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UNIVERSITY STUDENTS' ATTITUDES TOWARDS E-LEARNING

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ABSTRACT

Background. E-learning is a new paradigm of modern teaching methods. The aim of the paper was to reveal the university students' attitudes towards e-learning.

Methods. Research sample involved undergraduate (first cycle) and postgraduate (second cycle) students of three different universities, 156 men and 278 women. Questionnaire was comprised of 60 questions and statements.

Results. Research reveals that 40% of undergraduates and 42% of postgraduates positively treat e-learning as the method of study content presentation; 23% of undergraduate and 38% postgraduate students believe that study content presented in e-learning environment helps them focus attention; 61% of the undergraduates and 59% of postgraduate students claim that materials accessible in e-learning environment are relevant to their studies. Even 37% of undergraduates and 34% of postgraduates are completely satisfied with their study results achieved by studying materials presented in e-learning environment. Attitudes of male and female students and students from different universities differ significantly ($p < .05$). About 40% of undergraduate and 36% of postgraduate students believe that studying via e-learning is easier than studying based on traditional methods, 48% and 44% respectively think that it is harder. The majority, i.e. 59% of undergraduates and 52% of postgraduates, prefer blended learning methods. About 42% of first cycle students and 43% of second cycle students disagree or partly disagree with the claim that studies via e-learning and studies based on traditional methods do not differ in respect of their quality; 38% of undergraduate and 42% of postgraduate students believe that e-learning and traditional methods lead to the acquisition of the same competences. Students who have part-time jobs and students who have full-time jobs have significantly different ($p < .05$) attitudes towards competences acquired via e-learning and via traditional methods. The opinion that the same competences are acquired via e-learning and via traditional methods is more common among full-time workers. Students (45% of undergraduates and 37% of postgraduates) tend to believe that in the e-learning environment studies were organized as professionally, qualitatively and effectively as studies based on traditional methods. This view is opposed by 22% of undergraduate and 30% of postgraduate students.

Conclusions. Students treat traditional ("live") lectures more favourably than autonomous studies in the e-learning environment. They tend to believe that the blended learning method is the most acceptable. Male students' and female students' attitudes towards study results in the e-learning environment differ significantly. The majority believe that competences acquired via e-learning and the ones acquired via traditional methods do not differ.

Keywords: undergraduate students, postgraduate students, e-learning, traditional study methods.

INTRODUCTION

E-learning is one of modern education methods revealing the main vector of technological progress and tendencies of human behaviour in the age of the vehement technological advance (Calli, Balcikanli, Calli, Cebeci, & Seymen, 2013). Learning via application of modern information and communications technologies (ICT) can be

characterized by various concepts (Butrimė, 2011). This is partly due to the technology applied as well as to the educational paradigms on which elaboration and implementation of digital learning tools is based. However, in the documents of the European Commission, this method of learning is identified as e-learning (EFQUEL, 2007).

Thus, the present paper will use the concept of e-learning as the one which distinguishes the learning process where different types of ICT and digital information sources are used to promote efficiency, quality and accessibility of the education process.

In the context of the constructivist learning paradigm, apart from the content and technology, the process and its participants are the other two important factors, and they are even foregrounded as the essential dimensions in the process of quality evaluation (Ehlers & Pawlowski, 2006).

Today e-learning is based on the ideas of constructivism and connectivism, although, in the scientific literature the composite method is considered as the most progressive method of learning. According to the constructivist approach, learning person's consciousness encompasses and synthesizes different elements of previous experience and educational processes, in addition to this, it is claimed that previous experience is the basis for the formation and systematization of new knowledge. According to connectivism, learning is combining appropriate (relevant) information gained from different sources (Siemens, 2004). For this purpose, the ICT and digital information sources are indispensable.

The results of scientific studies reveal a wide variety of students' attitudes towards e-learning. Swanson (2014) found that the majority of undergraduate students tended to seek factual information in the Internet, and only about 27% of them tended to use any type printed text as a source in their studies. Meanwhile, Chou (2012) studied the screen reading habits and found that postgraduate students no longer preferred reading a text on a computer screen when they needed to examine the text carefully because they lacked possibilities of highlighting, underlining, and noting – i.e. all these functions possible while using printed texts.

The approach towards e-learning tools depends on previous application experiences. For example, Ainsa (2015) found those students who used e-learning tools 10 or more hours a week preferred e-materials to traditional printed texts, i.e. they were better adapted to the digital media. Research shows that proper preparation of e-learning tools contributes to the realization of the constructivist learning model with the emphasis on the learner and their needs (Dumčienė, Sipavičienė, (2010). Friesenbichler (2011) notes that we should carefully assess whether e-learning offers many opportunities to meet general principles of teaching

and learning highlighted in the strategic documents of universities. While it is important to strengthen the role of e-learning as a tool to “boost” quality of higher education, we need to be sure that e-learning itself meets certain quality requirements.

Kılıç-Öakmak, Karataş, and Akif Ocak (2009) emphasize the main factors that predestine the effectiveness of e-learning – i.e. disintegration of attention in e-learning, no working habits in the evening hours, increasing responsibilities and demanding self-regulated learning, seeing themselves as teacher, and failure to follow a strict timeline to work and do homework. Students prefer more “live” consultation and regret the lack of timely feedback. Nevertheless, they treat chat sessions quite ambiguously, in part, with view to the schedule of these sessions. Study performed by Calli et al. (2013) showed that students positively evaluated such factors of e-learning as fun, easiness of the application of its content, and effectiveness (in respect to the target outcomes of studies).

The aim of the paper was to reveal the university students' attitudes towards e-learning.

METHODS

In the research, a questionnaire consisting of 60 questions and statements was applied. The first part of the questionnaire was comprised of socio-demographic questions. The second part of the questionnaire was designed to reveal students' attitudes towards study materials presented in the e-learning environment (11 claims). The Likert scale (a 5 point scale), where 1 means “strongly disagree” and 5 – “totally agree”, was used to assess students' responses to the claims of the second part of the questionnaire. In the third part of the questionnaire, a version of ARCS Model JM Keller questionnaire (Keller, 1987; 36 claims) was applied. Responses were assessed using a 5-point Likert scale, where 1 means “completely disagree”, 2 – “disagree”, 3 – “neither agree nor disagree”, 4 – “agree”, 5 – “strongly agree”. Questions of ARCS questionnaire comprised four groups: the first aimed at the concentration of attention (12 items), the second – at relevance (9 items), the third – at reliance (9 items), and the fourth – at satisfaction (6 items).

Finally, the fourth part of the questionnaire was composed to reveal students' views on e-learning (7 questions and statements).

1. “Is distance learning easier or harder than traditional studies?” Answers were assessed

using a five-point Likert scale, where 1 means “is harder than the traditional”, 2 – “partly harder than the traditional” “3 – “equally hard”, 4 – “partly easier than the traditional”, 5 – “easier than the traditional”.

2. “Which form of education is the most attractive?” Answer options: a) “Studies in the classroom when a teacher says what must be done”, b) “Studies in classroom when one listens, writes, and then studies more deeply by themselves”; c) “Distance e-learning courses when one independently studies materials prepared by the teacher completing tasks at the convenient time”; d) “Individual tasks” e) “Live lectures and then studying the learning materials in the e-learning environment”.
3. “Which model of distance learning is the most attractive?” Response options provided: a) “synchronous (students and teachers are involved in the study process at the same time)”; b) “asynchronous (students and teachers participate in the educational process at different times)”; c) “mixed” and d) “other”.
4. “How do you assess the quality of distance learning compared to traditional studies?” (4 statements).
 - 4.1. “In respect to quality, scope, content and requirements e-learning does not differ from traditional study programs.”
 - 4.2. “E-learning ensures the same competencies as traditional studies.”
 - 4.3. “Do information technologies facilitate communication between student and teacher?”
 - 4.4. “E-learning environment studies are organized professionally, qualitatively and effectively as traditional studies.”

Statements were assessed using a five-point Likert scale, where 1 means “do not agree”, 2 – “partly disagree”, 3 – “neither agree nor disagree”, 4 – “partly agree”, 5 – “agree with the statement”.

Before each survey the students were explained the research purpose and filling instructions, the study ensured anonymity and opportunity to refuse to participate in the survey. All the students participated in the research voluntarily and were aware of the confidentiality of the research data. Research was carried out following the principles of the Declaration of Helsinki.

Research sample. The social science students from three different universities of Kaunas were the participants of the research.

X University students were selected using a convenience-sampling method; 434 completed questionnaires suitable for analyses were collected. All in all, 156 male (36%) and 278 female students (64%) were interviewed; 337 (77.6%) undergraduate (first cycle) students and 93 (21.4%) postgraduate (second cycle) students participated in the interview; 4 questionnaires (0.9%) did not provide the study level. Respondents' average age was 22.3 ± 4.35 years. With respect to employment (occupation), respondents dispersed as follows: 101 (23.3%) reported that they were studying and had a full-time job; 157 (36.2%) stated that they were studying and had a part-time job; 161 (37.1%) indicated that they were only studying; 13 respondents (3%) indicated that they were engaged in other activities (the most common were sports training and volunteering); 2 respondents (0.5%) did not specify their occupation.

Y University students were selected for the interview using convenience-sampling method. Only 80 filled in questionnaires were suitable for further analysis. This respondent group included 11 (13.8%) male and 69 (86.3%) female students. The average age of respondents was 20.48 ± 2.19 years. Most of the respondents (74 or 92.5%) were undergraduate students, the rest (6 or 7.5%) were postgraduate students. With respect to employment, respondents dispersed as follows: three respondents (3.8%) reported that they were studying and working full-time; 17 (21.3%) indicated that they were studying and working part-time; 59 (73.8%) indicated that they were studying only; 1 respondent indicated to be engaged in other activities.

Z University students were selected using, as in previous cases, a convenience-sampling method. Only 87 questionnaires suitable for further statistical analysis were received. In this group, there were 16 (18.4%) male and 71 (81.6%) female students. Respondents' average age was 19.43 ± 3.06 years. All respondents indicated to be undergraduate students. With respect to employment, dispersion of respondents was as follows: three (3.4%) reported to be studying and working full-time; 11 (12.6%) indicated to have part-time jobs and to study; 73 (83.9%) indicated that they were studying only.

Statistical methods. The data was processed using IBM SPSS V.20 program. In data processing, descriptive and nonparametric statistics was applied: Chi-square, Mann-Whitney and Kruskal-Wallis tests. The 95% ($p < .05$) confidence

interval was chosen in the research. Cronbach's alpha coefficient in the part of the questionnaire (11 questions) aiming at collecting information about study materials presented in e-learning environment was .889. Cronbach's alpha coefficient in the standardized ARCS model (36 questions) was equal to .895. Cronbach's alpha coefficient in the remaining part of the questionnaire (7 questions and statements) was .693. Cronbach's alpha coefficient of the entire questionnaire was equal to .927.

Factor analysis in the second part of the questionnaire ("Study materials presented in the e-learning environment are ...") allowed distinguishing two factors. The value of Kaiser-Mayer-Olkin test was .925; p -value of the Bartlett's sphericity test was .0. The following factors were distinguished: 1) suitability of study content; 2) form of study content presentation. The factors were evaluated on a scale from 1 to 5, where 1 means "very bad", 2 – "bad", 3 – "neither bad nor good", 4 – "good", 5 – "very good".

RESULTS

Research reveals that undergraduate and postgraduate students, irrespective of their employment, treat suitability of study content in a similar way; there were no statistically significant differences between students who had full-time jobs and the ones who had part-time jobs ($p > .05$). Even 39% of students from X University, 45% of students from Y University and 45% of respondents from Z University reported the suitability of study content presented in the e-learning environment to be very good or good. Attitudes of social science students from different universities towards the suitability of study content presented in e-learning environment differed significantly ($p < .05$).

Evaluating the form of the e-learning content presentation, 40% of undergraduate and 42% of postgraduate students expressed opinion that content presentation was good or very good, while 42% of undergraduate and 34% of postgraduate students reported it to be bad or very bad. With respect to employment, respondents' opinions differed as follows: 43% students who had full-time jobs assessed the presentation of study materials as very good or good; 39% of part-time workers reported that the form of study materials' presentation in the e-learning environment was very good or good; 39% of nonworking students rated the form of study content presentation as very good or good. There were no statistically significant differences in the evaluation of the form of study materials' presentation in respect to study cycle and having a job (full-time, par-time, $p > .05$). Even 63% of students from Z University, 39% of students from Y University and 35% of students from X University gave the highest ratings to the form of study materials' presentation in the e-learning environment. Attitudes of social science students from three universities toward the form of study materials' presentation in the e-learning environment differed statistically significantly ($p < .05$).

The study revealed that 23% of undergraduate and 38% postgraduate students agreed and 9% of undergraduate and 15% of postgraduate students did not agree that study materials' presentation in e-learning helped to focus attention. With respect to the study cycle, employment and university attended, there were no statistically significant differences in students' opinions whether study materials presented in the e-learning environment helped them focus attention ($p > .05$).

Distribution of students' evaluations of the relevance of study materials presented in the e-learning environment is shown in Figure.

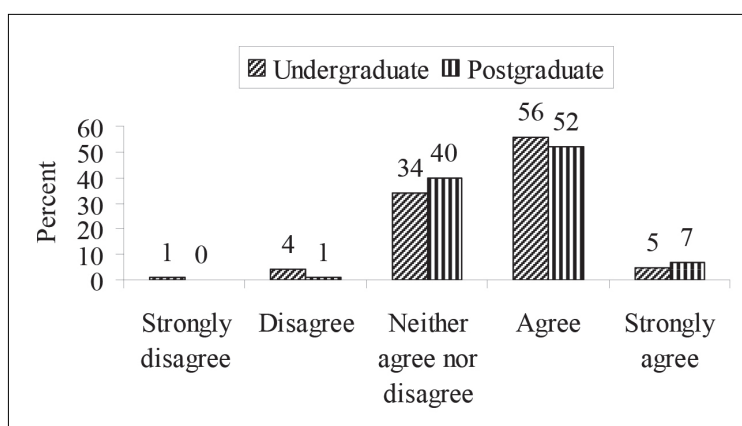


Figure. Distribution of undergraduate and postgraduate students' evaluations of the relevance of study materials presented in the e-learning environment

Attitudes towards the relevance of study materials presented in the e-learning environment did not differ significantly in respect to the study cycle, job involvement, or the university attended ($p > .05$).

Research showed that 33% of undergraduate and 36% postgraduate students trusted the study materials presented in the e-learning environment. Only 11% and 9% respectively expressed distrust in such materials. Only 10% of undergraduates did not trust and only 1% absolutely did not trust study materials presented in the e-learning environment. There were no statistically significant differences between students' opinions with respect to their study cycle and employment ($p > .05$). Even 32% of students from X University, 48% of students from Y University, and 15% of students from Z University admitted that e-learning environment and the materials presented there fostered confidence. Only less than 10% of students from these universities did not agree to it. Nevertheless, evaluations of students from different universities differed significantly ($p < .05$).

We found that 37% of undergraduate and 34% of postgraduate students were satisfied or fully satisfied with the learning outcomes studying the materials presented in the e-learning environment. The assessment of students' satisfaction with the outcomes did not provide statistically significant differences with regard to the study cycle or employment ($p > .05$). Research results showed that male students more enjoyed e-learning than female students. Male students wanted to have more study subjects in the e-learning environment. With respect to gender, opinions about satisfaction with study outcomes in the e-learning environment differed significantly ($p < .05$).

Research data concerning students' opinions about the effectiveness of different learning forms is presented in Table.

Thus, majority of students from different universities shared the opinion that the most effective learning form was studies in the classroom when the teacher gave lectures and tasks to perform. This opinion was shared by 74% of X University students, 80% of Y University students, and 80% of Z University students. Only 19% of X University, 11% of Y University and 14% of Z University students replied that they preferred lectures paralleled with studying materials in the e-learning environment. According to respondents, individual learning was the worst learning method. Nevertheless, differences in the opinions of students from different universities were not statistically significant.

In our study, 59% of undergraduate and 52% of postgraduate students identified blended learning as the most fascinating. Asynchronous mode of learning in virtual environments looked fascinating to 27% of undergraduate and 33% of postgraduate respondents. There were no statistically significant differences in respect to study cycle and employment ($p > .05$). More than half of respondents from different universities identified blended distance learning as the most attractive. Even 57% of X University students, 53% of Y University students, and 55% of Z University students would chose individual learning with a strictly limited number of contact hours.

Research showed that 42% of undergraduate and 43% of postgraduate students disagreed or partly disagreed with the statement that with respect to its quality, scope, and requirements, studies in the e-learning environment did not differ from traditional studies. Only 28% of undergraduate and 32% of postgraduate students agreed or partly agreed with this statement. Assessing study outcomes, there were no statistically significant differences with respect to study cycle or to employment ($p > .05$).

Table. Distribution of students' evaluations of the effectiveness of different learning forms

Learning form	Undergraduates (%)	Postgraduates (%)
Studies in the classroom when the teacher says what has to be done	43	31
Studies in the classroom when one listens, writes, and then studies more deeply by themselves	34	31
E-learning courses when the teacher prepares reading materials, and students complete tasks at the convenient time	17	28
Individual learning	2	3
Lectures paralleled with studying the materials in the e-learning environment	4	6

Even 38% of the first cycle and 42% of the second cycle students admitted that with respect to the competencies acquired, e-learning was identical to traditional learning methods. This statement was rejected by 39% of undergraduate and 38% of postgraduate students. In this case, the difference in the opinions was statistically insignificant ($p > .05$).

With respect to employment, students' opinions whether e-learning provides the same competencies as traditional learning differed statistically significantly ($p < .05$). Students who had full-time jobs were inclined to think that the same competencies were provided either via e-learning or using traditional methods.

38% of X University students, 43% of Y University students, and 52% of Z University students shared the opinion that both methods – e-learning and traditional learning – ensured the same competencies. Attitudes of students from different universities towards acquired competencies did not differ significantly ($p < .05$).

According to the survey, 49% of undergraduate and 38% of postgraduate students agree that information technology fosters closer collaboration between teacher and student. However, 24% of undergraduate and 32% of postgraduate students disagree with that claim. In this respect, statistically significant differences were not found. However, comparisons of students from different universities showed that their opinions differed significantly ($p < .05$). Even 46% of X University students, 61% of Y University students and 63% of Z University students agreed with the statement that information technology promotes collaboration between teachers and students.

Students (45% undergraduate and 37% postgraduate) tend to believe that in e-learning environment studies are organized as professionally, qualitatively and effectively as in traditional studies. However, the surveyed students' opinions differed insignificantly ($p > .05$); 43% of X University students, 48% of Y University students and 67% of Z University students pointed out that in terms of professionalism, quality and effectiveness, studies in e-learning environment did not differ from traditional studies. Nevertheless, in this respect, attitudes of students from different universities did not differ significantly ($p < .05$).

DISCUSSION

Part of interviewed students pointed out that distance learning was easier; however, another

part of respondents thought it was harder. There were no statistically significant differences in all three aspects. After all, it should be noted that the European Union shares general principles which encourage a shift to open education and open education sources (Camilleri, Ehlers, & Pawlowski, 2014). Open internet course is a brand new tendency in nowadays education (Hill, 2012).

According to the survey, more than 50% of respondents prefer blended (integrated) mode of learning. Research performed by Bentley, Selassie, and Shegunshi (2012) emphasized advantages of novel learning method in educational systems of such countries as Great Britain, Germany, France, Poland, etc. We should concede that in these countries there are more technological opportunities to use e-learning method and internet educational sources than in our country. According to Callaway (2012), blended learning is an easiest way to blur boundaries between traditional and innovative education.

It has been found (Taylor & Park, 2014) that nowadays students want e-learning materials to be provided via multimedia (i.e. PowerPoint presentations, video clips, diagrams, audio recordings, etc.). Another aspect of great importance is public attitude toward e-learning.

According to Poulsen, Lam, Cisneros, and Trust (2008), in order to increase attractiveness of e-learning materials, the later should be made (via suitable examples and modelling) more adequate to the practical need of the students. Students tend to believe (Taylor & Park, 2014) that the main factor that determines effectiveness of teaching and learning is relevance of the subject (or lecture theme). In this research, collaboration was given only the tenth place in the top-list. Taylor and Park (2014) emphasize that in the assessment of e-education environment, emotional climate and variety of multimedia tools are the most significant aspects for students today.

Summarizing the results of longitudinal research concerning character and extent of the internet education in United States, Allen and Seaman (2013) claim that in universities and colleges, interest in internet studies even increased during the past decade in comparison with traditional studies. According to their research, 77% leading universities share the opinion that e-learning provides the same or even better results than traditional methods. According to our research, less than a half of undergraduate and postgraduate respondents are satisfied with their e-learning outcomes.

Kransow (2013) point out that satisfaction with e-learning experience encourages students to continue their studies (do not change the study program or even university). Our research makes evident that those students who have full-time jobs are most satisfied with e-learning.

Palmer and Holt (2009) found that students' satisfaction with e-learning was related to the level of technology used. According to our research, students are satisfied with their studies when teachers give lectures and provide e-learning materials for individual work. It was not a task of our research to find out whether this aspect was related to the specific ICT technologies. The same tendencies were identified by other researchers. Among other things, it was found (Morais, Morais & Paiva, 2014) that, in general, quite many students remain sceptical about e-learning and studies using ICT. According to them, educational management systems do provide variety of functions, although, are not properly orientated toward application convenience and user experience.

According to the Cole, Shelley, and Swartz's (2014) research results, among the most important factors related to contentment with e-learning, students identify convenience. Those who were dissatisfied emphasized the lack of interaction between students and teachers as the main cause of dissatisfaction. Our research has revealed that in two universities more than half of respondents were content with educational communication via ICT.

According to Kirby, Sharpe, Bourgeois, and Griene (2010), despite the fact that most students prefer face-to-face learning, they tend to believe that experience gained via e-learning will be useful in the future.

Lambrinidis' (2014) study has shown that integrating video clips, synchronous online tutorials and online discussion groups in e-learning facilitate the use of interactive learning materials, increase its intelligibility and create a stronger bonds between students, teachers and learning material.

Harrison, Gemmell, and Reed (2014) have found that postgraduates who use only e-learning as the main method are, in general, content with their studies. Thus, this method can become a priority in the second cycle studies. This does not

contradict to the results of our study. In Omidian and Keyvanifard's (2012) research, postgraduates prefer e-learning because it lessens travel stress and expenses (especially for the working students), therefore e-learning opportunities should be developed in the future.

According to Siemens et al. (2015), properly organized and supported e-learning is associated with lower education costs, efficiency improvements and popularity of study programs (retention of students).

CONCLUSIONS

Working students are more inclined to attend e-learning courses and give higher value to this method, although, irrespective of employment and study cycle, students prefer live lectures to a greater extent than individual studies in e-learning environment. Blended learning seems to be the most acceptable to them.

More than half of respondents share opinion that study materials presented in e-learning environment are relevant, although only about one-third of respondents think that these materials help concentrate attention. The same proportions of interviewed students are absolutely satisfied or satisfied with learning outcomes in e-learning. In terms of satisfaction with learning outcomes in e-learning, attitudes of male students and female students differed significantly.

Less than a one-third of respondents shared attitudes that e-learning did not differ from traditional learning methods in terms of quality, scope, and requirements. There were more respondents who believed that the competencies acquired via e-learning and those acquired via traditional methods were the same. This opinion was common among working students mostly.

With respect to the university attended, students' attitudes whether studies in e-learning environment were organized to the same extent professionally, qualitatively and effectively as in traditional studies, differed significantly.

More students pointed out that application of e-learning method was more difficult than studies via traditional methods.

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ATTITUDES OF HIGH-LEVEL FEMALE SPRINTERS TOWARDS FACTORS INFLUENCING THE TRAINING SYSTEM

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ABSTRACT

Background. Research conducted in the field of sports science has supported the idea that training high-level sprinters is a consistent process, covering development of not only physical abilities (Bompa & Haff, 2009), but also a consistent personal development through the means of sports-related activity. For many years the prevalent opinion has claimed that success most often depends on the level of athletes' physical and tactical training; however, growing competition among the athletes calls for a deeper analysis and empirical substantiation in relation to factors influencing athlete training. Qualitative research results have demonstrated that high-level female sprinters prioritize athletic and technical training; however, there is a lack of attention to psychological, tactical and theory-based preparation. Obtained results have revealed that female runners are best motivated to excel, improve their performance by the external (cash prizes) rather than internal factors, the coach's authority also plays a significantly high role. The aim of research was to discuss factors, influencing the training system of high-level female sprinters.

Methods. Conducted qualitative research employed the semi-structured interview method. During the period from January to June of 2015, a total number of 20 best Lithuanian high-performance female sprinters of all time, dominating at the top of the World's and Europe's ratings, were interviewed.

Results. The obtained research results have demonstrated that in the course of their training process runners fail to concentrate on a significant component of their training – mental training, whereas athletic and technical training, according to the respondents, is integral, thus is a priority element of the sports-related training process. It was also revealed that high-performance female sprinters were far more motivated to excel and improve their results by the external rather than the internal factors. During the interview, the respondents mostly specified being satisfied with a reward, i.e. prizes, but not honour to represent the country, or despite the reward, willingness to improve their results. Personality of the coach is also a key component in the sports-related training among high-performance female sprinters. Data obtained during the interview showed that the coach was considered not only as a specialist, but also an integral part of the training process valued for the personal qualities, such as sincerity, friendliness, ability to motivate and encourage.

Conclusions. High-performance female sprinters fail to focus on a significant component of sports-related training process – psychological training. The results have demonstrated that the external factors rather than the internal ones influence their sports-related training and improvement of results. The coach is considered to be an integral part of the sports-related training process.

Keywords: high-performance, female sprinters, training system.

INTRODUCTION

Sport, embracing a system of physical, spiritual and cultural education, achievements in sport, knowledge of the field, and international communication, is a value in every nation (Karoblis, 2005).

The training process of athletes is a continuous educational action of a specific content and organizational form which develops physical abilities of an athlete, determines his/her activity, behaviour, independence and a sense of responsibility, and

promotes to excel. However, the greatest influence in improving the sports results still comes from optimization of athlete training technology, building of a training system and filling it with a worthy content (Bompa, 1999; Karoblis, 2005; Платонов, 2004).

High-level sport is inseparable from competitions and pursuit of sports results. (Hargreaves & Macdonald, 2000; Karoblis, 2005). Special training of athletes within the limits of a chosen sport is part of the personality's general education, having a close relationship with social, educational, political, and economic questions of human evolution (Johnson, Delva, & Malley, 2007). Research conducted in the field of sport science has supported the idea that training high-performance athletes is a consistent process, covering the development of not only physical abilities (Bompa & Haff, 2009), but also a consistent personal development through the means of sports-related activity. For many years the prevalent opinion has claimed that success most often depends on athletes' physical fitness and tactical training; however, growing competition among athletes calls for a deeper analysis of other aspects, having influence on athletes' training.

The aim of research was to discuss factors influencing the training system of high-performance female sprinters.

METHODS

The qualitative research method, i.e. interview, was used to obtain the opinion-based information from high-level female sprinters on factors affecting their training system. The semi-structured questionnaire, which provokes the athletes to reflectively analyse their sport-related activity and its quality and answer the key questions: motives influencing the training of high-performance female sprinters, strong and weak features of the training system and training objectives. The following ethical standards during the interview have been complied with: all of the informants participated in the research on a voluntary basis; the researcher introduced them to the research aims; anonymity of the respondents and their shared information has been guaranteed.

Research methodology is based on a content analysis strategy – the researcher's numbered categories were divided into subcategories, which facilitated to reveal the respondents' opinions on the questions provided. Twenty best Lithuanian

high performance female sprinters, dominating at the top of the World's and Europe's ratings, have been interviewed.

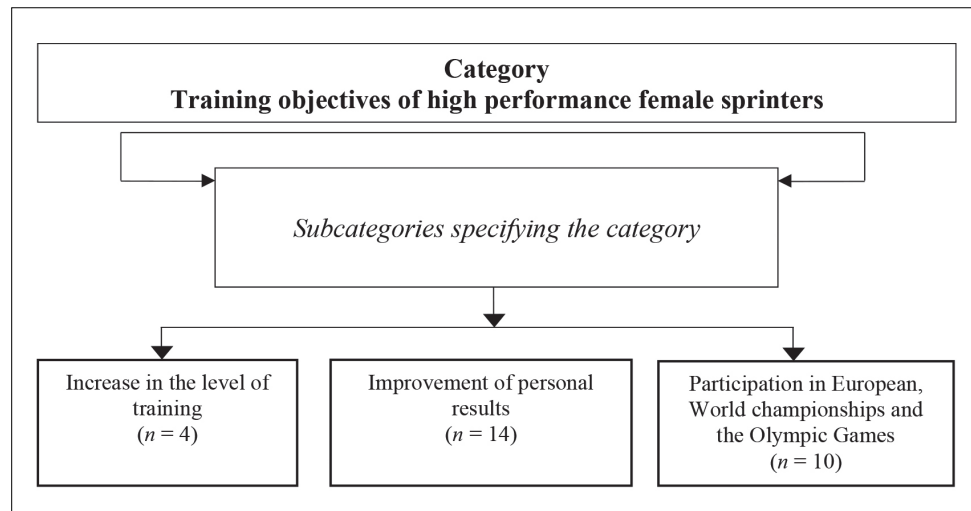
Data analysis. The qualitative research data analysis has been performed using the method of content analysis. Responses of high performance female sprinters were firstly processed using the content analysis method, where phrases and thoughts similar in their meaning were categorized and subcategorized. In other words, individual but similar in their content phrases, received a generalizing label called category, and subcategories specifying such categories in more detail allowed to detect the differences in respondents' attitudes toward the given question. Such analysis covers four steps (Žydzūnaitė, 2003): 1. Multiple reading of the texts, 2. Identification of manifest categories based on key words, 3. Subcategorization of the categories' content, and 4. Interpretation of categories and subcategories, their substantiation based on extracted phrases from the total data. This research procedure allowed to calculate the frequency of categories, which revealed the prevalence of individual attitudes and their combinations within the population being researched, i.e., allowed to reveal both the dominant and rare, atypical attitudes. It should be noted that the respondents during the interview could perceive and emphasize the most diverse aspects of a problem within the question provided, i.e. they were not given specific content related to the answer options. Theoretical position has been maintained claiming that the text provided by the female respondents is a material of content analysis as an educational diagnostics research, imaging a person's reflection process as a vital aspect of the experiential learning (Jonušaitė, Žydzūnaitė, & Merkys, 2005).

RESULTS

Results obtained during the qualitative research revealed that achievement of set goals influenced the high performance female sprinters' training. Results are provided in Figure 1.

The category identified in Figure 1, which allows revealing the training objectives of high performance female sprinters, is specified by four subcategories highlighting that the principal and top priority training objectives of the interviewed female athletes. They are improvement of personal results and self-realization during the high-level competitions (European championship, World

Figure 1. Principal training objectives of high performance female sprinters



championship, the Olympic Games) *<...the main purpose of my training in sport is to improve my personal result every year, record results at the major competitions...>*, *<...improve my results and fight for the top prizes...>*. However, the survey revealed that an increase in the level of training, according to the respondents, was less important in the sport-related training as the latter was regarded as an integral part of the sport-related educational process *<...with an increasing excellence in sport the extent of physical load is automatically increased...>*. The conducted research also revealed that motivation rather significantly influenced the implementation of goals. When pursuing to improve their results, their self-realization was increasing, which is an inseparable part of the sport-related training (Malinauskas, 2003; Ryan & Deci, 2007), playing a significant role. The scientific literature divides motivation into internal and external. The internal motivation is willingness to be effective and act for the activity itself. In that case, athletes are driven by their internal pride, which works as their inner engine, stimulating them to achieve the best results even when there is no one to appreciate it or even notice (Malinauskas, 2003). The external motivation is a reward-driven aspiration. This type of motivation, contrary to the internal one, is determined by the external factors, such as a reward for achieved results, honour-based acknowledgment, negative or positive attitude of the society, support or lack of support, etc. Both types of motivation are prevalent among high performance female sprinters in their training process. Such information is substantiated by the results, obtained during the interview-based survey (Figure 2).

Results presented in Figure 2 are explained by the category and specifying subcategories focusing

on the problem being researched. The data showed that three motives were the key influential factors in terms of high performance female sprinters' training and improvement in performance. The external top priority motive was monetary rewards *<...prize money won during the competition ensures financial stability...>*; *<...money, which I use for sport camps, supplements, etc., allows me to get ready for the next season...>* *<...winning opens the opportunity to sign profitable contracts with the sports brands, which grant a financial support...>* and the remaining two internal motives listed in the order of their importance were improvement of performance and pursuit to participate in the Olympic Games *<...my main goal is to participate in the Olympic Games...>*; *<...desire to prove myself that I can be one of the best in Europe...>*; *<...I wish to beat my 11 seconds running speed...>*.

According to Mester, Perl and Hartmann (2000), Perl and Weber (2004), the level of athletes' fitness is influenced by the abundance of training indicators (athletic, technical, tactical, functional fitness, mental, theoretical) and the results of sprinting competitions depend on a level of physical, functional, technical and psychological training (Eikenberry et al., 2008; Guggenheimer, Dickin, Reyes & Dolny, 2009; Hollings & Robson, 1991; Kale, Asçi, Bayrak, & Açıkada, 2009; Linder et al., 2010; Stanislovaitis, Grūnovas, & Butkus, 2006; Winchester, Nelson, Landin, Young & Schexnayder, 2008; Young, McLean, & Ardagna, 1995; Озолин, 1986; Табачник, 1988). Based on high performance female sprinters' interview extracts obtained during the conducted research, the strong and the weak features of sport-related training are discussed. Results are presented in Figure 3.

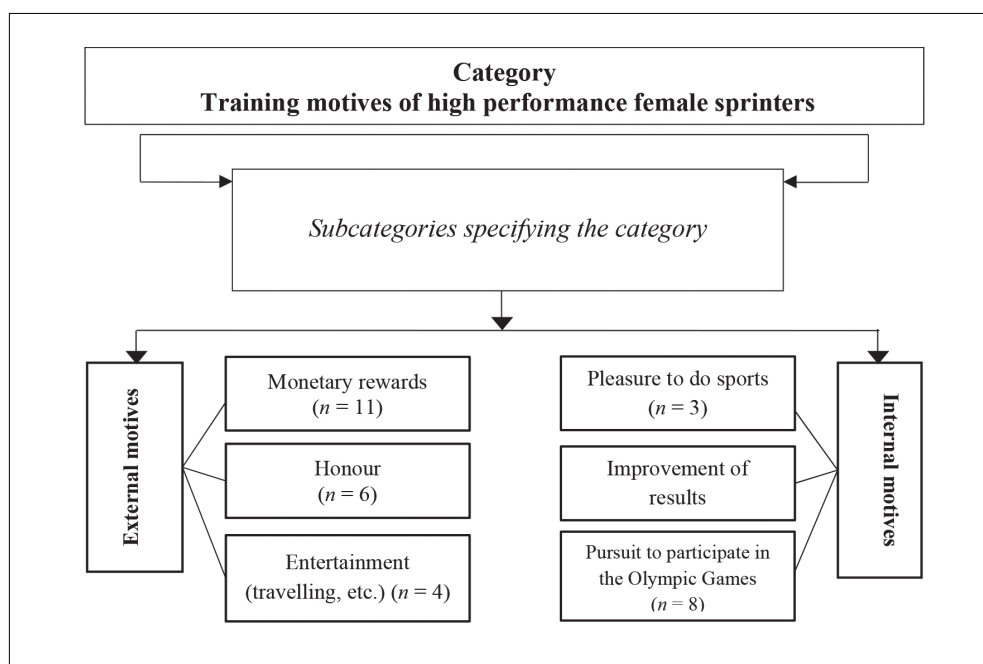


Figure 2. Motives influencing the training of high performance female sprinters

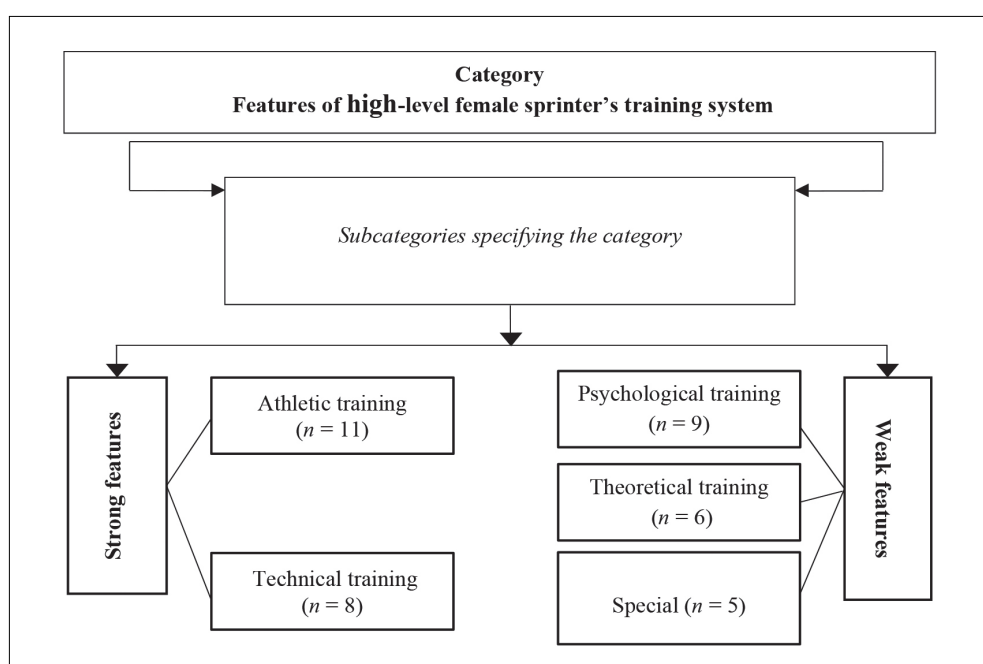


Figure 3. Strong and weak features of high performance female sprinters' training system

Category presented in Figure 3, labelled as features of high performance female sprinters' training system, is elaborated with two subcategories and the statements within them, substantiating the strong and weak features of the sport-related training. Based on the extracts from the interview, it should be noted that the informants prioritized athletic and technical readiness in the process of their sport-related training <...improvement of technique is constantly emphasized...>; <...we pay great attention to athletic fitness during the training

process...>, which were considered to be the strong features, while the weak features were named as:

- Psychological training <...during competitions I cannot cope with my nervousness, I get scared...>; <...“I burn out during competitions...”>; <...worrying does not allow me to realize myself to the fullest>, though Malinauskas (2003); Karoblis (1994) emphasize psychological fitness as a highly significant factor. Solid psychological preparation facilitates athletes to optimally use their physical

and mental powers during the workouts and competitions, which in turn has positive influence on final results:

- tactical training is more dominant in the middle distance running *<...no tactics are involved in sprinting as the entire distance (e.g. 100–200 m) is ran using maximum effort...>*;
- theoretical training *<...certain exercises, their effect, etc. are not given a theoretical reason...>*.

Subjects involved in the training process of high performance athletes are the athletes themselves and their coach. Their relationship, attitude and motives form the basis for the personality formation and pursuit of sport-related results (Miškinis, 1998). Professional excellence of a coach, qualification, knowledge in special physiology, sport medicine, psychology, pedagogy, biochemistry and other sciences have the greatest influence in the process of sport-related training (Karoblis, 1994; Wilmore & Costil, 1994). The role of a coach in the training process is evident from the results; it is presented in the Table.

Considering responses, presented in Table 1, gathered from the high performance female sprinters, it is evident that coach is regarded not only as a specialist, but also as an integral part of the training process with an emphasis placed on their personal qualities. The majority of the respondents valued their coach for constant encouragement and motivation *<... the coach encourages to work consistently during the workouts...>*, *<... always motivates and compliments...>*, while according to other athletes the coach was an authority figure *<...I fully trust the coach, his words are final in making certain decisions. He is able to perfectly control the workout sessions, deal with the athletes.>*, the remaining female sprinters appreciated the coach's sincere behaviour and friendliness *<...friendly and kind...>*, *<... helpful, gives sincere advice...>*.

During the process of research it was interesting to learn what brings satisfaction to high performance female sprinters in their sporting career. Having reviewed the results presented in Figur 4, with a category labelled as *satisfaction of high performance female sprinters*

Table. Communication and cooperation of a coach and high performance female athletes

Category	Subcategory	Substantiating statements (extracts from interview)
Relationship between a coach and high performance female athletes in sport	Encouragement, motivation (n = 8)	<i><...the coach encourages to work consistently during the workouts...></i> , <i><...always motivates and compliments...></i> , <i><...encourages athletes, compliments them during the workouts...></i> .
	Sincerity, friendliness (n = 4)	<i><...friendly and kind...></i> , <i><...helpful, gives sincere advice...></i> .
	Coach - authority figure (n = 5)	<i><...coach – authority figure... able to perfectly control the workout sessions, deal with the athletes.></i>
	Psychological help (n = 3)	<i><...takes care of athletes' psychological state...></i> , <i><...is able to handle psychological issues...></i> .

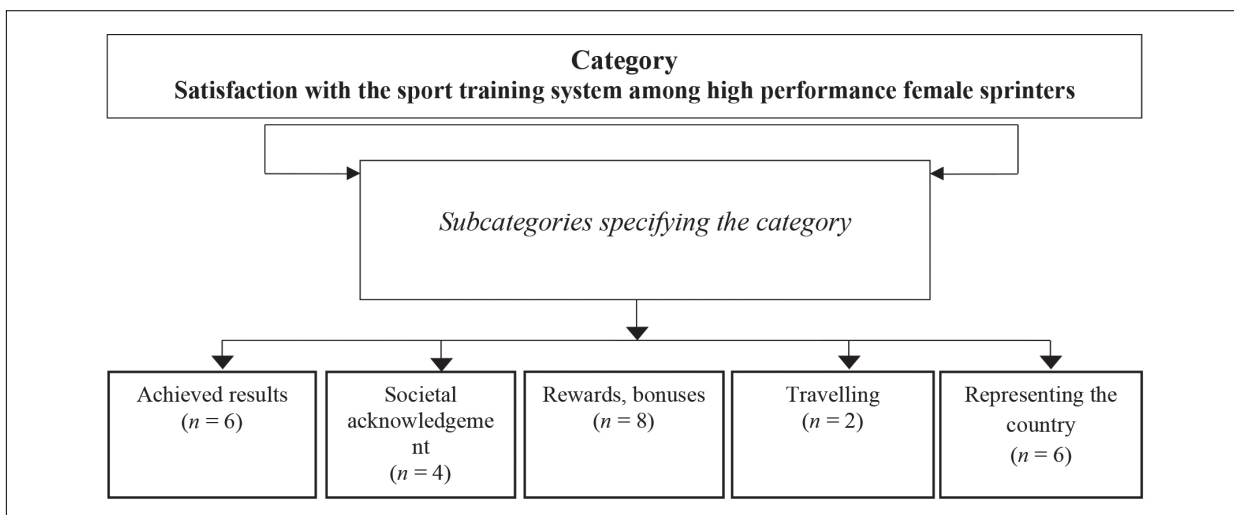


Figure 4. Aspects of satisfaction within the sporting career among high performance female sprinters

with the sport-related training system and subcategories specifying the named category, the main satisfaction aspects were identified. It was established that the informants felt satisfied having received rewards and bonuses <...I feel appreciated having received a reward>; <...prizes stimulate to pursue a better result or improve one...>, while a lower number of respondents mentioned that they felt satisfaction not because of monetary rewards, but because of achieving a set goal and the honour to represent the country <...I feel proud of myself when I achieve desirable results>; <...standing on an award podium with the country's anthem is overwhelming, it forces to forget all the trouble...>.

DISCUSSION

According to the scientists (Doscher, 2009; Eikenberry et al., Guggenheimer et al., 2009; 2008; Hollings & Robson 1991; Kale et al., 2009; Linder et al., 2010; Stanislovaitis et al., 2006; Winchester et al., 2008; Young et al., 1995; Озолин, 1986; Табачник, 1988), sprinting results depend on a level of physical, functional, technical and psychological training (Eynon et al., 2013). High performance female sprinters acknowledge this fact by prioritizing athletic and technical training, however, psychological training, according to the respondents, is a huge obstacle. Scientific literature (Malinauskas, 2003; Karoblis, 1994) emphasizes that psychological fitness is one of the key factors, facilitating athletes to optimally employ their physical and psychological powers during the workouts and competitions, which in turn has positive effect on a final result, thus, considering scientific observations, it is important to take into account not only the training of physical skills and technique, but psychological fitness.

Training for high performance female sprinters is a motive-driven process. The scientific literature divides motivation into internal and external motivation. The internal motivation is willingness to be effective and act for the activity itself. In that case, an athlete is driven by his internal pride, which works as his inner engine, stimulating the athlete to achieve the best results even when there is no one to appreciate it or notice (Malinauskas, 2003). The external motivation is a reward-driven aspiration. This type of motivation, contrary to the internal one, is determined by the external factors, such as a reward for achieved results, honour-based acknowledgment, negative or positive attitude of

the society, support or lack of support and etc. It is emphasized that a high performance athlete should train driven by the internal motives. i.e., train out of the desire to improve performance without any reward, represent the country, etc. (Smith, 2013). However, very often athletes are driven by monetary prizes and rewards. Such statement is substantiated with the results obtained during the present research. It was established that the majority of the best Lithuanian female sprinters, dominating at the top World's and Europe's ratings, are more satisfied with the awards rather than honour to represent their country, or despite the reward, willingness to improve results.

Scientific literature observes that a coach along with their professional excellence, qualification, and knowledge in special physiology, sport medicine, psychology, pedagogy, biochemistry and other sciences (Mageau & Vallerand, 2003) is a key in the training process of high performance female athletes. According to Mester et al. (2000) and Miškinis (1998), relationship between the coach and the athlete, attitude and motives form the basis for a personal development and achievement of results (Mester et al., 2000). For this reason, the present research shed some light on the contribution and a role of a coach in the training process of high performance female sprinters. Obtained results demonstrated that runners appreciated such personal qualities of their coach as sincerity and friendliness, according to them the coach helps in achieving better results by encouraging and motivating the athletes, thus is considered to be an integral part of the training process.

CONCLUSIONS

High performance female sprinters lack attention in the process of their training dedicated to a significant training component – psychological training. It was established that the external motives (monetary prizes, bonuses) rather than the internal ones (willingness to improve results, honour to represent the country) affected their training and improvement of performance. Personality of a coach was also a key influential factor. The coach was appreciated not only as a specialist, but also was considered to be an integral part of the training process by emphasizing such personal qualities as sincerity, friendliness, ability to motivate and encourage.

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MOTOR AND FUNCTIONAL ABILITIES OF U-19 ELITE CROATIAN SOCCER PLAYERS

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ABSTRACT

Background. Soccer is known as one of the most popular games in the world. Because of constant profiling and improving, players and their conditioning abilities need to be on top level to achieve great sport results. The aim of this study was to determine conditioning profile of junior players playing on different playing positions.

Methods. Sample of 85 junior elite soccer players (17.06 ± 0.74 years) was included in the study (height: 1.75 ± 0.05 m; weight: 73.59 ± 9.56 kg; body mass index: 23.97 ± 0.45 kg/cm²). Sample of variables consisted of five motor ability tests (standing long jump-SLJ, high jump-HJ, 30 m sprint-SP30M, 60 m sprint-SP60M, 5 x 10 m sprint-SP5 x 10M) and one functional ability test (1500 m run-R1500M). To determine significant differences among players playing on different playing positions and to establish where those differences were, one-way ANOVA with Scheffe post-hoc test were used. For better understanding, which tests distinguish each position the most, discriminant analysis was performed.

Results. Results showed that the sample which consisted of five groups (defenders, goalkeepers, attackers, stoppers and midfielders), significantly differed in variable SLJ ($p = .00$). Scheffe post-hoc test significant differences between defenders and goalkeepers ($p = .01$), goalkeepers and stoppers ($p = .00$) and goalkeepers and midfielders ($p = .01$).

Conclusions. Results clearly represented homogenous collective, where players, no matter which position they were, had similar values in obtained tests. The explanation of obtained results could be found in similar preparedness and great sports form, which must be on optimal level for best performance.

Keywords: motor abilities, functional abilities, preparedness.

INTRODUCTION

Soccer is one of the most-played sports in the world (Bangsbo, 1994b). It is played by women, children and adults at different levels of training (Janjić, Suzović, & Janković, 2010). Common characteristics are that these are team sports with intermittent high-intensity activities (Barbero-Alvarez, Soto, Barbero-Alvarez, & Granda-Vera, 2008; Bangsbo, Norregaard, & Thorso, 1991; Ben Abdelkrim, El Fazza, & El Ati, 2007). According to Bangsbo (1994a), for successful performance of specific tasks during games, athletes must possess appropriate abilities.

Abilities of the players are classified into four groups: technical, tactical, psychosocial and motor. In soccer, motor skills are built upon aerobic and anaerobic capacity, speed, agility, and muscle strength (Bangsbo, Mohr, & Krstrup, 2006). Kutlu, Yapıcı, Yoncalık, and Celik (2012) reported that motor skills such as acceleration, deceleration, and the ability to change direction during maximal effort were crucial. Based on that, the main task of all programs is improvement of trainings and results, improvement of general, targeted and specific abilities and characteristics that are

essential for successful participation in training and competition activities (Janjić et al., 2010). Team of experts led by coaches believe that success on the field is associated with anthropometric characteristics of players (Brahim, Bougatfa, & Mohamed, 2013). Some previous studies have shown the relationship between anthropometric profile of the players and their standing positions (Rienzi, Drust, Reilly, Carter, & Martin, 2000; Gil, Ruiz, Irazusta, & Irazusta, 2007). Because of that, the aim of the study was to determine whether there were significant differences in motor and functional tests among junior elite soccer players playing on different playing positions.

METHODS

Participants. The sample consisted of eighty-five junior elite soccer players (age: 17.06 ± 0.74 years; height: 1.75 ± 0.05 m; weight: 73.59 ± 9.56 kg; body mass index: 23.97 ± 0.45 kg/cm²) playing in Croatian First League. Players differed according to their standing positions on the field and, based on that, had different values in motor and functional ability tests in the group. All testing procedures were carried out following the principles of the Helsinki Declaration and with the permission of their parents/guardians. There were seven defenders and goalkeepers, fourteen attackers, twenty-nine midfielders and twenty-eight stoppers.

Procedures. The sample of variables consisted of five motor ability tests (standing long jump-SLJ, high jump-HJ, 30 m sprint-SP30M, 60 m sprint-SP60M, 5 x 10 m sprint-SP5 x 10M), and one functional ability test (1500 m run-R1500M). The measuring part took place in the morning (between 9–11 a. m.), before that participants had their morning breakfast and good night sleep. Also, participant did not participate in matches later that one day and wore soccer shoes, white socks, blue shorts, white T-shirts. Before testing, every player did a 10-minute warm-up and stretch training. The temperature was 23°C. The height of the participant was measured using anthropometry (at the Faculty of Kinesiology, University of Split).

Weight was also measured using digital scale with a precision to the nearest of 0.1 kg. Body mass index (BMI) was calculated using general formula: $BMI = \text{height [kg]} / \text{weight [m}^2]$. Standing long jump was measured using a tape measure affixed to the floor. Specific instructions were given to the players

to begin the jump with flexed knees and arm swing was allowed to assist the jump. If the player fell backward, the nearest body part from the start line to touch the ground was used to measure the distance of the jump. The best of three jumps was used for analysis (Almuzaini & Fleck, 2008).

Height jump was measured using Quattro Jump (Kistler, Switzerland, 2008). Each player attempted to jump as high as possible. Each player performed three jumps with two minutes rest between jumps. The highest jump was selected for analysis (Almuzaini & Fleck, 2008). Each participant swung with the arms to help the body got better vertical force.

Sprint over 30 and 60 m was measured using infrared photocells, where participant accelerated from the beginning to the end and times were recorded on the 30th and 60th m. The test was performed three times and the best score was used for the analysis. The rest between each series was two minutes.

5 x 10 m test outcomes were assessed using cones which were put 10 meters from each other. Participant had to run as fast as possible from one to the other cone 5 times. Test was measured three times and the best score was used for the analysis. The rest between each series was three minutes.

1500 m run results were assessed using athletic track, where one lap was 400 m in length. We calculated them for 1500 m and participants needed to run as fast as possible to cover the agreed distance. The test was performed only once.

Data analysis. Kolmogorov-Smirnov test was used to determine if distributions were normal. Also, descriptive statistics (arithmetic mean, standard deviation) was used for basic information about the participants. To determine significant differences between each playing position, one-way analysis of variance (ANOVA) was used. When significant differences were obtained, Scheffe post-hoc test was used to see among which groups those differences occurred. Statistical significance was set at $p < .05$.

RESULTS

Kolmogorov-Smirnov test showed that variables were normally distributed. Results in Table 1 showed basic descriptive statistics in each group of players according to their playing positions on the field and differences between each group. Results represented statistically significant differences in

Table 1. Descriptive parameters and significant differences between group (mean \pm standard deviations)

Variables	Defenders (<i>n</i> = 7)	Goalkeepers (<i>n</i> = 7)	Attackers (<i>n</i> = 14)	Midfielders (<i>n</i> = 28)	Stoppers (<i>n</i> = 29)	<i>p</i>
SLJ (m)	2.48 \pm 0.06*	2.72 \pm 0.11* ^{##}	2.56 \pm 0.10	2.53 \pm 0.11 ^{##}	2.50 \pm 0.13 [#]	.000
HJ (m)	0.53 \pm 0.05	0.60 \pm 0.07	0.57 \pm 0.04	0.56 \pm 0.05	0.55 \pm 0.05	n.s
SP30M (s)	4.23 \pm 0.15	4.24 \pm 0.11	4.20 \pm 0.09	4.28 \pm 0.15	4.26 \pm 0.13	n.s
SP60M (s)	7.57 \pm 0.23	7.65 \pm 0.19	7.57 \pm 0.16	7.75 \pm 0.26	7.71 \pm 0.27	n.s
SP5x10m (s)	10.74 \pm 0.25	11.04 \pm 0.70	10.71 \pm 0.23	10.85 \pm 0.32	10.92 \pm 0.24	n.s
R1500M (s)	292.2 \pm 18.0	294.6 \pm 13.8	303.6 \pm 16.2	300.0 \pm 18.0	300.0 \pm 21.6	n.s

Note. **p* < .05 between defenders and goalkeepers,
[#]*p* < .05 between goalkeepers and stoppers,
^{##}*p* < .05 between goalkeepers and midfielders.

Table 2. Significant discriminant root and *p*-value

Root	Eigenvalue	Canonical R	Wilks' lambda	Chi-Sqr.	<i>p</i>
1	0.74	0.65	0.46	60.79	.00

Note. *p* < .05.

standing long jump test between each group of players (*p* = .00). According to Scheffe post-hoc test, significant differences were found between defenders and goalkeepers (*p* = .01), goalkeepers and stoppers (*p* = .00) and goalkeepers and midfielders (*p* = .01). Other variables did not show statistically significant differences between groups.

In Table 2, discriminant analysis showed that only the first root was significant (*p* < .001), while in Table 3, results showed that variable SLJ differed in all five groups (defenders to stoppers) on the highest level (−1.00), SP60M (−0.91) and SP5 x 10m (−0.90).

Table 3. Standardized coefficients for canonical variables

Variables	Root 1
SLJ (m)	−1.00
HJ (m)	−0.44
SP30M (s)	0.58
SP60M (s)	−0.91
SP5x10m (s)	−0.90
R1500M (s)	0.28
Cum. Prop.	0.76

DISCUSSION

The aim of the study was to determine motor and functional test values between junior soccer players playing in different playing positions on the field and use these factors to conduct discriminant analysis to explore predictive ability of these factors. Also, we wanted to determine significant differences between each of the tests among players and their

role on the field. Our results showed that there were statistical differences in variable SLJ between defenders and goalkeepers (*p* < .05; +9.6% better result for goalkeepers), goalkeepers and stoppers (*p* < .05; +8.8% better result for goalkeepers) and goalkeepers and midfielders (*p* < .05; +7.3% better results for goalkeepers). Zalai et al. (2015) reported no statistical differences between each playing position in the same variable (*p* = .51). In their study, defenders had the highest result followed by midfielders. Our results were similar to other studies where there were no statistical difference in jump height between goalkeepers, defenders, midfielders and forwards (Zalai et al., 2015; Gil et al., 2007; Malina et al., 2000; Adhikari & Kumar, 1993; Rocha, 1975), but goalkeepers showed the highest results, except for the study of Zalai et al. (2015), where they had the lowest result. According to Malina, Cumming Morano, Barron, and Miller (2005), attackers had the highest scores in 30 m sprint, followed by defenders. Pivovarniček, Pupiš, Tonhauzerova, and Tokarova (2014) also showed that attackers had the best time in 30 m sprint, followed by midfielders (4.56 \pm 0.10 s), defenders (4.67 \pm 0.07 s) and goalkeepers (4.72 \pm 0.04 s). Zalai et al. (2015) reported that defenders had the best result in 30 m sprint (4.27 \pm 0.10 s), followed by midfielders (4.36 \pm 0.12 s) and attackers (4.37 \pm 0.24 s). According to Karavelioglu (2008), stoppers were the slowest group in 60 meter sprint, while attackers were the fastest, which our study also showed. Sporiš, Ružić, & Leko (2008) reported that mean value from three trials was around 8 sec

from the group independent on the playing position. Obtained results in 1500 meter run showed that defenders had best results, probably because of aerobic endurance, which need to be on a higher level, opposed to attackers, whose anaerobic capacities are well-trained for short distance covered and different situational efficiency on the field. Iorsac (2009) reported that 18-year-old soccer players had average values in agility 5 x 10 m test between 10.5–11 s, which was very similar to our results, although the author did not differentiate players according to playing positions on the field. From the obtained results of discriminant analysis and based on Table 1, where only values from SLJ represented statistical differences among groups, it could be seen that this variable differentiated groups the most, followed by SP60M (–0.91) and SP5 x 10m (–0.90). Discriminant values showed that players, especially goalkeepers, needed to have great explosive power of lower limbs because of the ability of catching the ball, kicking the ball and

going on the ball during the game. Also, attackers needed to have great sprinting performance on 30 m sprint to gain the advantage over the opponent and score the goal, while defenders had to show great sprinting performance over 60 meters for coming back from phase of attack to the phase of defence.

CONCLUSIONS

Obtained results showed that our sample was homogenous according to their values on motor and functional tests performed in the study. Our study clearly showed that players at different playing positions did not differ in their conditioning abilities (except for the standing long jump). That homogeneity comes from equal training protocols and competitive periods, where preparedness on and off the field represents good sports form, which must be at the optimal level for best performance and achieving great sport results.

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ADOLESCENT INVOLVEMENT IN SPORTS ACTIVITIES AND INTERNALISATION OF MORAL VALUES

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ABSTRACT

Background. Relatively little knowledge is available to date about moral values among adolescents. As participation in sports activities may contribute to positive youth development, this study aims to examine the relations between adolescents' involvement in sports activities and the internalisation of their moral values. We assessed this relationship with respect to gender as well.

Methods. The sample included 385 adolescents (192 girls and 193 boys) between 13 to 16 years of age ($M_{age} = 14.6$, $SD = 1.11$); 43.4% ($n = 167$) of the research participants were involved in competitive sports. The studied adolescents had participated in their respective sport for an average of 2.97 ($SD = 1.12$) years. The internalisation of moral values was assessed using the 24-item adolescent-report Moral Values Internalisation Questionnaire (Hardy, Padilla-Walker, & Carlo, 2008). Four forms of value regulation were assessed (external, introjected, identified and integrated). Overall value internalisation was also evaluated.

Results. Significant differences were found between adolescent involvement in sports activities and external regulation ($p < .05$), introjected regulation ($p < .01$), identified regulation ($p < .05$) as well as integrated regulation ($p < .01$). In depth analyses showed that the four forms of value regulations were higher for the athletes with experience up to three years and tended to be lower in the group of athletes with higher sports experience. The same relationship was established in the sample of boys, but not in that of girls.

Conclusions. The research results demonstrated that the identified regulation manifested more than other regulations did (external, introjected and integrated). Adolescent athletes possessed higher points of moral value internalisation in all regulations than adolescent non-athletes. Nevertheless, referring to sports experience, the internalisation forms of moral values of adolescent athletes with more than the three-year sport experience did not differ in comparison with those of adolescent non-athletes. Research results show that the internalisation of moral values for adolescents with higher sports experience is lower compared to that of adolescents with lower sports experience.

Keywords: adolescents' moral values, participation in sport, sports experience.

INTRODUCTION

The adolescent stage is the last and most challenging stage of child's development. It is a period of formation of a person's individuality and slow stabilization of personality. This stage marks the threshold from childhood to a person's preparation for adult life. Many authors emphasize similar descriptions of adolescence giving emphasis on various peculiarities of this stage. Myers (2000) argues that adolescence is a stage between biological maturity and social independence. According to Mathur (2011), every

person goes through individual and transitional period of adolescence when childhood ends and adulthood life begins. Expression of personal character traits becomes more active during adolescence because a young man or woman becomes a member of society (Timpau, 2015).

According to Hardy and Carlo (2011), adolescence is a very important stage when abstract thinking skills develop. Such skills lead to the absolute integration of moral principles and individual values (Paciello, Fida, Tramontano,

Cole, & Cerniglia, 2013). Moreover, qualities and skills related to moral functioning are more pronounced during adolescence (compared to childhood) when life is becoming more complex (Hardy & Carlo, 2005). Moral self-determinations of adolescents are based on everyday life experience when they have to make certain decisions and regulate their behaviour facing new challenges and social influence (Paciello et al., 2013). Moreover, adolescents gradually progress from external (parental) to autonomous regulation of their behaviour. They become increasingly responsible for their own behaviour and choices. While pursuing a morally responsible personality, an aspect of internalisation of moral values appears to be significant because the internalisation of values is a process by which adolescents progressively accept values and integrate them into their sense of self; their behaviour becomes internally controlled or self-regulated rather than primarily externally controlled (Grolnick, Deci, & Ryan, 1997; Grusec, 2002). Undoubtedly, the moral maturity and value system of children and adolescents are significantly influenced by parents as adolescents' value system shapes depending on how parents transfer their values to their children (Hardy et al., 2008). On the other hand, since most of the time adolescents spend at school together with their peers, they overestimate their values which potentially maintain their well-being (Barni, Ranieri, Scabini, & Rosnati, 2014). In addition, adolescent participation in extracurricular activities affects adolescents' development in a meaningful way.

A number of studies suggest that adolescent participation in extracurricular activities encourages positive youth development (Esteban-Cornejo et al., 2014; Guevremont, Findlay, & Kohen, 2014). But different types of activities may stimulate different developmental experiences. In this context, particular attention is paid to adolescent participation in sports activities. Despite the fact that participation in sport is one of the most popular forms of extracurricular activities (Vaitkevičius, Miliūnienė, & Bakanovienė, 2008), empirical studies do not always reveal the positive impact of sport on different aspects of behavior (Blomfield & Barber, 2010; Jankauskiene & Sukys, 2012). On the other hand, a close link between moral education and sport is indicated (Hardman, Jones & Jones, 2010). A number of scholars emphasize that sports activities are one of the most influencing and significant factors playing an important role in the development of personality traits and

value orientations for adolescents (Budreikaite & Adaskeviciene, 2010; Moreno & Cervello, 2005; Popescu, 2012).

It should be noted that values were researched in the context of sporting activities. Lee and Cockman (1995) identified 18 values spontaneously expressed by young athletes in discussion of moral dilemmas in their sport. Afterwards, other researchers also sought to distinguish the essential values in sport (Lee, Whitehead, & Balchin, 2000) identifying moral, competence and status values and their relation to achievement orientation and attitudes in youth sport (Lee, Whitehead, Ntoumanis, & Hatzigeorgiadis, 2008). A questionnaire constructed on the basis of recent research allowed comparing athletes' values identified in different cultures (Whitehead & Goncalves, 2013), analysing the relationship of values in sport with moral disengagement (Šukys & Jansonienė, 2012) and prosocial behaviour in sport (Stupuris, Šukys, & Tilindienė, 2013). Though this research focused on values identified in sports activities, it revealed some conflicts and compatibilities among basic values in sport. It is no coincidence that research aimed to compare values of athletes and non-athletes. Material and non-material traditional values of athletes and non-athletes (Perenyi, 2010), the approach to values as well as their perception were compared (Budreikaite & Adaskeviciene, 2010). However, moral values have not been studied in the research yet. In addition, there is a lack of research where the focus would have been placed on the internalisation mechanisms of values, especially moral values.

Describing values as motivational in their function (Schwartz, 1994) and understanding internalisation as integration of values into one's self that emphasizes self-regulation rather than external control (Grolnick et al., 1997; Grusec, 2002) highlights the importance of Self-Determination Theory (Deci & Ryan, 1990). According to this theory, each person is willing to engage in certain activity, however, when a person faces obstacles, he or she may lose motivation and become passive (Deci & Ryan, 1990). In Self-Determination Theory four forms of human value regulation are identified: external regulation (when behaviour is controlled by external incentives and discipline); introjected regulation (when values are absorbed from environment, however, they are not yet perceived as the person's "self-being"); identified regulation (when a person perceives values as his or her personal values; when he or

she lives in accordance with them); integrated regulation (when values are accepted as personal values; when a person tries to link them to other personal values) (Deci & Ryan, 1990). According to Hardy et al. (2008), the highest peak of value internalisation is achieved when personal values turn into his or her “self-being”, his or her identity, when behaviour derives from the inner faith. It can be said that when moral values are accepted as personal values, then morally responsible actions of adolescents can be expected.

In summary, the purpose of the current study was to examine the relations between adolescent involvement in sports activities and their moral values internalisation. Additionally, we examined the relationship between the internalisation of moral values by gender and experience in sports activities. Based on the concept of the “bracketed morality” (Bredemeier & Shields, 1986), which emphasized that morality appropriate in everyday life is partially suspended and egocentrism is more appropriate in a sporting context, and empiric finding supporting this concept (Bredemeier & Shields, 1986; Kavussanu, Boardley, Sagar, & Ring, 2013), we hypothesize that adolescents participating in sports activities would be more strongly linked to the more controlled forms of value regulation compared to non-athletes. Prior studies showed that moral values in sport became less important for the adolescent athletes with higher sports experience (Stupuris, Šukys, & Tilindienė, 2013). It could be related with an increasing pressure from teammates and coaches to contribute to winning (Bardi & Schwartz, 2013). Increasing pressure could be related with the more controlled motivation which is associated with less likelihood to internalised moral values and prosocial behaviour in sport (Hodge & Lansdale, 2011). Based on these findings we hypothesize that moral value internalisation index of adolescents with higher sports experience would be less compared to that of adolescents with lower sports experience. Given the dearth of research on this topic, we felt it important to examine this topic in an attempt to provide knowledge that could be useful to both educators and coaches.

METHODS

Participants. The sample included 385 adolescents (192 girls and 193 boys) between 13 and 16 years of age (M age = 14.6, SD = 1.11). The participants were recruited from four schools of

general education within Kaunas city applying the multistage sampling procedure. Among research participants, 43.4% (n = 167) were involved in competitive sports. Referring to gender, more boys were involved in sports activities compared to girls (52.3% of boys (n = 101) and 34.4% of girls (n = 66), (p = .001). The studied adolescents had participated in their respective sport for an average of 2.97 (SD = 1.12) years. The data of adolescents' participation in sports activities were divided into two groups based on adolescents' sport experience: > 3-year experience (n = 62), and ≤ 3-year of sport experience (n = 105).

Procedure. The research of schoolchildren was subject to permission of school directors and verbal consent of schoolchildren that had to be obtained prior to the research. After the successful agreement with the school administration and arrangement of survey time the researchers arrived to place. The survey was carried out in classrooms during lessons. The teacher of the schoolchildren or the school's deputy director were participating in the survey. Prior to each survey the schoolchildren were explained the research purpose and instruction of the questionnaire filling. Emphasis was always given to the survey anonymity and possibility to refuse to participate in the survey at any time.

Measures. *Internalisation of moral values* was assessed using the 24-item adolescent-report Moral Values Internalisation Questionnaire (Hardy et al., 2008) which was based on the Self-Determination Theory approach to internalisation (Deci & Ryan, 1990) and Prosocial Self-Regulation Questionnaire (Ryan & Connell, 1989). The questionnaire contained six questions with four answer options. As the questionnaire measures the internalisation of moral values, two questions were associated with fairness, two questions were associated with honesty, and two questions - with the value of kindness. Each question asked the participants to rate the importance of different reasons why they might or might not engage in certain behaviour, on a scale from 1 – not at all important to 5 – very important. The four items for each question represented the four forms of value regulation. Therefore, in total, six items for external regulation (α = .79), six items – for introjected regulation (α = .82), six items – for identified regulation (α = .84), and six items – for integrated regulation (α = .82) were represented. For example, a question reflecting a value of honesty was “How important is each of the following reasons for why you might decide to tell the truth when given an opportunity to lie?”

There were four reasons (items) corresponding to external regulation of values (“Because I wouldn’t want to get into trouble for lying”), introjected regulation of values (“Because I would not want people to think of me as a liar”), identified regulation of values (“Because I think telling the truth is the right thing to do”), and integrated regulation of values (“Because I consider myself an honest person”).

Composite scores for each level of internalisation (i.e. each form of value regulation) were created by calculating the mean of the six items corresponding to each level. Additionally, a composite of overall internalisation was calculated by differentially weighing individual composite scores on the four levels (–2 for external, –1 for introjected, +1 for identified and +2 for integrated), as suggested by Grolnick and Ryan (1989). This relative autonomy composite is a score that indicates the degree to which adolescents prefer using more internalized modes of value regulation (identified and integrated) compared to less internalized modes of value regulation (external and introjected).

Adolescents’ participation in sport was assessed using the question “Do you participate in competitive sports?” with response alternatives. This question measuring participation in sports was validated in the earlier studies with adolescents (Šukys, 2004). Therefore, in data analysis the subjects were divided into two groups: athletes (those persons who attended sports at schools or clubs for no less than two hours per week and participated in competitions, and these activities continued no less than one year) and non-athletes.

Data analysis. All the analyses were performed using IBM SPSS Statistics for Windows software (version 19.0). The analysis included Cronbach’s alpha coefficients, descriptive statistics, Pearson’s correlations, and distribution of data (including Skew and Kurtosis) calculation. The statistical or null hypothesis (Ho) of equality of the mean (M)

between groups was tested using independent sample *t*-test and One-Way ANOVA. In all instances (comparing more than two groups) where the Ho was rejected, post-hoc (Tukey’s test) was computed. For analyses of variance the effect size was calculated: $\eta^2 = \text{Sum of squares between groups} / \text{Total sum of squares}$. In interpreting effect size the guidance from Cohen (1988) was taken into account: 0.01–0.05 a very small effect, 0.06–0.14 a moderate effect and from 0.15 a very large effect. Comparing two groups Cohen’s *d* effect size was calculated.

RESULTS

Descriptive statistics and correlations were computed using the entire sample and presented in Table 1. The adolescents reported identified regulation more, followed by introjected regulation, integrated regulation, and external regulation, respectively. Significant correlations were determined between all levels of internalisation.

One-way ANOVA showed the difference in external regulation between the three groups of adolescents by their involvement in sports activities (Table 2). Tukey’s HSD tests demonstrated that the adolescents participating in sport less than 3 years scored statistically significantly higher than the group of adolescents not participating in sport ($p = .017$). ANOVA indicated the differences in introjected regulation between the three groups of adolescents. Tukey’s HSD tests showed that the adolescents participating in sport less than 3 years scored statistically significantly higher than the group of adolescent non-athletes ($p = .006$). One-way ANOVA revealed a significant difference between the identified regulation means. Tukey’s HSD tests showed that the adolescents participating in sport less than 3 years scored statistically significantly higher than the group of adolescent non-athletes ($p = .019$). Additionally, the analysis of variance identified differences in integrated

Variables	<i>M</i>	<i>SD</i>	Skew/ kurtosis	Correlation				
				1	2	3	4	5
1. External regulation	3.82	0.79	–1.04/ 1.49	(.79)				
2. Introjected regulation	3.93	0.81	–1.14/ 1.55	.79**	(.82)			
3. Identified regulation	4.05	0.79	–1.23/ 1.80	.73**	.81**	(.84)		
4. Integrated regulation	3.89	0.77	–1.14/ 1.82	.64**	.73**	.74**	(.82)	
5. Overall internalization	0.25	1.49	–0.1/ 1.49	–.45**	–.21**	.08	.35**	(.94)

Table 1. Correlations, reliability estimates, and descriptive statistics for moral value internalization ($N = 385$)

Notes. ** $p < .01$. Alpha coefficients are reported on the diagonal.

Table 2. Means, SD, and effect size of adolescents moral values internalization by the involvement in sport activities ($N = 385$)

Variable	Any sports		> 3 year experience		≤ 3 year experience		$F(2,384)$	p	η^2
	M	SD	M	SD	M	SD			
External regulation	3.73	0.84	4.06	0.69	3.85	0.74	3.90	.021	.020
Introjected regulation	3.84	0.88	4.21	0.51	3.92	0.77	4.82	.009	.031
Identified regulation	3.96	0.85	4.27	0.58	4.09	0.76	3.91	.021	.020
Integrated regulation	3.79	0.82	4.13	0.57	3.95	0.73	5.51	.004	.028
Overall internalization	0.21	1.51	0.22	1.51	0.37	1.17	0.46	.634	.001

Table 3. Means, SD, and effect size of adolescents girls moral value internalization by the involvement in sports activities ($n = 66$)

Variable	Any sports		> 3 year experience		≤ 3 year experience		$F(2,191)$	p	η^2
	M	SD	M	SD	M	SD			
External regulation	3.98	0.72	4.23	0.56	3.98	0.84	1.73	.180	.018
Introjected regulation	4.02	0.79	4.29	0.42	4.08	0.85	1.73	.179	.018
Identified regulation	4.17	0.75	4.39	0.51	4.26	0.75	1.25	.290	.013
Integrated regulation	3.92	0.73	4.11	0.51	4.08	0.80	1.32	.269	.014
Overall internalization	0.03	1.37	-0.15	1.58	0.38	1.96	1.08	.341	.011

Table 4. Means, SD, and effect size of adolescents boys moral value internalization by the involvement in sports activities ($n = 101$)

Variable	Any sports		> 3 year experience		≤ 3 year experience		$F(2,192)$	p	η^2
	M	SD	M	SD	M	SD			
External regulation	3.41	0.89	3.84	0.78	3.79	0.69	5.80	.004	.057
Introjected regulation	3.61	0.94	4.10	0.60	3.86	0.73	4.45	.013	.045
Identified regulation	3.68	0.90	4.13	0.64	4.02	0.75	5.27	.006	.053
Integrated regulation	3.60	0.91	4.16	0.65	3.89	0.70	6.30	.002	.062
Overall internalization	0.45	1.66	0.67	1.31	0.37	1.20	0.45	.640	.005

regulation means. *Post hoc* analysis revealed that adolescents participating in sport less than 3 years scored statistically significantly higher than the group of adolescents not participating in sport ($p = .005$).

Additionally we performed analyses separately in the girls' and boys' samples. It should be noted that there were no statistically significant differences comparing internalisation of moral values in girls' groups (Table 3). Otherwise, comparing the boys' groups, the study showed the relationship between involvement in sports activities and their moral value internalisation. One-way ANOVA showed the difference in external regulation between the three groups of adolescents by their involvement in sports activities (Table 4). Tukey's HSD tests showed that adolescent non-athletes scored significantly lower than the adolescent boys participating in sport up to 3 ($p < .05$), 3 and more years ($p < .01$). ANOVA indicated the differences in introjected regulation between the three groups of adolescents. Tukey's HSD tests showed that the adolescents participating in sport up to 3 years scored statistically significantly higher than the

group of adolescent non-athletes ($p < .05$). One-way ANOVA revealed a significant difference between the identified regulation means. Tukey's HSD tests showed that the adolescent non-athletes scored significantly lower comparing to both athlete groups ($p < .05$). Additionally, the analysis of variance showed differences in integrated regulation means. *Post hoc* analysis revealed that adolescent non-athletes scored significantly lower compared to boys involved in sports for less than 3 years ($p < .01$) and those competing 3 years and longer ($p < .01$).

DISCUSSION

The research focused on adolescents' internalisation of moral values according to the Self-Determination Theory. Research aim was to examine the relations between adolescents' involvement in sports activities and their moral value internalisation. Research results demonstrated that identified regulation manifested more than other regulations (external, introjected and integrated). It means that individuals accept values as their

own by identifying with the importance of values and behaviours they dictate. As Deci and Ryan (1990) state “when the person has identified with the regulatory structure, there is less experience of pressure and conflict and less salience of guilt and anxiety” (p. 256). On the other hand, introjected regulation, which refers to extrinsic motivation more when a person does not fully accept values as one’s own and own actions are still associated with expectations of self-approval, expresses alike integrated regulation that refers to the most self-determined form of internalised regulation. Neither extrinsic nor intrinsic regulations can be attributed to adolescents of the studied age in reference to this research results. This may be explained by the age of participants as socialization process develops resulting in the integration of moral principles and individual values at this particular age (Paciello et al., 2013).

The internalisation of moral values results in value integration and acceptance according to Deci and Ryan (1990) “...bring them into a consistent relation to the other needs, processes, and values that represent self” (p. 255). Since environment is important in this process, we compared moral values of athletes and non-athletes in this study. It was hypothesized that adolescents participating in sports activities would be more strongly linked to the more controlled forms of value regulation compared to those of non-athletes. The results only partly confirmed this hypothesis because adolescent athletes possessed higher scores in the internalisation of moral values in all regulations than non-athletes. In addition, the introjected and integrated regulations of adolescent athletes were higher, which represented greater autonomous forms of regulations. However, in the analysis of these results it is necessary to take into account sports experience because the moral values internalisation forms of adolescent athletes with more than three years of sports experience did not differ compared to those of non-athletes. It shows that the moral value internalisation of adolescent athletes with more sports experience is worse than that of athletes with two-three years of sports experience. These results partially reveal that the first hypothesis had not been completely wrong, and also confirms the other hypothesis that moral value internalisation of adolescents with higher sports experience would be lower compared to that of adolescents with lower sports experience.

The scientific literature is not abundant with studies where internalisation of values

is analysed with respect to sports experience of adolescents although some studies analyse athletes’ internalisation of values. For instance, the research of adolescents’ values (Lee et al., 2008) found that the most important values were based on inner personal experiences: enjoyment, personal achievement, sportsmanship, contract maintenance. Moreover, other studies revealed that the typical motives of children’s involvement in sports activities were to have fun, enjoy being physically active with friends (Sit & Lindner, 2006). Satisfaction and fun were more related with intrinsic motivation. However, extrinsic motives were more related to material rewards (Webb, 2008). Thus, while interpreting the moral value internalisation of adolescents with different sports experience, attention should be focused on several factors linked with the same activity. Motives and objectives in sports activities differentiate together with sporting experience. When winning becomes the most important goal, motives of joy and enjoyment become of lower importance (Webb, 2008). Additionally, the role of a coach is essential in creating a motivational climate in a team. Athletes positively value when the coach builds a task-oriented motivational climate which is related to various positive consequences as enjoyment and effort. Conversely, some studies show that coaches create an ego-oriented motivational climate that is related to emphasis on winning (Almagro, Saenz-Lopez, Moreno-Murcia, & Spray, 2015) and on less autonomous motivation of athletes. In turn, the ego-orientated motivation does not relate with moral values (Lee et al., 2008) as controlling coaching style does not relate with athletes’ autonomous motivation and their moral behaviour (Hodge & Lonsdale, 2011).

Discussing the differences of internalisation of moral values, it is worth noting that they partly confirm the studies which found that athletes with lower sport experience emphasized moral values more (Stupuris, Šukys, & Tilindienė, 2013). This is complemented by the research, which focused on the moral behaviour of athletes. The research of athletes’ fear of failure and interpersonal antisocial behaviour in educational setting and sport determined that sports experience positively predicted antisocial behaviour in university and sport, and the strength of these predictions did not differ between males and females (Sagar, Broadley, & Kavussanu, 2011). Nevertheless, the studies should be mentioned when athletes gain more experience in their sports, moral and

competence values become more important to them, but later their significance decreases (Šukys & Jansonienė, 2012) or athletes' moral reasoning is not related to sports experience (Proios, Doganis, & Athanailidis, 2004). Commenting on the results of different studies it may be claimed that in accordance with the Self-Determination Theory athletes could experience different styles of regulation (Almagro et al., 2015).

The research takes into consideration the moral values of the internalisation with respect to gender. It was found that girls' scores in moral values were higher than those of boys, but the overall moral value internalisation was more common in boys. Lee et al. (2013) who analysed which sport values were most important to young people claimed that girls were seen to attach less importance to sporting values than boys, sporting values appeared to become less important with aging but were more important at higher levels of performance. It is also argued that such differences may be influenced by the fact that adolescent girls were less engaged in sports activities than boys, the girls' interests in both general and sporting context varied. Gender differences were also identified in the analysis of moral decisions (Kavussanu & Roberts, 2001, Sage & Kavussanu, 2007).

In summary, it can be claimed that sports educators and coaches working with children and adolescents should take into account the creation of sports environment context. Since this age is particularly important in their socialization processes, an environment in the context of sporting activities must be guided not only placing emphasis on winning. In addition, it is important to use a sporting environment promoting the autonomous motivation of young athletes as it is more important for intrinsic processes of value internalisation. It should also be acclaimed that the results may be of interest to parents of athletes.

Strengths and limitations. The pattern of results reported provides important insights into the

adolescents' internalisation of moral values and its relationship with involvement in sports activities. The study showed that adolescents tended to use each of the four forms of value regulation (external, introjected, identified and integrated). Specifically, it seems that involvement in sport may play a role in the internalisation of moral values.

Despite the interesting findings regarding the relations between adolescents' involvement in sports activities and their moral values, there were several limitations to the present study. First, the study was carried out using a cross-sectional design, limiting our ability to draw causal inferences from the results. The second limitation of the current study is a relatively small sample size, which might account for some of the non-significant findings. The third limitation as continuum of the second is that we did not analyse the group of adolescents not participating in sports activities, i. e. which active leisure forms they were engaged in.

CONCLUSION

The research results demonstrated that the identified regulation was expressed more than other regulations (external, introjected and integrated). The research results only partially confirmed the hypothesis that adolescents participating in sports activities would be more strongly linked to more controlled forms of value regulation compared to non-athletes as adolescent athletes possessed higher scores of moral value internalisation in all regulations than non-athletes. However, given the sports experience, we observed that moral value internalisation forms of adolescent athletes with more than the 3-year sports experience did not differ from those of adolescent non-athletes. Considering gender, a relationship was found between internalisation of values and participation in sport in the sample of boys, but not in the sample of girls.

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SITUATIONAL EFFICIENCY PARAMETERS OF SUCCESSFUL AND UNSUCCESSFUL TOP MALE BASKETBALL TEAMS IN THE OLYMPIC TOURNAMENT GAMES IN LONDON 2012

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ABSTRACT

Background. The purpose of this study was to determine differences in situational efficiency parameters that differentiate male basketball teams according to outcome. Sample of entities consisted of 38 games played in the Olympic Games in London 2012.

Methods. Situational efficiency variables that affected the final outcome were comprised of 13 parameters. Differences between successful and unsuccessful teams were obtained using Student's t-test. Also, overall differences between teams were analysed applying multivariate analysis of variance (MANOVA) and discriminant analysis with standardized canonical coefficients (SCC). Significant value was set up at $p \leq .05$.

Results. Results showed overall statistical differences in situational parameters between teams ($p < .001$). Also, discriminant function showed that situation parameters 2 pts-fail (F -value -14.82, $SCC = -0.967$, $p < .001$), 3 pts-fail (F -value = 5.57, $SCC = -0.403$; $p < .05$), offensive rebounds (F -value - 16.38, $SCC = 0.943$, $p < .001$), defensive rebounds (F -value = 6.66, $SCC = 0.822$, $p < .05$), turnovers (F -value = 14.03, $SCC = -0.608$, $p < .001$) and steals (F -value = 4.78, $SCC = 0.425$, $p < .05$) differentiated most of the teams according to outcome.

Conclusion. On the basis of the obtained results we suggest that winning teams had technical-tactical parameters on higher level due to better timing of sports fitness with adequate resting periods and type of training process.

Keywords: team sport, notational analysis, final outcome.

INTRODUCTION

Basketball represents one of the most dynamic sports in the world (Pojskić, Šeparović, & Užičanin, 2009). Within the game, player's quality, cooperation between the players, tactics and overall teamwork primary determine the team's efficiency and competitive success (Trninić, Dizdar, & Dežman, 2000). Also, the whole game represents a furnished sequence of tasks which each player needs to get done according to the playing position and team role. The activity of individual player in basketball game started to get measureable through situational efficiency with standardised and non-standardised indicators in basketball game (Trninić, Milanović, & Dizdar, 1997). International Basketball Federation (FIBA) standardizes thirteen

indicators of situational efficiency that are followed during each game (Sindik & Vidak, 2010). That is why situational parameters contribute the most in basketball game.

Situational parameters become one of the most important and objective factors determining overall efficiency in the game, especially in team sports. For example, in rugby, Hunter and O'Donoghue (2001) compared performance of successful and unsuccessful teams in World Cup 1999. Their study found statistical differences in two of eleven analysed variables in favour of successful teams (Hunter & O'Donoghue, 2001). Also, Gruić, Vuleta, and Milanović (2006) analysed performance indicators of men's handball teams in

World Handball Championship in Portugal 2003. They reported that the contribution of the predictor variables to the final successfulness criterion was statistically significant. The partial effects of regression analyses confirmed the importance of the situational efficiency of backcourt attacking players in the generation of final outcomes of handball matches. More precisely, *missed shots from the field*, along with *fast break shots scored* mostly influenced the final score.

In basketball, according to Dezman, Erculj and Vuckovic (2002), the process of winning depends on creating a strong team, which is defined by individual quality of each player. The study of game performance as a function of the differences in the final score of the game is becoming an important variable to consider (Garcia, Ibáñez, De Santos, Leite, & Sampaio, 2013).

Therefore, it is not uprising that most of the studies tried to determine which situational efficiency parameters mostly differentiated successful and unsuccessful male basketball teams (Ibanez et al., 2008; Gomez, Lorenzo, Ortega, Sampaio, & Ibáñez, 2009; Gomez, Lorenzo, Sampaio, Ibáñez, & Ortega, 2008; Trninić, Dizdar, & Lukšić, 2002). To be more precise, Gomez et al. (2008) reported that 2 pts-made, defensive rebounds and assists represented parameters that differentiated successful teams from unsuccessful ones. Also, other studies showed that defensive rebounds differed the most winning and defeated teams (Akers, Wolff, & Buttress, 1991; Trninić et al., 2002). Melnick (2001) tried to find connection between assists and final outcome of the game. The study conducted by Montgomery et al. (2008) reported that several consecutive games (3-day tournament) decreased physical capacities (jump power, agility and speed), possibly due to fatigue accumulated from successive games (Gabbett, 2008; Royal et al., 2006). Sampaio and Janeira (2003) reported that defeated teams performed worse in every observed parameter. Trninić et al. (2002) found that *defensive and offensive rebounds* along with shooting variables discriminated successful from unsuccessful teams the most. On a sample of 25 games of basketball league 1973/1974, Trninić (1975) examined the relationship between frequencies of caught balls in the phase of attack and defence with the final score of the game. The author determined real, but not high correlation between caught balls in the phase of defence and attack ($r = .46$), along with low correlation between the same variables and the final score of the game ($r = .22$) and

between caught balls and number of baskets of the successful teams ($r = .25$). Moreover, on a sample of 26 games of Yugoslavian Basketball Championship, Milanović (1978) established a significant impact of 4 situational variables of scoring the basket from different distances and 11 situational variables of scoring the basket different ways on the final score in basketball game. The author concluded that the final result mostly depended on shooting accuracy from different distances, along with the fact that successful teams determined scoring the basket from the distance and under the basket efficiency. Swalgin (1994) was examining players from Men's Division College for 3 years and established the situational efficiency variable norms between different playing positions and the time spent in the game. Based on that, the author created a computer programme for evaluating the player's efficiency on the court. Pojskić et al. (2009) conducted a study on 37 matches analysing 22 variables of standard and derived statistical indicators. The authors revealed that assists, % of 2 points, 2 points-made, defensive rebounds and bench points statistically significantly differed successful from those in unsuccessful teams. Nevertheless, the lack of studies conducted on male basketball teams playing in the Olympic Games represents a very important factor for better understanding the main differences between indicators which discriminate teams the most.

So, the aim of the present study was to determine which situational efficiency parameters mostly differentiated successful and unsuccessful teams playing in the Olympic Games in London 2012.

METHODS

Subjects. The study was conducted on the sample of 12 basketball teams (38 games, 76 opponents) playing in the Olympic Games in London 2012. The teams were divided into group A (15 games), group B (15 games), teams which got into the quarter-finals (4 games), teams which got into the semi-finals (2 games), finals (1 game) and 1 game for the third place.

Variables. The variables which represented situational efficiency comprised 13 standard indicators in basketball game proven by FIBA. All results were downloaded from the official FIBA website.

Variables for *2 points* represent primary situational indicators for overall efficiency in the game. Those efficiencies ranged from 55 to 60%

from the total of scored points in a basketball game. One of the most important principles of an organized (transitional and set) attack represents a *selective shot*. Due to that, organisation of the game must contain ball control and movement line, which allows the release of a large number of players for an “opened shot on a different playing position (Trninić, 1996).

Variables for 3 points represent great strategic importance because they make around 25% of total scored points in basketball games and around 36% from the total of thrown balls. Because of that, requirements increase in the phase of defence for pressure in the front line of defence, but defence spreads. It means that opponent players have much more space for attack. Knight and Newell (1986) suggested that total shot percentage should not be lower than 52%.

Free throws are defined as indefensible ball throws in the basket made as the result of punishing the opponent’s team for a personal foul made. Between 15 and 30% of the total scored points during the game can be attributed to free throws.

Defensive rebounds represent the number of caught rejected balls in the phase of transitional or set defence. Trninić et al. (1997) showed that defensive rebounds were more significant indicators of situational efficiency than *offensive rebounds* (RO = 0.57). According to Trninić (1996), defensive rebounds account for about 66% of total rebounds. Based on the fact that the transition from the phase of defence to the phase of attack starts when the player comes in possession of the ball, it is necessary to point out that defensive rebounds are important component for overall efficiency in the game.

Offensive rebounds represent the number of caught rejected balls in the phase of transitional or set offense. According to Knight and Newell (1986), the number of caught balls in the phase of defence and attack must be over 58% of the overall rebounds. Well-prepared and organized attack will cover offensive rebounds and keep defensive balance. It decreases psychological pressure on the shooter and simultaneously increases realization in attack.

Assists, according to Trninić (1996), are factors that produce “easy shots”. Also, assists, percentage of free throws, offensive and defensive rebounds make very important components that discriminate successful from unsuccessful teams. Greater number of assists and caught balls generate with greater shoot efficiency, producing greater number of successful throws for 2 points and lower unsuccessful throws for 2 points.

Personal fouls represent illicit and irregular physical touch with the opponent, no matter if the ball is in the game or out.

Turnovers represent lost ball during the basketball game. In basics, minimal number of lost balls (around 6) points high level of individual and team game, along with high level of sports form of individuals and teams. Losing the ball in the phase of transitional and set attack was caused with aggressive defence and the level of ball control of the team who is in the phase of attack.

Steals represent successful and unsuccessful throws of the ball into the basket because higher numbers of stolen balls create assumptions for higher numbers of shots. Obtained balls occur when defensive players intersect passed balls, outbreak the ball and dead ball rebounds. Most of the college coaches think that winning 10–12 balls during first half is one of the important defensive goals (Trninić, 1996).

Blocks are events where a team shows individual or collective aggression in the phase of defence. It represents an indicator for evaluation of the central player in the phase of defence.

Table 1. Abbreviations and descriptions of each situational parameter

Abbreviation	Description
2P-M	2 points-made
2P-F	2 points-fail
3P-M	3 points-made
3P-F	3 points-fail
FT-M	Free throws-made
FT-F	Free throws-fail
RB-O	Offensive rebounds
RB-D	Defensive rebounds
AS	Assists
PF	Personal fouls
TO	Turnovers
ST	Steals
BS	Block Shots

Data analysis. For all parameters, arithmetic mean and standard deviation were calculated Kolmogorov-Smirnov test was used to determine whether the variables were normally distributed (maxD and *p* value). Group differences between variables were analysed using multivariate analysis of variance (MANOVA) and Student’s *t*-test for separate numerical differences. To determine parameters which differentiated teams according to outcome, discriminant analysis was performed.

RESULTS

Statistical data of situational efficiency parameters of successful and unsuccessful male basketball teams. Results in Table 2 showed descriptive parameters of analysed situational variables. Also, asterisk (*) represented statistical

the difference between the teams according to outcome (win/lose). Table 3 represented results from multivariate analysis of variance in overall effect of each winning and defeated teams.

Table 2. Basic descriptive parameters of successful and unsuccessful male basketball teams

Variables/Descriptive parameters	N	Mean \pm SD		maxD		p-value	
		Winning	Defeated	Winning	Defeated	Winning	Defeated
2P-M	38	22.84 \pm 4.37*	20.05 \pm 4.60	0.11	0.14	> .20	> .20
2P-F	38	19.82 \pm 5.39*	23.34 \pm 4.46	0.15	0.09	> .20	> .20
3P-M	38	9.32 \pm 5.50*	6.45 \pm 2.68	0.17	0.13	> .20	> .20
3P-F	38	15.08 \pm 4.78	13.74 \pm 4.30	0.11	0.10	> .20	> .20
FT-M	38	15.00 \pm 5.04	12.82 \pm 5.58	0.10	0.13	> .20	> .20
FT-F	38	6.21 \pm 3.60	5.82 \pm 3.14	0.10	0.14	> .20	> .20
RB-O	38	12.05 \pm 4.30	10.37 \pm 4.43	0.14	0.19	> .20	< .15
RB-D	38	28.32 \pm 4.46*	25.21 \pm 4.59	0.09	0.09	> .20	> .20
AS	38	20.47 \pm 6.26*	13.87 \pm 4.91	0.09	0.14	> .20	> .20
PF	38	20.26 \pm 4.05	21.08 \pm 4.96	0.13	0.10	> .20	> .20
TO	38	11.87 \pm 3.41*	15.11 \pm 4.26	0.10	0.11	> .20	> .20
ST	38	7.29 \pm 3.46*	4.55 \pm 2.68	0.14	0.21	> .20	< .10
BS	38	3.63 \pm 1.91*	2.50 \pm 2.10	0.18	0.22	< .20	< .05

Note. * – $p < .05$.

Presenting shooting results, successful teams scored 53.25% of 2 *points-made*, in contrast to unsuccessful teams (46.75%). Opposed to successful 2 *points-made*, unsuccessful teams made more 2 *points-fail* (52.87% vs. 47.13%). Successful teams scored 59.10% of successful 3 *points-made*, opposed to 40.90% scored by unsuccessful teams. In variable 3 *points-fail*, successful teams performed higher percentage (52.32%) better than unsuccessful teams (47.67%). Results from *free throws-made* showed higher percentage of realization by successful teams (53.93%) contrary to unsuccessful ones (46.07%), while similar percentages were obtained in *free throws-fail* among successful (51.64%) opposed to unsuccessful (48.36%) teams. Successful teams did more *offensive* (53.75% vs. 46.25%) and *defensive rebounds* (52.90% vs. 47.10%). Also, winning teams performed better in *assists* (59.61%), *steals*

(61.55%) and *blocks* (59.23%), but lower in *personal fouls* (49.01%) and *turnovers* (44%).

Multivariate analysis of variance between successful and unsuccessful male basketball teams in situational efficiency parameters. The aim of this part of study was to determine multivariate differences between successful and unsuccessful male basketball teams playing in the Olympic Games in London 2012 in a group of situational parameters. Results from table 3 showed that in general successful and unsuccessful teams statistically differed in situational indicators.

Table 3. Multivariate analysis of variance between successful and unsuccessful male basketball players

Effect	Value	F	p
Win/lose	0.39	7.85	.00

Note. $p < .05$.

Discriminant analysis between successful and unsuccessful male basketball teams in situational efficiency parameters. Further analysis in Table 4 represented discriminant differences

across groups in situational efficiency parameters. Coefficients that statistically differentiated successful from unsuccessful teams were highlighted and marked with an asterisk.

Variables	F-value	Standardized canonical coefficients	Factor structure-root 1
2P-M	0.40	0.123	0.311
2P-F	14.82	-0.967**	-0.076
3P-M	0.57	0.025	0.319
3P-F	5.57	-0.403*	0.202
FT-M	0.40	0.228	0.236
FT-F	0.09	-0.007	0.110
RB-O	16.38	0.943**	0.226
RB-D	6.66	0.822*	0.320
AS	0.22	0.123	0.516
PF	1.18	-0.232	0.077
TO	14.03	-0.608**	-0.147
ST	4.78	0.425*	0.407
BS	3.16	0.449	0.275

Table 4. Discriminant differences between successful and unsuccessful male basketball teams in situational efficiency parameters

Note. ** - $p < .01$, * - $p < .05$.

DISCUSSION

The aim of the study was to determine a group of significant situational parameters that differentiated winning and defeated male basketball teams playing in the Olympic Games in London 2012.

Numerical values in Table 2 showed that statistical differences between successful and unsuccessful basketball were established in shooting variables, defensive rebounds, assists, turnovers, steals and blocks ($p < .05$).

Global differences were identified between both successful and unsuccessful male basketball teams (F -value = 7.85; $p = .00$).

Partial differences occurred in variables 2 pts-fail (F -value = 14.82, $SCC = -0.967$, $p < .001$), 3 pts-fail (F -value = .57, $SCC = -0.403$, $p < .05$), offensive rebounds (F -value = 16.38, $SCC = 0.943$, $p < .001$), defensive rebounds (F -value = 6.66, $SCC = 0.822$, $p < .05$), turnovers (F -value = 14.03, $SCC = -0.608$, $p < .001$) and steals (F -value = 4.78, $SCC = 0.425$, $p < .05$).

According to presented results, the biggest positive contribution on the efficiency in the game was made by *offensive rebounds* (0.94). This result came from the fact that successful teams had greater percentage (53.75%) of them than unsuccessful teams (46.25%), along with greater unsuccessful shooting percentage among unsuccessful teams (successful teams 47.13% vs. unsuccessful

teams 52.87%). Nevertheless, aggressive offensive rebounds in the phase of attack represented a significant indicator for successfulness. According to Trninić et al. (1997), offensive rebounds were defined as extension of aggression of attack that opened the option of greater shoot percentage. This meant that the team had to close the way towards the basket. In that way, the team who got in possession of the ball had bigger percentage of shots and more successful transition from the phase of attack to defence, and vice versa.

Along with offensive rebounds, *defensive rebounds* contributed the most on the efficiency in the game (0.822). Trninić et al. (1997) explained that by maintaining the pressure on the ball in the phase of defence, stopping the opponents to achieve regular entrance in transitional and set offense along with stopping the attack with more than one shot. Successful teams forced unsuccessful teams for higher number of unsuccessful shots from the game and created greater chance for defensive rebounds (successful teams 52.90% vs. unsuccessful teams 47.10%).

Steals, as one of the situational indicators, also showed significant contribution on the final result (0.425). Successful teams had higher percentage of successful steals (61.55% vs. unsuccessful teams 38.45%) opposed to unsuccessful teams, which could be explained by more aggressive play in defence, making pressure on a player with the

ball and inaccurate passing the ball, which led to stealing the ball and made the fast transition from the phase of defence to the phase of attack.

Negative poles were obtained in variables 2 points-fail, 3 points-fail and turnovers. Variable 2 points-fail (-0.967) showed the biggest difference between successful and unsuccessful teams. Successful teams scored fewer unsuccessful shots for 2 (47.13%) opposed to unsuccessful teams (52.87%). Successful teams sent more shots from favourable positions; they had better shot selection and greater number of shots from the zone of high percentage of shots. It was also assumed that defence of successful teams was successfully prevented by regular entrance and line movement of the unsuccessful players in transitional and set attack.

Along with 2 points-fail, 3 points-fail represented lower, but also significant contributor of discrimination of successful teams from the unsuccessful ones (-0.403). Successful teams performed higher percentage of 3 points-fail (52.32%) than unsuccessful teams (47.67%). Nevertheless, successful teams compensated that with more 3 points-made (9.32 vs. 6.45), where they had "clearer" chances and open shots to score the shot.

Last negative variable that discriminated successful from unsuccessful teams was *turnovers* (-0.608). Successful teams performed lower in turnovers (44%) vs. unsuccessful teams (56%). This could be explained by lower technical-tactical preparedness in unsuccessful teams where players did not have game conversation on the optimal level. Cooperation between two or more players in unsuccessful teams failed because of bigger pressure and aggression of the players playing defence in successful teams.

Previous results from Pojskić et al. (2009) showed similar results, where *assists*, *percentage of 2 points scored*, *2 points-made*, *defensive rebounds* and *bench points* were situational parameters that differentiated groups the most. The study conducted by Grgurević, Jelaska, and Jelaska (2014) showed that variables *points-made*, *defensive rebounds*, *3 point shots-total*, *free throws-total* and *fouls-made* statistically differentiated the winning teams from the defeated ones.

Also, Sindik and Vidak (2010) showed that discriminant function did not indicate statistical significance among the players of the four most successful and 5 less successful teams based on all the standard situation efficacy parameters in basketball. Only two parameters, *2 points-made* and *2 points-fail*, showed statistically significant differences between more and less successful teams.

Nakić (2004) showed the largest differences between successful and unsuccessful teams in *free throws*, *assists*, *2 points-fail* and *3 points fail*. The author explained the results by basketball games not being as elite as those played in European championships with the lack of motivation during the competition.

Trninić et al. (2002) presented results which were similar to the present study, where the highest discriminative power was obtained in the variable *defensive rebounds*, *free throws-total*, *field goal-total* and *assists*.

Results from our study were also supported with results by Gomez et al. (2008), where winning teams showed better defensive performance. The authors concluded that good defence avoided the opponents' assists and forced poor shots. In unbalanced game, differences between winning and losing teams were in *defensive rebounds* and the games ended unbalanced by the differences in *successful 3 point field-goals* (Garcia et al., 2013).

Based on the obtained results in the study, model game of successful teams was based on strict selection of a 2- and 3-point shots from the external positions, as many offensive rebounds (to start new attack in the game) along with defensive rebounds (try to win the ball in defence with fast transitions in the phase of attack). Also, assists with stolen balls speed the game up and player's creativity came to higher level of performance. All these indicators comprised technical and tactical actions in the phase of attack and defence where players had to be well-prepared for the upcoming competition during the specific cycle period.

CONCLUSION

In conclusion, our results indicate that winning and defeated male basketball teams playing in the Olympic Games differed in situational efficiency parameters. Obtained in all studies, defensive rebounds were on the highest level of discrimination between successful and unsuccessful teams, also, with 2- and 3-points shots-fail, offensive rebounds, turnovers and assists. Based on the obtained results, coaches need to pay more attention to the team's transition from attack phase to defence and vice versa. Basketball game consists of very complex technical-tactical structures, which are required to gain advance over the opponent. Only using those elements on high level, teams can achieve positive outcome, especially in offensive and defensive rebounds, like it was shown in our and other studies.

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INTRARATER AND INTERRATER RELIABILITY OF MUSCLE TONE, ELASTICITY AND STIFFNESS CHARACTERISTICS MEASUREMENTS BY MYOTON-3 IN HEALTHY CHILDREN AGED 5–7 YEARS

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ABSTRACT

Background. Research literature highlights the need to use objective assessment tools to quantify muscle tone because all typically used clinical scales of muscle tone have reliability problems. Though hand-held device Myoton-3 has been used in research with children, its reliability has not been established. The aim of this study was to investigate intrarater and interrater reliability of muscle tone, elasticity and stiffness measurements by Myoton-3 in healthy children aged 5–7 years.

Methods. A total of 30 healthy children aged between 5 and 7 years participated in the study. Myoton-3 device was used by two measurers to assess tibialis anterior (TA), rectus femoris (RF), biceps brachii (BB), medial head of gastrocnemius (GM), biceps femoris (BF), trapezius (TR) and triceps brachii (TB) muscle tone, elasticity and stiffness values. Measurements were conducted for intrarater reliability on two consecutive days and for interrater reliability on the same day.

Results. Intrarater reliability expressed as intra-class correlation of frequency, decrement and stiffness characteristics measurements was moderate to high, between 0.60–0.72, while TR muscle ICC was low. Interrater reliability expressed as intra-class correlation of the frequency, decrement and stiffness characteristics measurements was high to very high, between 0.72–0.91, while TR muscle ICC was low.

Conclusion. Moderate to high (0.60–0.72) intrarater reliability and high to very high interrater reliability (0.72–0.91) was established for Myoton-3 measurements in healthy children aged 5–7 years. The Myoton-3 is a reliable device for measuring skeletal muscle tone, elasticity and stiffness in preschool children.

Keywords: Intra-class correlation, mechanical properties, children, Myoton-3.

INTRODUCTION

Muscle function could be characterized by muscle tone. Passive resting muscle tone (PRMT) is defined as state of muscle at rest when it has maintained a certain amount of tautness (Vain, Kums, Ereline, Pääsuke, & Gapeyeva, 2015). PRMT is influenced by muscle passive length and its location in human body (Murayama, Watanabe, Kato, Uchiyama, & Yoneda, 2012). While PRMT is expressed in stable position like lying, it has to be distinguished from postural muscle tone which plays an important role in maintaining the erect posture and equilibrium

(Vain et al., 2015). Muscle tone is related with mechanical properties of the skeletal muscles – elasticity and stiffness (Viir, Laiho, Kramarenko, & Mikkelsen, 2006)

Research literature highlights the need to use objective assessment tools to quantify muscle tone (Aarrestad, Williams, Fehrer, Mikhailenok, & Leonard, 2004; Lidström, Ahlsten, Hirschfield, & Norrlin, 2009; Pomeroy et al., 2000). Studies about children with cerebral palsy have frequently used measures of spasticity, such as Ashworth and Tardieu scales (Alhusaini, Dean, Crosbie, Sheperd,

& Lewis, 2010; Bar-On et al., 2014; Yam & Leung, 2006). Unfortunately, all typically used clinical scales of muscle tone have reliability problems (Aarrestad et al., 2004; Ansari et al., 2013; Pomeroy et al., 2000). Few instrumented methods in children have been used as well – devices like Myotonometer (Aarrestad et al., 2004; Lidström et al., 2009), Myoton-2 (Gavronski, Veraksitš, Vasar, & Maaros, 2007) and Myoton-3 (Gapeyeva & Vain, 2007; Straubergaite, Bernecke, Muckus, & Juodžbaliene, 2011; Straubergaite, Juodžbaliene, Tolocka, & Muckus, 2012; Vahimets et al., 2006).

A hand-held myometer device Myoton-3 provides painless and objective assessment of mechanical properties of muscles (Gapeyeva & Vain, 2008). Several studies have been conducted with children using device Myoton-3. For example, Gapeyeva and Vain (2007) investigated natural oscillation frequency of extensor digitorum, tibialis anterior and gastrocnemius muscles in 11-year-old boy with spastic hemiplegia. Vahimets et al. (2006) studied the influence of Trigenics Myoneural Treatment of six young basketball players' (aged 15.3 ± 0.5 years) muscle tone and elasticity of tibialis anterior, gastrocnemius, rectus femoris and biceps femoris muscles. Straubergaite et al. (2011) established the effect of horse-back riding on muscle tone, elasticity and stiffness of the lumbar erector spinae in healthy children aged 8–16 years. Straubergaite et al. (2012) also investigated the impact of physiotherapy on the lumbar erector spinae and gluteus medius muscle symmetry in children with and without cerebral palsy aged 8–16 years. Gapeyeva, Mitt, Erelina and Pääsuke (2015) studied the influence of 3-month physical therapy with the Atlant neuro-orthopedic pneumosuit on muscle tone characteristics (frequency of muscle oscillation) of erector spinae, rectus abdominis, rectus and biceps femoris, gastrocnemius and tibialis anterior muscles in preschool children (aged 3–7 years) with spastic cerebral palsy.

Despite numerous investigations, there is no intra- or interrater reliability research of skeletal muscles by Myoton-3 in children. The aim of this study was to examine intra- and interrater reliability of muscle tone, elasticity and stiffness characteristics measurements using Myoton-3 in healthy children aged 5–7 years.

METHODS

Thirty children (15 girls and 15 boys) aged 5.6 ± 0.6 years (mean \pm SD) participated voluntarily

in the study. Height, weight and BMI of participants are presented in Table 1. The subjects whose parents reported any physical impairment as well as other developmental disorders, orthopaedic problems, intellectual disability, sensory or speech disorder, did not take part in study. Children were from the same nursery school and had 1.5 hours of physical activity (PA) per week. Children's parents were asked about PA out of nursery school. Results showed that 10% of children had additional PA (gymnastics and football, 2–4 hours per week). One day before the study the children were asked to avoid physical training. For participation in the study, a written informed consent of children's parents and each child's assent were obtained. The study received the approval of the Ethics Committee of the University of Tartu for human studies.

Table 1. Anthropometric data of children ($n = 30$), mean \pm SD

Characteristics	Mean	\pm SD	Range (Min-Max)
Height (m)	1.19	± 0.07	1.07–1.32
Body mass (kg)	22.5	± 4.4	16.4–31.5
BMI (kg/m ²)	15.7	± 1.7	12.2–20.3

Note. BMI – body mass index.

Measurements of anthropometric parameters. Height and body mass were measured on the first day of the two consecutive days. The body standing height was measured to the nearest 0.1 cm using a Martin portable anthropometer. Body mass was measured by digital scale, accurate to 50 g (Soehnle, Germany).

Measuring mechanical characteristics (tone, elasticity, stiffness). A hand held non-invasive device Myoton-3 and Myoton software (Müomeetria Ltd, Estonia) were used. The Myoton-3 device induces oscillation of the muscle tissue by a mechanical impact with a force up to 0.4 N; it follows by quick release on the muscle belly. Muscle oscillations are registered by the accelerometer of the device with a sampling rate of 3200 Hz, and a graph is formed based on this recording. The mass of the device's testing probe is 18 g, diameter 3 mm, and the kick time 15 ms (Vain et al., 2015). A Multi Scan pattern of 5 consecutive measurements at one point was measured and the mean of 5 measures was calculated using Myoton software (Vain, 2002). Frequency of muscle oscillations (FMO) [Hz] as an indicator of the tone, logarithmic decrement of the dampening of muscle oscillations (LDDMO) as an

indicator of the elasticity and stiffness of the muscle (ST) [Nm^{-1}] were measured in relaxed (passive muscle tone) condition (Vain et al., 2015).

Seven muscles were tested bilaterally and muscles were always measured in same order – tibialis anterior (TA), rectus femoris (RF), biceps brachii (BB), medial head of gastrocnemius (GM), biceps femoris (BF), trapezius (TR) and triceps brachii (TB) muscles. Right body side muscles were constantly measured before. Marks were made in the middle of the muscle belly, which was identified with palpation and muscle contraction. Measuring point was marked using a non-toxic permanent Surgical Skin Marker (Viscot Medical LLC, USA). Participants were asked to lie in

comfortable position on the massage table and to relax before measuring. To measure TA, RF and BB muscles, subjects were supported with special pillows under the head and knees (Figure 1A), for measuring GM, BF, TR and TB muscles, pillows were placed under ankle, and the head was in the aperture of massage table to provide relaxation of the muscles (Figure 1B).

Study design. Measurements were performed on two consecutive days of a week at the same time, in the same room and temperature (recorded using digital thermometer, it was maintained at 21°C). Measurements were carried out by two different qualified measurers (M1 and M2). Firstly, measurements were done for intrarater

Figure 1A. Subject in a supported supine position for measuring TA, RF and BB muscles



Figure 1B. Subject in a supported prone position for measuring GM, BF, TR and TB muscles



reliability – each muscle was measured by M1 on two consecutive days. The interval between two measurements by M1 was 24 hours. Secondly, measurements were performed for interrater reliability – on the second day one set of the same muscles were measured by M2 as before by M1 to compare the results of two sets. The interval between the two sets of measurements (M1 and M2) was 15 to 30 minutes. During the pause children were asked to lie supine on massage table while reading a book or watching videos from smartphone.

Statistical analysis. Data was analysed using Microsoft Excel 2013 and it is presented as mean value \pm standard deviation (SD). Mean values from day one and day two also from set one set two were compared using Student's *t*-test. The lowest level of statistical significance was set at $p < .05$. Pooled data of the left and the right body side was used.

Reliability between trials at between days and at the same day (within session) as an intra-class correlation coefficient (ICC) model 3, 2 (two-way mixed model) was used (Shrout & Fleiss, 1979). For interpreting ICC, the following scale was used: very high = 1.00–.90; high = .89–.70; moderate = .69–.50; low = .49–.26 (Domholdt, 1993). Standard error of measurement (SEM) was calculated using formula $SEM = SD \cdot \sqrt{1 - ICC}$ (Fleiss, 2007). Minimal detectable difference (MDD) was calculated using formula $MCC = SEM \cdot (\sqrt{2}) \cdot 1.96$ (Fletcher & Bandy, 2008).

RESULTS

The muscle frequency, elasticity and stiffness characteristics during measurements by M1 and intrarater reliability ICC results are presented in Table 2. Values of FMO were highest in TA

Characteristics/ muscle	DAY 1 (M1)	DAY 2 (M1)	ICC	SEM	MDD
Frequency of muscle oscillations (Hz)					
TA	14.3 \pm 1.6	14.1 \pm 1.3	.66	0.85	2.34
RF	12.6 \pm 0.9	12.5 \pm 0.9	.65	0.54	1.49
BB	12.3 \pm 0.8	12.2 \pm 0.7	.66	0.42	1.17
GM	12.3 \pm 0.8	12.2 \pm 0.8	.60	0.49	1.36
BF	12.8 \pm 1.1	12.7 \pm 1.0	.72	0.56	1.55
TR	10.8 \pm 0.9	10.8 \pm 0.9	.10	0.84	2.33
TB	10.9 \pm 0.9	10.9 \pm 0.9	.66	0.51	1.41
Logarithmic decrement of dampening of muscle oscillations					
TA	0.9 \pm 0.1	0.9 \pm 0.1	.60	0.09	0.25
RF	1.2 \pm 0.2	1.2 \pm 0.2	.62	0.12	0.33
BB	1.0 \pm 0.1	1.0 \pm 0.1	.62	0.09	0.24
GM	1.0 \pm 0.1	1.0 \pm 0.2	.64	0.09	0.26
BF	1.2 \pm 0.2	1.2 \pm 0.2	.65	0.10	0.27
TR	1.0 \pm 0.1	1.0 \pm 0.2	.09	0.20	0.54
TB	1.1 \pm 0.2	1.1 \pm 0.2	.61	0.14	0.38
Stiffness (N/m)					
TA	268.0 \pm 26.3	268.1 \pm 29.8	.66	16.32	45.24
RF	182.8 \pm 18.4	180.6 \pm 17.5	.62	11.03	30.56
BB	190.1 \pm 20.6	188.9 \pm 19.8	.60	12.71	35.23
GM	172.5 \pm 14.3	174.4 \pm 15.4	.61	9.28	25.71
BF	183.8 \pm 19.3	184.0 \pm 19.1	.61	11.89	32.94
TR	173.8 \pm 32.2	177.9 \pm 29.5	.06	29.88	82.82
TB	154.6 \pm 24.6	159.3 \pm 24.2	.61	15.26	42.26

Table 2. Values of muscle frequency, elasticity, stiffness (mean \pm SD) and intrarater intra-class correlation (ICC), standard error of measurement (SEM), and minimal detected change in values of between days data (MDD) in healthy children aged 5–7 years ($n = 30$).

Note. M1– measurer 1; TA – tibialis anterior, RF – rectus femoris, BB – biceps brachii, GM –medial head of gastrocnemius, BF – biceps femoris, TR – trapezius, TB – triceps brachii muscle. Data for the right and left sides are pooled.

muscle, lowest in TR muscle. The TA muscle values differed from its antagonistic muscle GM values about 14% ($p < .01$), which was bigger than the difference between measured muscles BB and TB in the upper limb, where it was 11% ($p < .01$). The values of lower limb muscles RF and BF did not differ significantly. The values of the LDDMO had a similar tendency as FMO – TA and GM muscle values differed more than BB and TB muscles, while RF and BF muscles had similar values. In ST the highest values were in TA muscle. If we compare TA muscle with GM muscle, there is a contrast – 37% ($p < .01$). The lowest ST values were in TB, comparing with BB, the difference was 17% ($p < .01$). Like before, RF and BF muscles did not differ significantly.

Between the days, reliability of TA, RF, BB, GM and TB frequency measurements was moderate (ICC between .69 and .50). ICC of BF

frequency measurements was high – .72. Results of TR frequency measurements showed no reliability (ICC .1). ICC results of all measured muscles elasticity (.60 to .65) and stiffness (.60 to .66) were all medium except of TR, where ICC values were .09 and .06, respectively.

The muscle frequency, elasticity and stiffness measurements interrater reliability ICC values are presented in Table 3. Within session of measurements Set1 (M1) and Set2 (M2), values of the FMO were highest in TA muscle (14% ($p < .01$) different from GM muscle), lowest in TR and TB muscles. Antagonistic muscles BB and TB had 11% ($p < .01$) difference between values. Contrary to other muscles, BF and RF muscles had very similar values. The same trends as before in the difference of antagonistic muscles also appeared in the values of LDDMO. As between days' measurements, within session values of

Table 3. Results of muscles frequency, elasticity, stiffness (mean \pm SD) and interrater intra-class correlation (ICC), standard error of measurement (SEM) and minimal detected change values of within session data (MDD) in healthy children aged 5–7 years ($n = 30$).

Characteristics/ muscle	Set 1 (M1)	Set 2 (M2)	ICC	SEM	MDD
Frequency of muscle oscillations (Hz)					
TA	14.1 \pm 1.3	14.4 \pm 1.3	.72	0.69	1.91
RF	12.5 \pm 0.9	12.3 \pm 0.9	.78	0.43	1.20
BB	12.2 \pm 0.7	12.3 \pm 0.7	.76	0.33	0.92
GM	12.2 \pm 0.8	12.2 \pm 0.7	.78	0.35	0.96
BF	12.7 \pm 1.0	12.6 \pm 0.9	.91	0.29	0.81
TR	10.8 \pm 0.9	11.0 \pm 0.7	.02	0.78	2.15
TB	10.9 \pm 0.9	10.9 \pm 0.9	.79	0.40	1.11
Logarithmic decrement of dampening of muscle oscillations					
TA	0.9 \pm 0.1	0.9 \pm 0.2	.73	0.08	0.23
RF	1.2 \pm 0.2	1.2 \pm 0.2	.74	0.09	0.26
BB	1.0 \pm 0.1	1.0 \pm 0.1	.76	0.07	0.19
GM	1.0 \pm 0.2	1.0 \pm 0.1	.78	0.08	0.96
BF	1.2 \pm 0.2	1.2 \pm 0.2	.75	0.09	0.78
TR	1.0 \pm 0.2	1.0 \pm 0.1	.17	0.17	0.47
TB	1.1 \pm 0.2	1.1 \pm 0.2	.78	0.09	0.26
Stiffness (N/m)					
TA	268.1 \pm 29.8	268.8 \pm 30.4	.75	15.01	41.49
RF	180.6 \pm 17.5	179.8 \pm 17.6	.85	6.76	18.74
BB	188.9 \pm 19.8	190.8 \pm 19.6	.80	8.78	24.32
GM	174.4 \pm 15.4	174.6 \pm 14.8	.77	7.21	18.97
BF	184.0 \pm 19.1	185.2 \pm 19.3	.85	6.32	17.53
TR	177.9 \pm 29.5	180.5 \pm 22.2	.49	18.58	51.50
TB	159.3 \pm 24.2	161.6 \pm 23.4	.79	10.87	30.11

Note: M1 – measurer 1, M2 – measurer 2; TA – tibialis anterior, RF – rectus femoris, BB – biceps brachii, GM – medial head of gastrocnemius, BF – biceps femoris, TR – trapezius, TB – triceps brachii muscle. Data for the right and left sides are pooled.

ST were highest in TA muscle, although there is a contrast with GM muscle – 37% ($p < .01$). The lowest values were in TB, compared with BB, the difference was 15% ($p < .01$). RF and BF muscle values did not differ significantly.

Interrater ICC of BF muscle frequency measurements was very high (.91) and TA, RF, BB, GM, TB muscles measurements showed high ICC values (.72–.79). Only TR showed very low ICC values of frequency measurements (.02). All measured muscle characteristics, except for TR, showed high reliability of elasticity measurements within session, ICC values were in the range of .73 to .78. The ICC of stiffness measurements was high – .75 to .85 for all measured muscles, except TA, which was low (.49).

ICC values of measurements within session (interater reliability) were higher than those between days. SEM values were higher in between days' (intrarater reliability) measures than the ones within session and MDD were also higher in between days (Table 2 and Table 3). There were no significant differences between means of measured characteristics between days and within session values (Set 1 and Set 2).

DISCUSSION

The present study is the first to estimate intra- and interrater reliability of Myoton-3 measurements of muscle tone, elasticity and stiffness characteristics in healthy children aged 5–7 years. Our study included investigation of seven skeletal muscles from different body regions. The main findings of our study were: intrarater reliability expressed as intra-class correlation of the frequency, decrement and stiffness were moderate to high for all measured muscles, between .60–.72, except TR muscle. Interrater reliability expressed as intra-class correlation of the frequency, decrement and stiffness were high to very high for all measured muscles, between .72–.91, except TR muscle.

Previously, Marusiak, Kisiel-Sajewicz, Jaskolska and Jaskolski (2010) found excellent repeatability of the muscle stiffness measurements in ten elderly women (aged 77 ± 4 years) and in eight Parkinson disease diagnosed (PD) women (aged 77 ± 3 years). In their study, the Myoton-3 device was used for measuring muscle stiffness of short head of BB muscle in supine relaxed position. Intra-class correlation was .93 in healthy

subjects and .99 in the PD group. In our study, ICC values in this characteristic were lower, but our group of subjects was significantly different from previously described research. Bizzini and Mannion (2003) also investigated test-retest reliability of muscle stiffness measurements. The Myoton-2 myotonometer was used in their study for measuring BF, vastus lateralis, RF, lateral head of gastrocnemius and GM muscles at rest in ten volunteers (five males, five females, their mean age was 40). In this research they measured muscles on two consecutive days. The ICC values of BF were .80–.91, RF .84–.85, GM .80–.88. In our study, ICC values of stiffness in these muscles were slightly lower. It can be explained by differences of devices and subjects. While Myoton-2 has similar working principles as Myoton-3, it has larger mass of the testing end (37 g) than Myoton-3 (18 g). Additionally, Bizzini and Mannion (2003) made 20 consecutive measurements at each site while we made 5 consecutive measurements. The mean age of subjects in the later study was 40 ± 13 years, but in our study children aged 5–7 years were measured.

Lidström et al. (2009) investigated reliability of Myotonometer (Myo-Tech, Missoula, Mont) measurements by assessing muscle tone in RF muscle in children with cerebral palsy ($n = 15$, aged 7–15 years) and children without disabilities ($n = 15$, aged 6–15 years). They also measured differences in muscle tone between groups and contracted or relaxed conditions. They found high to very high (.7–1.0) intrarater intra-class correlation under both conditions and in both groups. Interrater intra-class correlation was high to very high (.7–1.0) under both conditions in the control group and in the cerebral palsy group under contracted conditions. Our study showed high (.74–.85) interrater intra-class correlation in relaxed RF muscle characteristics. Differently, our intrarater intra-class correlation was moderate (.62–.65). Firstly, it was probably affected by the time between two measurements, which was at least 24 hours. The possible explanation why they received greater reliability between values of intrarater measurements is that their study was committed on the same day. In our research we can see the tendency as well – interrater ICC values were higher than intrarater ICC values because measurements for the first one were made on the same day and for the other on two consecutive days.

Secondly, there were two different devices used in these studies for measuring. Myotonometer (Myo-Tech, Missoula, Mont) which Lidström et al. (2009) used is an electronic device where the probe is pressed perpendicularly against a muscle, the outer cylinder remains stationary as the inner cylinder pushes onto and compresses the underlying tissue. Eight tissue displacement values are registered for each pressure, corresponding to eight levels of force (0.25, 0.50, 0.75, 1.0, 1.25, 1.50, 1.75, 2.00 kg). In our study we used Myoton-3 which induces oscillation of the muscle tissue by a short (kick time 15 ms) mechanical impact with a very low force (up to 0.4 N). The testing probe diameter of Myoton-3 device is 3 mm while Myotonometer's (Myo-Tech, Missoula, Mont) probe has a diameter of 1 cm (Oliva-Pascual-Vaca et al., 2014).

Studying intrarater reliability on two consecutive days we have to considerate that healthy children aged 5–7 years are physically active. To analyse the effect of physical activity (PA) on measurement results, children's parents were asked about PA out of nursery school. Results showed that 10% of children had additional PA (gymnastics and football, 2–4 hours per week). We asked children to avoid additional PA on the day before measuring. Probably, children did not exercise as they use to do, but it is questionable how much they ran or jumped before the measuring day or on the same day. So it is difficult to analyse what effect physical activity had on our intrarater reliability results. Perhaps we should have done all measurements – intra- and interrater reliability – on the same day like Lidström et al. (2009).

In our study good intra- and interreliability ICC was noted for all measured muscles, except for TR muscle. Viir et al., (2006) examined trapezius muscle tone with Myoton-2 myometer in 20 women (5 healthy, 15 with various musculoskeletal disorders), their mean age was 44.2 years. Interrater reliability was investigated by two measurers within the same session. ICC values were very high (.97–.99). The subjects were in a relaxed sitting position, while in our study children were in a relaxed prone position. This could be one of the causes of differences in ICC results between two studies. Other possible explanation is that the position of the child's head in our study was with its support on the aperture edge of the massage table (length 15 cm, width 9.5 cm) which is made for adult head size. Indeed, a 5–7-year-old child has

smaller head circumference than adult: in the study of Bartholomeusz, Courchesne and Karns (2002) it has been noted that the head circumference of children aged 6 years and younger was from 48.6 cm to 56.1 cm, in adults – from 55.2 cm to 62.3 cm. For this reason children have to hold neck against gravity while the main force is carried on the frontal part of the head because the head aperture is too big for children. Despite the request for relaxation of muscles and palpation before measurement, the head position in case of such aperture of massage table apparently caused stress (contraction) to the neck and shoulder girdle muscle groups, including TR muscle.

The strength of the present study is the investigation of intrarater and interrater reliability of Myoton-3 measurements of skeletal muscle tone, elasticity and stiffness in healthy preschool children, which has not been investigated before. Only healthy children in preschool age were included in the study. Our measurers had earlier practical experience with Myoton-3 device and did have quite a big number of subjects. Also we tried to avoid the effect of different diseases and physical activity on measured characteristics. The study also had some limitations. We studied intrarater reliability between two consecutive days, but we do not know how children's physical activity affected the results. Therefore it is definitely necessary to compare measurement results which are conducted only on the same day. In the future, it is recommended to choose more appropriate position for the child's body segments for measuring neck and trunk muscles.

CONCLUSIONS

Results suggest that measurements of skeletal muscle tone, elasticity and stiffness characteristics by Myoton-3 have moderate intrarater and high interrater intra-class correlation values in healthy 5–7-year-old children. The Myoton-3 is a reliable device for the estimation of muscle tone and mechanical properties in children. It can be recommended to choose an appropriate position to ensure the achievement of muscle maximal voluntary relaxation during measurement, especially in preschool children in the aspects of their musculoskeletal system development peculiarities.

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RISK OF SPORTS-RELATED MUSCULOSKELETAL INJURIES AMONG ELITE WOMEN BASKETBALL PLAYERS ACCORDING TO POSITION ON THE COURT AND SPORT RESULTS

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ABSTRACT

Background. Basketball is a popular sport around the world, the number of players is growing, the probability to experience trauma is increasing, too. Studies have shown that women sustain 60% more injuries than men do. Pre-season physical examination helps to establish sports specific changes in the body of the athlete and to determine risk factors for training, competition, which cause injury to the players. **Research aim** was to analyse risk of non-contact musculoskeletal injuries in elite women basketball players according to the position on the court.

Methods. The study involved 100 players in Lithuanian women basketball league who completed the questionnaire about the level of physical fatigue, performed Lower Quarter Y Balance TestTM and Functional Movement ScreenTM tests during pre-season physical examination in 2014. Data were analysed and compared according to player's position on the court (guards and forwards).

Results. The level of physical fatigue during pre-season period was low in both groups. Dynamic stability of the right leg was better in guards (composite score – 105.2 to 101.8 in forwards) while dynamic stability of the left leg remained the same in both groups. Guards had higher total scores in Functional Movement ScreenTM tests pointing to the better quality of basic functional movement patterns.

Conclusions. The guard's playing efficiency during the season was higher than that of forwards and it was associated with better dynamic stability and higher level of physical fatigue at pre-season. Indirect indicators of non-contact musculoskeletal sport injuries showed that guards should have lower risk of non-contact sport-related injuries in women basketball.

Keywords: risk of sports trauma, female basketball players, functional movements, dynamic stability.

INTRODUCTION

Regular team sports participation has well-documented health benefits by improving physical fitness, socialization, and other health-related behaviours. However, as with any sport, basketball participation carries the risk of injury (Borowski, Yard, Fields, & Comstock, 2008; Van der Worp et al., 2011).

The activity patterns of many sports are intermittent in nature, fluctuating randomly from brief periods of maximal or near maximal work to

longer periods of moderate- and low-intensity activity (Glaister, 2005). Independently from technical training/skills, training in ball sports (e.g. soccer and basketball) involves dynamic (both aerobic and anaerobic) and static exercises (Akova, Yesilbursa, Sekir, Gur, & Sedar, 2005). Within this endurance context, numerous explosive bursts of activity are required, including jumping, kicking, tackling, turning, sprinting, changing pace, and sustaining forceful contractions to maintain balance and

control of the ball against defensive pressure (Stolen, Chamari, Castagna, & Wisloff, 2005). The findings of the study indicated that physical performance of professional basketball players differs among guards, forwards and centres (Köklü, Alemdaroğlu, Koçak, Erol, & Fındıkoğlu, 2011), but there is a lack of information to enable the determination of associations between sports injuries and position on the court (Vanderlei et al., 2013).

Basketball is becoming an increasingly popular sport around the world. Increasing numbers of basketball players create a probability of injury growth (Cantwell, 2004; McKay, Goldie, Payne, & Oakes, 2001). Previous work on middle school athletes has found that the most common body part injured was the knee (67.9%), followed by the ankle (21.4%) and the hand (3.6%). Of the 57 knee injuries, 35 (61.4%) occurred during games and 22 (38.6%) during practice (Barber Foss, Myer, & Hewett, 2014). Previous research in the high-school setting has shown that in basketball, injuries most often occur to the extremities (hands, wrists, ankles, and knees), with ankle sprain being the most common type of injury and injury location (Messina, Farney, & DeLee, 1999). Most sports activities always involve a certain level of risk, even when reasonable precautions are implemented. It is essential, therefore, for governing bodies to demonstrate that they have identified the potential risks within their sports and implemented adequate measures to control them.

Also one of the predictors of injury risk is fatigue. Neuromuscular fatigue, defined as an exercise-induced reduction in the maximal voluntary force produced by a muscle or group of muscles is proposed to increase the risk of ACL injury via altered lower limb joint kinematics associated with poor muscle activation patterns (McLean et al., 2007). Results of one study have shown that neuromuscular fatigue causes a number of biomechanical alterations that may increase the risk of noncontact ACL injury during landing. Also, the fatigue condition combined with a decision-making task may represent a worst-case scenario for ACL injury risk and is an area that clearly warrants further research (Borotikar, Newcomer, Koppes, & McLean, 2008). Therefore, it has been suggested that a fatigue element should be incorporated into injury prevention and rehabilitation programs (Kernozek, Torrey, & Iwasaki, 2008).

The purpose of assessments can vary, but often involve selection, goal setting, program

evaluation, and monitoring training progress (Hoffman, Ratamess, Klatt, Faigenbaum, & Kang, 2007). In addition, assessments can also be used to predict an individual's risk for injury. However, a lot of assessments tend to focus on individual joints or muscle groups that are not consistent with functional movements seen during sport (Mottram & Comerford, 2008). Although injury prevention remains an important goal, at present little agreement exists regarding the assessment tool that can successfully predict injuries associated with physical training (Kodesh et al., 2015).

A relatively new approach has begun to focus on examining movement patterns as opposed to isolated muscle groups or joints. As a result, a tool to assess characteristics of an individual's functional movement has been developed (Cook, Burton, & Hoogenboom, 2006). The Functional Movement Screen™ (FMS™) is a screening instrument which evaluates selective fundamental movement patterns to determine potential injury risk (Schneiders, Davidsson, Hörman, & Sullivan, 2011). While some screening methods require advanced training, certification or a period of familiarization, the FMS™ is a reliable screening method even when administered by novice examiners (Garrison, Westrick, Johnson, & Benenson, 2015). The Y Balance Test is a functional screening tool that is used to assess dynamic stability, monitor rehabilitation progress, assess deficits following an injury, and identify athletes at high risk for lower extremity injury (Filipa, Byrnes, Paterno, Myer, & Hewett, 2010). Although balance has been proposed as a risk factor for sports-related injury, few researchers have used a dynamic balance test to examine this relationship (Plisky, Rauh, Kaminski, & Underwood, 2006). FMS and dynamic balance test scores may be able to accurately categorize risk of lower extremity injury (Lehr et al., 2013). So our hypothesis was that basketball players' position on the court is associated with the risk of non-contact sports injury.

It is very important to understand that the players are in a risk group (Van der Worp et al., 2011). Exploring the effects of specific rule changes on injury rates can help us identify risk factors in games that may predispose players to injury (Agel et al., 2007). The purpose of our study was to analyse results of pre-season physical examination, risk of non-contact injury and to compare with sports results in elite Lithuanian women basketball players.

METHODS

The research was accomplished in Lithuanian University of Health Sciences, Institute of Sports. We got a license from Kaunas Regional Biomedical Research Ethics Committee (No. BEC-KN (B)-90).

Research Participants. Research participants were evaluated in pre-season training period in September of 2014. The study involved Lithuanian women basketball league (LWBL) players. All tests were carried out on the same day for each team. Research included 100 women aged 22.62 ± 5.21 years, average height was 180.40 ± 8.28 cm, weight - 74.44 ± 9.42 kg, average body mass index was 21.90 ± 2.02 kg/m². Descriptive variables and demographic data are presented in Table 1.

All respondents participated in the survey voluntarily; they were informed about the purpose of the study. Physical examination consisted of the Y Balance Test™ and the Functional Movement Screen™ tests. The questionnaire about the level of physical fatigue was completed in a free time from tests.

Physical examination and functional movement patterns assessment. The Lower Quarter Y Balance Test™ (modified Star

Excursion Balance Test) was used to assess player's dynamic balance. It involves a stance platform to which three pieces of PVC pipes are attached in the anterior, posteromedial and posterolateral reach directions (Figure 1) (Borowski et al., 2008, Butler, Queen, Beckman, Kiesel, & Plisky, 2013). Plisky, Gorman, Butler, Kiesel, and Underwood (2009) observed that players whose composite reach distance is lower than 96 on the Y Balance Test are at the elevated risk for lower extremity injury. In addition, poor performance in this test is a strong predictor of ankle sprains or helps to find individuals with chronic ankle instability, weak hip abduction and other lower extremity problems (Plisky et al., 2009). The subject stood with the right foot on the centre of the footplate and the most distal aspect of the subject's barefoot was at the starting line. Three trials were completed in each direction (anterior, posteromedial, posterolateral). The same process was repeated using the contralateral limb as the stance limb. A trial was discarded if the subject failed to maintain unilateral stance (Borowski et al., 2008), touched down on the reaching foot (Butler et al., 2013), or failed to return to the starting position (Cantwell, 2004). Performance for all trials was recorded, and

Group	Age (years)	Height (cm)	Weight (kg)	BMI (kg/m ²)
Guards (<i>n</i> = 38)	22.65 ± 5.77	$174.01 \pm 4.39^{\wedge}$	$65.34 \pm 7.48^{\diamond}$	21.54 ± 1.92
Forwards (<i>n</i> = 62)	23.11 ± 5.43	$184.26 \pm 5.98^{\wedge}$	$74.15 \pm 8.35^{\diamond}$	21.82 ± 2.14

Table 1. Summary of demographic data for guards and forwards

Notes. * – $p < .05$ compared between groups; \wedge , \diamond $p < .001$.

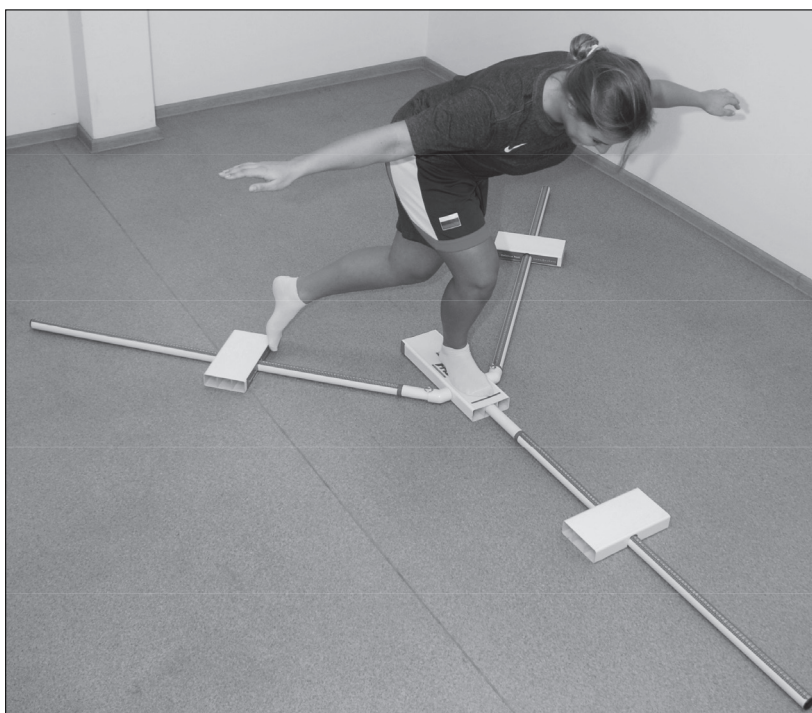


Figure 1. Posterolateral reach using the Y Balance Test Kit™

the maximum reach score for each reach direction was extracted for data analysis. The composite score on the test was calculated by averaging the maximum scores for each reach direction after the maximum scores were normalized to limb length (Butler et al., 2013).

The Functional Movement Screen™ was developed by Cook et al. (2006). The Functional Movement Screen™ (FMS™) is one of the new generation screening assessments evaluating selective fundamental movement patterns to determine potential injury risk (Cook et al., 2006). The FMS™ includes seven tests that are scored on a zero – three ordinal scale. The seven tests are the deep squat, hurdle step, lunge, shoulder mobility, active straight leg raise, push-up, and rotary stability (Figure 2). A score of three indicates that the movement was completed as instructed and is free of movement compensation and pain. A score of two indicates that the subject could complete the movement pain-free but with some level of compensation; a score of one indicates that the subject could not complete the movement as instructed; a zero is assigned if the subject experiences pain with any portion of the movement. Five of the seven tests that comprise the FMS are performed and scored separately for the right and left sides of the body. When assigning a score to a test that incorporates both left and right sides, the lesser of the two scores is used for a final event

score. Overall FMS scores can range from zero to 21. Final FMS score was obtained when the results of FMS tests were summed (O'Connor, Deuster, Davis, Pappas, & Knapik, 2011).

Measurement of level of physical fatigue and sports results. The players completed Physical Fatigue Assessment section from the Pre-participation Health Questionnaire (European Athletics Championships, Göteborg 2013). Each athlete had to mark a point on 10 cm line, which the best described her physical fatigue level in pre-season trainings. This point was measured with a ruler and presented as a numeric value. The player's efficiency was calculated by efficiency score of all games per season. The players were grouped by positions in guards and forwards. Results were compared between groups and with the efficiency score and the level of fatigue.

Statistical analysis. The analysis was performed using SPSS for Windows software (version 22.0). The study data was processed determining the arithmetic means of the research group (\bar{x}), the dispersion was evaluated in association with standard deviations (S). To compare differences between groups, Independent Samples test was used for independent samples, which was normally distributed. The level of significance was set at $p < .05$. Correlation coefficients of tests results and efficiency were analysed using Spearman's correlation coefficient.



Figure 2. Functional Movement Screen (FMS™) tests: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg rise, push-up and rotary stability

RESULTS

Results of physical examination and functional movement patterns. The averages of total FMS score of groups are given in Figure 3. The result of guards was 16.47 ± 1.94 points out of 21. The average of total FMS score 15.79 ± 1.69 was in forwards group. The total FMS score was statistically significant higher in guards ($p = .041$).

Composite score of left leg obtained from the Y Balance Test in guards group was 105.21 ± 7.32 , in forwards group – 102.69 ± 5.59 score. Composite score of right leg obtained from the Y Balance Test in guards group was 105.10 ± 7.54 , in forwards group – 101.83 ± 5.69 score. The dynamic balance of right leg was statistically significantly better ($p = .025$) in guards (Figure 4).

Evaluation of efficiency of players and physical fatigue during pre-season period.

Efficiency score in guards group was 3.55 ± 0.59 , in forward group – 5.91 ± 0.75 . There were statistically significantly different ($p = .029$) results between groups. Evaluation of physical fatigue during pre-season period had shown that the score of fatigue in guards group was 3.64 ± 2.15 points out of 10. Fatigue score in forwards group was 4.26 ± 2.05 points. There were no statistically significant differences between groups (Table 2).

Table 2. Efficiency of groups and physical fatigue intensity in the last month in 2013/2014 pre-season period

Group	Fatigue (cm)	Efficiency
Guards	3.64 ± 2.15	$3.55 \pm 0.59^*$
Forwards	4.27 ± 2.05	$5.91 \pm 0.75^*$

Note. $*p < .05$.

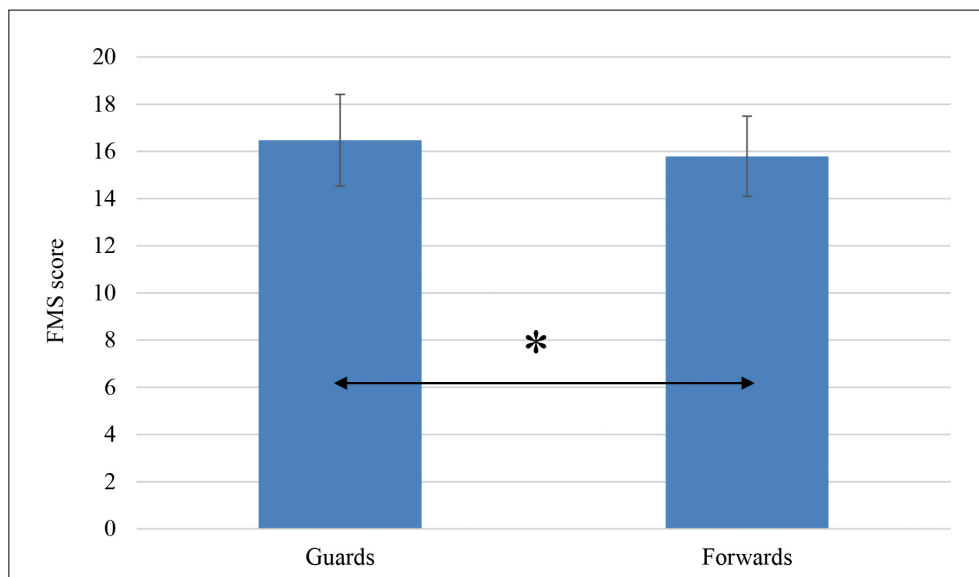


Figure 3. The final Functional Movement Screen (FMS™) score of the groups

Note. $*p < .05$.

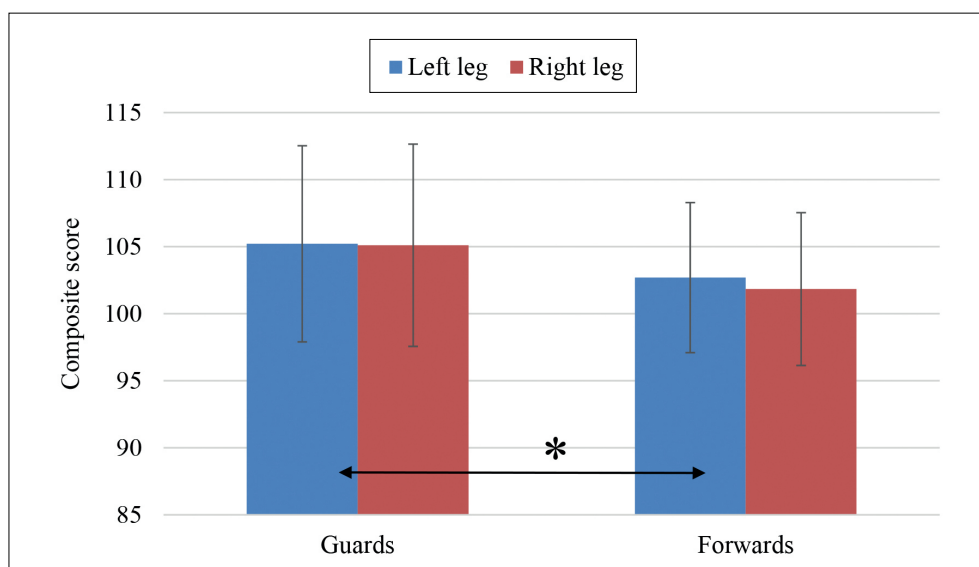


Figure 4. Left and right legs' composite scores of Y Balance Test™ of the groups

Note. $*p < .05$.

Statistically significant moderate positive correlations were found between players' efficiency, fatigue and dynamic balance in guards. Better dynamic stability of lower limbs in guards is associated with higher players' efficiency and with higher level of physical fatigue (Table 3).

Table 3. Correlation coefficients of efficiency, fatigue, intensity and Y Balance composite scores in guards and forwards

Variables	Guards		Forwards	
	Efficiency	Fatigue	Efficiency	Fatigue
Y Balance test Composite score Left leg	.448*	.365*	.037	-.184
Y Balance test Composite score Right leg	.414*	.350*	.013	-.068

Note. * $p < .05$.

In the group of forwards, significant weak positive correlation was found between players' efficiency and fatigue indicating that higher forwards' efficiency might be associated with elevated level of physical fatigue (Table 4).

Table 4. Correlation coefficients of efficiency and fatigue intensity in guards and forwards

Variable	Efficiency	
	Guards	Forwards
Fatigue	.280	.295*

Note. * $p < .05$.

DISCUSSION

The main aim of this study was to analyse results of pre-season physical examination: assess the level of non-contact injury risk using functional tests, set the level of physical fatigue and analyse the efficiency of sports results in elite Lithuanian women basketball players according to the players' position on the court.

Our data revealed that guards and forwards in our study had no increased risk level of injury according the total FMS score in pre-season period – the scores were higher than the injury risk cut-off point found in literature – score of ≤ 14 . In the study of O'Connor et al. (2011), FMS scores ≤ 14 were associated with increased injury risk, although the sensitivity was low. In the study of Schneider, Davidsson, Hörman, and Sullivan (2011), among young active population, 31% of the participants had a score of 14 or less, but the

average of total FMS score in females was similar to that in our findings – 15.6 ± 0.2 . Other research showed that basketball players had the worst results of FMS test compared to football and handball players (Letafatkar, Hadadnezhad, Shojaedin, & Mogamadi, 2014). Some authors claim that if the FMS result is 14 or less, it can be said that the athlete has 11 times increased risk of sports injury compared with players who have scored more than 14 points (Kiesel, Plisky, & Voight, 2007).

The results of Y Balance Test of guards and forwards showed that composite scores in both groups were higher than the cut-off point of injury risk level (≤ 94) (Plisky et al., 2006). In our study guards had statistically significantly better dynamic balance than forwards on the right limb. Gribble, Kelly, Refshauge, and Hiller (2013) showed good interrater reliability of the test: whether the chosen outcome was average or maximum scored and used raw or normalized data, the anterior, posteromedial, and posterolateral directions had excellent reliability. In Butler's study, college football players who scored below 89.6 were 3.5 times more likely to get injured (Butler et al., 2013). Some authors claim that players with poor dynamic balance are more likely to experience ankle injury (McGuine, Greene, Best, & Levenson, 2000). Interestingly, Plisky et al. (2006) found that female basketball players with composite score less than 94 were more than 6 times more likely to have a lower extremity injury, but this risk factor was not significant for boys.

Results of the questionnaire about physical fatigue (European Athletics Championships, Göteborg 2013) showed that there were no statistically significant differences between fatigue in groups. However, some authors say that neuromuscular fatigue is proposed to increase the risk of ACL injury via altered lower limb joint kinematics associated with poor muscle activation patterns (McLean et al., 2007). For example, neuromuscular fatigue has been demonstrated to induce changes in knee flexion, knee abduction and hip internal rotation in female NCAA athletes performing single-leg landings (McLean & Samozov, 2009).

Players were classified and analysed according to the position on the court - guards and forwards. Results showed that guard's higher playing efficiency score and higher physical fatigue level during pre-season training was associated with better dynamic balance of right limb. Increased efficiency score in forwards was associated with

higher level of physical fatigue in pre-season training period. We decided to split players in two positions because basketball player's body height and body mass is one of the factors that determine court position; guards are significantly shorter than forwards (Köklü et al., 2011). Vanderlei et al. (2013) found that individual (age, height and weight) and training (length of time in training and number of practice hours per week) characteristics might be associated with intrinsic and extrinsic risk factors for guards and forwards, and body mass might be a risk factor for all positions. Findings of another study demonstrate that guards have higher VO_2max values than forwards (Köklü et al., 2011). This can explain obtained correlations in forward group of our investigation.

CONCLUSION

The level of physical fatigue during pre-season training period of elite Lithuanian women

basketball players was low and it was the same in guards and forwards. Dynamic stability of right leg and fundamental functional movements were better in guards than in forwards. The guards' playing efficiency during the season was higher than that of forwards and it was associated with better dynamic stability and higher level of physical fatigue at pre-season. Indirect indicators of non-contact musculoskeletal sports injuries showed that guards should have lower risk of non-contact sports-related injuries in women basketball.

A major strength of this study was the large number and comprehensive descriptive profile of the participants, which allowed both meaningful comparisons between groups and the potential to make useful future comparisons with similar studies. Registration and analysis of sports injuries during the season might get us more accurate results about the prediction of sports traumas. Future studies should focus on interventions that lower the risk of non-contact sports related injuries.

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RELATIONSHIP BETWEEN ORGANIZATIONAL INTELLIGENCE AND INNOVATIONS: CASE OF LITHUANIAN SPORTS FEDERATIONS

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ABSTRACT

Background. Sports organizations exist to perform tasks that can only be executed through cooperative effort, and sports management is responsible for the performance and success of these organizations. The main problem concerning sports organizations and making them implement modern management paradigms is the duality of functions, which divides a sports organization into units increasing the internal competition and reducing the possibilities to create new knowledge. This undoubtedly affects the insufficiently productive functioning of a sports organization under modern conditions of globalization. Organizational intelligence (OI) could be a way to promote innovations, create and share knowledge (McMaster, 1998; Winand, Qualizza, Vos, Zintz, & Scheerder, 2013b).

Methods. Two questionnaires were used in this research: first, regarding the evaluation of organizational intelligence level, the second regarding the sports organization's preparation for innovations.

Results. One of the lowest evaluated OI factors was organizational openness and the highest rating was given to group work. Comparing OI internal dimensions score of sports organizations which implemented or not innovations during the last 12 months it became clear that there was a significant difference in the scores for organizational openness in sport organizations which implemented innovations and ($M = 4.2747$, $SD = 0.82337$) and for sport organizations which did not implement innovations ($M = 3.5874$, $SD = 0.51288$), $p = .24$ (two-tailed).

Conclusion. Sports organizations having more features of intelligent organization more analyse innovation development opportunities in various aspects, but the level of intelligence and innovation ideas development has no relation, except for costs analysis. Sports organization becoming intelligent and developing innovations had advantage only in some phases of innovation development: situation analysis and decision making.

Keywords: sport federations, organizational culture, readiness to innovation process.

INTRODUCTION

A very interesting case of the global function system in the world society is the global system of sports, which only appeared late in the 19th century society. The global sports system involves the mechanisms of production, experience and consumption. Achievement sport involves the identification and development of talent, its production on a global stage, in a single or multi-sport event and its consumption by direct spectators or, through the media complex, a global mass audience. Over time, there has been a tendency towards the emergence of global

achievement sport monoculture – a culture where administrators, coaches and teachers promote and foster achievement sport values and ideologies and where competitions and tournaments are structured along highly co-modified and rationalized lines (Maguire, 2009).

Sports organizations exist to provide sport products and services in the sports industry (Chelladurai, 2005). One critical difference between sports organizations and business organizations is the way they measure performance (Smith & Stewart, 1999). The main purpose of business

organizations is to make a profit. Sports governing bodies is a sports organization whose primary goal is to promote and develop sports at all levels in a given territory and sports discipline. This entails control and supervision of a sport, guaranteeing periodic competition at national and international levels, amateur and professional, and from grassroots to senior categories. Another type of sports organization is the one whose main activity is associated with the production of sports events. The operations and activities of these organizations are subordinated to the venue and rules of sports governing bodies, as well professional teams. The main activity of these sports organizations is to design a competition system articulating the interests of all the actors in order to create an attractive sports event. The third type of sports organization in the classification is the one we call the sports providing entity the main activity of which is to design and deliver sports programs for a given community such as clubs, local sport programs, fitness centres, and university sports programs (Gomez, Opazo, & Marti, 2008). These are private, non-profit associations, dedicated to the provision of recreational sports activities at a local level.

Sports organizations exist to perform tasks that can only be executed through cooperative effort, and sports management is responsible for the performance and success of these organizations. With so many options now available to the sports consumer, it is no longer enough for a sport organization to be simply managed well. To compete and succeed in today's environment, the challenge for every sport organization is to be better. Sports federations are being encouraged to adapt themselves to the expectations of their stakeholders and individual members' satisfaction and attraction of new members represent major goals. Given the growing number of commercial sports providers and the popularity of non-organized sports activities (Vos et al., 2012), it is crucial for sports federations to implement new services to retain and attract members. Achieving new standards (to increase the quality of the products and services, speed and flexibility in responding to customers, to innovate and constantly provide new products and services) is important for different types of sport organizations. The main problem concerning sports organizations and making them implement modern management paradigms is the duality of functions, which divides a sports organization into units increasing the internal competition and

reducing the possibilities to create new knowledge. This undoubtedly affects the insufficiently productive functioning of the sports organization under modern conditions of globalization.

According to the approach of constant development, when the architecture of a sports organization is purposefully transformed, it becomes possible to develop the internal dimensions of the organization expediently, aiming to create an intelligent sports organization. An intelligent sports organization should act as a system where collaborative decisions are made, the co-workers show initiative and the ability to make teams unreservedly; such organization should allow a degree of decentralization which promotes organizational learning and integrating processes; sports organization should also be able to generate knowledge and use it when it adapts to the environment.

Scientific literature suggests different conceptions of organizational intelligence, but all of them are united by one common feature: organization's ability to adapt to the changing environment together with knowledge management, as OI encompasses competition based on knowledge, which is common to an organization. This competition is the basis to success of a knowledge organization in the rapidly changing and competitive environment. The profound analysis of research literature let us conclude that OI can be perceived as a certain way of organizing organizational activities which emerge organizational culture and become an inseparable part of it.

The formation of OI directly depends on the number of creative, innovative and initiative employees in the organization and their ability to communicate among themselves; the heads of the organization must be discontent with the present situation and constantly look for ways to act more effectively; organizational culture must reflect the values of each employee: orientation to the problems and changes, initiative, taking risk. When knowledge is successfully integrated in the organization, every worker in the organization perceives how all kinds of work are done in the organization; managers and workers' perceptions about the roles, responsibilities and methods in the organization coincide; it is not difficult to identify and eliminate drawbacks impeding success, good experience is quickly identified and implemented in practice, and knowledge integration ensures feedback in all the hierarchical layers.

In the theoretical analysis of managing intelligent organizations, most attention was paid to the analysis of the conceptions of management and leadership, and organizational leadership as a resource. Different organizational models suggest different management styles, thus, when we spoke about organizational management, we paid most attention to indirect management. Three main systems in indirect management were distinguished – delegating in the hierarchical structure; creating a community with a common goal and values; and implementing the system of free market. In the management of an intelligent organization we distinguished and discussed three main theories: 1) transformational leadership (Tsoukas & Vladimirou, 2005), 2) intelligent leadership (Sydanmaanlakka, 2002), and 3) connected leadership (Gobillot, 2007). Managing intelligent organizations means not only administration functions, which are also important, but also engaging workers into the organizational management processes, motivating them, creating the sense of community, providing freedom in decision making, innovations, learning and knowledge creation.

It can be stated that OI refers to its created value – the improvement of the effectiveness of its activities. Activities of any organization are directed towards the achievement of results, which are expressed as aims, vision and mission. Modern management applies various indices of the evaluation of organizational effectiveness. The effectiveness of activities of sports organizations cannot be linked with the increase of profit because the aims of sports organizations deal with meeting the needs of the community. Thus, the notion of intelligence of sports organizations is different because they are conditioned by the social needs and attitudes despite their effort to compare to business organizations.

Knowledge and skills become valuable only when they are used in certain purposeful activities. In the society of science there is an increase of interest in the recognition, mobilization and formalization of employees' knowledge in order to promote innovations and competitive ability. There is much of research about innovations, but there is still a lack of studies about innovation development in sports organizations such as non-profit sports organizations (various sports federations or associations). Many academic articles could be found under the topic of innovations in basic organizational context (Crossan & Apaydin, 2010).

Researchers have pointed out that innovation is a source of competitive advantage, in the public, private, and non-profit sectors, through improved effectiveness and efficiency (Damanpour & Aravind, 2012; Dess & Picken, 2000; Lee, Ginn, & Naylor, 2009; McDonald & Srinivasan, 2004). The for-profit sector is often seen as the most dynamic sector of sports market as competition leads to innovation (Gratton & Taylor, 2000; Robinson, Hewitt & Harris, 2000). Non-profit sport organizations (NPSOs), such as voluntary sports clubs or sports federations, are encouraged to change to satisfy and meet new expectations of their members. Indeed, their ability to innovate is just as important as for other organizations (Newell & Swan, 1995), in part because of the growing commercialization and professionalization of sports industry. That competition, as perceived by the management board, leads NPSOs to innovate (Winand, Qualizza, Vos, Zintz, & Scheerder, 2013a). Sports federations compete for financial support, sports results, and membership participation (Newell & Swan, 1995). Sports federations innovate to attract and retain members (Newell & Swan, 1995; Thibault, Slack, & Hinings, 1993) and might develop an attitude favouring innovation to cope with their competitive environment. This type of sports federations would be more innovative (Winand et al., 2013b).

Organizational intelligence could be a way to promote innovations, create and share knowledge. At the beginning most authors (March, 1999; McMaster, 1998) compared organizational intelligence to information/data management by means of informational technologies, but lately researchers (Farrel, 2007) view this management paradigm as an absolutely new means of organizational management which involves all the processes (organizational openness, formality, knowledge creation and management, group work, organizational learning, leadership expression, systemic thinking) on the plane of internal dimensions.

Very few studies have paid attention to the notion of innovation in NPSOs (except for Caza, 2000; L. Hoeber & O. Hoeber, 2012; Newell & Swan, 1995), and none of them have developed a conceptualization of innovation in NPSOs, which could form the basis for further research.

Research question: Are sports organizations prepared for the development of innovations and how it relates to organizational intelligence.

METHOD

Procedure and sample representatives. The data was collected by web-based survey conducted in various sports federations of Lithuania in March–May, 2015. Each questionnaire was completed by the all personnel of sports organizations.

Overall, the questionnaire was sent to a total number of 75 sports organizations of 80 sports federations of Lithuania. Having official permission, the questionnaires were distributed via employees' emails aiming to increase the accessibility of the respondents. Thus, we can claim that inside a sport organization the questionnaires were distributed to all employees irrespective of their positions. The response rate was 60% in each sports organization. The relatively low response rate can be explained by the great extent of the questionnaire, which required much time to fill it in taking into account the size of the questionnaire (more than 200 questions), the response rate must be regarded as satisfactory.

Questionnaire. In relation to the topic of this paper, two batteries with questions were relevant. First, one battery included 148 questions regarding the evaluation of organizational intelligence level in sports organizations (Staskeviciute, 2009). An original research methodology was created comprising 146 rank scale questions. Participants of the research had to respond on a seven-point Likert scale ranging from "I absolutely do not agree" to "I absolutely agree".

The second battery included 23 questions regarding the sports organization's preparation for innovations. The research instrumentation was formed on the principle of individual diagnostic blocks, derived from the theoretical analysis and research to determine the desired components: an innovative service development process (described as NuServ model by Shekar, 2007). The background variables included in this study are: size and type of organization, the position in organization.

The internal reliability of organizational intelligence instrument was computed by using Cronbach's alpha rate. The rate of the constructed questionnaire was .977. It can be stated that the internal reliability of this questionnaire was high – the questions were interrelated and they measured the same phenomenon. The devised instrument for the evaluation of the development of the organization in the context of an intelligent organization allowed evaluating the degree of internal organizational dimensions and foreseeing the direction of its development.

Data analysis. The statistical analysis was performed using the statistical software SPSS version 17.0. The methods of analysis included Cronbach's alpha coefficients, descriptive statistics, Pearson's correlations, and Student's *t*-test. Statistical significance was set at $p < .05$ for all tests.

RESULTS

The results are presented in two sections: first, the analysis of sports organizations' organizational intelligence; second, the relationship between organizational intelligence and intentions to innovate.

Organizational intelligence. The analysis of the survey results showed that the Lithuanian sports organizations' OI differed – 52% of all organizations involved in the study had an average level of organizational intelligence.

The analysis of each factor separately showed that the assessment of each range from 3.9 to 4.16 points. One of the lowest evaluated OI factors was organizational openness (average score – 3.9 out of 6 points). The highest rating is group work (4.16 out of 6 points) (Figure 1).

Analysing the relationship between organizational openness sub-factors, it appeared that employees were likely to miss important deadlines and the use of the phrase "I do not know" is used in the absence of the climate of confidence between workers and direct manager (correlation coefficient .609 and .630 at the significance level of .05). If the leaders of the organization were able to listen and hear, the cooperation between employees was much more efficient (correlation coefficient .733 at the significance level of .05). The employees of sports organizations believed that direct manager trusted them when they presented their plans, results, involved them in the decision-making process (correlation coefficient .772 at the significance level of .05). Thus, the results of the study revealed that the openness of sports organizations was dependent on the attitude of the direct manager to the employees and their behaviour.

The study of organizational formality factors revealed that in compliance with the sports organization's priorities, rules and regulations, the information channels within the organization operates more efficiently (correlation coefficient .752 at the significance level of .05), decisions were taken in meetings (correlation coefficient .837 at the significance level of .05). The study also revealed that in a significant and compelling vision, the

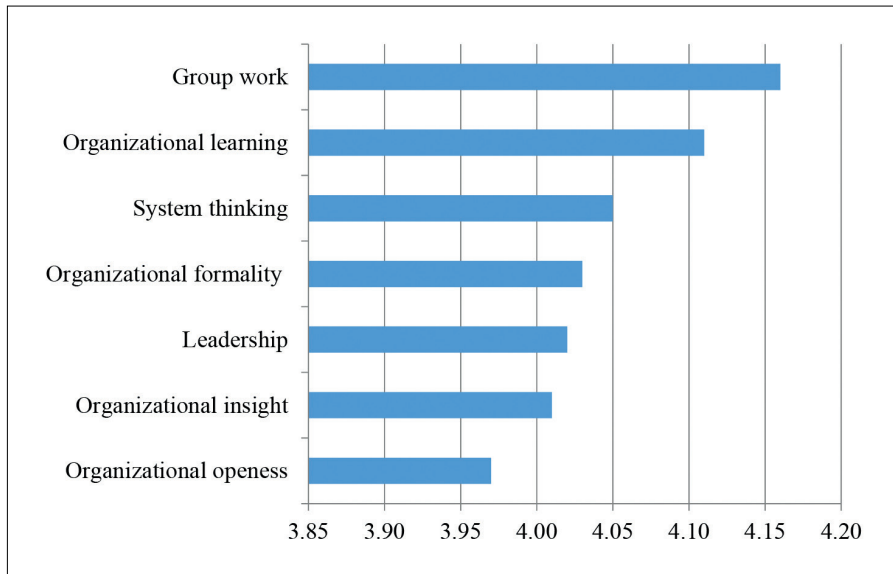


Figure 1. The evaluation of OI factors

current organizational structure supported strategic initiatives (correlation coefficient .847 at the significance level of .05). Every sports organization employee was encouraged to introduce new methods if the direct manager was willing to help solve problems (correlation coefficient .821 at the significance level of .05).

The study data showed that if every employee believed that their suggestion and opinion would be heard and taken into account then the overall quality of the organization's work was seen as high (correlation coefficient .789 at the significance level of .05). The organization preferred to measure its success by the human resource development, teamwork and dedication of staff if the staff involved in the development and review of the strategy (correlation coefficient .714 at the significance level of .05).

If the direct manager perceived knowledge and learning as key resources and professional skills showing them respect and recognition, it activated the natural cultural process in which people shared knowledge and other relevant information (correlation coefficient .707 at the significance level of .05). Problem solving was based on the involvement of employees if the head of the organization perceived knowledge and learning as key resources and professional skills showing them respect and recognition (correlation coefficient .730 at the significance level of .05). If the direct manager was willing to admit their mistakes and undo the steps that were not effective and beneficial, when they supported and encouraged openness, making changes and the atmosphere of new ways of thinking (correlation coefficient .729 at the significance level of .05).

If the organization regularly examined the implemented changes and their results, then it was likely that the organization had the organizational performance, employee performance and etc. evaluation systems (correlation coefficient .716 at the significance level of .05) and it showed that direct managers were more likely to trust their employees (correlation coefficient .716 at the significance level of .05). If there was cooperation between direct managers and employees, then cooperation among the staff was much more efficient (correlation coefficient .850 at the significance level of .05). If the head of the organization together with the employees took responsibility for risky decisions made and the consequences of the change, the direct manager was more likely to ask the staff for their opinion (correlation coefficient .822 at the significance level of .05).

Every staff member felt that their contribution had an impact on the success of the organization if they received feedback on their work performance and contribution to the recognition and respect of the organization's expectations (correlation coefficient .800 at the significance level of .05). If every employee in an organization expressed a sense of belonging, then the work atmosphere encouraged them to learn from their mistakes (correlation coefficient .726 at the significance level of .05) and their leaders deliberately trying to inform employees (correlation coefficient .701 at the significance level of .05).

If an organization had an effective planning, each employee was willing to accept and implement changes (correlation coefficient .775 at the significance level of .05). If the direct manager

presented plans, priorities and results to the employees, then each employee was ready to help the organization to achieve its goals (correlation coefficient .748 at the significance level of .05). If there was a reliance on the decisions of the employees, then the head of the organization created an atmosphere in which employees were motivated (correlation coefficient .706 at the significance level of .05). In a clear distribution of authority and responsibility, more frequent conversations were about the environment and how to overcome frequent challenges (correlation coefficient .771 at the significance level of .05).

The relationship between organizational intelligence and intentions to innovate. Fifty six percent of respondents in last 12 months implemented innovations or planned to do so. The comparison of sports organizations OI levels by intentions to innovations is shown in Figure 2.

An independent samples *t*-test was conducted to compare the OI scores for sports organizations which implemented or not innovations during the last 12 months. There was no significant difference in the scores for sports organizations which implemented innovations ($M = 4.2357$, $SD = 0.61470$) and for sports organizations, which did not implement innovations ($M = 3.7909$, $SD = 0.59909$), $p = .82$ (two-tailed).

Comparing the scores of organizational intelligence factors by an independent samples *t*-test in the sport organizations which implemented or not innovations during the last 12 months, it became clear that there was a significant difference in the scores for organizational openness in sports

organizations which implemented innovations and ($M = 4.2747$, $SD = 0.82337$) and for sports organizations which did not implement innovations ($M = 3.5874$, $SD = 0.51288$), $p = .24$ two-tailed). Also, there was a significant difference in the scores for organizational insight in sports organizations which implemented innovations ($M = 4.2313$, $SD = 0.60172$) and for sports organizations which did not implement innovations ($M = 3.7186$, $SD = 0.51528$), $p = .34$ (two-tailed).

Correlation of intent to innovate and the level of organizational openness (correlation coefficient .450 at the significance level of .05) and organizational insight (correlation coefficient .425 at the significance level of .05) of organizational intelligence showed causality of medium strength. Significance and correlation coefficient had medium strength and showed tendencies: a) the more organization was open, the more they thought about innovations and their implementation; and b) the more organization showed internal insight, the more they thought about innovations and their implementation.

The results of the research revealed that the level of organization's group work correlated with the aim to develop innovations corresponding to sports organization's aims and vision (correlation coefficient .767, $p = .01$). This means that when organization values group work, i.e. group efforts, it will more seek to develop innovations according to the vision and aims. Sports organization which is open to the environment and has organizational learning features more researches the environment aiming to identify innovation opportunities (cor-

Figure 2. The relationship between OI and intentions to innovate

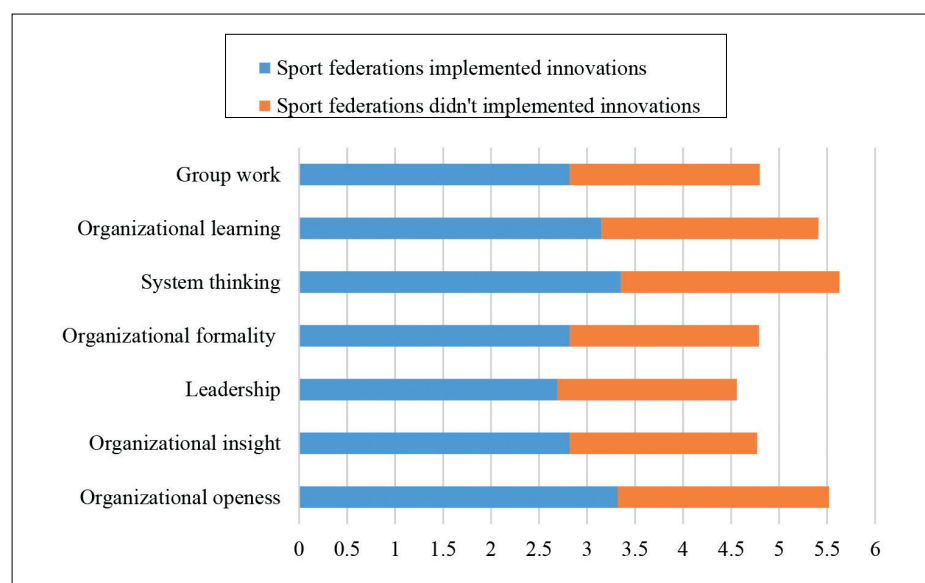


Table 1. Correlation matrix: preparation for innovations vs OI

Variables		Organizational openness	Organizational formality	Group work	Organizational learning	Organizational insight	Systemic thinking	Leadership
Creating innovations:	<i>Checking whether there is enough information</i>	.758	.785			.716	.817	.846
	<i>Analysing the global market situation</i>	.801	.872		.758	.824	.859	.836
	<i>Analysing the internal data of the company</i>		.745	0.851			.747	
	<i>Analysing the market</i>	.811	.756			.757	.830	.822
<i>Innovation development is often influenced by the situation in the external environment</i>			.768				.780	.778
<i>Always performing analysis of the demand before implementing the innovations</i>		.769	.730		.739	.810	.804	.791
<i>Always calculating a preliminary investment required for the development before implementing the innovation</i>		.725	.850		.759	.830	.831	.787
<i>Always performing target market analysis, anticipating innovations, consumer groups before implementing the innovation</i>		.870	.902	0.823	.871	.930	.848	.864
<i>Generating different ideas and options before creating innovations</i>		.716	.702				.767	.746
<i>Creating innovations accurately describing their conception</i>			.752				.770	.748

Note. * $p = .01$.

relation coefficients .811 and .739, $p = .01$ and $p = .03$). Organization's formal level correlates with the investments needed for the evaluation of innovations (correlation coefficient .850, $p = .000$). Research results also revealed that sports organizations having more features of intelligent organization more analysed innovation development opportunities in various aspects, but the level of intelligence and the development of innovation ideas had no relation, except for costs analysis. The choice of innovation concept and development had a direct relation with the intelligent organization features, especially systematic thinking and openness, when customers' attitudes had an impact on the choice of innovations.

DISCUSSION

The results revealed that Lithuanian sports organizations were not sufficiently well prepared for modern management methods and challenges of globalization. The lowest level of openness estimate showed that the dissemination of information within the sports organization was limited, although it is necessary to draw attention to the fact that the

majority of the Lithuanian sports organizations can be classified as small and very small organizations. The results of the study revealed that the limited capacity of the relevant internal information reduced possibilities for sports organizations to become a learning organization. The current limited capacity of the internal information was closely related with the strategy of leadership: the example of the leaders was determined by a number of behavioural changes among employees who fostered better information sharing and reducing internal competition. The results show that sports organizations in Lithuania were more focused on the formal processes using contacts of the hierarchical organizational structure, acting in accordance with established rules and procedures. It is important to note that only the current match between the declared and actual operating rules is effective and encouraging employee involvement in the organization's activities and decision-making process.

Teamwork level has direct links with sports organizations in the common assessment of quality: the more frequently group work method is used, the more positively the quality of sports organization

is evaluated. Accordingly, the involvement of employees in the decision-making process suggests that the success of an organization is more often seen as a result of teamwork. It should be noted that teamwork was given the highest scores by Lithuanian sports organizations, which can be evaluated as a strong point, but due to the limited internal dissemination of information this factor does not allow creating a learning organization. The behaviour and attitudes of employees towards the head of the organization is significant for organizational learning. The results of the study showed quite favourable conditions from the heads of the organization for the organizational learning in the Lithuanian sports organizations, but the existing framework of openness and the level of formality did not facilitate and encourage the creation of new knowledge and the sharing of the information available.

Although the results of the study revealed that systemic thinking was higher than the average level in Lithuanian sports organizations, it was more related to the loyalty and dedication to the organization rather than the ability to collectively reach the insights necessary for the success of sports organizations for further action, providing the potential challenges.

Accordingly, processes and organizational systems of an intelligent sports organization influenced by intelligent processes create an effect of synergy, which becomes an advantage of an intelligent sports organization while competing in the global market. Intelligent decisions made and their implementation together with intelligence processes create value, the expression of which is qualitative and quantitative indicators of sports organization's activities and the improvement of its activities, as well as tangible and intangible resources.

Organizational intelligence becomes significant not only at different levels of the organization, but also in the relationship of the organization with its environment and the parties concerned. The theoretical preconditions suggest that the changes in the conceptions of organizational management and activity processes enabled identifying transformations in organizational intelligence which affected its evolution and specificity of activities.

The analysis of factors influencing success of sports organizations in the theoretical part let us claim that those factors affected the transformations and analysis of organizational activities allowing

effective adaptation to the rapidly changing environment implementing strategic aims. The changes in the environment encourage sports organizations to review their management methods and modernize them if they want to remain or compete in the global market and to create its long-term advantage. The main problem concerning the organizations and making them implement modern management paradigms is the duality of functions, which divides the organization into units increasing the internal competition and reducing the possibilities to create new knowledge. This undoubtedly affects the insufficiently productive functioning of the organization under modern conditions of globalization.

Research results also show that there is a strong and moderate correlation between the groups of factors in the components of organizational intelligence, and between different components of it. The existence of the cause relation allows a more purposeful and systematic development of internal organizational dimensions. The transformations in the development of the internal dimensions of intelligent organizations become possible only after the evaluation of the level of internal dimensions in respect to an intelligent organization.

The empirical results of the research showed that among the intelligence components of the organizational strength of different causal relationships – affecting a particular component of the organizational intelligence – changing its internal quality levels, respectively, just some of the other organizational components of the inner dimensions of intelligence. In the development of intelligent organization it is necessary to evaluate the internal dimensions of independent existence, and their inclusion in the development of organizational intelligence.

The level of organization's group work correlates with the aim to develop innovations corresponding sports organization's aims and vision. Sports organization which is open to the environment and has organizational learning features more often researches the environment aiming to identify innovation opportunities.

Sports federations whose staff favours novelty are significantly more innovative and develop different types of service innovation. These types include leisure sports activities for adults, training programmes as well as club management support. In line with previous research in other contexts (Damanpour, 1991; Damanpour & Aravind, 2012; Damanpour & Schneider, 2009), the study of

Winand, Qualizza, Vos, Zintz, and Scheerder (2013b) demonstrated that attitudes favouring the introduction of new knowledge within NPSOs were critical to the level of innovativeness. The sports characteristics managed by sports federations influence preferences in knowledge creation/appropriation, and ultimately the type of innovation developed (Winand et al., 2015). In line with Bierly, Damanpour, and Santoro (2009), some sports federations might be inclined to develop similar types of innovation over time and organizational characteristics influence preferences in knowledge creation/appropriation, and the type of innovation non-profit sports organizations develop.

CONCLUSIONS

Diagnosis of the current situation in sports organizations according to organizational intelligence components, so that organizations could make decisions about their further development or the maintenance of the current level of the organization.

The backgrounds of the formation of organizational intelligence are: 1) the formation of

organizational intelligence directly depends on the number of creative, innovative and initiative employees in the organization and their ability to communicate among themselves; 2) the heads of the organization must be discontent with the present situation and constantly look for ways to act more effectively; 3) organizational intelligence is more common to those organizations which exist in the turbulent environment; 4) organizational culture must reflect the values of each employee: orientation to the problems and changes, initiative, taking risk.

Developing an intelligent organization, it is necessary to know the current situation because the interaction of the components of intelligent organization creates a synergetic effect.

Sports organizations having more features of intelligent organization more analyse innovation development opportunities in various aspects, but the level of intelligence and innovation ideas development has no relation, except costs analysis. Sports organization becoming an intelligent sports organization and developing innovations had an advantage only in some phases of innovation development: situation analysis and decision making.

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RELATIONSHIPS BETWEEN COMPONENTS OF PHYSICAL ACTIVITY AND HEART RATE VARIABILITY IN OLDER WOMEN

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ABSTRACT

Background. The level of daily activities of elderly persons decreases with aging. Also, reduced heart rate variability has been seen with normal aging. So, the aim of this study was to examine the relationships between physical activity and heart rate (HR) variability in older women.

Methods. Nine healthy women were invited to participate in this study (age 67.0 ± 4.4). HR variability was assessed during active orthostatic test; physical activity was assessed by accelerometer.

Results. Total physical activity was significantly correlated with mean HR ($r = -.73$), RRI ($r = .73$), RMSSD ($r = .83$), HF ($r = .78$), SD1 ($r = .78$) and SD1/SD2 ($r = .72$) in supine position. In addition total physical activity was significantly correlated with mean HR ($r = -.68$), RMSSD ($r = .80$), LF ($r = .87$), HF ($r = .83$), SD1 ($r = .82$), SD2 ($r = .65$) and SD1/SD2 ($r = .72$) in standing position.

Conclusion. Total physical activity is positively associated with higher heart rate variability in older women.

Keywords: physical activity, heart rate variability, older women.

INTRODUCTION

The number of people older than 60 years is increasing. The aging process leads to reduced physical fitness and results in difficulties in daily life activities and normal functioning of the elderly. The level of daily activities of elderly persons decreases with aging. Physical activity is important for independent living, prevention of chronic health problems, and quality of life (Milanovic et al., 2013).

Cardiorespiratory fitness is important for endurance exercise performance. Low cardiorespiratory fitness is related to the development of the metabolic syndrome, the progression of atherosclerosis and coronary arterial disease and may account for 16% of all deaths (Ramsbottom, Currie, & Gilder, 2010). Accelerometers are widely accepted as valid objective measures of physical activity, and the ActiGraph is the most commonly used brand (Cain, Conway, Adams, Husak, & Sallis, 2013). Heart rate variability (HRV) is a non-invasive technique

for estimating the characteristics of the autonomic nervous system and for quantifying modulation of the sympathetic and parasympathetic inputs. Low HRV may be indicative of disturbed cardiac autonomic activity, in particular excessive sympathetic and/or inadequate parasympathetic activity. Reduced HRV is related to increased risk of cardiac events and all-cause mortality (Jandackova & Jackowska, 2015).

We hypothesized that heart rate variability would be associated with physical activity. The aim of this study was to determine the relationship between components of physical activity and heart rate variability in older women.

METHODS

The present study received the approval of Kaunas Regional Biomedical Research Ethics Committee. All participants signed a statement of

Table 1. Characteristics of participants

Participant (n = 9)	Age	Height (cm)	Weight (kg)	Body mass index	Fat mas (kg)	Fat mass (%)	FFM (kg)	$\dot{V}O_{2\max}$ (ml/kg/min)
Mean	67.0	160.3	67.7	26.4	24.0	35.0	43.7	14.3
SD	4.4	5.7	10.2	3.4	6.8	4.3	4.1	5.4

informed consent after receiving both written and verbal information as to the nature and purpose of the experiment. The study was performed in the Lithuanian Sports University.

Of the 11 volunteers recruited to the study, 9 of them completed it. All participants were women, non-smokers. Exclusion criteria included type I or II diabetes, hypertension, any known heart disease, asthma or any respiratory restrictive problem, muscular skeletal injury.

Pre-test information sheets required the participants to abstain from caffeine-containing beverages 2–3 h before testing heart rate variability. Volunteers were also asked to refrain from alcohol and participation in vigorous exercise for 24 h prior to measurement of HRV.

Anthropometry. Height was measured in centimeters using an upright stadiometer. Participants stood barefoot with their heels and head in contact with the wall and arms at their sides. Weight, fat mass and FFM were measured in kilograms using a body composition analyzer (Tanita BC-418MA). Body mass index (BMI) was calculated using the equation: $BMI = \text{weight (kg)} / \text{height (m)}^2$ (Tomaz, Lambert, Karpul, & Kolbe-Alexander, 2016).

Cardiorespiratory fitness ($\dot{V}O_{2\max}$) was estimated by University of Houston Non-Exercise Test (BMI Model). Subjects had to determine their physical activity rating from 1 to 7 (PAR) using test table. $\dot{V}O_{2\max}$ was calculated using the equation: $\dot{V}O_{2\max} \text{ (ml/kg/min)} = 56.363 - (.381 \times \text{age (years)}) - (.754 \times \text{BMI}) + (1.951 \times \text{PAR})$ (Kelley, Lowing, & Kelley, 1999).

HRV was measured using active orthostatic test. HR was determined for 5 minutes with the patients in the supine posture. Thereafter, subjects actively stood up, maintaining upright posture quietly for 5 minutes. Prior to the active orthostatic test subjects were instructed to stand quickly and independently. All subjects stood up within 3–4 seconds.

HR was recorded using a Polar S810i heart rate monitor. Analysis of heart rate variability was via a software program (*Polar Precision Performance*), which calculated time- and frequency-domain

measures. The main time domain variables investigated were SDNN (ms) (standard deviation of all normal-to-normal intervals) and RMSSD (ms) (the square root of the mean of the sum of the squares of differences between adjacent normal-to-normal intervals). The main frequency-domain variables investigated were low frequency power (LF power, $\text{m} \cdot \text{s}^{-2}$), power in the low-frequency range (0.04–0.15 Hz), high-frequency power (HF power, $\text{m} \cdot \text{s}^{-2}$), power in the high frequency range (0.15–0.4 Hz), and the low-frequency/high-frequency (LF/HF) ratio, which is thought to reflect the relative proportions of ventilatory and baroreceptor modulation of heart rate variability (Ramsbottom et al., 2010). Poincaré variables were also derived from the R-R interval data, namely SD_1 , a measure of the instantaneous beat-to-beat variability, and SD_2 , thought to quantify long-term heart rate variability, as well as the ratio SD_1/SD_2 or Poincaré dimension, thought to reflect non-linear components of heart rate variability (Mourot et al., 2004).

Accelerometry. The tri-axial ActiGraph GT3X accelerometer (Tri-axis ActiTrainer Activity Monitor) was used in this study. The device was set to measure motion in all three axes and was set to record data in 60-second epochs. Accelerometer data were captured and cleaned using the ActiLife Software. Data from all three axes were captured and used in the analysis. The accelerometer was given to the participants after the active orthostatic test, and physical active questionnaire, and participants were requested to maintain their usual activity levels while wearing the device. Participants were requested to wear the accelerometer on their right hip for seven consecutive days, but not while bathing, showering or swimming. A minimum of 4 days of wear, with 600 minutes per day were required for data analysis. Non-wear time was defined as 60 continuous minutes of no counts (zeros). Moderate, light and sedentary intensity physical activity levels were estimated based on accelerometer counts using the cut-off points. Counts between 1952 and 5724 (inclusive) represents moderate to vigorous intensity PA (MVPA), counts between

100 and 1951 (inclusive) represent light activity, and counts below 100 (0 - 100) represent sedentary activity (Keadle, Shiroma, Freedson, & Lee, 2014).

Statistical analysis was carried out using Microsoft Excel (2010) and SPSS (Version 17). Kolmogorov-Smirnov test was used to check for normality of data ($p > .05$). The strength of the association between variables was assessed by Spearman's product – moment correlation coefficient.

RESULTS

Participants self-reported low physical activity, from which cardiorespiratory fitness (VO_{2max}) was calculated. There was no significant correlation between estimated VO_{2max} and physical activity components (Table 1, 2). The highest correlation was found between total physical activity and RMSSD ($r = .83$). Also significant correlation was estimated between total physical activity and high-frequency power ($r = .78$), and SD1 ($r = .78$) (Table 1).

Table 2. Spearman's correlations between components of physical active, cardiorespiratory fitness and heart rate variability in supine position

	Steps/day	Total activity	Moderate PA	Light PA	Sedentary PA
VO_{2max} (ml/min/kg)	.05	.12	.05	.13	-.22
HR average (beats/min)	-.38	-.73*	-.23	-.17	.20
HR supine (beats/min)	-.42	-.72*	-.37	-.43	.47
RMSSD (ms)	.52	.83*	.35	.75*	-.82*
LF ($m \cdot s^{-2}$)	.57	.43	.57	.22	-.22
HF ($m \cdot s^{-2}$)	.42	.78*	.25	.70*	-.73*
LF/HF ratio	.18	-.05	.33	-.12	.13
SD1	.42	.78*	.25	.70*	-.73*
SD2	.62 *	.45	.67*	.52	-.53
SD1/SD2	.35	.72*	.17	.60*	-.63*

Notes. *Significant at $p < .05$.

Time domain analysis: SDNN, standard deviation of the R-R intervals; RMSSD, square root of the mean of the sum of the squares of the differences between adjacent R-R intervals. Frequency domain analysis (autoregression analysis): LF, low-frequency power (0.04–0.15 Hz); HF, high-frequency power (0.15–0.40 Hz); LF/HF, low-frequency/high-frequency power ratio. SD1, short axis of the Poincaré' plot; SD2, long axis of the Poincaré' plot; SD12, the ratio SD1/SD2 or Poincaré' dimension.

Table 3. Spearman's correlations (rs) relationships between components of physical active, cardiorespiratory fitness and heart rate variability during standing position

	Steps/day	Total activity	Moderate PA	Light PA	Sedentary PA
VO_{2max} (ml/min/kg)	.05	.12	.05	.13	-.22
HR average (beats/min)	-.38	-.68*	-.23	-.17	.20
HR standing (beats/min)	-.13	-.53	-.20	-.67*	.62*
RMSSD (ms)	.68*	.80*	.44	.27	-.43
LF ($m \cdot s^{-2}$)	.82*	.87*	.63*	.43	-.53
HF ($m \cdot s^{-2}$)	.67*	.83*	.40	.40	-.52
LF/HF ratio	-.10	-.23	.17	.02	.10
SD1	.70*	.82*	.47	.30	-.45
SD2	.48	.65*	.22	.25	-.35
SD1/SD2	.58*	.72*	.33	.38	-.52

Notes. *Significant at $p < .05$.

Time domain analysis: SDNN, standard deviation of the R-R intervals; RMSSD, square root of the mean of the sum of the squares of the differences between adjacent R-R intervals. Frequency domain analysis (autoregression analysis): LF, low-frequency power (0.04–0.15 Hz); HF, high-frequency power (0.15–0.40 Hz); LF/HF, low-frequency/high-frequency power ratio. SD1, short axis of the Poincaré' plot; SD2, long axis of the Poincaré' plot; SD12, the ratio SD1/SD2 or Poincaré' dimension.

In standing position heart rate variability components are more expressed. There was found a significant correlation between the number of steps per day and low-frequency power LF ($r = .82$). Total activity was significantly correlated with HR average ($r = -.68$), RMSSD ($r = .8$), low-frequency power LF ($r = .87$) and high-frequency power HF ($r = .83$), SD1 ($r = .82$), SD2 ($r = .65$) and SD1/SD2 ($r = .72$) (Table 3).

DISCUSSION

The main finding of this study is that heart rate variability is associated with physical activity in older women. We found positive significant correlation between total physical activity and many heart rate variability components both in supine and standing positions.

Objective information on the physical activity levels and sedentary behavior has the potential to increase our understanding of physical activity in older age. The introduction of accelerometers for objective assessment of physical activity allows for valid and reliable assessments of activity intensity, frequency, and duration. It has been established that women demonstrate significantly more minutes of low-intensity physical activity than men (Lohne-Seiler, Hansen, Kolle, & Anderssen, 2014).

The most frequently used heart rate variability parameters are the frequency-domain (high and low frequency ratio), time-domain (SD, SDNN, RMSSD), and Poincaré plot (SD1, SD2) parameters (Makivic, Djordjevic Nikic, & Willis, 2013). Cardiac diseases and arrhythmias are common with aging. It has been established that walking at least 1.0 h or more per week was associated with > 50% reduction in coronary heart disease risk in multivariate models (Lee, Rexrode, Cook, Manson, & Buring, 2001). Women ($n = 88,393$) who were moderately active (1–3.49 h/week) and active (≥ 3.5 h/week), had 43% and 58% lower risk of coronary heart disease, respectively, compared to sedentary women (< 1 h/week) (Li et al., 2006). Increasing the level of physical activity was associated with a 36% reduction in cardiovascular mortality in sedentary older women (Swift et al., 2013).

We found a significant negative correlation between total physical activity and HR average, which means that physical activity is associated with increased parasympathetic activity. In middle-aged populations, habitual physical activity has been associated with more favorable HRV

indices, especially those reflecting increased vagal modulation and reduced sympathetic activity. Older adults have much higher risk for abnormal HRV and cardiac events than middle-aged populations (Soares-Miranda et al., 2014). HRV parasympathetic activity decreases faster until the age of 80 years and then starts to increase again (Reardon & Malik, 1996).

Lots of studies have identified the effects of exercise on enhancing vagal tone. Poor physical fitness is associated with impairment in cardiac vagal function during exercise (Makivic et al., 2013). Greater total leisure time activities, as well as walking alone, were prospectively associated with healthier cardiac autonomic function (Poirier, 2014). In our study, total physical activity was significantly correlated with HRV time domain (RMSSD), frequency-domain (high and low frequency rates) and Poincaré plot (SD1, SD2 and SD1/SD2). It has been established that HRV depends on leisure – time activity, walking distance and speed. Those participants who had increased walking speed had significantly higher SDNN in comparison with those that decreased or maintained their walking speed. Similarly, those that increased walking speed had significantly higher normalized low-frequency power, low frequency/high frequency ratio and less irregular HRV in comparison with those that decreased or maintained their walking speed. Additionally, those that increased walking speed had lower normalized high-frequency power in comparison with those that maintained or decreased their walking speed (Soares-Miranda et al., 2014).

Physical activity is associated with a more favorable HRV profile (Borghi-Silva et al., 2009). The specific associations with indices that might reflect circadian variation (SDNN and ultra-low frequency power (ULF)), combined activity of sympathetic and parasympathetic modulation (normalized low-frequency power), vagal control of heart rate and also renin-angiotensin system neurohormonal modulation (very-low-frequency power), and less abnormal HR patterns (Poincaré ratio suggests relatively selective effects of physical activity on the biological pathways influencing these parameters). Although the biological interpretation of these indices is complex (e.g. SDNN and ULF may reflect multiple inputs beyond circadian variation), physical activity is not related to all HRV indices similarly in older adults (Soares-Miranda et al., 2014).

Regularly performed physical activity is associated with a reduced risk of cardiovascular disease, some forms of cancer, and all-cause mortality (Orsini et al., 2008). Reduction in sympathetic activity and increased vagal activity has been implicated as possible pathways by which regular physical activity provides cardio protective benefits (Carter, Banister, & Blaber, 2003). Physical activity may also directly affect cardio myocytes by leading to improved contractile capacity (Wisløff, Ellingsen, & Kemi, 2009), and by enhancing cardiac electric stability (Billman, 2009). Also, physical activity may reduce arrhythmic, myocardial infarction and heart failure risk in humans (Soares-Miranda et al., 2014).

HRV modulation depends on body fat (Poliakova et al., 2012; Salamin et al., 2013). Aging is associated with decreased muscle mass and increased fat mass, particularly visceral fat. Abnormal HRV has been associated with the severity of left ventricular diastolic dysfunction (Poirier et al., 2003), which has been associated with lower exercise capacity (Poirier et al., 2000).

Regular physical activity in older adults is very important for healthy aging (Lohne-Seiler et al., 2014). Women taking 7,500–9,999 steps/day had significantly lower BMI and percent body fat than women taking < 5,000 steps/day. The steps range for healthy older adults is recommended 7,000–10,000 steps/day, at least 3,000 of which should

be accumulated at a brisk pace (Tudor-Locke et al., 2011). In our study, women were taking about 7662 steps/day. Increasing PA (expressed as energy per week) is positively related to reductions in total adiposity, and the effects occur in a dose–response manner. A protective effect of physical activity on site-specific cancer risk, with a dose–response association between physical activity and colon and pre- and postmenopausal breast cancer, has also been suggested by the particular biological mechanisms that are responsible for the development of these diseases (Pelcova, Gaba, Tlucakova, & Pospiech, 2012). We found significant correlation between steps per day number and RMSSD, LF, HF, SD1, SD1/SD2. Walking 10,000 steps/day or more for 12 weeks was effective at lowering sympathetic nerve activity, but ineffective on parasympathetic nerve activity, baroreceptor reflex sensitivity, BMI, lipids, and glucose tolerance (Iwane et al., 2000).

CONCLUSION

In conclusion, we estimated significant correlation between physical activity and heart rate variability in older women. More physically active older women demonstrated higher HRV during orthostatic test. Physical activity proved to be very important for normal cardiac autonomic function in older women.

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INSTRUCTIONS FOR CONTRIBUTORS

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Page 2 should include the **abstract** (250 words) revealing the scientific problem and providing the major data of the research. It must be structured into the following sections: Background. Methods. Results. Conclusion. Keywords (from 3 to 5 informative words and/or phrases).

The full text of the manuscript should begin on page 3. It should be structured as follows:

Introduction. It should contain a clear statement of the problem of the research, the extent of its solution, the new arguments for its solution (for theoretical papers), most important papers on the subject, the aim, the object and the original hypothesis of the study.

Methods. In this part the choice of specific methods of the research should be grounded. The research participants, methods, apparatus and procedures should be identified in sufficient detail. If the methods of the research used are not well known and widely recognized the reasons for the choice of a particular method should be stated. References should be given for all non-standard methods used. Appropriate statistical analysis should be performed based upon the experimental design carried out. It is necessary to indicate the methods of mathematical statistics applied (statistical reliability, statistical power, confidence interval, effect size), and to explain the estimation of the sample size. Information that will identify human subjects must not be included. Research involving human subjects should be carried out following the principles of the Declaration of Helsinki.

Results. The findings of the study should be presented concisely, consistently and logically, not repeating the chosen methods. The statistical significance and statistical power of the finding should be denoted.

Discussion. At the beginning of the discussion section the authors should provide major original research statements that are supported by the data. We recommend structuring the discussion of the findings into subsections (each original research finding should be discussed in a different subsection). The data and the conclusions of the research are compared to the data obtained by other researchers evaluating their similarities and differences. Authors should emphasize the original and important features of the study and avoid repeating all the data presented within the Results section.

Conclusions. The conclusions provided should be formulated clearly and logically avoiding excessive verbiage. The most important requirement for the research conclusions is their originality in the world. It is advisable to indicate the further perspectives of the research.

Acknowledgements. On the Acknowledgement Page the authors are required to state all funding sources, and the names of companies, manufacturers, or outside organizations providing technical or equipment support (in case such support had been provided).

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All abbreviations should be explained in parentheses what they stand for on their first occurrence in the text. Non-standard special abbreviations and symbols need only to be defined at first mention. The results of all measurements and symbols for all physical units should be those of the System International (SI) Units. In the text of the article all numbers up to ten are to be written in words and all numbers starting from eleven on – in Arabic figures.

Every **table** should have a short subtitle with a sequential number given above the table (the tables are numbered in the same sequence as that of references given in the text). All explanations should be in the text of the article or in a short note added to the table. The symbols and abbreviations given in the tables should coincide with the ones used in the text. The location of the table should be indicated in the text, e.g. [Insert Table 1 here].

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In-text references should be cited as follows: Brown (2011) investigated... or: An investigation (Brown, 1991) found References cited in the text with two authors should list both names: Wright and Mander (2002) found...; Reviews of research on sport and reading (Wright & Morgan, 2001) have concluded.... references cited in the text with three, four, or five authors, list all authors at first mention; with subsequent citations, include only the first author's last name followed by et al.: Campbell, Brady, Bradley, and Smithson (1991) found ... (first citation); Campbell et al. (1991) found ... (subsequent citations); (Campbell, Brady, Bradley, & Smithson, 1991), (Campbell et al., 1991). References cited in the text with six or more authors should list the first author et al. throughout.

In the reference section, references should be listed in alphabetical order taking account of the first author. First the references in Latin characters are given, then – in Russian (Cyrillic) characters. For works up to seven authors, list all authors. For eight or more authors, list the first six, then ellipses followed by the last author's name. In the case when there are several references of the same author published at the same year, they must be marked by letters, e.g. 2001 a, 2001 b, etc. in the list of references and in the article, too.

Examples:

Books (print and online)

Author, A. A. (year). *Title of work*. Location: Publisher.

Author, A. A. (year). *Title of work*. doi:xx.xxxxxxxxxxxxxxx

Author, A. A. (year). *Title of work*. Retrieved from <http://www.xxxxxxxxxxx>

Author, A. A. (year). *Title of work*. Retrieved from xxxxxxxxxxxx database.

Chapter in a book:

Author, A. (year). Title of chapter. In E. Editor (Ed.), *Title of book* (pp. xx–xx). Location: Publisher.

Author, A. (year). Title of chapter. In E. Editor (Ed.), *Title of book* (pp. xx–xx). Retrieved from <http://xxxxxxxxxx>

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Journal and newspaper articles (print and online)

Author, A. A., Author, B. B., & Author, C. C. (year). Article title. *Journal Title*, volume number (issue number), page numbers.

Author, A. A., Author, B. B., & Author, C. C. (year). Article title. *Journal Title*, volume number (issue number), page numbers. doi:xx.xxxxxxxxxxxxxxx

Author, A. A., Author, B. B., & Author, C. C. (year). Article title. *Journal Title*, volume number (issue number), page numbers. Retrieved from <http://www.xxxxxxxxxxxxxxx>

These are the most common examples cited. For a complete list of examples please consult *Publication Manual of the American Psychological Association*, 6th ed.

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