies (Choi, 1985, p. 12; Rhee, 2012, p.150), just at the WTF does today. While many martial arts have codes of conduct, Taekwondo's tenets (i.e., courtesy, integrity, perseverance, self-control, and indomitable spirit) prevent students from falling into savagery (Rhee, 2012, p. 106) by providing purpose for their physical training. The above five desired character traits are not easily acquired, and the discipline demanded in Taekwondo training provides the mental fortitude to uphold them (Cynarski, 2004, p. 20-1). This Confucian interpretation does not negate previous studies and other opinions on *mudo*, however. It only provides a new avenue of study, which may be more practical due to students' ability to find personal meaning through practice.

Although controversial, research in Taekwondo history has shown the art's roots lie within Japanese martial arts (Adrogué, 2003, p. 21-2; Moenig, 2013, p. 327-37). *Budo*, the Japanese pronunciation of the Chinese ideograms for *mudo*, has a three-step pedagogical process referred to as *shu*, *ha*, and *ri* (Reilly, 1998, p. 94-6; Sidney, 2003, p. 175). In Japanese arts, *shu*, *ha*, and *ri* refer to *observing*, *breaking away*, and *detaching*, respectfully. Koch states that "there is Shu within Ha and both Shu and Ha within Ri," and that the concept is often represented as a concentric circle (2015). Thus, one does not progress through *shu*, *ha*, and *ri* individually: each step is influenced and intertwined with each other. This concentric nature of *budo* creates a dissimilarity between it and the aforementioned concept of the Korean *mudo* process.

In *shu*, *ha*, and *ri*, students begin by following their instructors' methods and techniques precisely (i.e., observe and emulate their instructor) at the *shu* level. Taekwondo students must likewise mimic their teachers' physical motions to learn the art's physical skills during the *musul* stage. Students enter the *ha* stage of learning in Japanese martial arts when they experiment and establish a more personal method of performing the art (i.e., to break away from their instructors' methodologies). The *ha* stage resembles the *muyae* level of the Taekwondo pedagogical process, since both call for personal interpretations of the art. After many more years of practice, Japanese martial artists are expected to understand the art and its teachings fully and philosophically. At this, the final *ri* stage, they should be nearly indistinguishable from their art as the lessons they have learned influence their every thought, word, and action. Thus, the lessons have transcended from the art and impact the practitioners' lives completely, which is akin in concept to *mudo*.

Adding to the *shu-ha-ri* process, Stevens (2002) states the highest stage of *budo* practice is *shin* (martial spirit) (p. 110), in which a cosmology can be achieved through martial art practice. Donohue (2005) disagrees: "While it is certainly possible that this connection was important for selected martial artists, it is neither universal nor historically accurate" (p. 13). Deshimaru (1914-1982) (1982) agrees with Donohue by stating that education in Zen Buddhism and the Japanese military arts also follows a three-stage process: *Shojin* when the "will and consciousness are involved in practice," a second nameless stage when practitioners can concentrate without effort on their tasks, and a third unnamed stage achieved when the spirit is free within the work (p. 16-7). It can be therefore be concluded that a religious end can be met in martial art practice, but the practitioner must determine that goal for him/herself as it is not an innate part of the skill acquisition process.

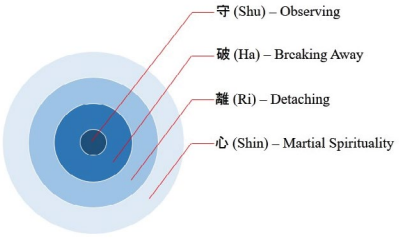

Fig. 2 Pedagogical process of Japanese martial arts depicted in a concentric circle as suggested by Koch (2015) with Stevens' fourth level, shin (martial spirituality), included.

Since Taekwondo knowledge is rooted in its physical skills (Mayen et al., 2015, p. 25), the Taekwondo pedagogical process should correspond with how skills are acquired. Indeed, Dreyfus and Dreyfus (1980) produced a five-stage model for skill acquisition (p. 7-14). Sennett (2008) also explains how skilled laborers and artisans acquire skills through a three-step process (p. 58). Both analyses illustrate that the road to mastery of a skill is initiated by the learning of physical actions required to perform the skill. Then, students begin to perform the skill without cognitive thought due in part to the thousands of repetitions and internalization of those movements. After years of practice, the student-now-master culminates their education into an intuitive awareness of how to accomplish a task. They also identify a large part of their personality to their skill and the process in which it was learned. The *shu-ha-ri* experience has also been likened to the stages of learning undertaken by craftsmen and artisans (Koch, 2015). These processes are parallel with the aforesaid definitions of *musul*, *muyae*, and *mudo*.

Discussion

Defining *musul*, *muyae*, and *mudo* is a common discussion topic within South Korean martial art groups. Oddly enough, no research has discussed the correlation between *musul*, *muyae*, and *mudo* and Japanese *budo*'s three-step *shu-ha-ri* process. This cursory comparison reveals only some of the commonalities between the two pedagogies. Nonetheless, the Taekwondo pedagogical process is fundamentally different from its Japanese progenitors. Further exploration of this topic is necessary to flush out other similarities and differences between *mudo* and *budo*.

Musul, *muyae*, and *mudo* is a hierarchical process where students progress from one stage to other. *Musul* must be learned in order to have the fluidness and self-expression found in *muyae*. Likewise, *mudo* cannot be attained until after years of self-reflection

and adoption of Taekwondo knowledge into one's daily life (Mayen et al., 2015, p. 26), which culminates in a Taekwondo way of life (p. 28). The *musul-muyae-mudo* process thus can be used to set quantitative goals for Taekwondo practitioners. These terms establish learning objectives so Taekwondo instructors can best guide students through the *musul-muyae-mudo* process. Therefore, this paper outlines Taekwondo pedagogy for the first time.

Conclusions

Many conclusions can be drawn from this new interpretation of the *musul*, *muyae*, and *mudo*. First, the newly defined process distinguishes Korean *mudo* from Japanese *budo*, because the former is a stratified process and the latter is represented as a concentric circle. As Taekwondo has struggled to separate from the Japanese arts that inspired it, this new distinction is critically important to establishing its separate identity. Secondly, this new interpretation allows for a less nationalistic, more realistic understanding of Taekwondo. Thirdly, this paper illustrates for the first time how Taekwondo practitioners progress through the lower levels of Taekwondo (*musul* and *muyae*) to its highest level (*mudo*), and by doing so establishes long-term learning objectives and demystifies Taekwondo education. Students can now know the art's pedagogical process, which is beneficial since they can better comprehend what they are learning and can track their progress. Instructors can also ensure students are aware of those learning objectives as well as devise effective ways to guide students toward them, both of which facilitates learning (Savage et al., 2006, p. 239) and motivation (p. 105). Knowing the purposes for and the end results of an educational process (i.e., knowing the learning objectives) allows learners to develop the metacognitive skills (Carnegie Melon, 2015) needed to transcend to the *muyae* and *mudo* levels, provides structure to the learning process for all involved (Simon & Taylor, 2009, p. 56), and gives numerous benefits to instructors (p. 57). Fifth, this interpretation explains how more than one *Do*, or "way," of Taekwondo is possible. It allows *Do* to be a personal pathway for character, social, and/or spiritual development. This paper therefore does not negate previous attempts to understand *Do*; rather, it validates all of them.

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THE FLOW EXPERIENCE IN QIGONG AND ITS IMPACT ON QUALITY OF LIFE

Jindřiška Kohoutková
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

This paper pres ents a proposal of research design to examine flow experience in Qigong exercise. We know that experiencing flow is a very subjective phenomenon as we talk about the state of mind of an individual. Subsequently, we observe the effect of experiencing flow state in Qigong on quality of life of the practitioners. We expect that regular exercise of Qigong will induce flow experience during the exercise and that it will have positive changes on the quality of life of the practitioners. In the first part, we studied theoretical knowledge of the phenomena flow, qigong, and quality of life. The study of literature was also done to obtain the proper tools for the research. To collect the data we chose the method of reasoning and comparison. In the second part, we collected all the tools available and based on research done in this area (flow in sports) we selected tools that correspond with our intention and compiled the research design. In the third part, we focused on the qigong centers where the research can be done. We determined the criteria with which we selected the centers matching our requirements. We also chose the form of distribution of the questionnaires and the way to carry out the interviews. Based on the research done to select the proper tools to asses flow experience we chose to use two standardized questionnaires (The Flow State Scale-2 (FSS-2) measuring intensity and Dispositional Flow Scale-2 (DFS-2) measuring frequency of the state. These versions of questionnaires are adapted to sport environment. To obtain more detailed data about the flow experience, qigong and quality of life we decided to conduct in-depth interviews. The interview is divided into 4 parts (personal anamnesis, flow experience, qigong, and quality of life). The interview is based on the study of Yang Yang et al. (2011). The expected research group will consist about 50 participants (1. Participants who attend regular classes of Qigong in the Czech republic and 2. Participants who attend regular classes of Qigong in other western countries). The selected centers are those which focus on body-mind-spirit integration during the exercise. The data collection will be done during a period of 6 months via a link with the questionnaires sent to the participants. The interview part can be done personally or via electronic devices (skype).

Keywords: *Qigong, flow experience, quality of life*

Introduction

This paper presents a proposal of research design to examine flow experience in Qigong exercise. We know that experiencing flow is a very subjective phenomenon as we talk about the state of mind of an individual. The psychological state "flow" was named by Cszikszentmihaly (1975). He defined flow as an optimal and positive psychological state attained through deep concentration on the task at hand and involving total absorption (Csikszentmihalyi, 1990). He studied this experience in different areas of life, i.e. arts, sport, work.

We suppose that Qigong is an appropriate exercise for experiencing flow. Cszikszentmihalyi (1975) mentions that in order to achieve flow, one has to be in a state of deep concentration. Flow helps to integrate the self because in that state of deep concentration consciousness is unusually well ordered. Thoughts, intentions, feelings, and all the senses are focused on the same goal. One experiences harmony. Qigong is also used as a practice of concentration on the task. It helps to cultivate mindfullness and sense of being in the present moment (Friedman, 2009).

Qigong is defined as a skill of body-mind exercise that integrates the three adjusments of body, breath, and mind into one (Liu, 2013). Traditionally, the purpose of pursuing Qigong practices is to unify the mind, body, and spirit in order to move toward greater harmony with oneself and the environment, and thus toward improved health and functioning (Wile,1996/Yang 2005). Qigong consists of standing, sitting, and lying down meditation, and simple movements, all with an emphasis on meditation. Qigong is also an exercise considered to be a part of the traditional chinese martial arts such as kungfu. Cszikszentmihalyi (1990) mentions the connection between eastern martial arts and flow experience. Eastern martial arts were influenced by Taoism and by Zen Buddhism, and emphasize consciousness-controlling skills. Those who can perform it well claim that it can become a joyous artistic performance, during which the everyday experience of duality between mind and body is transformed into a harmonious one-pointedness of mind. It seems appropriate to think of the martial arts as a specific form of flow (Cszikszentmihalyi, 1990).

The main purpose of this paper is to find connection between physical activity (qigong) and flow experience, find the proper methods to assess the state of flow in Qigong exercise, and choose the Qigong centers matching our requirements where the research can be done.

Methods

In the first part, we studied theoretical knowledge of the phenomena flow, qigong and quality of life. We studied literature to obtain proper tools for the research. To collect the data we chose the method of reasoning and comparison.

In the second part, we collected all the tools available, and based on research done in this area (flow in sports) we selected tools that correspond with our intention and compiled the research design. There have not been studies done measuring qigong specifically. However, there have been many studies done on sports (Cszikszentmihalyi, Jackson, 1999). The tools for measuring flow experience in general and in sports specifically are the Experience Sampling Method (ESM) made by Csikszentmihalyi and Larson (1987). The ESM is not appropriate to use in the sport environment as the tested person has to be interrupted during the activity they are doing in order to collect the data, in-depth interview (Jackson, 1996), and questionnaires, for example the Flow State Scale-2 (FSS-2), and the Dispositional Flow Scale-2 (DFS-2).

We also did research on methods assessing quality of life and well-being. For that part we decided to use the method of in-depth interview. We went through several studies in order to create questions for the interview connected with exercise, motivation, and quality of life. It is important that the exercise and physical activity contribute to the motivation to maintain an active lifestyle for optimal health and well-being (Phillips, 2005).

In the third part, we focused on the qigong centers where the research could be done. We determined the criteria with which we selected the centers matching our requirements. The criteria are body, mind, and spirit integration during exercise. These are the essential elements according to Liu (2013).

We also considered the form of distribution of the questionnaires and the way to carry out the interviews.

Results

Based on the research done to select the proper tools to assess flow experience we chose to use two standardized questionnaires: The Flow State Scale-2 (FSS-2) measuring intensity of the state and Dispositional Flow Scale-2 (DFS-2) measuring frequency of the state (Jackson and Eklund, 2002). These versions of the questionnaires are adapted to sport environment. The FSS-2 was designed to assess the experience of flow in a specific sporting event, which in our case is Qigong exercise. The DFS-2 assesses the frequency with which participants report experiencing flow during participation in the physical activity. The FSS-2 and DFS-2 consist of 36 items plus 13 additional items for confirmatory factor analyses.

To obtain more detailed data about the flow experience during the exercise, experience of qigong, and its impact on quality of life we decided to use the method of in-depth interview. The interview will be divided into 4 parts (personal anamnesis, flow experience, qigong, and quality of life). The interview is partly based on the study of Yang Yang et al. (2011) and the thesis of Phillips (2015). We decided to use

an open-ended, in-depth interview to gain insights into the nature of the experiences that led to respondents practice Qigong. The interviews are semi-structured, asking general questions about the personal anamnesis (sociodemographic data). The participants will be interviewed with an invitation to tell the story of their Qigong experience; subsequent questions and probes will pursue participant motivations for joining the class, experiences during the class, and any reported changes in aspects of daily life and general health and well-being. Finding out more about the flow experience will be done through questions asking for intrinsic motivation. When one is intrinsically motivated for an activity they do the activity strictly for the sake of doing it (Deci & Ryan, 1985).

The expected research group will consist about 50 participants (1. Participants who attend regular classes of Qigong in the Czech republic (Wushu akademie Brno, Daoyin Yangscheng Gong – Markéta Hrdá) and 2. Participants who attend regular classes of Qigong in other western countries (Legacy of wisdom, Switzerland, New York). The selected centers are those which focus on body-mind-spirit integration during the exercise. The data collection will be done during a period of 6 months via links to the questionnaires on the internet. The interview part can be done personally, and if that is not possible via electronic devices (skype).

Discussion

The purpose of this paper was to make a research design, and find the tools to examine flow state during the Qigong exercise and its impact on quality of life. There have not been many studies done in the area of body and mind exercise, however we suppose that there is a deep connection between flow state and Qigong exercise. Jeong (2012) focused on measuring flow state in dancers using imagery intervention. This study confirmed that the flow was enhanced after using imagery intervention. One of the main parts of Qigong is working with intention (visualization) (Friedman, 2009). Phillips (2005) did a study on the connection between Yoga and flow. Jiro Taylor (2015) in his article confirms a connection between Qigong and flow state. Through this practice, we learn to transcend our ego and our thinking mind.

There are several types of qigong, so there could be differences in the structure of the classes and knowledge of the teacher leading the class. There should be other factors considered such as the skill level of each participants experience with qigong, and how frequently they attend classes.

Conclusion

The main purpose of this paper was to discover and analyze the phenomenon flow in a specific type of physical activity.

The secondary purpose was to find out if Qigong would be an appropriate exercise for experiencing flow. We found several studies leading us to the fact that there could be a clear connection between flow experience and qigong.

The third purpose was to find proper tools to measure the flow experience in sports. We decided to use methods which already have been used in the area of physical activity (Phillips, 2005) in order to conduct further studies of other physical activities such as qigong which have not been done yet.

If we are able to discover a connection between Qigong and flow, there may be many benefits for people searching for a way to improve their quality of life.

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EDUCATIONAL BACKGROUND OF SECURITY BODIES IDENTIFICATION IN THE STUDY PROGRAMME OF APPLIED SPORT EDUCATION OF SECURITY BODIES

Zdenko Reguli, Martin Bugala, Michal Vít
Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

Abstract

Applied Sport Education of Security Bodies (ASESB) is a unique study programme at Masaryk University in Brno. The aim of this paper is to analyse theoretical background for graduate competency, according to learning outcomes in ASESB. For this study methods of content analysis, learning objectives analysis, and exploration were used. The theoretical background comes from the cycle of conflict and legal principles of using police force, as well as from science of kinanthropology. In ASESB all three educational dimensions are developed. Learning outcomes build on cognitive domain and through psycho-motoric domain the affective one is fostered. Self-defence is understood as a key competence, and it is incorporated into a broader idea of self-protection.

Keywords: *Academic degree, self-protection, safety education, combat sports*

Introduction

Masaryk University pay attention to help security bodies to achieve high level of education. Faculty of Sport Studies run bachelor study programme Special Education of Security Bodies (SESB) and master degree study programme Applied Sport Education of Security Bodies (ASESB). Both programmes include combat and martial arts training as inseparatable part of education. Self-defense training is stressed as important part of preparation for Police work (Stanislas, 2014). In this article the relation between combat/martial arts identity and identity of security body officers is briefly described. From this point of view, bachelor study programme SESB was well described by Bugala (2015). ASESB is a unique study programme at Masaryk University in Brno, which is a public university. The aim of this paper is to analyse theoretical background for self-defence competency, which is one of the learning outcomes in ASESB. Both SESB and ASESB are part of kinanthropology study highly oriented on self-defense and martial arts as inseparable part of security bodies training (Cihounkova, Kordik, 2015). ASESB is currently open only as a part-time study programme. That means, that students are employed typically in the

security area. Students are professionals looking for the suitable education enable to force their professional careers up. Therefore, we comes out from the characteristic of various types of security bodies in the Czech Republic. Table 1 show different state and local government security bodies in the Czech Republic with different superior unit. Among them there are private agencies making their business in both of personal and corporate security.

Tab. 1 The list of Security forces in the Czech Republic

Security force	Superior unit
Czech Police	Ministry of the Interior
Czech Security Information Service	Government o the Czech Republic
Municipal Police	Mayor
Czech Army	Ministry of Defence, Commander-in-Chief is the President of the Czech Republic
Army Police	Ministry of Defence
Customs Service	Ministry of Finance
Prison Service	Ministry of Justice

Masaryk University is the second largest university in the Czech Republic. Faculty of Sport Studies (FSpS MU) provides various bachelor's, master's and doctor studies (Studijní, 2014). Although Masaryk University is a public university, there are two special programmes for security bodies among them. Bachelor's study programme (3 years) Special Education of Security Bodies is offered for full time and part time students. Master's degree study programme Applied Sport Education of Security Bodies continues bachelor's degree study programme. The condition for enrolling in the study programme is completed any bachelor's degree study programme. Standard length of study is 2 years. Study is completed by the state final examination together with diploma thesis defence. Graduates are bestowed the Master Academic Degree (abbreviated to Mgr.). Study programme ASESB is currently offered only for part time students. In this study, only master study programme of Applied Sport Education of Security Bodies will be analysed.

Material and Methods

For this study the methods of content analysis, learning objectives analysis and exploration were used. Methodology was used in the same way as it was in Bugala (2015) article aimed on bachelor study programme Special Education of Security Bodies.

At Masaryk University ECTS Label is fully implemented as it is not on every Czech university (Šťastná & Walterová, 2014). European Credit Transfer and Accumulation System (ECTS) allows to compare amount of student performance and impact of particular subject in the study programme. Among others, learning outcomes are defined for study programmes at whole as well as for every single subject. ECTS label standardise education at university level through clear study structure. Study catalogue at Faculty of Sport Studies at Masaryk University enable analysis of ECTS and weight of combative subjects in the Special Education of Security Bodies study programme.

Learning objectives at all three of psycho-motoric, affective and cognitive dimensions are defined. Analysis of learning objectives was done from accreditation documents as well as from public information at Information System of Masaryk University (IS MU), which was developed to manage and share system information about study (Brandejs at al., 2010).

Results

Applied Sport Education of Security Bodies is from the year 2009 a unique master study programme at the Faculty of Sport Studies at Masaryk University. It is built on the base of physical education and sport, and it is aimed to prepare security experts both in theoretically and practically. The profile of the graduate, which is highlighted publicly on the Masaryk University website, said:

"According to the Bologna process, Applied Sport Education of Security Bodies is 2nd cycle master study programme. It is aimed to prepare highly qualified experts for different security bodies management. The content follows bachelor study of Special Education of Security Bodies. ASESB offers wide range of practical and theoretical security courses. Practical ones requirethe ability to work in the contact with other person, as well as special gear and training weapons manipulation. Study programme is oriented on personal self-defense, tactical, legal, educational and other aspects of security bodies actions. Graduate is competent not only to lead, organise, manage and evaluate educational process aimed on self-defense, but also lead, organise, manage and evaluate educational process aimed on security bodies actions. Graduates gain both managers and teachers competency. They can find jobs in the area of

security area. Students are professionals looking for the suitable education enable to force their professional careers up. Therefore, we comes out from the characteristic of various types of security bodies in the Czech Republic. Table 1 show different state and local government security bodies in the Czech Republic with different superior unit. Among them there are private agencies making their business in both of personal and corporate security.

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lifelonglearning education within security bodies and security bodies training. Job market offers wide range of jobs in public and state administration, private security companies, prison service, correctional educational facilities, airport and railway police, state police, municipal police, and other security bodies. Graduates are able to animate combat activities, can serve as martial arts teachers, combat sports couches, and self-defense instructors."

Learning outcomes comes from work of Bloom, who developed the theory and cognitive domain (Bloom, Cartwohl, Massia, 1984). Table 2 shows learning outcomes and methods of evaluation at ASESB. In the ASESB, also learning outcomes based in Karthwohl affective domain, and Harrow psychomotoric domain are stressed out. The effect of all domains is simultaneous (Pierce, Gray, 2013). While cognitive domain is dominant in gaining knowledge, affective domain is important to understand the role of security bodies and the role of teacher in educational process (Miller, 2011). Psychomotoric domain is the way, is the tool how to achieve skills, how to apply them when necessary, and how to explain them and teach to people. For ASESB, psycho-physical background of martial arts is also an important valu (Cynarski, Jong-Hoo, Warchol, Bartik, 2015). As table 2 shows, also methods of evaluation are important to evaluate that earning outcomes were obtained by students.

Tab. 2 Graduate profile, learning outcomes and evaluation methods in ASESB

Graduate profile	Learning outcomes *After successful fulfilling the study, the graduate:*	Evaluation methods
There are various practical and theoretical security courses in the Applied Sport Education of Security Bodies (ASESB). Graduates are well applied in work with security bodies, public administration and in the martial arts, combat sports, and self-defense training.	1. Knows theory of sports in security bodies, is able to show and explain single skills,is skilfull in excercise programing and is able to lead training proces according to the plan.	Written test, oral exam, seminar work, methodical performance
	2. Has all pedagogical, psychological, and other knowledge needed to gain teachers competency.	Written test, oral exam, seminar work, teaching practice
	3. Naturaly aplly practical skills in self-defense model situations, join single moves, and change structure of movement in the way suitable to solve the problém.	Solving of model situations
	4. Accept moral background of self-defense, respect legislation, clearly distict between personal and social needs.	Essay, case study
	5. Possess knowledge of kinanthropological methodology, apply research methods in the own project, analyse data and is able to give general conclusion.	Research project, master thesis
	6. Knows theoretical background in law and security, is able to select substantial information and to apply them in the field of education of security bodies.	Written test, oral exam, seminar work

According to the self-evaluation of the Applied Sport Education of Security Bodies, six experts were asked in the years of 2009 and 2013 to evaluate (Sebehodnotící, 2014, Reguli, Sebera, 2009):

- curricular quality,
- personnel quality,
- equipment and facilities,
- competitiveness,
- and employability of graduates.

Expert sampling in both evaluations included by two independent scholars, employer of graduates and graduates employed in the security bodies management. After detailed review, experts gave evaluation similar to the evaluation of bachelor study programme Special Education of Security Forces. In ASESB, curricular quality is at high level. It is focused on deep theoretical background from the field of kinanthropology, security, and pedagogy and education. Some courses that explain administrative processes in police were recommended. The practical subjects are oriented on didactics and the training process. Quality of personnel needs more professors involved as full time teachers. Equipment and facilities is on a high level although there is not any real rival at Czech or even European universities. Employability confirmed by independent research of National Educational Found (Šimková et al., 2014) is very high, the highest among study programmes at Faculty of Sport Studies at Masaryk University. According to the cited report, employment rate was 88 % and only 6 % of graduates is searching for job.

Conclusion

The educational background in ASESB comes from good experience with bachelor study programme Special Education of Security Bodies. ASESB is deep in theory, it comes out from kinanthropology, security and law, and not less important, pedagogy and education. In ASESB, six learning outcomes are defined to fulfil the profile of graduate. In learning outcomes, all three of cognitive, psychomotoric, and affective domain are jointly highlighted to emphasize need for educating real professionals. Correctness of this way of formulating outcomes and processes of education was confirmed independently by experts, employers, and graduates.

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SPORTS INJURIES

FUNDAMENTALS OF SPORTS INJURY SURVEILLANCE / ESTABLISHING A SPORTS INJURY SURVEILLANCE SYSTEM

Eric D. Zemper
Research College of Osteopathic Medicine, Michigan State University, USA

Introduction

In this paper I will introduce some fundamental concepts of epidemiology, the basic science of preventive medicine, and its application to sports medicine, specifically the epidemiology of athletic injuries. Then I will discuss some considerations in designing and implementing a sports injury surveillance system.

The word "epidemiology" is comprised of three Greek root terms: epi (meaning "upon"), demos ("people"), and logos ("study"). Therefore, epidemiology is the study of what is upon, or befalls, a people or population. A more formal definition is that provided by Duncan (1988):

> "Epidemiology is the study of the distribution and determinants of the varying rates of diseases, injuries, or other health states in human populations."

The basic method of studying and determining these distributions and determinants is comparing groups within a population (the sick and the well; the injured and the non-injured). Doing an epidemiological study is a lot like being a detective, using logic to discover cause and effect relationships for illnesses or other medical conditions in a population. In many ways it is similar to diagnosing an illness, but it is done with a large population rather than with an individual patient.

Duncan (1988) lists seven major uses for epidemiological data:

- Identifying the causes of disease.
- Completing the clinical picture of a disease.
- Allowing identification of syndromes.
- Determining the effectiveness of therapeutic and preventive measures.
- Providing the means to monitor the health of a community or region; i.e., input for rational health planning.
- Quantifying risks (health hazard appraisals).
- Providing an overview of long-term disease trends.

The initial development of the theory and methods of epidemiology in the 19th century focused on applications to communicable diseases. However, in recent decades epidemiologic theory and methodologies have been applied to a broader range of subject areas, including athletic injuries. One of the primary tools in applying

epidemiologic theory and methods to the study of athletic injuries is the use of the techniques of injury surveillance.

For our purposes in athletic medicine, epidemiological data collected through sports injury surveillance can be used to:

- Identify causes of injuries.
- Provide a more accurate picture of clinical reality. Clusters of injuries (and the resulting media attention they often generate) give a distorted view of reality; on the other hand, data may reveal a previously unsuspected injury problem.
- Determine the effectiveness of preventive measures (on a local or national scale), whether they are rule changes, new or modified equipment, or modifications of training techniques.
- Monitor the health of athletes, which will assist in rational medical planning.
- Quantify the risks of various types, frequencies, and intensities of exercise activities.
- Provide an overview of long-term injury trends in specific sports.

Sports injury surveillance applies the well-established principles of public health surveillance to the problem of athletic injury. Injury surveillance is not the same as injury research, although the two are similar. Injury research involves the slow and thorough accumulation of very precise data and can take years to come to fruition. By contrast, injury surveillance uses methods for the rapid collection and dissemination of data and evolves and develops to meet the ever-changing needs of the sports medicine community in general, and users of the data in particular.

Epidemiologic Rates

The basic tool of epidemiology is the calculation of rates of occurrence of medical cases of interest in a given population. The two most commonly used rates are prevalence and incidence. The prevalence rate includes all cases of the medical condition of interest that exist at the beginning of the study period and all new cases that develop during the study period. Incidence rates include only the newly developed cases. In sports medicine, the incidence rate is predominantly used to study athletic injuries, since it is assumed that all athletes are uninjured at the beginning of the season and it is the incidence of new injuries during the season that is of interest. Therefore, we will deal only with incidence rates here. The incidence rate is a measure of the rate at which new events (illnesses, injuries, etc.) occur during a specified time in a defined population:

$$\text{Incidence Rate} = \frac{(\#\text{ new events during specified time period} \times k)}{\#\text{ in the population at risk}}$$

The numerator is simply a count of the number of new cases that occur during the study period. The denominator is the total number of people in the population under study who are "at risk" or exposed to the possibility of infection, injury, etc. To provide reasonable numbers that are neither extremely large nor extremely small, and to make comparisons easier, this ratio is transformed to a common metric by multiplying by a convenient multiple of 10 (represented by the constant **k** in the above equation). If k=1,000 the result would be a rate per 1,000 in the population; if k= 100,000 the result would be a rate per 100,000.

For example, suppose 24 cases of measles were reported on a college campus of 34,000 students. A moment's thought will show that stating a rate of 24/34,000 is not the most informative way of presenting this information. The probability of an individual having the disease is not readily apparent, and it is not easy to compare that rate with the five cases that occurred in the population of 630 student-athletes on that campus. The base ratio of 24/34,000 is 0.000706, which is the probability that any one individual has measles. But obviously this is not an easy number to work with. Using k=100,000 we transform this rate to 70.6 cases per 100,000, which is a little more manageable. If we make the same calculation for student-athletes, we get a case rate of 793.7 cases per 100,000. Now it is easier to see that student-athletes had a much higher rate of measles. So, while preventive measures may be needed for the entire campus population, an immediate focus on preventive measures for this special population might be considered.

Determining the numerator of the case rate equation is usually relatively easy. The most critical part of the calculation is determining the denominator, or the "population at risk." This should include everyone in the population who could be affected by the disease or condition of interest, and should exclude those who could not be affected or are not really a member of the population of interest. For instance, in calculating a case rate for pregnancy, males, females past menopause, and younger females who have not reached menarche should not be used in the denominator. In calculating a case rate for soccer injuries during games, only those who actually played and were exposed to the possibility of injury, not the whole team, should be included in the denominator.

In sports medicine, case rates generally are used to present epidemiological information about athletic injuries. In the past these rates have been presented most often as injuries per 100 athletes, which is analogous to the rate per 100,000 population used for reporting disease rates. However, there is a difference between

the continuous exposure of a population to a disease and the discrete exposure of an athlete to injury, which occurs only during practices or games. The number of practices and games varies considerably from one sport to another, and often varies from one team to another, or even from one year to another in a given sport. In addition, not every player participates in every practice and every game, and the number of participants on a team may change considerably as the season progresses. Thus, the common practice of reporting athletic injuries as a rate per 100 participants can lead to questionable conclusions, particularly when results from different sports, or even from different studies of the same sport, are compared. A more precise method is to report case rates per 1,000 athlete-exposures. An athlete-exposure is defined as one athlete participating in one practice or game where there is the possibility of sustaining an athletic injury. If a soccer team of 25 players has five practices during the week, there are 125 athlete-exposures to the possibility of being injured in practice during that week. If 15 players get into the game on Saturday, the team has 15 athlete-exposures in the game, and the weekly total is 140 athlete-exposures to the possibility of being injured.

Using athlete-exposures as the denominator allows more accurate and precise comparisons of injury rates between sports and in different years. Case rates per 1,000 athlete-exposures were used by the NCAA Injury Surveillance System and the Athletic Injury Monitoring System that I developed years ago, and this method of reporting has been frequently used by others doing research in this field. An even more precise approach would base the exposure rate on the amount of time actually spent in practices or games. Case rates per 1,000 hours of participation exposure might be possible in smaller local studies, and should be done at this level if possible, in addition to rates per 1,000 athlete-exposures. But, in cases of large-scale studies, the amount of record keeping required for a national-scale surveillance system may be prohibitive and impractical for those doing the on-site data recording. Case rates per 1,000 athlete-exposures therefore are believed to be a reasonable compromise that gives a more accurate picture of the epidemiology of athletic injuries than the use of simple rates per 100 athletes. However, if collecting data and reporting rates based on case rates per hours of exposure is possible, it should be the primary means of doing so.

In many team sports, the time of exposure in games is relatively easy to estimate, because the games last a specified length of time and involve a specified number of players at any one time. A soccer game will involve two halves of 45 minutes each (plus any extra time), and eleven players from a team are on the field at any given time. Therefore, the amount of exposure time for a single team in a single game will be 990 player-minutes per game, or 16.5 player-hours (2 halves/game x 45 minutes/half x 11 players ÷ 60 min/hr). It is more difficult to get data on time of exposure in

practices, but it basically means keeping track of the number of players participating in each practice and the length of the practices. When collecting athlete-exposure data, the time element is ignored, and data are recorded only on the number of players at each practice and the number who actually get into the games and are exposed, however briefly, to the possibility of injury (not the number who dress for the game).

For individual sports like swimming or track and field, collecting time of exposure during competitions, and even practices, can be a complex problem, because of the differing amounts of time different individual events take to complete during competitions, and the differing amounts of practice time for athletes in different events within the sport. In these cases, using rates per 1,000 athlete-exposures becomes a more practical approach in larger scale injury surveillance systems.

A major weakness commonly seen in the published literature on athletic injury rates is that the denominator data for the incidence rate equation is poorly defined or has not been determined. This reduces these articles to simple case series reports that have little or no epidemiological value. Unless the calculation of rates is based on the population at risk, it is impossible to generalize the results beyond the specific population used in the study. This highlights a major problem in much of the earlier research literature on athletic injury rates, and even some of the current literature: most authors have little or no training in epidemiology, so these articles often are not of any great use on a broader scale in that the information cannot be generalized to other places and situations.

While the research literature in recent years has become less problematic, much of the earlier sports injury literature had shortcomings. Many studies covered only one year (or season), occasionally two. Nearly all studies had limitations imposed by sample size, covering one team or one city or one geographic area. Some studies were limited to injuries of one anatomical site, such as the knee, or one type of injury, such as fatalities or ankle sprains. Getting a clear national perspective by combining results from different studies are greatly hindered by differences in methodologies, such as dissimilar definitions of a reportable injury or different means of collecting and reporting data. Combining study results would be ill-advised in any case, because it would be highly unlikely that the various data sources being combined are truly representative of athletes and teams across the whole country. Future sports injury surveillance systems should be designed with the idea that the data produced will be generalizable and able to be compared with and combined with data from other injury surveillance systems.

Establishing a sports injury surveillance system

Let's turn now to the task of designing and implementing a sports injury surveillance system. First you need to establish what the primary goals of such a system are going to be. For instance, do you want to monitor overall rates and patterns of sports injuries? Are you going to need data on illnesses of athletes as well as injuries? For what purpose are the data going to be used? Which sports will you need to cover? Answering questions like these will be necessary at the beginning of this process. Will you be able to collect data from all the teams/clubs in a particular sport, or will you need to develop a representative sample of teams/club? What specific data will need to be collected? As I used to teach students in research methods, start with your final goals or research questions/hypotheses and work backward. What information or data will you need to accomplish your goal, or to get an answer to your research question/hypothesis? Knowing that, what variables will you need to collect information on to get that data? Knowing that, where can you get that data on those variables and how will you collect it?

Another issue to consider is how long you should collect data. Many studies of sports injuries collect data for only a year or two, which can be a problem because injury rates and patterns tend to change from year to year, sometimes only a little and sometimes a lot. If you are trying to track the impact of a new piece of protective equipment or the impact of a new rule, data from one or two years is not going to be very useful. The only practical way to do this is through a continuing national data collection system that provides representative data over a period of years. Data for only one or two years is not sufficient because it provides no basis for making reasonable comparisons (before and after implementation of a change). Sometimes it may take more than one year for a rule or equipment change to produce a noticeable impact on injury rates because there may be local or regional differences in using a piece of equipment or in adopting, interpreting or enforcing a rule change.

Because there are yearly fluctuations in injury rates, using only one or two years of data can lead to invalid conclusions and faulty decisions. An illustration of the potential for this type of problem is found in fatality data among US high school pole vaulters collected by Dr. Carl Blyth and Dr. Fred Mueller at the University of North Carolina in the US during the early 1980s. During the first year they began collecting fatality and catastrophic injury data (a catastrophic injury being defined as a cervical spine injury resulting in permanent paralysis) for youth, high school, college, and professional sports, they recorded four fatalities among US high school pole vaulters in track and field. Relatively few high school athletes compete in this track and field event, so this data caused considerable concern about the safety of this event at the high school level. However, there was no way to know whether these four

deaths represented an average year, or were an unusually high or low number, because there was no previous data for comparison. (Note also that if Blyth and Mueller had not started collecting national fatality data, nobody would have been aware of the problem.) If these four deaths represented a statistical aberration resulting in a much higher number of fatalities than normal for that year, then the need for immediate major action might not be so urgent. The next year no deaths among high school pole vaulters were recorded, much to everyone's relief. But even this second year of data collection did not settle the question of the normal fatality rate. Which year's data, four deaths or no deaths, was more representative? That question cannot be answered until data is collected for several more years. Meanwhile, the realization that there is a potentially major problem with pole vaulting resulted in a closer look at the design and performance characteristics of landing pits and renewed emphasis on proper coaching techniques, particularly how to "bail out" of a bad vault. The mere fact that national fatality and catastrophic injury data collection was begun had a positive impact on the safety of that one sport as a result of the beginning of a steady progression in changes in the size and extended areas of coverage of pole vault landing pits.

While fatalities are rare, and yearly fluctuations in the numbers are therefore relatively more noticeable, the same principle applies to common non-fatal injuries. With a representative national sample, injury rates for some types of injuries will tend to be fairly stable from year to year, but there will be enough statistical fluctuation in the rates for many types of injuries to require data collection over several years to establish stable patterns. Decisions on measures to reduce injury rates should be based only on stable long-term data. Besides the expected yearly fluctuations in specific injury rates, there also are potential differences in injury rates at different levels of a given sport (youth sports, high school, university, professional, elite, masters and recreational levels). Therefore, it is desirable to collect data at each of these levels. Unfortunately, little or no data is available at this time for any level other than university and high school.

Still another problem with many studies is the source used to obtain injury data. Some rely on insurance claim forms, which have the disadvantage of not representing the true injury rate since not all athletic injuries result in insurance claims. Also, these records seldom contain much detail on the circumstances and mechanisms of injury. Some studies rely on a coach's assessment or recognition of an injury even though it has been shown that, unless coaches have received specific training, they do a poor job of recognizing most treatable injuries (Rice et al., 1985). Studies that depend on recall of injuries at the end of a season have the obvious problems of inaccuracy and incompleteness of recall. One study a few years ago (Junge and Dvorak, 2000) compared weekly recording of soccer injuries with a retrospective questionnaire completed by the athletes at the end of the season, and showed that while more than

80% of the players were injured during the season, less than half the players reported being injured. Only 73% of serious injuries, about one third of the moderate injuries, and less than 10% of the mild injuries recorded by medical staff during the season were reported by the athletes in the retrospective questionnaire at the end of the season. The fundamental point here is that a good data collection system will be prospective, and not dependent on retrospective coach or athlete recall of injuries.

Another consideration is whether to collect data just during competitions or during practices as well. It often is reported that most injuries occur in practices, giving the impression that practices are at least as risky as competitions. Most injuries in a given sport usually do occur during practices, but the actual risk of an individual athlete being injured is actually much higher in competition. As an example, in American college football (or gridiron football) nearly 60% of the recorded injuries occur in practice. However, while the total number of injuries in US college football over a season may be higher in practices, the *rate* of injuries is considerably higher in games, in this case 8.7 times higher, as shown in the Table. In other words, a college football player is nearly nine times as likely to be injured in a game as he is in a practice session. Bear in mind that there are at least five to six times as many practices as games in a football season, and not every player who participates in practice will participate in a game. The most obvious explanation for the difference in risk between practices and games is the continuously higher intensity of play during games.

As you can see in the Table, American football represents the upper extreme in the difference between practice and competition injury rates. At the other end of the spectrum is women's volleyball, where the risk of injury in games is only slightly higher than in practices. This is reasonable considering that, at the US collegiate level, volleyball practices often are as intense as the games. The data presented here show that most sports at the collegiate level in the US have a competition injury rate about two to four times higher than for practice.

Tab. 1 (adapted from Zemper and Dick, 2007):

Injury Rates in Practices vs Competition in Fifteen College Sports

Sport	Injury rate/1,000 Athlete-exposures (Column Rank) Practice	Competition	Relative Risk*
Baseball	2.0 (16)	5.7 (14)	2.9
Basketball (M)	4.1 (8)	8.9 (9)	2.2
Basketball (W)	4.2 (7)	8.1 (11)	1.9
Field Hockey	3.8 (11)	8.4 (10)	2.2
American Football	4.1 (8)	35.6 (1)	8.7
Gymnastics (M)	4.4 (6)	16.5 (6)	3.8
Gymnastics (W)	7.2 (1)	21.5 (3)	3.0
Ice Hockey	2.5 (15)	16.2 (8)	6.5
Lacrosse (M)	4.1 (8)	16.4 (7)	4.0
Lacrosse (W)	3.4 (13)	6.3 (13)	1.9
Soccer (M)	4.5 (5)	19.2 (4)	4.3
Soccer (W)	5.1 (3)	17.0 (5)	3.3
Softball	3.4 (13)	5.1 (17)	1.5
Volleyball (W)	4.6 (4)	5.3 (16)	1.2
Wrestling	4.6 (2)	30.8 (2)	4.3

* Relative Risk = higher rate divided by lower rate

Example: Men's lacrosse - 16.4 injuries/1,000 athlete-exposures in games divided by 4.1 injuries/1,000 athlete-exposures in practices equals a relative risk of 4.0; i.e., a men's lacrosse player participating in a game is 4 times as likely to be injured as he would be if her were participating in a practice session.

Meeuwisse and Love (1997) suggested that researchers should take the following general recommendations into consideration when collecting and publishing injury data:

- Maximize comparability of data between systems through clear indication of reporting system design and the methods used to collect data.

If you want the data from your surveillance system to be useful to others as well, you should clearly define how it is collected, so it will be easier for others to make reasonable comparisons with other sources of data. In recent years there have been a number of consensus statements on the design of sports injury data collection systems for particular sports, and these should be reviewed and utilized. In my other paper presented at this conference I will talk about such a consensus statement regarding track and field injuries.

- Clearly define what constitutes a reportable event.

A clear definition of what is a reportable event is very important. Do you want data only on injuries that cause time-loss? Do you want to collect data on illnesses as well as injuries? Do you want data on anything that requires the attention of the medical staff, whether it involves time-loss from participation or not? There are a number of considerations here, and what you choose will depend on what your ultimate purposes are for collecting the data. At the time I designed the NCAA Injury Surveillance System and later my own data collection system after I left the NCAA, we wanted data only on time-loss injuries and not on illnesses. Our definition of a reportable injury was: *A reportable injury is any injury a) occurring in a scheduled practice or competition, b) requiring medical attention, and c) resulting in the athlete being restricted from further normal participation for the remainder of that practice or competition or for the following day or more*. To reduce the burden on our data collectors, we did not want them to report every minor injury that just required a band-aid and the athlete continued participation immediately. This time-loss data was intended to be used to highlight areas of concern where rule changes, equipment changes, changes in coaching practices or administrative changes would reduce injuries, and to track the impact of any changes introduced to reduce injury rates. In recent years there has been a movement toward more concern about the total health and wellness of the athlete, and as a result injury surveillance systems now often include illnesses and all injuries, whether time-loss is involved or not.

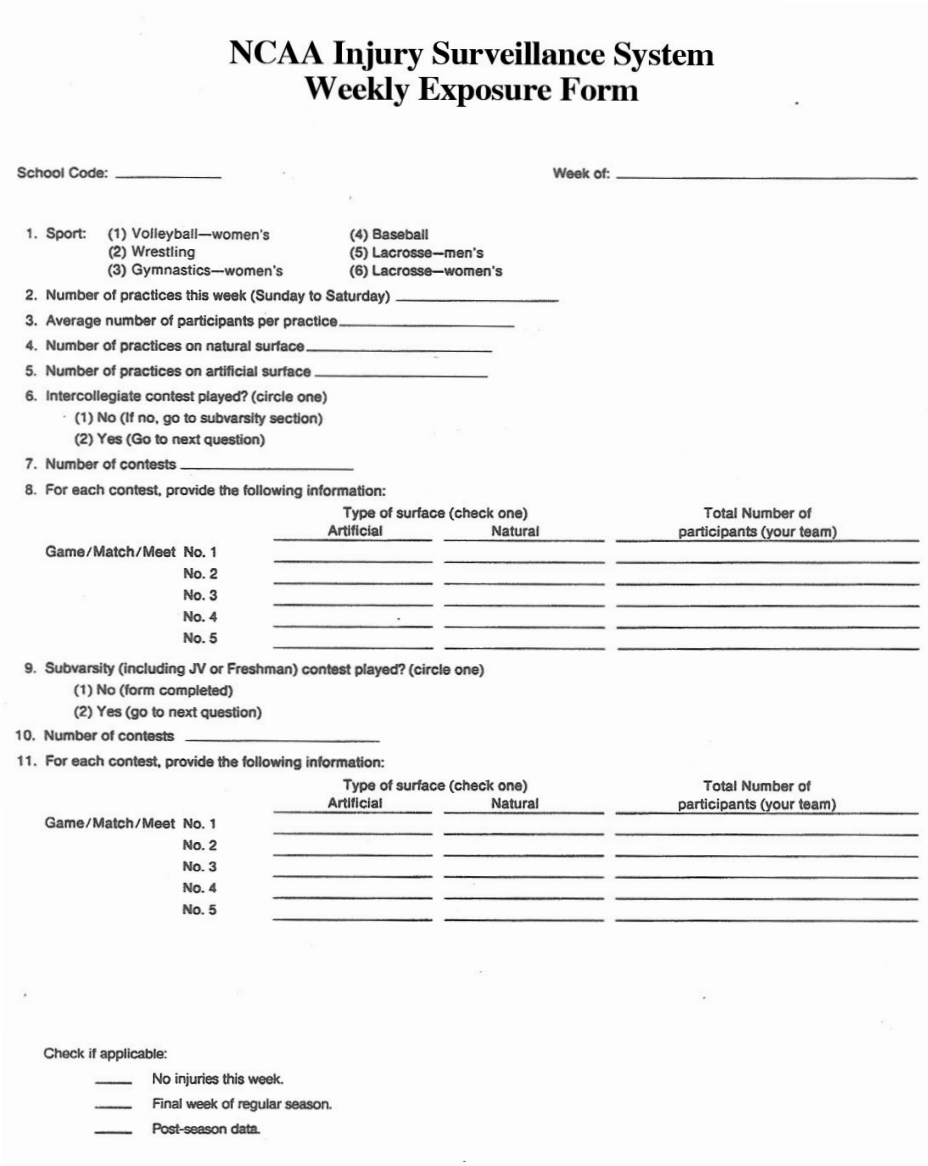
- Collect outcome information on each reportable event.

Once you have a definition of a reportable event, you need to design your system to ensure you get every reportable event actually reported to you. As was noted earlier, depending on retrospective post-season surveys of coaches or athletes is not a very dependable way to collect the data you want. The system needs to be prospective, collected by someone on site (preferably with some medical training), and reported on a weekly basis, so you can contact the responsible people if data is not turned in during a given week.

Meeuwisse and Love (1997) also suggest that an "ideal" system for assessing athletic injury data would include:

- Simplicity and ease of use.
- Collection of athletic exposure data.
- Standardized documentation of injury diagnosis, severity, treatment and associated risk factors.

Simplicity and ease of use for the data collection methods and the collection of exposure data are both vital to the success of the injury surveillance system. If there are several data collection forms that are long and complex, the chances of getting them turned in on a regular basis is greatly reduced, as is the chance that they will be accurately completed even when they are submitted. The weekly data collection forms for the NCAA system and for my later system were limited to two forms, a weekly exposure form to collect the denominator data (Figure 1), and an injury report form that was completed for every reportable injury to collect the numerator data (Figure 2).



NCAA Injury Surveillance System
Weekly Exposure Form

School Code: _____ Week of: _____

1. Sport: (1) Volleyball—women's (4) Baseball
   (2) Wrestling (5) Lacrosse—men's
   (3) Gymnastics—women's (6) Lacrosse—women's
2. Number of practices this week (Sunday to Saturday) _____
3. Average number of participants per practice _____
4. Number of practices on natural surface _____
5. Number of practices on artificial surface _____
6. Intercollegiate contest played? (circle one)
   (1) No (If no, go to subvarsity section)
   (2) Yes (Go to next question)
7. Number of contests _____
8. For each contest, provide the following information:

	Type of surface (check one)		Total Number of participants (your team)
	Artificial	Natural	
Game/Match/Meet No. 1			
No. 2			
No. 3			
No. 4			
No. 5			

9. Subvarsity (including JV or Freshman) contest played? (circle one)
   (1) No (form completed)
   (2) Yes (go to next question)
10. Number of contests _____
11. For each contest, provide the following information:

	Type of surface (check one)		Total Number of participants (your team)
	Artificial	Natural	
Game/Match/Meet No. 1			
No. 2			
No. 3			
No. 4			
No. 5			

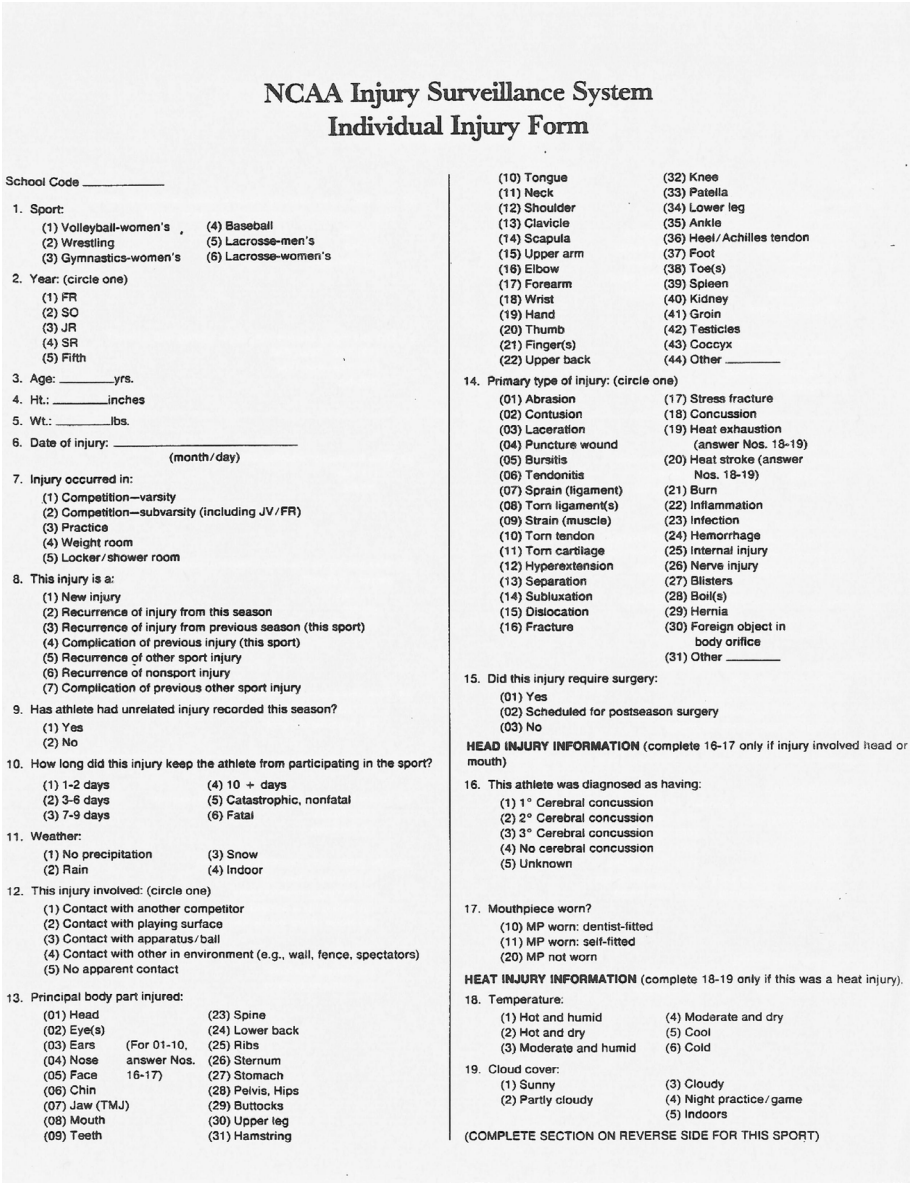
Check if applicable:

____ No injuries this week.

____ Final week of regular season.

____ Post-season data.

Fig. 1 Example of a Form for Collecting Exposure Data



NCAA Injury Surveillance System
Individual Injury Form

School Code _____

1. Sport:
   (1) Volleyball-women's
   (2) Wrestling
   (3) Gymnastics-women's
   (4) Baseball
   (5) Lacrosse-men's
   (6) Lacrosse-women's
2. Year: (circle one)
   (1) FR
   (2) SO
   (3) JR
   (4) SR
   (5) Fifth
3. Age: _____yrs.
4. Ht.: _____inches
5. Wt.: _____lbs.
6. Date of injury: _____
   (month/day)
7. Injury occurred in:
   (1) Competition—varsity
   (2) Competition—subvarsity (including JV/FR)
   (3) Practice
   (4) Weight room
   (5) Locker/shower room
8. This injury is a:
   (1) New injury
   (2) Recurrence of injury from this season
   (3) Recurrence of injury from previous season (this sport)
   (4) Complication of previous injury (this sport)
   (5) Recurrence of other sport injury
   (6) Recurrence of nonsport injury
   (7) Complication of previous other sport injury
9. Has athlete had unrelated injury recorded this season?
   (1) Yes
   (2) No
10. How long did this injury keep the athlete from participating in the sport?
    (1) 1-2 days
    (2) 3-6 days
    (3) 7-9 days
    (4) 10 + days
    (5) Catastrophic, nonfatal
    (6) Fatal
11. Weather:
    (1) No precipitation
    (2) Rain
    (3) Snow
    (4) Indoor
12. This injury involved: (circle one)
    (1) Contact with another competitor
    (2) Contact with playing surface
    (3) Contact with apparatus/ball
    (4) Contact with other in environment (e.g., wall, fence, spectators)
    (5) No apparent contact
13. Principal body part injured:
    (01) Head
    (02) Eye(s)
    (03) Ears
    (04) Nose
    (05) Face
    (06) Chin
    (07) Jaw (TMJ)
    (08) Mouth
    (09) Teeth
    (For 01-10, answer Nos. 16-17)
    (23) Spine
    (24) Lower back
    (25) Ribs
    (26) Sternum
    (27) Stomach
    (28) Pelvis, Hips
    (29) Buttocks
    (30) Upper leg
    (31) Hamstring
    (10) Tongue
    (11) Neck
    (12) Shoulder
    (13) Clavicle
    (14) Scapula
    (15) Upper arm
    (16) Elbow
    (17) Forearm
    (18) Wrist
    (19) Hand
    (20) Thumb
    (21) Finger(s)
    (22) Upper back
    (32) Knee
    (33) Patella
    (34) Lower leg
    (35) Ankle
    (36) Heel/Achilles tendon
    (37) Foot
    (38) Toe(s)
    (39) Spleen
    (40) Kidney
    (41) Groin
    (42) Testicles
    (43) Coccyx
    (44) Other _____
14. Primary type of injury: (circle one)
    (01) Abrasion
    (02) Contusion
    (03) Laceration
    (04) Puncture wound
    (05) Bursitis
    (06) Tendonitis
    (07) Sprain (ligament)
    (08) Torn ligament(s)
    (09) Strain (muscle)
    (10) Torn tendon
    (11) Torn cartilage
    (12) Hyperextension
    (13) Separation
    (14) Subluxation
    (15) Dislocation
    (16) Fracture
    (17) Stress fracture
    (18) Concussion
    (19) Heat exhaustion (answer Nos. 18-19)
    (20) Heat stroke (answer Nos. 18-19)
    (21) Burn
    (22) Inflammation
    (23) Infection
    (24) Hemorrhage
    (25) Internal injury
    (26) Nerve injury
    (27) Blisters
    (28) Boil(s)
    (29) Hernia
    (30) Foreign object in body orifice
    (31) Other _____
15. Did this injury require surgery:
    (01) Yes
    (02) Scheduled for postseason surgery
    (03) No

HEAD INJURY INFORMATION (complete 16-17 only if injury involved head or mouth)

16. This athlete was diagnosed as having:
    (1) 1° Cerebral concussion
    (2) 2° Cerebral concussion
    (3) 3° Cerebral concussion
    (4) No cerebral concussion
    (5) Unknown
17. Mouthpiece worn?
    (10) MP worn: dentist-fitted
    (11) MP worn: self-fitted
    (20) MP not worn

HEAT INJURY INFORMATION (complete 18-19 only if this was a heat injury).

18. Temperature:
    (1) Hot and humid
    (2) Hot and dry
    (3) Moderate and humid
    (4) Moderate and dry
    (5) Cool
    (6) Cold
19. Cloud cover:
    (1) Sunny
    (2) Partly cloudy
    (3) Cloudy
    (4) Night practice/game
    (5) Indoors

(COMPLETE SECTION ON REVERSE SIDE FOR THIS SPORT)

Fig. 2 Example of a Form for Collecting Individual Injury Data (front)

Questions to Be Completed for Specific Sports

Baseball

20. Position played at time of injury (circle one):
    (01) Batter
    (02) Base runner
    (03) Pitcher
    (04) Catcher
    (05) First base
    (06) Second base
    (07) Shortstop
    (08) Third base
    (09) Left field
    (10) Center field
    (11) Right field

21. Injury occurred during:
    (1) Inning No._____
    (2) Pregame warm-up
    (3) Practice

22. Did this injury directly involve metal spikes on shoes (e.g., laceration, "catching" on a base, etc.)?
    (1) Yes
    (2) No
    (3) Unknown

23. Did this injury involve the player sliding into a base?
    (10) Yes—head first
    (11) Yes—feet first
    (20) No

Lacrosse—Men's

20. Position played at time of injury (circle one):
    (1) Goalie
    (2) Attack
    (3) Midfield
    (4) Defense

21. Injury occurred during:
    (1) First period
    (2) Second period
    (3) Third period
    (4) Fourth period
    (5) Pregame warm-up
    (6) Practice

22. At the time of injury the player was playing:
    (1) Offense
    (2) Defense

23. The player was injured (circle one):
    (1) During a face-off
    (2) During a clearing play
    (3) Going for a ground ball
    (4) None of the above situations

24. Was the player wearing shoulder pads?
    (1) Yes
    (2) No

25. Was this injury the direct result of contact from another player's helmet?
    (1) Yes
    (2) No
    (3) Unknown

26. This injury occurred while playing/practicing on:
    (1) Natural surface
    (2) Artificial surface

Lacrosse—Women's

20. Position played at time of injury (circle one):
    (01) Goalkeeper
    (02) Point
    (03) Cover point
    (04) Third man
    (05) Right defense wing
    (06) Left defense wing
    (07) Center
    (08) Right attack wing
    (09) Left attack wing
    (10) Third home
    (11) Second home
    (12) First home

21. Injury occurred during:
    (1) First half
    (2) Second half
    (3) Pregame warm-up
    (4) Practice

22. At the time of injury the player was playing:
    (1) Offense
    (2) Defense

23. The player was injured (circle one):
    (1) During a face-off
    (2) During a clearing play
    (3) Going for a ground ball
    (4) None of the above situations

24. This injury occurred while playing/practicing on:
    (1) Natural surface
    (2) Artificial surface

Fig. 2 (continued): Example of a Form for Collecting Individual Injury Data (back)

These are examples of each of these forms. Note in the Individual Injury Form there are special sections for collecting detailed data on heat injuries and head injuries. These types of injuries were of particular concern at the time. Data providers were instructed to complete an injury form and report on *any* head injury, whether there was time loss or not. On the forms for American football there also were special sections for detailed information on knee and ankle injuries, which also were of special concern for that sport. These two forms were fairly standard across all sports to provide the standardized documentation of injury diagnosis, severity, treatment and associated risk factors, although for some sports there might be some slight changes in the options that were presented, based on unique aspects of a given sport, such as position played by the injured athlete.

- Flexibility to address changing patterns of injury.

These forms were used during an era when they were collected as paper and pencil forms. At the time these forms were developed and used in the early 1980s, computers were still in early stages of development and the internet was still unheard of. In 2003 the NCAA system changed from these paper and pencil forms, which were mailed in every week, to online report forms. The information seen on these forms would now be used as the basis for developing online computerized data collection screens. This use of online data collection greatly increases the ability to be flexible and make changes in the forms when necessary, and it provides a means to immediately return results to the people responsible for submitting the data, which makes the whole process very attractive to the data providers and greatly increases their willingness to participate.

- Data collection by team athletic trainers who work with the team on a daily basis.

In the US we have certified athletic trainers at every college and university, and at many high schools, throughout the country. These athletic trainers are ideal persons to use to provide injury surveillance data, since they have a great deal of medical training, plus they are educated in the importance of research, so they have proven to be very willing and reliable in reporting injury data.

The European equivalent of the athletic trainer is probably the physiotherapist, and these would likely be the first people to approach about taking part in an injury surveillance system. But the data reporters can also be team physicians if they are available. However, if possible, it is much better to use someone who is in daily contact with the athletes rather than occasionally or just once a week, as is often the case with team physicians. In situations where there is no medically trained individual

associated with the team or club, it might be necessary to use a coach. If this is the case, you should plan on having a training program that you put the coach through so they can do a better job of recognizing reportable injuries and their characteristics that need to be reported. Research has shown that coaches who receive this type of training do a much better job of consistently and accurately reporting injuries (Rice et al., 1985).

This is a brief summary of some of the many important considerations that need to be addressed when designing and implementing a sports injury surveillance system. The following presentations by my US colleagues, all former students of mine, will present summaries of their work in collecting injury epidemiology data for various sports, and I will make a second presentation suggesting ways to apply the information presented here to designing an injury surveillance system for the sport of athletics (track and field).

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COMPETITION INJURIES IN JŪDŌ: A REVIEW

Willy Pieter

Abstract

To review the epidemiology of injuries in jūdō as reported in the literature as well as conference proceedings and unpublished reports. The focus will be on injury incidence, distribution, type and mechanism in adult men and women.

Electronic databases and the ancestry method were used for relevant published articles in English, German and French. The search included publications since 1960 and involved both peer-reviewed publications, international presentations and proceedings as well as unpublished theses where available. The search terms used were: judo, martial, injuries, epidemiology and risk.

The first prospective investigation on jūdō injuries was done in1960. It was reported that German elite male judōka incurred an injury rate of 17.42 per 1,000 athlete-exposures (A-E) (95% CI: 13.48 – 21.36)*. Men were not at a higher risk but the effect was not reliable: OR = 0.683 (95% CI: 0.605 – 0.771). CLR = 1.274. British research reported the upper extremities in females (18.87/1,000 A-E, 95% CI: 3.77 – 33.97) did not incur more injuries compared to the lower extremities (6.29/1,000, 95% CI: 0.00 – 15.01). The men were at a higher risk of incurring an injury: OR = 0.683 (95% CI: 0.605 – 0.771), but the effect was not reliable: CLR = 1.274. Based on the point estimates, Brazilian judōka incurred more sprains (26.36%, 95% CI: 19.03 – 35.26) than strains (14.55%, 95% CI: 9.16 – 22.33) but the difference was not statistically significant. Regardless of type of injury, the major mechanism was reported to be standing techniques.

Future research on jūdō injuries should consider including mechanisms as well.

*There were no competitions for women at that time.

Keywords: *judo, injury, type, mechanism*

Introduction

Jūdō is the first Asian combat sport to become an Olympic event. As far as is known, some of the very first research on the epidemiology of jūdō injuries started in the 1960s. Based on the 1959 competition season in Germany, Sturm (1960) registered a total injury rate of 17.42/1,000 athlete-exposure (A-E) (95% CI: 13.48 – 21.36) in male jūdōka (jūdō athletes). Abrasions were the most often occurring injury type

(3.72/1,000 A-E, 95% CI: 1.90 – 5.54) followed by nosebleeds: 3.25/1,000 A-E (95% CI: 1.55 – 4.95) but the difference was not statistically significant.

Witak and Sturm (1968) reported a rate of 18.00/1,000 A-E (95% CI: 14.28 – 21.72) in men, which was not significantly different from that reported by Sturm (1960). In 72% (95% CI: 70 – 74) of all cases, the match had to be interrupted and in 28% (95% CI: 26 – 30) it had to be stopped. Injuries significantly often occurred while competing in the standing position (58%, 95% CI: 56 – 60) followed by groundwork (42%, 95% CI: 33 – 53).

In a retrospective investigation covering a whole year in Germany, the injury occurrence in men was reported to be 1716 in a sample of 410 jūdōka (von Brüggemann, 1978), which amounted to 4 injuries per jūdōka per year. The contusion was the most often occurring injury type: 54.31% (95% CI: 51.95 – 56.67) followed by the sprain: 31.29% (95% CI: 29.10 – 33.48). The difference between the two was significant. The lower extremities (43.18%, 95% CI: 40.84 – 45.52) were most often affected. The upper limbs, including the shoulder girdle (39.92%, 95% CI: 37.60 – 42.24) came in second, but the difference was not statistically significant.

In the largest prospective jūdō injury investigation to date, Barrault et al. (1983) found a total injury rate of 135.13/1,000 A-E (95% CI: 129.40 – 140.85) in jūdōka collapsed over gender and level of competition (national, regional and club) [the rate was calculated based on the information provided by the authors of the article]. The time-loss injury rate for females collapsed over age group and level of competition was 8.21/1,000 A-E (95% CI: 4.78 – 11.64). When age group and level of competition were combined, the total rate for injuries in females was 130.60/1,000 A-E (95% CI: 116.92 – 144.28). Collapsed over gender and age group, the time-loss injury rate for jūdōka active at the regional level was 12.67/1,000 A-E (95% CI: 10.73 – 14.61), which was significantly higher than that of national jūdōka (6.23/1,000 A-E, 95% CI: 4.87 – 7.60) (Barrault et al., 1983).

Research conducted in the UK revealed a rate of 48.54/1,000 A-E (95% CI: 18.46 – 78.63) for males and 34.25/1,000 A-E (95% CI: 4.23 – 64.27) for females, which was not significantly different from each other (James and Pieter, 2003).

Belgian jūdōka showed injury rates of 8.6/1,000 hours of exposure (HE) for both men and women. The rate for acute injuries was 6.6/1,000 HE and for overuse injuries: 2.1/1,000 HE (Boonen et al., 2005). The women were not at a higher risk of sustaining an injury: OR = 0.52, 95% CI: 0.34 – 0.77 but the effect was not reliable: CLR = 2.27.

At the 2012 Olympic Games, judō recorded a combined training and competition injury occurrence of 12.27% (95% CI: 8.98 – 15.56). Competition injuries constituted 6.79 % (95% CI: 4.27 – 9.31) (Engebretsen et al., 2012). At the 2008 Olympic Games, there were 9.87% (95% CI: 6.89 – 12.85) jūdō competition injuries (Junge e al., 2009),

which was not significantly different from that of four years later. The purpose of this study, then, was to review the injuries in adult male and female jūdō athletes.

Methods

Electronic databases were searched and the ancestry method used for relevant published articles. The search included publications since 1980 and involved peer-reviewed publications, international presentations and proceedings as well as unpublished theses where available. The search terms used were: judo, martial, injuries, epidemiology and risk. Injuries were expressed per 1,000 athlete-exposures (A-E) and their 95% confidence intervals (CI) or percentages and their 95% CI. Where appropriate, odds ratios were also calculated.

Results

Table 1 shows a summary of comparative injury rates per 1,000 A-E in mostly elite jūdōka.

Tab. 1 Selected competition injury rates per 1,000 A-E (95% CI) in jūdōka

Study	Men	Women
Sturm (1960)	17.42 (13.48 – 21.36)	--
Witak and Sturm (1968)	18.00 (14.28 – 21.72)	--
Barrault et al. (1983)	122.63 (118.80 – 126.46)	130.60 (116.92 – 144.28)
Pieter et al. (2001)	25.18 (6.53 – 43.83)	41.28 (14.31 – 68.26)
James and Pieter (2003)	48.53 (18.46 – 78.63)	34.25 (4.23 – 64.27)
Green et al. (2007)	41.32 (28.52 – 54.13)	40.88 (18.66 – 63.10)

Based on the information in the table and excluding the studies from the 1960s, the men were not at a higher risk of incurring an injury but the effect was not reliable: OR = 0.683 (95% CI: 0.605 – 0.771) CLR = 1.274. According to Green et al. (2007), of those who were injured, 36.54% (95% CI: 23.45 – 49.60) won their fights and 11.54% (95% CI: 2.86 – 20.22) of them could not continue competing, i.e., they suffered time-loss injuries.

Pierantozzi and Muroni (2009) reported an injury rate of 108.87/1,000 A-E (95% CI: 67.81 – 149.94) for a combined group of male and female jūdōka, which is not significantly different from the combined rates for men and women in Table 1 (excluding the investigations from the 1960s): 119.02/1.000 A-E (95% CI: 115.33 – 122.71). Based on the information in the table, the men were not at a higher risk but the effect was no reliable: OR = 0.683 (95% CI: 0.605 – 0.771). CLR = 1.274.

Anatomical Location

Table 2 displays the injury rates by body region in male jūdō athletes. In a combined sample of elite Italian male and female jūdōka, the fingers incurred most of the injuries in absolute terms (40.00%, 95% CI: 19.82 – 64.25) followed by the calf (20.00%, 95% CI: 7.05 – 45.19), but they were not statistically different (Pierantozzi et al., 2009). The information in the table seems to suggest that there were no statistical differences in injury rates between the body regions across all investigations. More research is indicated with larger sample sizes, so that more accurate estimates will be possible.

Tab. 2 Injury rates by body regions in male jūdōka per 1,000 A-E (95% CI)

Study	Head and Neck	Trunk	Upper Extremities	Lower Extremities
Pieter et al. (2001)	7.19 (0.00 – 17.17)	--	10.79 (0.00 – 23.00)	7.19 (0.00 – 17.17)
James and Pieter (2003)	19.42 (0.39 – 38.45)	--	14.56 (0.00 – 31.04)	14.56 (0.00 – 31.04)
Green et al. (2007)	6.20 (1.24 – 11.16)	4.13 (0.08 – 8.18)	16.53 (8.43 – 24.63)	2.07 (0.00 – 4.93)

Tab. 3 Injury rates by body regions in female jūdōka per 1,000 A-E (95% CI)

Study	Head and Neck	Trunk	Upper Extremities	Lower Extremities
Pieter et al. (2001)	7.19 (0.00 – 17.17)	--	18.35 (0.37 – 36.33)	13.76 (0.00 – 29.33)
James and Pieter (2003)	13.70 (0.00 – 32.68)	--	13.70 (0.00 – 32.68)	6.85 (0.00 – 20.27)
Green et al. (2007)	12.58 (0.25 – 24.91)	3.15 (0.00 – 9.31)	18.87 (3.77 – 33.97)	6.29 (0.00 – 15.01)

Injury Types

Table 4 depicts the rates for most often occurring injury types per unit of exposure.

Tab. 4 Percent distribution (95% CI) of selected injury types in male and female jūdōka

	Men		Women	
Injury type	Percent	95% CI	Percent	95% CI
Abrasion	11.76	3.29 – 34.33	33.33	12.06 – 64.58
Contusion	29.09	18.77 – 42.14	34.78	18.81 – 55.11
Dislocation	10.00	1.79 – 40.41	--	--
Hyperextension	--	--	40.00	11.76 – 76.93
Laceration	18.00	9.77 – 30.8	--	--
Sprain	16.00	8.34 – 28.51	20.00	7.05 – 45.19
Strain	20.00	11.24 – 33.04	38.46	17.71 – 64.48
Fracture	--	--	22.22	6.32 – 54.74

Time Loss

Table 5 displays rates for time-loss injuries in jūdō, including the estimated days lost. Based on the information in the table, there were no differences between men and women in time-loss injuries.

Tab. 5 Selected injury rates per 1,000 A-E for jūdō time-loss injuries and estimated days lost

Study	Males	Days	Females	Days
Green et al. (2007)	10.33 (3.93 – 16.73)	21	18.87 (3.77 – 33.97)	29
James and Pieter (2003)	4.85 (0.00 – 14.37)	≥ 21	13.70 (0.00 – 32.68)	7 ≤
Pieter et al.(2001)	3.60 (0.00 – 10.65)	> 21	9.17 (0.00 – 21.89)	> 21

Intrinsic Factors

No research was located investigating intrinsic determinants of injuries in jūdō. It is, however, possible to relate potential risk factors to the occurrence of jūdō injuries. For instance, weight cycling has been suggested to potentially lead to injuries (Brito et al., 2012). Brito et al. (2012) found that at the regional level, 57.14% (95% CI: 46.89 – 66.81) of all jūdōka engaged in weight cycling. At the national level, this was 38.46% (95% CI: 29.13 – 48.73) and internationally, 4.40% (95% CI: 1.72 – 10.77). There

was no statistical difference in weight cycling between those competing regionally and nationally. However, those who were active at the international level engaged in weight cycling significantly less than the other groups.

Research should also be conducted on psychological mood and jūdō injuries. For instance, Pieter et al. (2009) assessed to what extent psychological mood predicted injuries in young adult karate athletes. Vigor was not significantly lower in injured female karateka compared to their non-injured counterparts (6.86 ± 3.58 versus 9.18 ± 2.66): omega^2 = 0.005, 95% CI: 0.000 – 0.257; d = 0.845, 95% CI: 0.034 – 1.656, but the effects were not clear. In the female karateka, 83.78% (95% CI: 65.79 – 90.52) were correctly classified as injured or not injured (Eigenvalue = 0.469, Canonical R = 0.565, 95% CI: 0.322 – 0.738, Wilks' l = 0.681, χ^2 = 15.004) with 57.14% (95% CI: 25.04 – 84.18) as injured and 90.00% (95% CI: 74.38 – 96.54) as not injured. In the males, 77.78% (95% CI: 66.91 – 85.83) were correctly classified as injured or not injured (Eigenvalue = 0.111, Canonical R = 0.316, 95% CI: 0.124 – 0.485, Wilks' l = 0.900, χ^2 = 8.864), which was not significant. In male karateka, 6.25% (95% CI: 1.11 – 28.33) were classified as injured and 98.21% (95% CI: 90.55 – 99.68) as not injured.

Injury Mechanisms

Table 5 displays the major injury mechanisms reported in the studies cited. Pierantozzi and Muroni (2009) relayed that being thrown from standing encounters led to most of the injuries: 40.32/1,000 A-E (95% CI: 15.30 – 65.32) or 37.04% (95% CI: 21.53 – 55.77) of all mechanisms. Green et al. (2007) reported that grip fighting was the major injury mechanism in males (31.43%, 95%%: 18.55 – 47.98), while it was being thrown in the females (33.33%, 95% CI: 15.17 – 58.28), which was not significantly different from the mechanism in the men. The kind of throw was not specified, however.

Tab. 5 Percent distribution (95% CI) of jūdō techniques most often implicated in competition injuries

Technique	Barsottini et al. (2012)		Green et al. (2007)	
	Men	Women	Men	Women
Shoulder throw	29.27 (17.61–44.48)	17.39 (6.98–37.14)	--	--
Body drop	24.39 (13.82–39.34)	28.57 (11.72–54.65)	-	-
Grip fighting	--	--	11.36 (4.65 – 18.08)	--
Being thrown	--	--	--	15.72 (1.94 – 29.50)

At an international judō competition in the UK, the major injury mechanism in women was performing a shoulder throw (25.00%, 95% CI: 7.15 – 59.07) (Pieter and De Crée, 1997), while it was also the major mechanism in Brazilian men: 29.27%, 95% CI: 17.61 – 44.48) (Barsottini et al., 2012). In Brazilian women, the shoulder throw was at the basis of 17.39% (95% CI: 6.98 – 37.14) of all injuries (Barsottini et al., 2012), which was not significantly different from that of the men's. In both men and women, the affected body part for injury was the shoulder of the thrower. The body drop was the major mechanism leading to injuries of the knees in male (40%, 95% CI: 16.82 – 68.73) and female jūdōka (75%, 95% CI: 30.06 – 95.44) (Barsottini et al., 2012).

Suggestions for Injury Prevention

Preventive measures have already been mentioned throughout the text. Additional ones include conducting longitudinal studies of jūdō injuries, preferably according to the following pattern: 1) determine the extent of the injury problem; 2) determine the etiology and mechanisms of injuries; 3) introduce preventive measures; and 4) assess their effectiveness by repeating step #1 (van Mechelen, 1992).

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EPIDEMIOLOGY OF TRACK AND FIELD INJURIES

Eric D. Zemper
Research College of Osteopathic Medicine, Michigan State University, USA

Introduction

In the sport of athletics, or track and field, there are numerous ways to sustain injuries because of the large variety of activities involved in this sport. In addition to sustaining an injury to muscles and joints while performing the movements required during the throwing events, there also is the risk of being struck by a thrown implement. This risk applies not only to the athletes participating in a throwing event, but also to officials, other athletes, coaches and spectators. Keep in mind that all throwing implements used in track and field were originally developed from weapons of war. Among the jumping events, the one with the highest risk of serious injury is the pole vault, because the athlete is falling from a great height and dependent on landing correctly on the landing pads. In the running events there is possibility of sustaining injuries from hitting hurdles or the immovable steeplechase barriers. Sprinters are always at risk for muscular injuries like hamstring strains. Distance runners are at risk of sustaining stress fractures in the leg and foot. These are just a few among the many ways of being injured in this sport.

Track and field is a difficult sport to cover with an injury surveillance system. For both men and women there are 21 separate events on the outdoor competition program, in seven groupings:

- Sprints (100, 200, 400) and relays (4x100 and 4x400)
- Middle distance runs (800, 1500)
- Long distance runs (5000, 10,000 and 3000 steeplechase)
- Hurdles (100H for women, 110H for men, and 400H)
- Jumps (high jump, pole vault, long jump, triple jump)
- Throws (discus, javelin, shot put, hammer throw)
- Combined events (decathlon for men, heptathlon for women)
- Plus Athletics also includes:
- Race Walking
- Cross Country
- Road Racing (e.g., Marathons, Half-Marathons)

This extensive variety of events, each with its own set of requirements and mechanisms of possible injury, and differing time requirements during competition and during practices, makes this a complex sport when it comes to setting up an injury surveillance system. For instance, how do you set up data collection for exposures (denominator data) in this situation?

Current Literature

As a result of these complexities, there are very few studies in the research literature on the epidemiology of track and field injuries. Among the few studies available, differences in study design and inconsistencies in the definition of reportable injuries result in major hindrances to making comparisons or combining data across studies. A review published ten years ago (Zemper, 2005) on injuries in youth track and field found only nine studies that met minimal criteria; six studies were prospective and three were retrospective. There were at least six different definitions of reportable injuries. Only one study provided enough information to calculate rates per 1,000 A-E (1.0 for males, 1.5 for females); the rest showed rates per 100 athletes, which, as I noted in the previous presentation, is not a very useful way to present sports injury rates. Among the few conclusions that could be made from this review were that lower extremities account for the majority of injuries, and muscle strains and ligament sprains are the predominant type of injury. Most injuries occur during training, but risk of injury during competition is four times higher than during training.

A more recent review of track and field injuries (Timpka et al., 2015) found 14 studies, many done only during major championship events. Very few used the same or similar definitions of a reportable incident, many recording injuries only if they resulted in time-loss of one week or more.

A separate consensus statement by Timpka et al. (2014) made a series of recommendations for promoting consistency in designing track and field injury surveillance studies and reporting results in the future, which we will look at now.

Recommendations for track and field injury surveillance design

Based on the consensus statement developed by Timpka et al. (2014), I will briefly cover the major issues regarding the design and implementation of a sports injury surveillance system for track and field. This will cover recommendations regarding definitions of reportable incidents, including injury and illness, time-loss, injury severity, and a discussion of what details should be recorded for each incident; e.g., body part injured, type of injury, mode of onset, illness-affected systems, illness symptoms and mode of onset and causes of illness. Also covered will be the problem of defining and recording exposure data.

An important fundamental step in designing an injury surveillance system is deciding on the definition of a Reportable Injury/Incident. A reportable health-related *incident* in Athletics, as recommended by the consensus statement, is defined as:

Any physical or psychological complaint or manifestation experienced by an athlete, irrespective of the need for medical attention or time loss from Athletics activities.

This is a very broad definition that includes traumatic injury, overuse injury, illness, and psychological conditions (e.g., overtraining, burnout). It also includes any athlete complaint, whether or not it involves being seen by medical staff or whether or not any time-loss is involved. Whether or not to use such an all-inclusive definition of a reportable incident is an issue that needs to be addressed at the very beginning of designing an athletics injury surveillance system. As noted by Clarsen and Bahr (2014), the study setting and the purpose of the surveillance system will impact the appropriateness and success of using this broad definition or more restrictive alternatives such as incidents requiring medical attention, incidents resulting in time-loss from participation (practice and competition) in the sport, or incidents resulting in inability to participate in competition only. Each definition has its strengths and weaknesses that must be taken into account when making this important early design decision.

Further definitions provided in the Timpka et al. consensus statement include those for injuries and illnesses. A reportable *injury* in Athletics is defined as:

A physical complaint or observable damage to body tissue produced by the transfer of energy experienced or sustained by an athlete during participation in Athletics training or competition, regardless of whether it received medical attention or its consequences with respect to impairments in connection with competition or training.

This definition includes both traumatic injuries and chronic/overuse injuries. This again is the broadest possible definition of injury in that it does not require that it receive medical attention or result in time-loss. Depending on the setting or purposes of the surveillance system, this definition can be made more restrictive by requiring the injury to have received medical attention, and/or further restricted by requiring some element of time-loss. Naturally, the more restrictive the definition is, the fewer the number of incidents will be reportable. Keep in mind, however, that particularly in youth and club situations the medical coverage may be inconsistent, resulting in systematic bias in the resulting surveillance data.

A reportable *illness* in Athletics is defined as:

A physical or psychological complaint or manifestation experienced or sustained by an athlete not related to injury, regardless of whether it received medical attention or its consequences with respect to impairments in connection with competition or training.

This definition includes psychological complaints as well as disease states, which will allow the capture of non-disease incidents such as overtraining and burnout. As with the injury definition, this illness definition can be made more restrictive by adding the requirement that it received medical attention and/or that it resulted in time-loss.

The consensus statement's definition of *time-loss* is:

> *A time loss injury or illness is one that leads to the athlete being unable to take full part in athletics training and/or competition the day after the incident occurred.*

Note that this definition of time-loss will miss those few incidents where the athlete must suspend participation on the day of the incident but has fully recovered and returns to unrestricted participation the next day.

While the severity of some specific types of injuries can be categorized by using standard grading or degree scales (e.g., concussion, ACL strains), it is the general practice to use the number of days out of full and unrestricted participation to define *incident severity*:

> *The number of days that have elapsed from the day after the onset of the incident to the day of the athlete's return to full participation in Athletics training and becomes fully available for competition.*

Incident severity is further subdivided or categorized according to the following recommendations:

- Minor injury = 1-7 days (Slight = 1 day, Minimal = 2-3 days, Mild = 4-7 days)
- Moderately Serious injury = 8-28 days
- Serious injury = >28 days – 6 months
- Long-term injury = >6 months

One pitfall to avoid when using this scale is to make sure the data reporters understand that they may have to modify their report once it becomes known exactly how many days the athlete is out of full participation. The immediate reporting of "days out" is always going to be a best guess, which often can be wrong, and if this is the case then the data recorder must revise the report in order to maintain accuracy of recording.

Another factor to consider in recording injuries is the difference between *recurring injuries* and *subsequent injuries*:

> *Recurrent condition: An incident of the same type and at the same site linked to an index (or original) incident and that occurs after an athlete's return to full function and participation from the index recordable incident.*

Subsequent injury: Injuries (of either the same or a different type) that are or may have been influenced by a previous injury.

A design decision must be made as to whether or not these two types of injuries should be distinguished when recording injuries. As noted in the definitions, a recurrent injury will be at the same body site and of the same type as an original injury from which the athlete has fully recovered (e.g., a recurring hamstring injury), while a subsequent injury is one that is influenced or caused by a previous injury (e.g., a distance runner sustains a hip injury as a result of compensating for the pain of a knee or ankle injury while running).

Details of recordable incidents – designing the data form

The design of the data collection forms, or the online data collection screens seen by the individuals recording and reporting data to the injury surveillance system, will have an impact on the accuracy of the data reported and the success of the system. The forms/screens should be as few as possible and easy to use, yet collect sufficient details necessary for making decisions based on the data. The incident (injury/illness) report should include standard information about the athlete, such as age, sex, height, weight, event group, date of incident, a code number identifying the school/club/team, etc., as well as the severity according to the categories noted above. An early question should be whether the incident being reported is an injury or an illness, so the data reporter can be immediately sent to the proper screens without having to see inappropriate screens.

An injury report should contain information about the body part injured, the type of injury, and the injury situation or mode of onset. The list of *body parts* recommended in the consensus statement to be used in Athletics injury surveillance (Timpka et al., 2014), including code numbers for computer analyses, are:

Head and trunk	Upper extremity	Lower extremity
1 Face (including eye, ear, nose)	11 Shoulder/clavicle	21 Hip
2 Hand	12a/p Upper arm (anterior/posterior)	22 Groin
3 Neck/cervical spine	13a/p Elbow (anterior/posterior)	23a/p Thigh (anterior posterior)
4 Thoracic spine/upper back	13m/l Elbow (medial/lateral)	24a/p Knee (anterior/posterior)
5 Sternum/ribs	14a/p Forearm (anterior/posterior)	24m/l Knee (medial/lateral)
6 Lumbar spine/lower back	15a/p Wrist (anterior/posterior)	25a/p Lower leg (anterior/posterior)
7 Abdomen	16a/p Hand (anterior/posterior)	26 Achilles tendon
8 Pelvis/sacrum/buttock	17a/p Finger (anterior/posterior)	27m/l Ankle (medial/lateral)
	18a/p Thumb (anterior/posterior)	28a/p Foot/toe (anterior/posterior)

There also should be a question about side of body – left/right.

The *type of injury* should include:

1. Concussion (regardless of loss of consciousness)
2. Fracture (traumatic)
3. Stress fracture (overuse)
4. Other bone injuries
5. Dislocation, subluxation
6. Tendon rupture
7. Ligamentous rupture
8. Sprain (injury of joint and/or ligaments)
9. Lesion of meniscus or cartilage
10. Strain/muscle rupture/tear
11. Contusion/haematoma/bruise
12. Tendinosis/tendinopathy
13. Arthritis/synovitis/bursitis
14. Fasciitis/aponeurosis injury
15. Impingement
16. Laceration/abrasion/skin lesion
17. Dental injury/broken tooth
18. Nerve injury/spinal cord injury
19. Muscle cramps or spasm
20. Growth plate disturbance/avulsion
21. Other

Note the statement with regard to concussion "regardless of loss of consciousness"; this is because less than ten percent of concussions involve loss of consciousness. Given the recent heightened concerns about concussion in many sports, particularly at the youth level, when a time-loss definition of a reportable injury is being used I would recommend that data providers be instructed to report *any* head injury, whether or not it involves time-loss.

Information about *mode of onset* or injury situation should include:

Mode of onset	Causes	Contributing factors
1. Sudden onset incident	1. Traumatic injury	A. Recurrence of previous injury
2. Gradual onset incident	1.1. Contact injury	B. Violation of rules (obstruction, pushing)
	1.1.2. Contact with another athlete	C. Field of play conditions
	1.1.3. Contact with moving object	D. Weather conditions (e.g., discus)
		E. Equipment failure
	1.1.4. Contact with immobile object	F. Fatigue (e.g., hurdle)
		G. Psychological
	1.2. Non-contact injury	Z. Other
	2. Overuse injury	

Turning now to illnesses, a report about an illness should contain information about the affected body system, illness symptoms, and mode of onset and causes of illness. Information about *illness-affected systems* should include:

1. Upper respiratory tract (nose, sinuses, pharynx, larynx)
2. Lower respiratory tract (trachea, bronchi, lungs)
3. Gastrointestinal
4. Cardiovascular
5. Urogenital, gynaecological or reproductive
6. Endocrine or metabolic
7. Haematological or immunological
8. Neurological, central nervous system
9. Dermatological/skin
10. Musculoskeletal
11. Dental
12. Ophthalmological/otological
13. Psychiatric/psychological
14. Other

Information about *illness symptoms* should include:

1. Pain, ache or soreness
2. Fever, excess sweating or chills
3. Nausea, vomiting or diarrhoea
4. Weight loss or dehydration
5. Fatigue, lack of energy, lethargy or arterial hypotension
6. Irregular heartbeat, palpitation, syncope, collapse or chest pain
7. Congestion, hypersecretion rhinorrhoea or discharge

8. Cough, wheezing, dyspnoea or shortness of breath
9. Dizziness or vertigo
10. Rash, itch or eczema
11. Numbness, weakness or tingling
12. Mood/sleep disturbance, anxious or depressed
13. Other

Finally, information about mode of onset and causes of illness should include:

Mode of onset	Causes of sudden illness	Causes of gradual onset illness
1. Sudden onset incident	1.1. Pre-existing disease (exacerbations of allergy, asthma, diabetes, degenerative, systemic inflammatory disorders, congenital, etc.)	2.1. Pre-existing disease (exacerbations of allergy, asthma, diabetes, degenerative, systemic inflammatory disorders, congenital, etc.)
2. Gradual onset incident	1.2. Infectious (virus, bacterial, fungus, etc.)	2.2. Infectious (virus, bacterial, fungus, etc.)
	1.3. Environmental (heat, cold, altitude, etc.)	2.3. Environmental (heat, cold, altitude, etc.)
	1.4. Nutritional, endocrine or metabolic disturbance	2.4. Nutritional, endocrine or metabolic disturbance
	1.5. Drug related or toxic reaction	2.5. Drug related or toxic reaction
	1.6. Exercise related (dehydration, exhaustion, etc.)	2.6. Exercise related (dehydration, exhaustion, etc.)
	1.7. Psychiatric	2.7. Psychiatric
	1.8. Other/idiopathic	2.8. Other/idiopathic

The coding for the different *event areas* should be:

1. Sprints (100, 200, 400) and relays (4x100 and 4x400)
2. Middle distance runs (800, 1500)
3. Long distance runs (5000, 10,000 and 3000 steeplechase)
4. Cross Country
5. Road Racing (Marathons, Half-Marathons)
6. Race Walking
7. Hurdles (100H for women, 110H for men, and 400H)
8. Jumps (high jump, pole vault, long jump, triple jump)
9. Throws (discus, javelin, shot put, hammer throw)
10. Combined events (decathlon for men, heptathlon for women)

Exposure data

Some of the more difficult decisions regarding the design of an Athletics injury surveillance system will involve collecting adequate exposure data. Much will depend on the purpose of the system. If the intent is to just monitor injury rates and patterns during competitions, then collecting exposure data for practice sessions will be unnecessary. However, doing that would leave out a lot of important and useful information if the intent is to find ways to prevent or reduce the severity of all injuries to track and field athletes. So it is recommended that injury and exposure data be collected for both competitions and practice sessions.

Collection of training and competition exposure data should be kept separate, so that separate incidence rates can be calculated for both situations. Exposure data can be based on time (which may be easier in training situations) or on participation/start (e.g., in competition).

Competition exposure is defined as:

> *Competition including warm-up, the interval between starts during the competition day, competition and cool-down.*

Incidence of competition injuries can be reported as rates per 1,000 registered athletes (which may not be advisable, since not all athletes who register for a competition actually compete), per 1,000 competing athletes and/or per 1,000 athlete participations (i.e., athlete-exposures).

Training exposure is defined as:

> *Bodily movements or isometric force produced by skeletal muscles requiring energy expenditure and aimed at maintaining or improving an athlete's athletic performance.*

This can include any activities in addition to actual event practice activities, such as weight lifting or stretching activities. Incidence of training injuries can be reported as rates per 1,000 hours of athletic practice (or rates per 1,000 athlete-exposures). While exposure data can be collected, and incidence rates reported, in more than one metric (e.g., rate per 1,000 hours of participation, rate per 1,000 athlete-exposures), there should be at least one common metric used for both training and competition so data for each can be compared and the data can be combined to present total injury rates for the sport.

In summary

This has been a brief summary of some of the major factors that must be considered when designing and implementing an injury surveillance system for track and field. In addition to the items noted above, a well-designed system that will be broadly useful and able to produce data that can be easily compared with and combined with other track and field injury surveillance systems will be a prospective cohort design and will record both injuries and illnesses. Naturally, a data collection system such as this will need to be approved by a recognized institutional (ethics) review board. The system designers and operators should also get approval and support from the Athletics organizations involved with the study population. Data collection should be performed on a weekly basis, preferably using on-site persons with medical training, with immediate follow-up to retrieve any missing weekly data reports. It is highly recommended that the consensus statement produced by Timpka et al. (2014) be used as the starting point for any surveillance system design for track and field.

Final thoughts

Informed decisions with regard to preventing injuries in track and field are dependent upon the quality of the basic epidemiological data available, and at this time such data are for the most part nonexistent. Because of the large numbers of participants and the large number and variety of activities involved in track and field, the design of adequate epidemiological research for this sport is difficult, but opportunities for such research are available for anyone willing to take on the challenge.

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COMPETITION INJURIES IN T'AEKWŎNDO: A REVIEW

Willy Pieter

Abstract

To review the epidemiology of injuries in t'aekwŏndo as reported in the literature as well as conference proceedings and unpublished reports. The main focus will be on injury incidence, distribution, type and mechanism in adult men and women.

Electronic databases and the ancestry method were searched for relevant published articles in English, German and French. The search included publications since 1980 and involved both peer-reviewed publications, international presentations and proceedings as well as unpublished theses where available. The search terms used were: t'aekwŏndo, martial, injuries, epidemiology and risk.

American male t'aekwŏndo athletes sustained an injury rate of 127.36/1,000 athlete-exposures (A-E) (95% CI: 79.32 – 175.40) and their female counterparts of 90.09/1,000 A-E (95%CI: 50.61 – 129.57), which was not significantly different. Iranian male competitors sustained an injury rate of 19.10/1,000 A-E (95% CI: 11.12 – 27.08). Compared to their colleagues competing at the 1999 World Championships, the former recorded a statistically significantly lower injury rate but the latter were not at a higher risk: OR = 0.61, 95% CI: 0.41 – 0.91, CLR = 2.20, although the result was not as precise. American male university t'aekwŏndo athletes incurred an injury rate of 235.85/1,000 A-E (95% CI: 143.40 – 328.30) and their female counterparts a rate of 333.33/1,000 A-E (95% CI: 144.73 – 521.93). At the 2012 Olympic Games, t'aekwŏndo was reported to sustain most of the injuries with male athletes at a higher risk (RR = 1.9, 95% CI: 1.1 – 3.5), but the result was not precise (CLR: 3.2). The most often occurring injury type in females was the contusion: 56.36/1,000 A-E (95% CI: 44.91 – 67.82). The major injury mechanism was delivering a roundhouse kick in the men: 46.51/1,000 A-E (95% CI: 20.20 – 72.83) and receiving one in the females (35.09/1,000 A-E, 95% CI: 0.70 – 69.47). The roundhouse kick led to a higher resultant linear acceleration (RLA) than the hook punch in boxing: 130.11 ± 51.67 g vs. 71.23 ± 32.19 g, which was statistically significant: d = 1.39, 95% CI: 0.00 – 20.41. However, the difference was not clear, which is attributed to the small sample size. The t'aekwŏndo headgear that was approved by the WTF/KTA has been found to fail the ASTM standards for martial arts headgear safety. Improving safety equipment that is currently used in t'aekwŏndo is recommended.

Epidemiological studies have shown t'aekwŏndo to be a high-risk activity. The headgear will not offset or mitigate the occurrence of head injury.

Keywords: *t'aekwŏndo, injury, type, mechanism*

Introduction

T'aekwŏndo is the second Asian combat sport to become an Olympic event. As far as is known, the very first research on the epidemiology of t'aekwŏndo injuries started in the early 1980s. It was shown that the lower extremities (70%, 95% CI: 60–80) incurred significantly more injuries than the rest of the body (30%, 95% CI: 21–39) in a combined sample of men and women (Zandbergen, 1982). The head sustained 8% (95% CI: 2 – 9) of all injuries, which was significantly lower than the other body regions. The study was carried out at a time when the athletes were only wearing the chest protector.

A larger follow-up in the late 1980s was done in the US by Zemper and Pieter (1989), who reported injury rates of 95.07/1,000 athlete-exposures (A-E) (95% CI: 84.72 – 105.42) for men and 105.46/1,000 A-E (95% CI: 89.79 – 121.12) for women, which were not significantly different from each other. It was recently revealed that Australian counterparts incurred an injury rate of 79.3/1,000 A-E (95% CI: 22.8 – 275.4) collapsed over men and women as well as age and level of competition, i.e., amateur or elite (Lystad,et al., 2009).

Iranian male t'aekwŏndo athletes sustained an injury rate of 69.51/1,000 A-E (95% CI: 55.38 – 83.63) (Ziaee et al., 2010), which was significantly higher compared to Greek counterparts (20.55/1,000 A-E, 95% CI: 11.76 – 29.34) (Beis et al., 2001). They were also at a higher risk: OR = 11.12 (95% CI: 6.74 – 18.34, CLR = 2.72), although the result was not reliable (Pieter et al., 2010). An older study revealed an injury rate of 113.43/1,000 A-E (95% CI: 87.93 – 138.94) for German adult male and female t'aekwŏndo athletes combined (Braun, 1999), which was not significantly different from that of the Australians.

The most frequently occurring injury type is the contusion in women (16.99/1,000 A-E, 95% CI: 4.40 – 29.58) (Beis et al., 2001), while cerebral concussions (5.23/1,000 A-E, 95% CI: 1.36 – 9.11) are among the serious injuries in males (Ziaee et al., 2010). The purpose of this article, then, is to review competition injuries in adult t'aekwŏndo athletes based on prospective studies.

Methods

Electronic databases were searched and the ancestry method used for relevant published articles. The search included publications since 1980 and involved both peer-reviewed publications, international presentations and proceedings as well as unpublished theses where available. The search terms used were: taekwondo, martial, injuries,

epidemiology and risk. Injuries were expressed per 1,000 athlete-exposures (A-E) and their 95% confidence intervals (CI). Where appropriate, odds ratios were also calculated.

Results

Table 1 shows a summary of comparative injury rates per 1,000 A-E in mostly elite t'aekwŏndo athletes. Based on the information in the table, the men were not at a higher risk of incurring an injury but the effect was not accurate and not reliable: OR = 1.172 (95% CI: 0.902 – 1.521) (CLR: 1.69).

Tab. 1 Selected competition injury rates per 1,000 A-E (95% CI) in t'aekwŏndo athletes

Study	Men	Women
Zemper and Pieter (1989)	127.36 (79.33–175.40)	90.09 (50.60–129.57)
Pieter Van Ryssegem et al. (1995)	139.54 (93.95–185.12)	96.49 (39.47–153.51)
Koh et al. (2001)	120.81 (92.91–148.72)	90.05 (61.42–118.68)
Beis et al. (2001)	20.55 (11.76–29.34)	36.41 (17.99–54.84)
Kazemi and Pieter (2004)	79.91 (53.44–106.38)	25.25 (3.12–47.39)
Yiemsiri et al. (2008)	39.47 (17.59–61.35)	32.41 (8.79–56.03)

Anatomical Location

The prospective studies included in Table 2 seem to suggest the lower extremities and the head and neck to sustain many of the injuries in female t'aekwŏndo athletes, the latter of which is a cause for great concern. A Greek study (Beis et al., 2001) showed no difference in the men between injuries to the head and neck (6.85/1,000 A-E, 95% CI: 1.78 – 11.92) and those incurred by the lower extremities (9.79/1,000 A-E, 95% CI: 3.72 – 15.85). The same finding was reported by Koh et al. (2001) for the men: the head and neck sustained a rate of 28.52/1,000 A-E (95% CI: 14.96 – 42.08) and the lower extremities, 57.05/1,000 A-E (95% CI: 37.87 – 76.22).

Tab. 2 Injury rates by selected body regions in female t'aekwŏndo athletes per 1,000 A-E (95% CI)

Study	Head and Neck	Upper Extremities	Lower Extremities
Pieter et al. (1995)	8.77 (0.00–25.97)	8.77 (0.00–25.97)	52.63 (10.52–94.75)
Pieter and Zemper (1999)	28.49 (20.34–36.63)	16.36 (10.19–22.54)	50.30 (39.48–61.13)
Beis et al. (2001)	4.85 (0.00–11.58)	4.85 (0.00–11.58)	24.27 (9.23–39.32)

Injury Types

Table 3 displays the distribution of selected injury types. The contusion was the most often occurring injury. Regardless of the definition used for the injury,research has highlighted the cerebral concussion to be an area of great concern in the epidemiology of t'aekwŏndo injuries (e.g., Pieter and Zemper, 1998; Koh and Watkinson, 2002a; 2002b).

Tab. 3 Rates of selected injury types in male t'aekwŏndo athletes per 1,000 A-E (95% CI)

Injury type	Beis et al. (2001)	Kazemi and Pieter (2004)	Koh et al. (2001)
Concussion	0.98 (0.00–2.90)	6.85 (0.00–14.60)	10.07 (2.01–18.12)
Contusion	10.76 (4.40–17.12)	11.42 (1.41–21.42)	33.56 (18.85–48.26)
Sprain	0.98 (0.00–2.90)	22.83 (8.68–36.98)	16.78 (6.38–27.18)

Table 4 depicts the injury rates for cerebral concussions per 1,000 A-E. More males sustained the higher grades of concussion (Pieter and Zemper, 1998; Zemper and Pieter, 1994). Males sustained all of the higher Nelson grades 3 and 4 concussions with a total rate of 6.10/1,000 A-E, 95% CI: 2.50 – 9.71) (Zemper and Pieter, 1994).

Tab. 4 Selected cerebral concussion rates per 1,000 A-E in t'aekwŏndo

Study	Males	Females
Pieter and Lufting (1994)	15.27 (4.69–25.85)	3.23 (3.09–9.55)
Pieter et al. (1995)	15.50 (0.31–30.69)	8.77 (8.42–25.96)
Koh et al. (2001)	10.07 (6.04–26.18)	4.47 (2.10–11.04)
Koh and Watkinson (2002a)	55.15 (27.24-83.06)	49.30 (12.78–85.82)

Time Loss

Table 5 displays rates for time-loss injuries in t'aekwŏndo, while the rates for the estimated days lost are shown in Table 6.

Tab. 5 Selected injury rates per 1,000 A-E for t'aekwŏndo time-loss injuries

Study	Males	Females
Pieter and Bercades (1997)	25.64 (9.90–61.18)	23.81 (22.86–70.48)
Koh et al. (2001)	33.56 (18.85–48.27)	14.22 (2.84–25.60)
Pieter et al. (2004)	20.41 (0.41–40.41)	21.74 (0.44–43.04)
Beis et al. (2007)	6.85 (1.78–11.92)	2.43 (2.33–7.19)

Tab. 6 Selected injury rates per 1,000 A-E for estimated days lost

Study	Males	Days	Females	Days
Pieter and Bercades (1997)	25.64 (0.00–61.18)	7	23.81 (0.00–70.48)	7
Koh et al. (2001)	Not reported	--	Not reported	--
Pieter et al. (2004)	20.41 (0.41–40.41)	> 21	21.74 (0.44–43.04)	> 21
Beis et al. (2007)	Not reported	--	Not reported	--

Intrinsic Factors

Although skill level has been suggested to be implicated in t'aekwŏndo injuries (Zandbergen, 1982), research to establish this relationship is lacking (Pieter, 1996). With limited information on recreational t'aekwŏndo athletes available or on those below black belt level, it is not possible at this time to make any meaningful comparisons.

Pieter, Wong et al. (2005) revealed a relationship between pre-competition mood and injury in recreational t'aekwŏndo athletes. In depressed mood female non-successful athletes, the injured group scored higher on fatigue (4.33 ± 3.08 vs. 2.13 ± 1.83, d = 1.067, 95% CI: 0.478 – 1.656) and confusion (5.33 ± 3.61 vs. 2.61 ± 2.28, d = 0.720, 95% CI: 0.037 – 1.403) but the effect of the latter was not clear. 80.85% (95% CI: 66.97 – 94.73) were correctly classified as injured or not injured. In the depressed mood male winners, those who were injured were more tensed (5.78 ± 3.07 vs. 4.27 ± 2.40, d = 0.609, 95% CI: 0.000 – 1.318) but the effect was not clear.

Injury Mechanisms

Table 8 displays the percent distribution of t'aekwŏndo techniques implicated in injury. A rotational technique, a spinning hook kick, led to the fatal injury reported by Oler et al. (1991). Zandbergen (1982) found that the roundhouse kick was implicated in 40% (95% CI: 29 – 51%) of all reported time-loss injuries, followed by the spinning hook kick (23%, 95% CI: 14 – 32). This study was carried out before the athletes were required to wear protective equipment other than the chest protector.

Research on Greek t'aekwŏndo athletes showed 85.71% (95% CI: 59.78 – 100.00) of all techniques involved in time-loss injuries were the result of so-called swing kicks, i.e., the roundhouse (turning) kick and spinning hook kick (Beis et al., 2007). The roundhouse kick elicited a resultant linear acceleration (RLA) of 130.11 ± 51.67 g (Fife et al., 2012).

Recent biomechanical research has revealed all WTF-approved helmets to fail

attenuation tests on all sides: front, back, left and right (O'Sullivan et al., 2013). There was a Helmet x Location interaction for acceleration ($\eta^2 = 0.368$, 95% CI: 0.225 – 0.827). The simple effects analysis indicated that almost all pairwise comparisons were significantly different from each other. The highest accelerations were produced on the right sides (187.69 ± 53.04 g and 175.63 ± 28.17 g, respectively) of two of the helmets. The lowest accelerations were found on two other helmets: 89.77 ± 16.62 g (right side) and 94.18 ± 13.74 g (back side).

Tab. 8 Percent distribution (95% CI) of t'aekwŏndo techniques most often implicated in competition injuries

Kick	Koh et al. (2001)		Beis et al. (2001)	
	Men	Women	Men	Women
Turning	50.72 (39.48–61.98)	65.79 (50.71–115.87)	47.62 (26.28–68.96)	20.00 (17.74–22.60)
Back	1.45 (0.00–4.27)	2.63 (0.00–7.72)	9.52 (0.00–22.07)	6.67 (0.00–19.30)
Axe	2.90 (0.00–6.86)	2.63 (0.00–7.72)	4.76 (0.00–13.87)	6.67 (0.00–19.30)

The roundhouse or turning (57.14%, 95% CI: 8.64 – 93.80) and spinning hook kicks (28.57%, 95% CI: 0.00 – 91.18) were the major techniques involved in time-loss injuries in Greek t'aekwŏndo athletes (recalculated from Beis et al., 2007). The roundhouse kick has been reported to be involved in injuries most of the time (Pieter et al., 1995; Koh et al., 2004), while it is also almost the only technique used in competition (Pieter and Pieter, 1995)

Suggestions for Injury Prevention

Preventive measures have already been mentioned throughout the text. Additional ones include conducting longitudinal studies of t'aekwŏndo injuries, preferably according to the following pattern: 1) determine the extent of the injury problem; 2) determine the etiology and mechanism of injuries; 3) introduce preventive measures; and 4) assess their effectiveness by repeating step #1 (Van Mechelen, 1992).

Competitions should not continue until late at night (midnight or even later), because the chances for injury due to fatigue will increase. Guidelines are needed for minimum coursework requirements for potential coaches (Pieter, 1996). They should be thoroughly educated according to the latest scientific insights and should keep abreast of recent developments by reading the literature on a regular basis.

More than 25 years ago, lack of blocking skills or evasive maneuvers was identified as being related to injuries and preventive measures were suggested (Zemper and Pieter, 1989). Subsequent studies also emphasized improving blocking skills to help

prevent injuries, including those leading to time loss (e.g., Beis et al., 2001), while evasive maneuvers are recommended for high force kicks (e.g., Koh et al., 2001). However, research seems to indicate that no changes for the better have been made over the years, i.e., deficient blocking skills and no evasive maneuvers are still among the mechanisms of both general (Koh et al., 2001) as well as severe injuries (e.g., Koh and Watkinson, 2002b). Without specifying the exact technique, Kazemi et al. (2009) revealed that the defensive kick was the most often occurring injury mechanism (43.94%, 95% CI: 40.43 – 47.45).

Just like in other subjective sports (e.g., Myers, et al., 2006), regional and nationalistic bias is also present in t'aekwŏndo, which has an impact on the occurrence of potential injuries. Moon (2003) revealed that despite overwhelming problems in judging t'aekwŏndo matches at national and international tournaments, hardly any effort has so far been undertaken to arrive at a fair and more objective method to score competitions. For instance, in the certification of referees there is no place for such subjects as referee philosophy, ethics, education on injuries, or match management. There is also no review of past referee performance at the end of each competition to rectify any problems (Moon, 2003). Moon (2003) is of the opinion that a comprehensive program should be developed to overhaul the current "education" of referees and a committee established independent of any organizations or groups within organizations to curb the widespread abuse of the referee system.

The most recent attempt to reduce the subjective nature of the refereeing system in t'aekwŏndo competition is the development of the so-called electronic body protector (EBP). The EBP purports to score legitimate points when it is hit. However, there is no objective information about how it was validated (Bae and Pieter, 2014). Future studies should investigate injuries at competitions for both juniors and seniors at (inter)national competitions.

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MOVEMENT VARIABILITY – SCIENCE AND PRACTICAL APPLICATION

Guido Van Ryssegem
Oregon State University, USA

Abstract

In the last 20 years concepts related to the dynamic systems theory have influenced the way we think about movement, movement variability and noise or error of data. Variability in movement is a natural and normal phenomenon that influences our lives, our physical accomplishments and our health. Motor skills in the healthy populations are associated with an optimal amount of movement variability, while in the unhealthy populations motor skills are less than optimal. As exercise is prescribed as an intervention, a clear understanding on what movement variability is, how it gets influenced and how it can be manipulated should be a priority so audiences' goals can be met. This paper reviews the literature related to movement variability in the human adult, what its relationship is to performance, to injury, how this variability impacts different populations and how the concepts related to movement variability can be manipulated so performance or return to performance can be improved.

Keywords: *dynamic systems theory, movement variability, variability, performance*

Introduction

Human movement variability has been recognized as the normal variations in motor skill acquisition across multiple repetitions of a task (1) (2) (3). Variability is inherent to movement and can easily be observed when learning a new task. Until recent, movement variability was attributed to random error or noise in data and was thereby mostly ignored(4) (5) (6) (7) (8). Others suggested that movement variability is not entirely random, and accordingly, contains important data and information (1) (9) (10).

In a more practical sense, movement variability can be described as the amount of variability present within the entire neuromuscular system while performing a specific task. This can then provide an individual with the capability of adapting to a variety of challenges (2). These challenges include changes in the biological system, (i.e. the body), the environment, and the task constraints in order to produce a more consistent pattern when performing the same movement (11). The author suggests a systematic approach, manipulating these three constraints to augment performance or return to performance after injury.

Numerous studies found a relationship between movement variability and performance as well as a relationship between movement variability, injury and health. Although some variability is required in order to be effective in a variety of circumstances, too much or too little may lead to a decrease in performance (12) (13) and increases one's susceptibility to injury (14).

Perspectives on Movement Variability

A variety of perspectives on movement variability have been published in the scientific literature. Variation in a given movement pattern has been considered by some as the result of errors. Task-specific practice gradually eliminates these errors, optimizing the accuracy and efficiency of the challenged movement pattern (15) (16). Davids, K. suggests (17) that elite performance is often characterized by low variability of outcomes (18) as their motor performances are characterized by highly consistent patterns of movement. Many assume that people share a common optimal pattern of movement and that there is a single most efficient and effective way of performing it (19). Therefore, motor variability has been considered being a problem in the sensorymotor system that should be minimized or eliminated (4) (5) (6). Also, sports biomechanists and movement coaches often make the assumption that sport performances are associated with optimal patterns of movement execution, believing that there is a single most efficient and effective way of performing a skill at the elite level. They believe that this elite performance should then be copied by others (19). These assumptions may have contributed to the negative connotations of human movement variability.

Zazone, et al. suggested that from a dynamic systems perspective, biological systems like the human body self-organize to find the most stable solution when moving (20) (21) (22). If so, then decreased variability generally indicates highly stable and cooperative behavior and increased variability is the opposite. Optimal variability is said to lie between these two limits (23). Thereby movement variability needs to be carefully interpreted in relationship to the task at hand and not be dismissed as not being important. When the sensorymotor system adopts a functionally preferred state of coordination, the capacity of the system to produce consistent and stable patterns of coordination is considered ideal (24) (25). Also a flexible and adaptable sensorymotor system can adapt into optimal states of coordination when exposed to environmental and task demands (26). Numerous studies suggest that this movement variability is an essential feature of human motor behavior as it affords the necessary flexibility and adaptability to be successful in a variety of performances (16) (22) (27) (28) (29) (30).

Recently, Stergiou, et al. (23) proposed a new model on movement variability and how it relates to health and motor learning. Their perspectives are based on the idea that mature motor skills and healthy states are associated with an optimal amount of movement variability, reflecting the adaptability of the body as a system. Less than optimal movement variability characterizes systems that are overly rigid and unchanging, whereas greater than optimal variability characterizes systems that are noisy and unstable. Both situations characterize systems that are less adaptable to challenges, typically associated with the unhealthy. Thus, stable yet adaptable systems maintain a rich repertoire of movement strategies containing optimal variability. They also then suggest that interventions should foster the development of this optimal amount of movement variability by incorporating a rich repertoire of behavioral strategies. Promoting complex variation in human movement allows either motor development or the recovery of function after injury through active engagement of the individual within their environment.

Movement Variability and Performance

Movement variability has a functional role in motor behavior. Recently, dynamic systems based research supports that movement variability is an essential feature of motor behavior that affords the sensorymotor system the necessary flexibility and adaptability to operate proficiently in a variety of performances (16) (22) (27) (28) (29) (30) (32).

The amount of variability present within the neuromuscular system changes as individuals learn the movement patterns necessary to perform a skill. During the initial stages of learning a skill, typically there is a tendency to produce very stiff and seemingly uncoordinated movements (31). As individuals become more comfortable with the movement associated with the new skill, they begin to appear more fluid and coordinated. Once individuals master a skill, the amount of variability present in one's performance may remain stable or may change across multiple repetitions of a given task (32). Although some variability is required in order to be effective, too much or too little may lead to a decrease in performance (12) (13).

The amount of coordination variability present within the neuromuscular system should reach a level of stability as individuals learn a given task (13). Untrained and skilled individuals have different levels of coordination variability across different skills. The untrained show greater variability than skilled performers when bouncing a basketball (33) and playing handball (34). In other studies, untrained and highly skilled performers have shown more coordination variability than those with intermediate skill level in the triple jump (13). According to Wilson et al., as participants learn

a skill, the amount of coordination variability present within the neuromuscular system undergoes a U-shaped pattern. While novices have high coordination variability due to the neuromuscular system being highly unstable, experts have high coordination variability due to their ability to adapt to change (13).

Already in 1968 and 1969, Arutyunyan, et al. (35) (36) found that skilled marksmen showed reduced variability in the orientation of the pistol barrel when aiming. In contrast, the novice marksmen exhibited greater variability, not able to optimally control the task. In serving, consistency in ball placement during the toss phase can facilitate success in tennis, volleyball as also in badminton, squash, table tennis and racquetball (37) (38). The study on serves (38) clearly demonstrated that practicing ball tossing should emphasize the development of a stable peak height in favor of consistency in the other directions. Studies on triple jumpers (13) showed that initially high variability was utilized as different strategies are attempted. As performance became more successful, variability decreases and at expert level variability increased again, increasing flexibility of the skill in a variety of environmental challenges. Nakayama, et al. (39) found that trained distance runners showed decreased variability in stride interval than non-runners during treadmill running at or close to their preferred speeds. Recently Cortes, et al. (40) noticed that also exercise induced fatigue lead to a decrease in variability of the ground reaction forceand knee movements and loss of coordination during a side-step cutting task as typically seen in soccer**.**

The above study findings can be interpreted in the following way, when the sensorymotor system adopts a functionally preferred state of coordination; the capacity of the system to produce consistent and stable patterns of coordination is ideal (24) (25). Also a flexible and adaptable sensorymotor system can adapt into optimal states of coordination when exposed to environmental and task demands (26).

Movement Variability and Injury

Recently research has shown that there are a number of reasons why movement variability is important in relationship to running injuries, (41) (42) (44), ACL injuries (45) (46), elderly (47) (48) (49), patellofemoralpain (43) (42) (50) and back pain (51) (52) (53) (54) (55).

Running studies on the hip-knee Q-angle relationship and injury risk as well as data on running mechanics showed that variability in coordination during the period between initial foot contact and the neutral position of the stance phase is an important feature of normal, healthy running (41) (42). Holt, et al. (50) reported similar findings

for walking, making them suggest that this variability can have important implications for injury prevention and performance (41). It is speculated that constantly varying the point of force application during movement may prevent overloading the same anatomical surfaces. Also, variability in coordination could provide the flexibility necessary to adapt to environmental perturbations as seen in running on uneven terrain**.**

In their second study, Hamill et al. (41) examined the influence of patellofemoral pain and the coordination of lower extremity body segments during treadmill running between those with vs. those without patellofemoral pain. Heiderscheit (56) similarly found that reduction of patellofemoral pain coincided with an increase in variability of the measured body segments. A follow-up study by Heiderscheit et al. (46) examined the influence of patellofemoral pain on joint coordination and stride characteristics. The results demonstrated that stride length was significantly greater in the injured population. This coexisted with an increased limb variability of the noninjured limb and a decrease in the variability of the injured limb.

Pollard doctoral dissertation (45) examined variability in lower-extremity coupling in males and females performing an unanticipated cutting maneuver. Results showed that women have significantly less variability in mean thigh-leg joint coupling during the stance phase than males. Based on this study, Pollar (45) suggested that the reduced variability places females under a greater risk for knee injury. Moraiti, et al. (46) also found that those with a deficient ACL show decreased stride-to-stride movement variability. Based on the above studies it appears that for optimal performance to occur, levels of stability and variability must be balanced (57). It is suggested that this relationship may be specific per task (23) (58) (59).

Those with back pain show increased sway in standing and sitting as compared to those with no back pain (51) (52) (53) but hold their trunks very stiffly; the healthy subjects compensate the tendency to sway by coordinated adjustments of their trunk posture, i.e. an increased variability in this particular part of the overall motor pattern (52) (54).

The author suggests that injury management can benefit from a movement variability approach as seen in studies that examined the relationship between pain and movement analysis (41) (42) (50). For example, examining variability in coordination of lower extremity body segments can monitor the effectiveness of rehabilitation protocols.

Conclusion

Human movement in healthy populations are associated with an optimal amount of movement variability. This allows performance success and optimal health. Movement in unhealthy populations are associated with a less-than-optimal amount of movement variability. These limitations may hamper their safe return to optimal health and performance. Performance, movement and rehabilitation experts need to understand what movement variability is and how they can manipulate it so optimal movement variability can be obtained with their populations (60) (61) (62) (63) (64).

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