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CONTENT

Editorial Policy

BJSHS is an international quarterly peer-reviewed scientific journal that keeps sports and health professionals up to date with advances in the fields of sports science, health education and promotion and physical rehabilitation. The journal publishes research articles in the following areas: *Social Sciences* (Physical Education, Sports Coaching, Sports Pedagogy, Sports Psychology, Sports Sociology, Research Methods in Sports, Sports Management, Recreation and Tourism), *Biomedical and Health Sciences* (Coaching Science, Sports Physiology, Motor Control and Learning, Sports Biochemistry, Sports Medicine, Physiotherapy and Occupational Therapy, Physical Activity and Health, Sports Biomechanics, Adapted Physical Activity) and *Humanities* (Sports History, Sports Philosophy, Sports Law, Sports Terminology).

The issues contain editorials, reviews of recent advances, original scientific articles, case studies. In all cases, it is vital that the journal's integrity, independence and academic reputation is not compromised in any way.

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BALTIC SPORT SCIENCE SOCIETY

The organization which supports mobilization and training of senior and junior researchers in the field of sport sciences in the Baltic countries is Baltic Sport Science Society (BSSS). BSSS is a non-profit organization founded in Vilnius (Lithuania) on April 24, 2009. The main aims of BSSS are: (1) to promote the study and development of sport sciences in the Baltic countries (Estonia, Latvia, Lithuania), (2) to enhance the quality of doctoral studies in the Baltic countries, (3) to organize scientific meetings and courses in the field of sport sciences, (4) to cooperate with national and international organizations in sport sciences and related fields. The leading academic institutions of the BSSS are currently:

- Faculty of Exercise and Sport Sciences, University of Tartu (UT, Tartu, Estonia),
- Latvian Academy of Sports Education (LASE, Riga, Latvia),
- Lithuanian Sports University (LSU, Kaunas, Lithuania, formerly *Lithuanian Academy of Physical Education*),
- Faculty of Sports and Health Education, Lithuanian University of Educational Sciences (LUES, Vilnius, Lithuania; formerly *Vilnius Pedagogical University*).

The membership of BSSS includes individual members from the Baltic countries who have a doctoral (PhD) degree in sport sciences or related sciences. Doctoral (PhD) students are on the status of junior members. Membership is open for scholars and doctoral students from other countries as well. Currently, there are over 150 members in BSSS. The following bodies govern BSSS: (1) The President and two Vice-Presidents will named by the council of BSSS for a 3-year period from each Baltic country by rotation; (2) Council (in total 8 members, 2 from Estonia and Latvia and 4 from Lithuania). The first President of BSSS (2009–2012) was professor Toivo Jürimäe (UT). Currently the President of BSSS is professor Albertas Skurvydas (LSU) and Vice-Presidents are professor Juris Grants (LASE) and professor Mati Pääsuke (UT). Council meetings are organized two times per year: in January-February and during annual conference in April-May.

The aims of the annual conferences are: (1) to enhance the quality of teaching and research in sport sciences in the Baltic countries, (2) to organize young scientists' section during the conference in order to promote PhD students, (3) to invite leading scholars all over the world as key-note speakers. The 1st Baltic Sport Science Conference was organized in 2008 by UT in Tartu, the 2nd conference – in 2009 by LUES in Vilnius, the 3rd conference – in 2010 by LASE in Riga, the 4th conference – in 2011 by UT in Tartu, the 5th conference – in 2012 by LSU in Kaunas and the 6th conference – in 2013 by LASE in Riga. The 7th BSSS Conference will be organized in 2014 by UT in Tartu on May 7–9. The number of presentations in BSSS conferences increased from 119 (during the 1st conference) to 178 (during the 2nd conference) and the number of participating countries – from 9 to 17. Colleagues from Poland, Russia, Finland, Sweden and other countries have regularly participated in BSSS annual conferences.

Each year, during its meeting, the Council of BSSS compiles statistical summary of activities in the field of sport sciences in the Baltic Countries by each academic institution: bibliometric analysis of research productivity (number of scientific articles published in international refereed journals), productivity of PhD studies (number of defended PhD dissertations), success obtained in research funding (number of national and international research projects), conferences and meetings organized, etc. During the last BSSS Council meeting in February 2014, the respective analysis revealed that in 2013, 81 articles indexed in Thomson Reuters Web of Science database were published and 18 PhD degrees were awarded in the field of sport sciences in the Baltic countries.

Within the framework of BSSS a new scientific journal, Baltic Journal of Sports and Health Sciences, has been launched. The first issue of the journal will be published in 2014 before the 7th BSSS conference. The publisher is LSU (Kaunas) with partners from Tartu (UT), Riga (LASE) and Vilnius (LUES). The new journal aims to improve and strengthen sport sciences and associated fields (educational, behavioural and health sciences) in the Baltic countries, and, possibly in the larger regions, as well as to promote better cooperation among sports universities in the Baltic countries.

Mati Pääsuke

Vice-President of Baltic Sport Science Society

PRINCIPAL FACTORS DEFINING SUCCESS OF TECHNICAL-TACTICAL ACTIONS OF ELITE FOOTBALL TEAM

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ABSTRACT

Research background and hypothesis. Factor analysis method enables to reveal the complex of dominating indicators determining the competitive result, as well as to define extend of interrelation between indicators and establish the role of individual factors important in the achievement of sports result.

The aim of this study was to reveal manifestations of factors of technical-tactical actions determining success of football teams taking part in the country's championship.

Research methods. The study participants were 24 football players from elite level "Aktobe" team, playing in Kazakhstan Premier League and the champion of Kazakhstan. The technical-tactical actions was analysed separately and compared during the first and the second rounds of the championship (11 games in each round).

Research results. The analysis of factor contribution into the structure of technical-tactical actions in the first and the second rounds of the country's championship showed that during the second round of the championship the volume of technical-tactical actions, indicating the possession of play initiative, decreased from 49.6 to 44.1% of total variance, but the contribution of technical-tactical actions, indicating completing of team's attacking actions, increased from 16.5 up to 24.8% of total variance. It enabled the team to score more goals in the second round of the championship.

Discussion and conclusions. Pursuant to the factor analysis, such indicators as "short and medium passes forward", "long passes", "interceptions", "hitting the goals" and "total number of technical-tactical actions" are dominating parts of the integral factor – "Possession of play initiative". Quantifying all the activities of individuals, group of players and of the entire team, which contributed to achievement of elite football teams, is essential in programming and managing the training process.

Keywords: football, game analysis, technical and tactical preparation.

INTRODUCTION

The structure of highly qualified athletes' training process is based on objectively existing rules having specific peculiarities for different sports (Платонов, 2004). The value of the data related to the game analysis can serve as feedback information for coaches when planning and programming training activities as to prepare for competitive performance of individuals or the team in football (Janković, Leontijević, 2008; Lago, 2009; Lago et al., 2010).

In K. Adambekov's (Адамбеков, 2007) and S. Tiulenkov's (Тюленьков, 2007) opinion, competition activity in sports games is characterized by vast variety, complexity and resourcefulness, but success depends on numerous factors and different aspects of athlete's preparation. The analysis of separate correlation coefficients does not provide complete understanding of the leading factors, defining control of football players' technical-tactical preparation at each training stage and, what is most important, of their quantitative significance in it. At the stage of the analysis of different sources, it is not possible to reply with certainty to the main question of the work considering the significance of

diagnostic indicators in their complex interaction, which can provide different results (Ali, 1988; Reilly et al., 2000).

Rational planning of a long-term training process is in many respects related to the exact definition of the structure of competition activity and athlete's preparation, which provide for successful sports results (Годик, 2009) as well as to defining of main factors limiting the results in different sports and establishing inter-dependence between these factors (Franks, McGarry, 1996).

Lately, specialists in various sports apply vastly the factor analysis method, which enables to reveal the complex of dominating indicators, determining the sports result, as well as to define the extend of interrelation between indicators and establish the role of individual factors affecting the sports result (Маслов, 2002; McGarry, 2005; Bjelica, 2008; Taylor et al., 2010). Thus, the essence of factor analysis is in distinguishing several main factors among a large number of interrelated indicators, which play the role of more fundamental variables, as they characterize the phenomenon (Carling et al., 2005). The factors themselves are important causes of the established correlations between the indicators. That is why the aim of the analysis was to define the factors on the basis of the study of correlation coefficients between different parameters and their correct interpretation (Reilly, Korkusuz, 2009).

In accordance with the algorithm of the main components method, reliability of the research results was achieved setting the condition that the rate of the selection of components with significant correlations between them was not less than 60% of total variance.

This circumstance enables us to select the main indicators among many others and accordingly correct the training program for athletes. This is particularly important when preparing elite football players, as the arsenal of technical preparation for them should be wide enough (Chartad, Cotte, 2011; Шамардин, 2012; Gražulis, Kareiva, 2013).

The aim of this study was to reveal the factors of technical-tactical actions of hifgh-performance football team during the country's championship.

The aim of this study was to reveal manifestations the factors of technical-tactical actions determining success of football teams taking part in a country's championship.

RESEARCH METHODS

The participants of this study were 24 football players from high-performance "Aktobe" team, taking part in Kazakhstan Premier League and the champion of Kazakhstan. The assessment and analysis of the results obtained during the study was divided in two parts, i.e. during the first round of the country's championship and during the second round of the championship. At each round the team played 11 games with Premier League teams of the country. The total of 22 games was taken for the analysis.

The following indicators of technical-tactical actions were registered during each game: 1) short and medium passes forward; 2) short and medium passes backwards; 3) headings; 4) long passes; 5) ball control; 6) dribbling; 7) ball interception; 8) winning the ball; 9) hitting the goals; 10) the total number of technical-tactical actions.

The method of mathematical statistics was used for the calculation of arithmetical mean values (X), their standard deviation (S) and the error of average values (Xs). Correlation analysis of the received data was performed using the method of Pearson's rectilinear dependence.

For the detection of the complex of dominating indicators during the game, as well as for the evaluation of the influence of each of them for sports results, the factor analysis of the data was carried out. Three factors F1, F2, F3 were distinguished from the data matrix according to their significance. The indicators of F1 included the actions demonstrating the possession of play initiative; F2 – completing the team's attacking actions; F3 – winning the ball for the development of the attacking actions of the team. Contribution of each factor was normalized, i. e. evaluated in percentage from the total variance.

RESEARCH RESULTS

The results obtained during the study are presented in Tables 1 and 2 and Figure 1. Figures in tables marked bold were significant correlations and in our study were assessed as strong correlations.

The results of the performed factor analysis of technical-tactical preparation of football players during the first round of the championship are presented in Table 1, in which the structure of indicators is defined by three factors and the total

selection variance is 79.9%. The first and the most significant factor with a high factor loading which contributed to the total variance of 49.6%, consisted of 5 indicators: short and medium passes forward, long passes, ball interception, hitting the goals and the total number of technical-tactical actions. This factor was named as "possession of play initiative".

The second factor with the total contribution into the selection variance of 16.5% with the highest factor loading included the indicator of hitting the goals (r = –0.819). Medium loading in the second factor was characteristic of short and medium passes across and backwards, and ball control (r = 0.557 and 0.561 accordingly). This factor was named as "completing the team's attacking actions".

The third factor accounted for 13.8% of total selection variance and the highest loading was laid upon winning of the ball (r = –0.707), short and medium passes across and backwards (r = –0.553), and dribbling (r = 0.543) was characterised by a medium loading. The above mentioned factors enable us to consider them as creating conditions for winning of the ball in order to develop the team's attacking actions.

As the result of the performed factor analysis of technical-tactical actions in the second round of the championship, three factors were also selected with their contribution into the total selection variance of 81.6% (Table 2).

The first and the most significant factor included the indicators of short and medium passes forward, long passes, interception, hitting the goals, which accounted for 44.1% of the total number of technical-tactical actions with factor loadings from r = –0.769 to –0.917.

The second factor (24.8%) included short and medium passes across and backwards (r = –0.802),

Table 1. **Factor structure of technical-tactical actions during the first round of the country's championship**

No.	Indicators	Factors		
		F1	F2	F3
1	Short and medium passes forward	**–0.915**	0.016	0.204
2	Short and medium passes across and backwards	–0.487	0.557	–0.553
3	Long passes	**–0.816**	0.206	0.185
4	Headings	–0.474	–0.298	–0.336
5	Ball control	–0.575	0.661	0.189
6	Dribbling	–0.343	–0.117	0.543
7	Ball interception	**–0.882**	–0.117	0.208
8	Winning of the ball	–0.452	0.068	**–0.707**
9	Hitting the goals	**–0.860**	**–0.819**	–0.056
10	Total number of technical-tactical actions	**–0.987**	0.097	0.057
	Total contribution into selection variance, %	49.6	16.5	13.8

Table 2. **Factor structure of technical-tactical actions during the second round of country's championship**

No.	Indicators	Factors		
		F1	F2	F3
1	Short and medium passes forward	**–0.769**	–0.514	0.082
2	Short and medium passes across and backwards	0.270	**–0.802**	–0.079
3	Long passes	**–0.804**	–0.411	–0.016
4	Headings	–0.483	0.096	0.012
5	Ball control	0.419	**–0.753**	0.246
6	Dribbling	0.625	–0.469	0.254
7	Ball interception	**–0.863**	–0.043	–0.300
8	Winning of the ball	–0.152	0.141	**0.943**
9	Hitting the goals	**–0.917**	0.551	0.369
10	Total number of technical–tactical actions	**–0.825**	–0.529	0.140
	Total contribution into selection variance, %	44.1	24.8	12.7

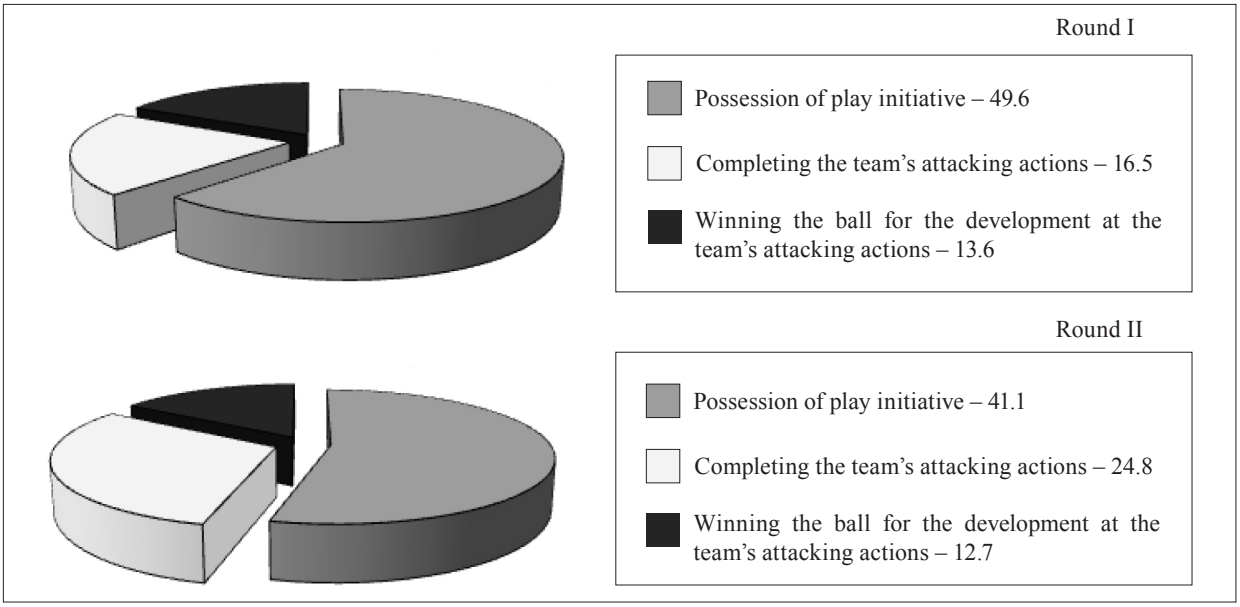

Figure. **Important indices of competitive performance**

ball control (r = –0.753), hitting the goals (r = 0.551) and the total number of technical-tactical actions (r = –0.529). The third factor (12.7%) factor loading was higher than other indicators of the selection, which was shown only by the "winning of the ball" indicator (r = 0.943).

Figure presents the important indices of competitive performance during the first and the second rounds of the championship. The results obtained during such analysis showed a significant increase ($p < 0.05$) of completing of the team's attacking actions during the second round of the championship. Factor analysis showed that during the second round of the championship the volume of technical-tactical actions, indicating possession of play initiative, decreased from 49.6 to 44.1% of total variance, but the contribution of technical-tactical actions, indicating the completion of the team's attacking actions, increased from 16.5 up to 24.8% of total variance. It enabled the team to score more goals in the second round of the championship.

DISCUSSION

This paper focused attention on the observation of successfully organized attacks which resulted in tactical resource of shot on goal, as well as characteristics of the game with the application of passes, ball possession and the structure of passes. For the purposes of this paper, we analysed the data which directly affected the result of the game as well as the attacking activities of the participating teams. According to the authors quoted herein, one of the selection methods for discriminator signs of technical-tactical preparation indicators is the definition of leading game actions, providing for success of each player in particular and the team in general (Bangsbo et al., 2006; Taylor et al., 2010).

Pursuant to the factor analysis (presented in Tables 1 and 2), such indicators as "short and medium passes forward", "long passes", "interceptions", "hitting the goals" and "total number of technical-tactical actions" are dominating in the formation of the integral factor – "Possession of play initiative". Analogical data were received in the studies of others (Janković, Leontijević, 2008; Lago, 2009; Cărăbas, 2013).

Variation of values of "short and medium passes across and backwards" and "ball control" indicators is explained by the fact that technical-tactical means of the game, in case the team possesses the play initiative, are not significant and their influence is stipulated by the peculiarities of annual training cycle structure (Milanovič et al., 2011).

The value of the third factor (F3) – winning the ball for the development of the team's attacking actions in both stages of the research varied insignificantly (Figure). Factor loading of "winning the ball" in the first stage was r = 0.707, in the second stage r = 0.943. It is worth mentioning that more high correlations were registered in the second round of the championship. Thus, there were 7 high correlations in the first micro-cycle, and 8 – in the second one. Consequently, we

suggest that the dynamics of correlations and their integration into factors defining the game were quite stable during the competition season, and this circumstance was one of the components for the team's successful performance in the country's championship, enabling it to participate in the tournaments of UEFA Cup.

The study of the characteristics of correlations between the components of technical-tactical preparation structure and the selection of the most significant factors in the data matrix defining success in the game enabled to improve football players' preparation and correct the training process, which became the basis of technical-tactical preparation in the annual training cycle of high-performance football teams players.

Modern football requires players with high percentage of correct passes, especially in the manoeuvring space and under the pressure of the opponents (Janković, Leontijević, 2008; Lago, 2009; Lago et al., 2010). Cooperation among players and the efficacy of attacking tactics of the team represents essential information of the playing efficiency in the field. The value of the data related to the game analysis, regardless of their significance, can serve as feedback information for coaches. Such information is useful when planning and programming training activities, but not as the only source of information of competitive performance of individuals or the team in football.

CONCLUSIONS

1. In the second round of the country's championship the level of the indicators of "possession of play initiative" technical-tactical actions decreased, but at the same time the contribution of the indicators of "completing the team's attacking actions" increased and this circumstance contributed to more effectiveness of attacking actions – to more scored goals.

2. Quantifying all the activities of individuals, group of players and the entire team, which contributed to the achievement of elite football teams, is essential in programming and managing the training process.

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DESIGN CHARACTERISTICS OF THE SHORT VERSION EI-DARL-V1 OF ORIGINAL EMOTIONAL INTELLIGENCE MEASUREMENT TECHNIQUE

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ABSTRACT

Research background and hypothesis. In the absence of unanimous definition of emotional intelligence (EI), it is reasonable to integrate various concepts of this construct when constructing the new original EI research methodology. Therefore, a decision was made to provide the tasks in various ways, i. e. not only in the form of items, but also providing face mimic identification and emotional-social and interpersonal situation solution assignments, which would cover a larger part of the research phenomenon.

Research aim was to present the short version of the created EI measurement technique – EI-DARL-V1 – based on the best practices of foreign scientists by identifying the problems of the construction methodology and providing psychometric characteristics.

Research methods. While constructing EI measurement technique, the two following blocks of tasks were prepared: 1) the block of tasks that defines EI as a personality trait; 2) the block of tasks that define EI as a cognitive (ability) characteristic. 119 items were generated for the version EI-DARL-V1. The study data were collected in 2012–2013 from 1430 subjects (experimental group consisted of 1400 subjects and control-contrast (i. e. older age) group consisted of 30 subjects) in different regions in Lithuania. Subjects' age of the main (experimental) sample was 19.7 years (SD = 3.29).

Research results. The created EI measurement technique EI–DARL has two forms – the short (EI-DARL-V1) and the long (EI-DARL-V2) ones. The short version, presented in this article, consists of five scales ("Understanding your emotions", "Your emotional control", "Understanding emotions of the other person", "Control of other emotions", "Manipulations"), a 73-item questionnaire, where subjects reveal their degree of agreement with the items.

Discussion and conclusions. The psychometric quality characteristics of the measurement technique subscales meet the requirements: Cronbach's alpha coefficient values fluctuate from 0.73 to 0.89; the average inter-correlation among the measurement technique items is from 0.29 to 0.49; i/tt (resolution) indicators often exceed 0.5; the instrument has only those items, the factorial loadings exceed 0.3; factor's overall explained dispersion ranges from 22 to 46%; KMO values range from 0.88 to 0.94. EI-DARL-V1 validity and reliability conditions are met.

Keywords: emotional intelligence, psychometrics, validity, reliability.

INTRODUCTION

Emotional intelligence (EI) measurement is a manifold topic. Firstly, the sceptical attitude towards EI measurement possibilities in the academic community is strengthened by the fact that there is no common agreement on how the EI construct should be determined. Secondly, EI is a latent construct which cannot be observed directly, thus the methodology validity issue becomes really acute. Thirdly, in general there is a fairly sceptical view of the accuracy of the psychometric and statistical methods, their declared capabilities (Brody, 2004). Fourthly, authors themselves make significant mistakes when constructing methodology (Schmidt, Hunter, 1999; Hunsley, Meyer, 2003;

Borsboom, 2005). This list of problems could be extended even more (detailed analysis of the issue is presented in the article of R. Lekavičienė and D. Antinienė called "Emotional intelligence: measurement problems and opportunities", 2013). On the other hand, it is generally recognised that the key to personal satisfaction with life is the understanding of your own and others' emotions, their management. And on the contrary – emotional illiteracy makes the personality stumble along the way, experience frustration, misunderstandings, twitching relationships. Scientific understanding of EI, the development of measurement methodologies would let to create training programs for emotional skills, which would help to make life more full and productive (Sternberg, Grigorenko, 2007; Schutte, Malouff, 2012). It is this scientific problem that influenced the authors to contribute to the challenges of taking up a challenging task – the original EI measurement methodology development.

The purpose of this article was to introduce the short version EI-DARL-V1 of the original EI measurement technique by revealing its design process. *Objectives:* 1) introduce the construction logics and the structural parts of the measurement technique; 2) to provide psychometric statistics of this measurement technique.

RESEARCH METHODS

Methodology. Two task blocks were prepared while constructing the measurement technique: 1) EI is treated as a personality trait; 2) EI is defined as a cognitive (ability) characteristic. The methodological problems of the development of the first block and psychometric characteristics will be discussed in the result section.

Subjects. EI research respondents were selected to a sample by quota sampling method, while maintaining the natural proportions of the general population in Lithuania. In total 1430 subjects were questioned, 1400 of which were young people, living in various Lithuanian regions, studying, employed, unemployed and even sentenced in prison; 30 subjects were assigned to control-contrast group, their age ranging from 28 to 51 years. The study covered the geography of Vilnius, Kaunas, Klaipėda, Šiauliai, Telšiai, Panevėžys, Utena, Marijampolė, Kaišiadorys, Alytus. The age of the main sample (n = 1400) subjects was from 17 to 27 years (M = 19.7, SD = 3.29). The study included 43.8% of men and 56.2% of women. The largest part of the measurement technique subjects were pupils (56.7%) and students (35.2%), the remaining part of subjects consisted of employed, un-employed and engaged in other activities. To sum up the characteristics of the study sample, it can be stated that according to the nature of the study (non-experimental correlation study) and a variety of outlets, the sample size and the compliance of the socio-demographic characteristics with the statistical indicators of population, the sample can be seen as relatively presentable and satisfying the requirements of the study.

Stages of the study. *In the first stage,* a pilot test on 30 subjects was conducted. Some statements had been revised in order to avoid ambiguity in understanding. *In the second stage,* graphically attractive form of a comprehensive three-part EI questionnaire and the test of *Social Competence* were prepared. *In the third stage,* a study, which included 1430 subjects, was carried out. The data were collected in 2012 fall – 2013 spring. *In the fourth stage,* five–six weeks later, a re-test with 50 subjects was conducted. *In the fifth stage,* a statistical processing of the part of the data obtained was performed (2013 autumn).

Methods of mathematical statistics. Data analysis was conducted using SPSS 17.0 statistical package for data processing. We applied descriptive and mathematical statistics methods – a multi-factor analysis was conducted by using the VARIMAX orthogonal rotation, Cronbach's alpha coefficients were calculated, ANOVA analysis was used, Spearman's and Pearson's correlation coefficients were calculated, Wilcoxon signed rank test, split-half method and others were used.

RESEARCH RESULTS

The prepared measurement technique has **two versions –** the short (EI-DARL-V1) and the long (EI–DARL–V2). This article will introduce the short version of EI-DARL-V1. It consists of a traditional questionnaire, where the subjects reveal their degree of consent with the items (evaluations were performed on a six-point Likert scale). During the time of the measurement technique development (in the initial version) it was hypothetically aimed at a five scale measurement technique: the perception of one's own emotions, perception of others' emotions, management/control of one's own emotions and behaviour, management/control of interpersonal relations. The aforesaid scales reflected the fundamental, from the researchers' point of view, dimensions of the emotional

intelligence. These scales were complemented by a hypothetical fifth – manipulation – scale. The items of the manipulation scale were designed to grope the person's ability to control the behaviour of people around them by using their emotions, discovering their weaknesses. The scale scores of manipulative behaviour that reflected a person's ability to control the other person's feelings provided an opportunity to see a more detailed psychological portrait of the subject. As many as 119 items were generated in the original version.

By using the original factorial validation (n = 1430), the items which subverted the factor analysis model were eliminated. The remaining 73 items were compacted into nine sub-scales named in the following working titles: 1) "Causal understanding of your own emotions" (*Sometimes I feel very sad, but I do not know why (–))*; 2) "Understanding of your own emotions" (*Usually I have a good understanding of why I am experiencing specific feelings);* 3) "Transforming your negative emotions into positive" (*I know very well what to do to brighten up my mood);* 4) "Self-control/Suppressed expression of emotions" (*I am good at controlling myself even when it seems that the patience is lost);* 5) "The control of your negative emotions" (*I am good at controlling myself even when it seems that the patience is lost)*; 6) "Perception of other's emotion" (*I always recognise my friends' emotions based on their behaviour)*; 7) "Regulation of other's emotion" (*I know how to encourage a person who is in a difficult situation*); 8) "Selfish influence on others' emotions or behaviour" (*I am capable of finding a sensitive chord in a person and using that*); 9) "The ability to cause other people's negative emotions" (*If necessary, I would know how to make fun of other people knowing that it would hurt badly).*

Psychometric quality characteristics of the EI diagnostic conduct have been calculated: 1) Cronbach's alpha coefficient value fluctuates from 0.73 to fairly high values, i. e. 0.89; 2) the average correlation among the items of the measurement technique is from 0.29 to 0.49; 3) i/tt – resolution rates – often exceed 0.5, which indicates that the items of measurement technique pretty accurately differentiate the subjects according to certain properties; 4) L – factorial loadings: the instrument is left with only those items, whose factorial loadings exceed 0.3; 5) factor's overall explained dispersion fluctuates from 22 to 46%; 6) KMO values range from 0.88 to 0.94. In conclusion, the psychometric quality of the measurement technique is sufficient.

The aforesaid sub–scales were multiplexed into five wider scales by using secondary factor analysis: "The causal understanding of emotions" and "Emotion perception" sub–scales into the scale of "Emotion perception"; "Transforming your negative emotions into positive", "Self-control/ Suppressed expression of emotions" and "The control of your negative emotions" into the scale of "The control of your emotions"; "Selfish influence on others' emotions or behaviour" and "The ability to cause other people's negative emotions" into the scale of "Manipulation". The remaining two scales "Perception of other's emotion" and "Regulation of other's emotion" remained the same as they were obtained in the initial factor analysis.

In order to determine the psychometric appropriateness of the EI measurement technique, the internal consistency of the total scale and other parameters of EI-DARL-V1 measurement technique were checked. The obtained data is shown in the Table 1.

Table 1. **The internal consistency of the EI-DARL-V1 measurement technique scales**

Scale name	Cronbach's α	i/tt	Average inter–correlation among items	Minimum inter–correlation among items	Maximum inter–correlation among items
"The understanding of your own emotions"	0.87	0.40	0.35	0.16	0.60
"The control of your own emotions"	0.91	0.36	0.27	0.06	0.53
"The understanding of other emotions"	0.89	0.54	0.36	0.23	0.53
"The control of other emotions"	0.84	0.40	0.32	0.11	0.57
"Manipulations"	0.89	0.13	0.40	0.25	0.59

In order to get a clearer and more defined structure of the EI characteristics, a tertiary factor analysis was performed with scale scores. The data of the analysis allows us to speak about the three–dimensional structure of emotional intelligence: The understanding and control of your own emotions (overall explained dispersion 35.7%), The understanding and control of other emotions (20.6%) and Manipulation factors (19.0%) were distinguished. The entire three–factor model explains 75.3% of the sampled features scatter, KMO index reaches 0.73. Thus, the relevance of data of the factor analysis is sufficient. Dispersion, explained by individual factors is not high, but it is tolerable in psychometric studies. The factor weights obtained in the model are high, $0.71 \leq r \leq 0.92$, suggesting that the created categories are relevant since they meet the construct validity methodological norm, which is generally acceptable in the diagnostic research. The variables, segregated in each of the three factors, are easy to interpret, thus it can be stated, that the model is statistically significant and theoretically valid.

Criteria validity of EI-DARL-V1 was checked on the ground of *Social Competence Test* adapted by R. Lekavičienė (Lekavičienė, 2001; Lekavičienė, Antinienė, 2013). Subjects of EI research also had to evaluate the questions of the latter test. Analysis of variance (ANOVA) was selected for the verification. After selecting a significance level $\alpha = 0.01$, $p \leq 0.001$ was obtained, so the null hypothesis was rejected, in other words, not all means are equal. So the scores obtained by EI–DARL and *Social Competence Test* are related. The connections between the EI-DARL-V1 and the scales of *Social Competence Test* were checked. The correlation data are shown in Table 2.

As Table 2 shows, the combined emotional intelligence scale is significantly positively correlated with all of the joint social competence scale.

To evaluate the reliability of the measurement technique, the re-test method was used. Due to this reason, two EI measurements were performed five–six weeks later in order to see how the respondents recognize the contents of the questions and if their answers remain unchanged during the period. The results of the first and second testing procedures were compared by using the Wilcoxon signed rank test. Hypotheses about the compatibility of the two measures were formed, i. e. if the statistical significance level $p \leq 0.05$, then the hypothesis about the compatibility of the two measurements is rejected and the item of the difference between the two measurements is approved. By using the Wilcoxon signed rank test, it was found that neither

Table 2. **Correlations (Spearman's correlation coefficient) between the EI-DARL-V1 and Social Competence Test scales**

	THE SUB–SCALES OF THE EMOTIONAL INTELLIGENCE					
SOCIAL COMPETENCE TEST SUBSCALES	**1. "Emotion perception"**	**2. "Emotion regulation"**	**3. "Perception of other's emotion"**	**4. "Regulation of other's emotion"**	**5. "Manipu-lations"**	**6. Joint "Emotional intelligence" scale**
1. "The general self-confidence"	0.47 ***	0.44 ***	0.39 ***	0.38 ***	0.28 ***	**0.59** ***
2. "Resistance to failures and critics"	0.42 ***	0.43 ***	0.19 ***	0.24 ***	0.09	**0.47** ***
3. "The ability to express feelings"	0.22 ***	0.23 ***	0.31 ***	0.44 ***	0.12 *	**0.32** ***
4. "The ability to ask for a favour"	0.39 ***	0.32 ***	0.24 ***	0.32 ***	0.05	**0.38** ***
5. "Noncompliance"	0.15 *	–0.12 **	0.22 ***	0.15 **	0.28 ***	**0.15** *
6. "The ability to demand"	0.17 **	0.17 *	0.16 **	0.09	0.16 ***	**0.22** ***
7. "Not feeling guilt"	0.28 ***	0.22 ***	0.02	–0.08	0.06	**0.26** ***
8. Joint "Social competence" scale	0.40 ***	0.35 ***	0.29 ***	0.31 ***	0.23 ***	**0.46** ***

Note. – negatively correlated; – positively correlated; – not related (checked with statistical criteria).

* – $p \leq 0.05$; ** – $p \leq 0.01$; *** – $p \leq 0.001$.

the overall evaluation of the first test or the re-test, nor the evaluations of both measures by separate scales satisfy the $p \leq 0.05$ condition, suggesting that there are no statistically significant differences between the measures. After conducting the re-test, the results showed sufficient reliability of the methodology and the stability of the indicators: the obtained Spearman's correlation coefficients: $r = 0.79$ of the joint EI-DARL-V1 test, $r = 0.61$ of "Emotion perception", $r = 0.58$ of "The understanding and control of other emotions" and $r = 0.56$ of "Manipulations", $p \leq 0.05$ in all the cases. When assessing the reliability of the measurement technique using yet another – split-half method, the Spearman – Brown coefficient value for the whole measurement technique is high – 0.88.

DISCUSSION

A. Maul (2009) points out that despite the fairly long development of the EI theory, EI test validity and reliability issues remain ambiguous, i. e. the construction of the EI research instruments requires various methods to check these characteristics. According to M. Tavakol and R. Dennick (2011), reliability is closely related to validity. An instrument cannot be valid if it is not reliable. However, instrument reliability does not depend on validity. Thus, reliability is a necessary but not sufficient condition for validity; in addition, criterion-related validity research of the methodology can take plane only when the factorial validity of the methodology is proven (Gignac, 2009). The extraordinary importance of the factorization procedure was stressed by J. C. Nunnally (1978, pp. 112–113) stating that "... factor analysis is intimately involved with questions of validity; factor analysis is at the heart of the measurement of psychological constructs". Factor validity helps to answer the question "What does this test really measure?", and not "Does this test measure what it is supposed to measure?" (Gignac, 2009). Measuring factor reliability is very important to the EI research, since various EI models require narrower dimensions, such as perception of emotions, control of emotions, etc. Factor validity helps the researcher to determine which statements should be used to determine each scale. Thus, factor analysis on principle evaluates if the test is valid in a constructive sense. The inspection of the construct validity is especially important when it comes to such mental construct studies, which are characterized by theoretical concepts, in this case – EI. The authors of the measurement technique EI-DARL-V1 managed to create sufficiently high factorial loadings methodology ($0.71 \leq r \leq 0.92$), suggesting that the created categories are appropriate, the theoretical construct of EI is measured with sufficient precision and satisfies the construct validity methodological norm. However, it must be recognized that the authors sometimes manage to achieve even higher estimates, for example, the factorial weights of the EI measurement methodology MSCEIT, well-known in the academic environment, are $0.96 \leq r \leq 0.98$ (Brackett, Mayer, 2003).

When the test is constructed in factorial principle, it is requested to check the *criterion validity* (Зеличенко, Шмелев, 1987). In this case, EI-DARL-V1 *criterion concurrent validity* was tested by choosing the results independent from the measurement technique, but related with the studied phenomenon – the *Social Competence Test* scales estimates as the validation criteria. As shown in the previous section, the constructed scale of the joint measurement technique is statistically significantly positively correlated with all the joint scale of the social competence. It is logical and theoretically significant that there is no statistical correlation between the understanding and control of other people's emotions and guilt. At the same time, there was no correlation detected between the "Manipulations" scale and the three social competence scales: "Resistance to failures and critics", "The ability to ask for a favour" and "Not feeling guilt". Negative statistical relationship was only found between the EI "Control of your own emotions" scale and the social competence "Noncompliance" scale.

As for the reliability of the measurement techniques (tests), the analysis of various sources has shown that the most recommended minimal test internal consistency estimate is 0.70 (Peterson, 1994). The values presented in this study fluctuate from 0.73 to 0.89, so it can be stated that the measurement technique items correlate with each other sufficiently. Actually, similar estimates of these measurements are indicated by authors of other EI methods (e. g. internal consistency of the test TEIQue–ASF prepared by K. V. Petrides, Y. Sangareau, A. Furnham, N. Frederickson (2006) is 0.80). Some authors point out that the very high alpha coefficient (tending to 1.00) should not be the aim because it does not always

mean a high degree of internal consistency. This is due to the fact that the coefficient is influenced by the length of the test. In other words, this means that in this case there are excess items which test the same question. Alpha value decreases when the test is shortened. M. Tavakol and R. Dennick (2011) recommended an alpha maximum of 0.90, the limit which EI-DARL-V1 did not exceed. If the problem is opposite – you want to increase the coefficient – more items, testing the same concept, have to be added. It is important to mention that every time an empirical study is carried out, it should not rely on the Cronbach's alpha of specific methods published by authors, i. e. reliability should not be seen as a permanent feature of a test. Reliability should be interpreted as a feature of scores obtained during the testing; that is why it is recommended to measure the alpha in every case when the test is being administrated, since the value of the alpha varies depending on the testing conditions (Gignac, 2009; Tavakol, Dennick, 2011). Since the internal consistent reliability and retest reliability are not related to each other (Gignac, 2009), test-retest reliability of EI-DARL-V1 was checked; the results showed the sufficient reliability of the measurement technique and the stability of characteristics (see Results section). Some authors manage to get even higher retest estimates for the developed methodologies: the test-retest reliability of the full-test MSCEIT over a three-week interval was r = 0.86 (Brackett, Mayer, 2003). When assessing the test in yet another – split-half – method, the value of the Spearman – Brown coefficient for the entire test is high – 0.88. By the way, this method only reaffirms the reliability of the test, even though it was tested on principle in analogous way – by estimating the Cronbach's alpha, which represents the average reliability of all possible split-halves (Cronbach, 1951). Other authors also get similar estimates by testing their created tests by using the split-half method (e. g. MSCEIT estimate is 0.93 (Brackett, Mayer, 2003)).

CONCLUSIONS AND PERSPECTIVES

1. In the absence of unanimous definition of EI while constructing the new original EI research methodology, it is reasonable, based on the best practices of foreign scientists, to integrate both major prevailing conceptions – treating the EI as both a personality trait and ability.

The created EI measurement technique EI–DARL has two forms – the short form (EI-DARL-V1) and the long form (EI–DARL–V2). The short version presented in this article consists of five scales ("Emotion perception", "Emotion regulation", "Perception of other's emotion", "Regulation of other's emotion" and "Manipulations"); it is a 73-item questionnaire, where the subjects reveal their degree of agreement with the items. The long version was supplemented by the scale of identification of nonverbal facial expressions and the scale of emotional, social and interpersonal situations.

2. The psychometric quality characteristics of the measurement technique meet the requirements: Cronbach's alpha coefficient values fluctuate from 0.73 to 0.89; the average inter–correlation among items is from 0.29 to 0.49; i/tt (resolution) indicators often exceed 0.5; the instrument has only those items, the factor weights of which exceed 0.3; factor's general explained dispersion ranges from 22% to 46%; KMO values range from 0.88 to 0.94. EI-DARL-V1 validity and reliability conditions are met.

It would be promising to explore more in detail the validity of the measurement technique EI-DARL-V1. For example, should the empathy scale be incorporated into the technology? It is not an easy question since there is no unanimous definition of EI, therefore further theoretical and empirical research of EI construct are needed.

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NUTRITION STATUS OF HIGH PERFORMANCE ROWERS, CANOEISTS AND KAYAKERS

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ABSTRACT

Research background and hypothesis. Rowing and canoeing-kayaking are some of the leading sports in Lithuania, and athletes have achieved victories in European and world championships. In order to effectively manage the preparation of Lithuanian elite rowers, canoeists and kayakers, research in their nutrition status is important, relevant and necessary. Hypothesis: dietary intake of rowers and canoeists-kayakers comply with nutrition requirements.

Research aim was to assess nutrition status, physical development and the interactions between them for Lithuanian Olympic team rowers, canoeists and kayakers.

Research methods. Research on the nutrition status and supplementation was carried out in the preparatory competition period in 2012. The sample included 18.2 ± 2.3-year-old rowers (n = 24) and 21.5 ± 5.2-year-old canoeists-kayakers (n = 12). Body composition analysis and physical development of athletes was performed using multi-frequency bioelectrical impedance analysis (BIA) method.

Research results. Regardless of gender, MFMI of kayakers-canoeists and rowers was only average. Athletes' dietary energy intake (EI) does not fully cover the energy expenditure, the diet lacks carbohydrates, dietary fibres, omega-3 fatty acids, vitamin D, and there is too much fat, saturated fatty acids and cholesterol. 92% of athletes take supplements. Most often athletes' dietary supplementation includes carbohydrates (73.9%), amino acids (73.9%), minerals (73.9%), vitamins (65.2%), and multivitamins (65.2%).

Discussion and conclusions. Nutrition status and physical development of Lithuanian elite kayakers-canoeists and rowers does not meet the requirements of nutrition. Diets of high performance kayakers-canoeists and rowers must be optimized, adjusted and individualized.

Keywords: rowers, canoeists and kayakers, high sports performance, athlete nutrition.

INTRODUCTION

Proper and balanced diet leads to athletes' improved health and physical working capacity indicators, helps to reduce violations of the body resulting from the intense and long-lasting physical loads. Sports nutrition characteristics depend on the physical load, workout mode leading to completely different needs of athlete's body for nutrients compared to the population of non-athletes. Rowing sport in Lithuania has very deep and long-standing traditions; rowers have achieved major victories. Today rowing is one of the leading Lithuanian sports and athletes in this sport win awards at European and world championships, so it is very

important to improve planning and management of the preparation of elite rowers as well as highlight not only the main features of rowers who have close links with the main sports results of the covered distance, but also their nutrition characteristics. In other countries and in Lithuania nutrition of elite rowers, canoeists and kayakers has not been much researched. In order to effectively manage the preparation of Lithuanian elite rowers, canoeists and kayakers, research in their nutrition status is important, relevant and necessary. The **aim of the present research** was to assess nutrition status, physical development and the interactions between them for Lithuanian Olympic team rowers, canoeists and kayakers.

RESEARCH METHODS

Participants. Research on the nutrition status was carried out in the preparatory competition period in 2012. The sample included 18.2 ± 2.3-year-old rowers (n = 24) and 21.5 ± 5.2-year-old canoeists-kayakers (n = 12). The subjects trained six times a week, 175.3 ± 45.9 min a day. Their sports experience was 7.1 ± 4.1 years. They were athletes included in the approved lists of perspective candidates for the Lithuanian Olympic team, preparing for the Olympic Games (Table 1).

Anthropometric measures. Athletes' height was measured applying electronic scales at the Lithuanian Sport Medicine Centre. Body composition analysis of athletes was performed at the Lithuanian Olympic Sports Centre using Body Composition Analyser X-SCAN using multi-frequency bioelectrical impedance analysis (BIA) method (*American College of Sports Medicine*, 2009) applied in research with athletes. We also established athletes' body weight (BW) (kg), fat-free mass (FFM) (kg and %), protein mass (PM) (kg and %), body minerals (M) (kg and %) and body fat (BF) (kg and %), as well as body mass index (BMI) (*The World Health Report*, 2002) and muscle and fat mass index (MFMI) (Skernevičius et al., 2004).

Physical activity level. To estimate total energy expenditure and basal metabolic rate we used Harris-Benedict equation (Haris, Benedict, 1919). To estimate exercise energy expenditure we used metabolic equivalents records over a 24-hour period (Ainsworth et al., 2011). 24-hour records of physical activity were collected on the same day participants recorded their dietary intakes to estimate physical activity level during a period of active training.

Dietary intake. Nutrition status of athletes in the Lithuanian Olympic Team was assessed using the food recall method. Respondents were interviewed by a trained interviewer in the course of direct interviews at the Lithuanian Olympic Sports Centre. We recorded the data for each athlete's consumed food and dishes. Dietary recall was investigated using special Atlas of Foodstuffs and Dishes Sizes where portions of different foods and meals evaluated in grams were presented in order to record all consumed food and dishes as well as their amounts. In addition, food supplements (carbohydrates, amino acids, vitamins, minerals, multivitamin, omega-FA (fatty acids), L-carnitine, herbal, caffeine, creatine) as well as their usage peculiarities were assessed, but their chemical composition was not included in the chemical composition of the diet.

In accordance with the tables of food composition, we calculated the chemical composition of athletes' diet (Sučilienė, Abaravičius, 2002). We estimated athletes' carbohydrate, protein, dietary fat, phosphorus, calcium, potassium and magnesium intakes. Macronutrient intake was assessed

Age and sports experience	Canoeists and kayakers (n = 12)	Rowers (n = 24)	Total (n = 36)
	Mean ± SD		
Sports experience, yr	5.7 ± 2.7	12.8 ± 0.4	7.1 ± 4.1
Workouts per week, no	5.8 ± 0.4	6.0	5.8 ± 0.4
Workouts per day, no	1.6 ± 0.5	1.8 ± 0.4	1.6 ± 0.5
Average training time per day, min	116.3 ± 23.8	104.0 ± 19.4	113.8 ± 23.2
Total training time per day, min	173.8 ± 42.4	178.3 ± 54.1	175.34 ± 45.9
Age, yr	18.2 ± 2.3	21.5 ± 5.2	19.1 ± 3.8

Table 1. **Age and sports experience of Lithuanian Olympic team canoeists, kayakers and rowers**

according to the recommendations provided in research literature (*American College of Sports Medicine*, 2009; Burke, 2010; Kreider et al., 2010). Compliance of micronutrient intake with RDI was assessed referring to recommended daily intake norms approved in Lithuania (*Rekomenduojamos paros maistinių medžiagų ir energijos normos*, 1999). As RDI of vitamins and minerals depends on age and gender, the uptake of these materials is given as a percentage of RDI (intake/RDI x 100).

Data analysis. Statistical data analysis was carried out using the SPSS (Statistical Package for Social Sciences) v. 15.0. Data analysis was performed using conventional methods of descriptive statistics: calculation of arithmetic means, standard deviations (SD). Student's t-test was used for the comparison of means between two independent groups of respondents. Categorical data analysis was performed using Fisher's exact test. The relationship between variables was assessed calculating statistical significance and Pearson's correlation coefficient. Hypothesis was verified using the level of significance of $\alpha = 0.05$. The significance level was set at $p < 0.05$.

RESEARCH RESULTS

Physical development. The analysis of the physical condition of the Lithuanian Olympic team rowers, canoeists and kayakers (Table 2) showed that BW, LBM, MM, FM, PM, M and MFMI of male and female athletes in different branches of sport did not differ. The only established difference was in athletes' BMI. Excessive BMI indicating overweight (25.8 ± 1.9 kg/m^2) was typical of male canoeists and kayakers. BMI of male rowers (23.9 ± 1.9 kg/m^2) was significantly lower than the one of male canoeists and kayakers ($p = 0.032$), and it was regarded as normal. Women athletes' BMI in both sports was within the normal range.

MFMI was assessed in order to objectively evaluate if the physical condition of the athletes met the requirements for high performance athletes. It was found that MFMI of male canoeists-kayakers and rowers, respectively equal to 4.3 ± 1.4 and 3.9 ± 1.0, did not differ ($p = 0.393$), and was regarded as average (average MFMI for men is 3.4–4.69). Meanwhile, MFMI of female athletes in kayak-canoe and rowing sport, respectively 2.9 ± 0.5 and

Table 2. **Anthropometric data of Lithuanian Olympic team canoeists, kayakers and rowers**

Anthropometric data	Canoeists and kayakers		Rowers		t-test[1/3]		t-test[2/4]	
	Male[1] (n = 7)	Female[2] (n = 5)	Male[3] (n = 21)	Female[4] (n = 3)				
	Mean ± SD				t	p	t	p
Height, cm	185.6 ± 6.0	169.1 ± 1.9	191.8 ± 6.1	176.8 ± 7.3	2.345	0.027	2.354	0.057
BW, kg	88.7 ± 7.8	65.0 ± 3.2	88.1 ± 8.8	71.4 ± 7.2	–0.189	0.852	1.779	0.126
LBM, kg	72.1 ± 5.7	49.0 ± 0.7	70.4 ± 5.0	54.6 ± 4.1	–0.734	0.470	2.365	0.138
LBM, %	81.4 ± 4.9	75.5 ± 3.2	80.0 ± 3.4	76.7 ± 4.0	–0.842	0.408	0.455	0.665
MM, kg	66.9 ± 5.4	45.2 ± 0.6	65.3 ± 4.5	50.4 ± 3.7	–0.782	0.441	2.492	0.132
MM, %	75.5 ± 4.9	69.7 ± 3.2	74.4 ± 3.6	70.9 ± 3.9	–0.643	0.526	0.463	0.66
FM, kg	16.7 ± 5.2	16.0 ± 2.9	17.7 ± 4.7	16.8 ± 4.3	0.457	0.652	0.319	0.760
FM, %	18.6 ± 4.9	24.5 ± 3.2	19.8 ± 3.6	23.3 ± 4.0	0.646	0.524	–0.455	0.665
PM, kg	15.0 ± 1.3	10.0 ± 0.1	14.6 ± 1.0	11.2 ± 0.8	–0.919	0.366	2.618	0.115
PM, %	17.0 ± 1.3	15.4 ± 0.9	16.6 ± 1.0	15.7 ± 1.1	–0.692	0.495	0.458	0.663
M, kg	5.1 ± 0.4	3.8 ± 0.2	5.1 ± 0.5	4.1 ± 0.4	–0.158	0.876	1.849	0.114
M, %	5.8 ± 0.1	5.8 ± 0.1	5.8 ± 0.1	5.8 ± 0.1	–0.168	0.868	0.457	0.663
BMI, kg/m^2	25.8 ± 1.9	22.7 ± 1.6	23.9 ± 1.9	22.8 ± 2.3	–2.264	0.032	0.473	0.947
MFMI	4.3 ± 1.4	2.9 ± 0.5	3.9 ± 1.0	3.1 ± 0.7	–0.869	0.393	0.492	0.640

Note. Values are expressed as mean ± SD; BW – Body Weight; LBM – Lean Body Mass; MM – Muscle Mass; FM – Fat Mass; PM – Protein Mass; M – Body Minerals; BMI – Body Mass Index; MFMI – Muscle and Fat Mass Index.
Significant differences set by independent samples Student's t-test among groups: [1]– Group 1, [2]– Group 2, [3]– Group 3, [4] – Group 4.

3.1 ± 0.7, did not differ (p = 0.640) and also was medium (average MFMI of women is 2.9–3.99).

Evaluation of athletes' fat mass revealed the differences by gender. Irrespective of the sports branch, women athletes' fat mass was seen as optimal, and for male athletes it was too big and seen as only acceptable (Table 2).

The evaluation of the relationship of BMI with the PM and the FM for male and female athletes showed that higher body mass of men and higher BMI were related to both higher muscle mass (r = 0.634, p < 0.001) and higher fat mass (r = 0.559, p = 0.002). Meanwhile, for women athletes the higher BMI had a strong connection to the fat mass (r = 0.961, p < 0.001), but there were no links with muscle mass (r = 0.131, p = 0.131) (Figure 1). It can be concluded that men athletes have a tendency to increase the total body mass at the expense of muscle and fat mass and their MFMI is below high levels only when they have excessive fat mass. Meanwhile, for women athletes, the average MFMI is determined by low muscle mass.

Dietary intake. The analysis of athletes' food rations showed that regardless of the branch of sport and gender, kayakers-canoeists and rowers do not cover their daily estimated energy expenditure with the food they eat (Table 3).

Table 4 gives the results of athletes' food recall. The evaluation of athletes' consumed macronutrient amounts revealed that fat intake exceeded the recommended norms (fat supply energy value ranged from 35 to 42%) among all the tested athletes. The analysis of the fat qualitative value of athletes' food rations showed that athletes

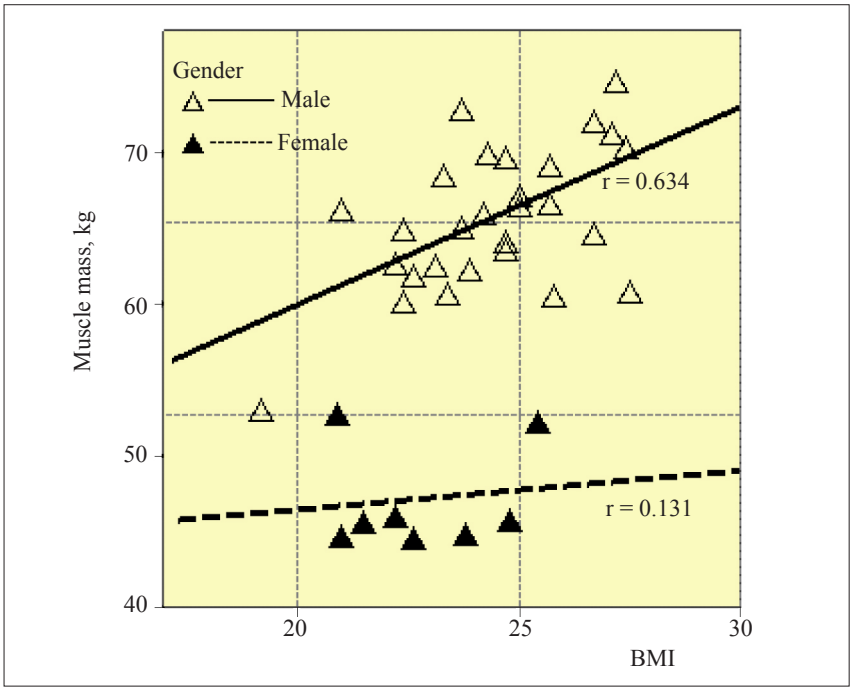


Figure 1. **Correlation of BMI with muscle mass (by gender)**

Note. BMI – Body Mass Index.

Daily energy intake vs. energy expenditure	Canoeists and kayakers		Rowers	
	Male (n = 7)	Female (n = 5)	Male (n = 21)	Female (n = 3)
	Mean ± SD			
EER, kcal	5473.2 ± 1005.6	3771.5 ± 422.0	5303.1 ± 638.6	4258.0 ± 338.9
EER, kcal BW	61.6 ± 9.1	58.0 ± 5.4	60.4 ± 6.5	59.8 ± 3.2
EI, kcal	3710.5 ± 680.2	2296.4 ± 132.9	3952.2 ± 945.7	2999.6 ± 605.6
EI, kcal/kg BW	42.0 ± 8.4	35.4 ± 3.1	45.2 ± 11.1	42.6 ± 10.9
% EER	68.7 ± 12.5	61.7 ± 10.4	75.5 ± 19.8	70.8 ± 14.9

Table 3. **Energy intake of Lithuanian Olympic team canoeists, kayakers and rowers**

Note. Values are expressed as mean ± SD; EI – Energy Intake; EER – Estimated Energy Requirement; BW – Body Weight; % EER – Ratio of EER and EEI.

Table 4. **Dietary intake of Lithuanian Olympic team canoeists, kayakers and rowers**

Nutrition profile	Canoeists and kayakers			Rowers		
	Male (n = 7)	Female (n = 5)	Recommended	Male (n = 21)	Female (n = 3)	Recommended
	Mean ± SD			Mean ± SD		
CHO, g/kg BW	4.0 ± 1.2	4.4 ± 0.5	7–10	4.6 ± 1.3	4.6 ± 0.8	7–10
CHO, %	38.6 ± 11.3	49.4 ± 2.4	> 55	40.9 ± 10.6	44.1 ± 5.7	55–70
Dietary fibre, g/1000 kcal	8.5 ± 2.3	8.7 ± 0.8	14	9.9 ± 3.3	8.6 ± 3.6	14
PRO, g/kg BW	2.0 ± 0.9	1.4 ± 0.1	1.6–1.8	1.6 ± 0.4	1.4 ± 0.2	1.4–1.6
EEA, mg BW	761.4 ± 373.2	513.8 ± 47.1	491–545	570.8 ± 165.1	505.9 ± 54.8	436–491
Val, mg BW	107.2 ± 48.6	75.1 ± 6.0	63–71	84.9 ± 24.5	74.2 ± 8.5	55–63
Leu, mg BW	159.0 ± 75.4	109.7 ± 11.3	95–106	120.0 ± 35.3	109.1 ± 12.5	83–95
Izoleu, mg BW	96.6 ± 48.2	63.4 ± 6.4	48–55	72.3 ± 20.8	62.6 ± 7.5	42–48
BCAA, mg	362.7 ± 172.2	248.3 ± 23.6	206–232	277.2 ± 80.3	246.0 ± 28.0	180–206
FAT, %	42.5 ± 13.3	34.6 ± 1.7	20–30	45.1 ± 10.2	42.3 ± 7.3	20–30
SFA, %	12.1 ± 4.1	12.0 ± 1.0	< 10 %	15.5 ± 4.9	12.9 ± 0.8	< 10%
PUFA, %	10.9 ± 5.5	6.9 ± 1.1	6–10 %	6.6 ± 2.7	6.4 ± 1.1	6–10%
Omega–3 FA, %	0.6 ± 0.4	0.3 ± 0.1	1–2 %	0.4 ± 0.1	0.4 ± 0.2	1–2%
Omega–6 FA, %	9.9 ± 5.2	6.3 ± 1.0	6–10 %	6.0 ± 2.5	5.7 ± 0.9	6–10%
Cholesterol, mg	1155.7 ± 468.4	620.0 ± 155.6	£ 500	1083 ± 494.6	780.7 ± 295.8	£ 500

Note. Values are expressed as mean ± SD; LBM – Lean Body Mass; BW – Body Weight; CHO – carbohydrate; PRO – protein; EAA – Essential Amino Acids; Val – Valine; Izole – Izoleucine; Leu – Leucine; BCAA – Branch Chain Amino Acids; FAT – Fat; FA – Fatty Acids; SFA – Saturated Fatty Acids; PUFA – Polyunsaturated Fatty Acids.

consumed more than recommended saturated FA, cholesterol and not enough omega-3 FA. Following the recommendations athletes consumed polyunsaturated FA and omega-6 FA.

During long-term and intense physical loads, aerobic reactions in athlete's body become important when the energy is produced from carbohydrates. For this reason, elite athletes have to intake the recommended amount of carbohydrates with food equal to 7–10 kg/body weight. Our research results showed that regardless of gender, rowers as well as canoeists-kayakers reported low dietary intake of carbohydrates, far below the recommended amounts of carbohydrates. This was confirmed by male and female kayakers-canoeists' carbohydrate content which was respectively equal to 4.0 ± 1.2 g/kg body weight and 4.4 ± 0.5 g/kg body weight. Similar quantities of carbohydrates were consumed by rowers. Male and female rowers' diets included carbohydrates amounting to 4.6 ± 1.3 g/kg body weight and 4.6 ± 0.8 g/kg body weight (Table 4).

Dietary fibre which does not provide energy is also important in athlete nutrition. Recommended dietary fibre intake is 14 g per 1000 kcal. After analysing the food recall records of athletes we found that the athletes' average intake of dietary fibre was less than 9 g/1000 kcal and it was below the recommended norm (Table 4).

In order to maintain a positive protein balance in the body, athletes are recommended to consume a sufficient amount of proteins. It was found that the average consumption of proteins among men and women kayakers-canoeists was respectively equal to 2.0 ± 0.9 g/kg body weight and 1.4 ± 0.1 g/kg body weight, which does not meet the guidelines: men consumed too much and women – too little proteins. Meanwhile, rowers irrespective of gender consumed proteins more rationally. Consumption of proteins for rowers, both men and women, was respectively 1.6 ± 0.4 g/kg body weight and 1.4 ± 0.2 g/kg body weight, which is the recommended amount. Additional assessment of the athletes' qualitative intake of proteins showed that regardless of the branch of sport and gender,

the tested athletes consumed essential amino acids (EEA), including branch chain amino acids (BCAA) (valine, leucine and isoleucine) in excess of the recommended quantities (Table 4).

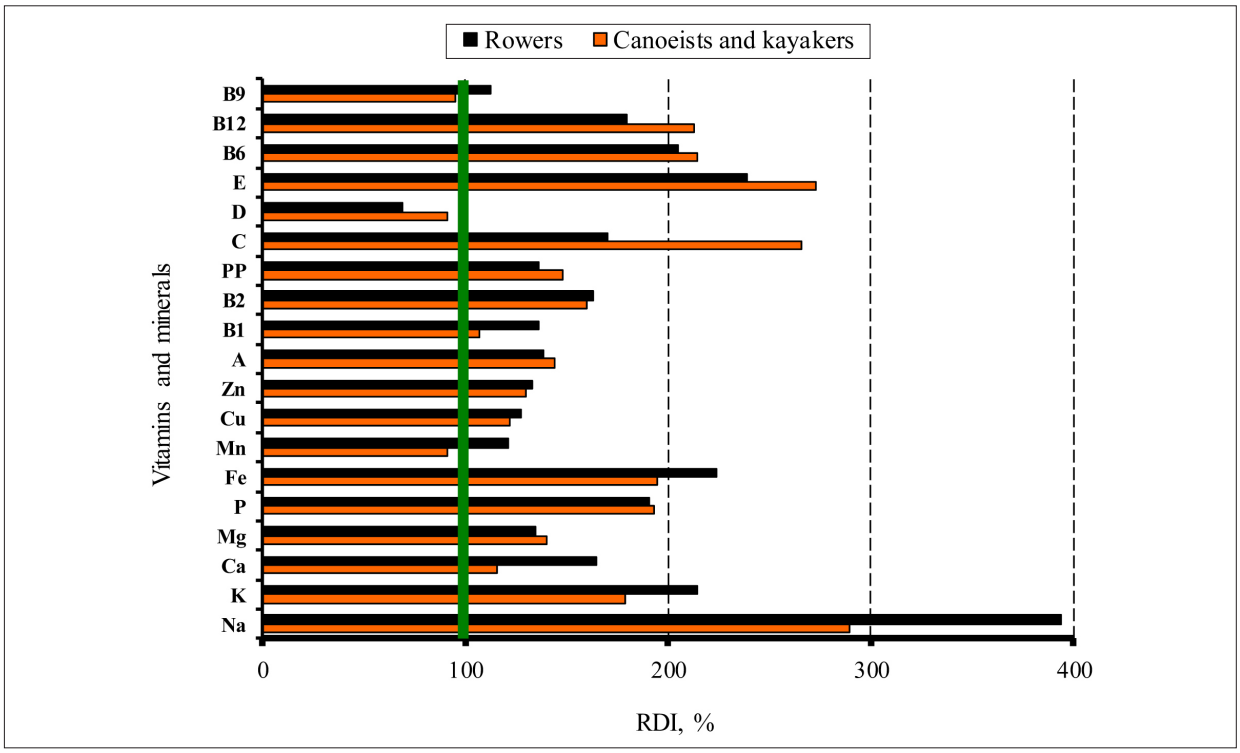
Athletes' body supply of micronutrient status is indicated in Figures 2 and 3. Athletes consumed more of almost all of the vitamins and minerals than it was recommended. However, regardless of the sport, athletes consumed insufficient amounts of vitamin D. Kayakers-canoeists' diets included 4.5 ± 2.3 mg of vitamin D, rowers' diets – 3.4 ± 2.3 mg, which made 47–69% of RDI. Moreover, kayakers-canoeists' diets lacked folic acid and manganese. Female athletes consumed insufficient amounts of folic acid (219.8 ± 29.4 μg/94% of RDI), and male athletes – manganese (4.2 ± 1.5 mg/84% of RDI).

Food supplementation. Dietary supplements were reported to have been used by 92% of the Lithuanian Olympic team rowers and kayakers-canoeists. Even 60% of the athletes took food supplements 7–12 months per year, and 32% – 1–6 months per year. Most often athletes used food supplements containing carbohydrates (73.9%), amino acids (73.9%), minerals (73.9%), vitamins (65.2%), and multivitamins (65.2%). Fewer (35.0%) athletes took omega fatty acids, creatine and herbal supplements. Least often athletes used L-carnitine (13.0%) and caffeine (8.7%) supplements. Analysing the use of food supplements in the aspect of the branch sport we found that the kayakers-canoeists compared with rowers more often used creatine and caffeine ($p = 0.002$, $p = 0.040$). Creatine and caffeine were used by respectively 100 and 40% of kayakers and canoeists. Meanwhile, the rowers did not consume caffeine at all, and they made only 16.7% of creatine users. Moreover, we found that the use of dietary supplements among athletes for men and women was almost identical, except for the fact that women athletes (100%) more often than men athletes (25%) used herbal supplements ($p = 0.032$).

Links between dietary intake and body composition. The analysis of the links between dietary intake and athletes' body composition showed that higher fat mass was not related to athletes' higher fat mass ($r = 0.164$, $p = 0.339$) because the energy intake from food of the tested athletes was less than the energy expenditure.

Muscle mass of both male kayakers-canoeists and rowers was well-developed. Meanwhile, the women athletes' muscle mass was too low and was associated with poorer physical condition compared to male athletes. The assessment of links between the dietary intake and the muscle mass revealed that the increased muscle mass of the Lithuanian elite kayakers-canoeists and rowers was developed

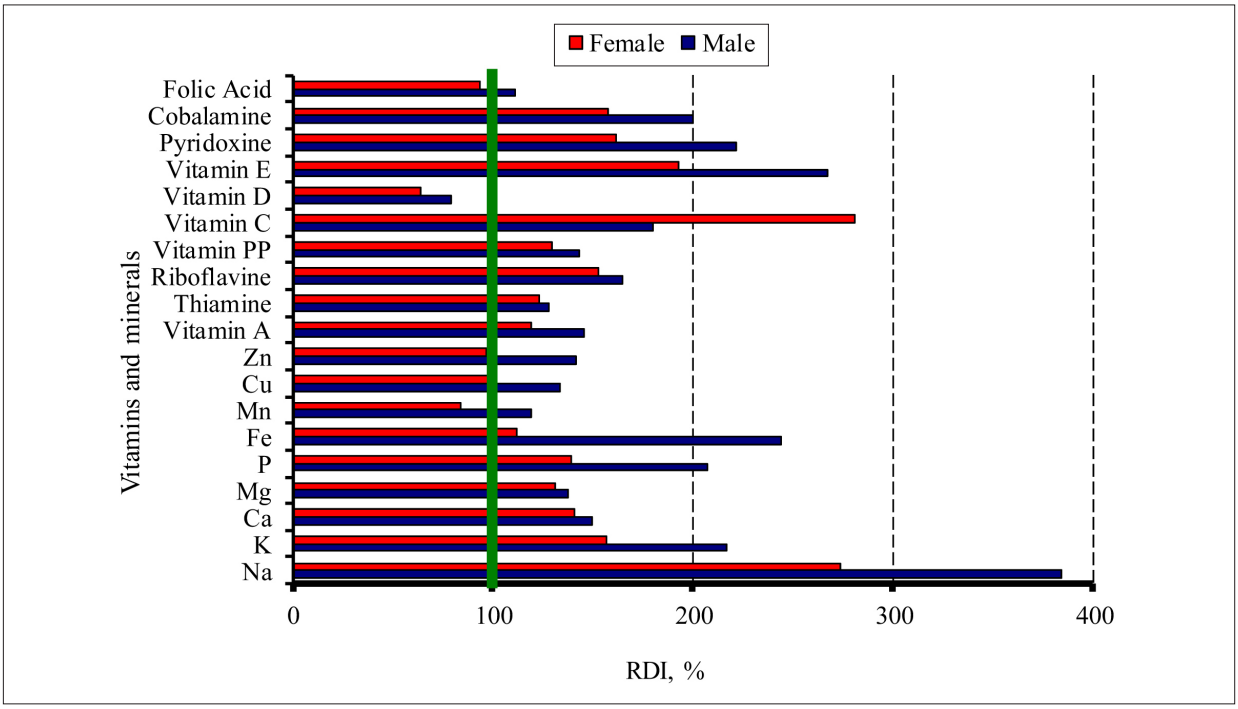
Figure 2. **Vitamin and mineral intake of athletes (by sports)**



Note. Values are expressed as mean; RDI – Recommended Daily Intake; Zn –Zinc; Cu = Cooper; Mn – Manganese; Fe – Iron; P – Phosphorus; Mg – Magnesium; Ca – Calcium; K – Potassium; Na – Sodium.

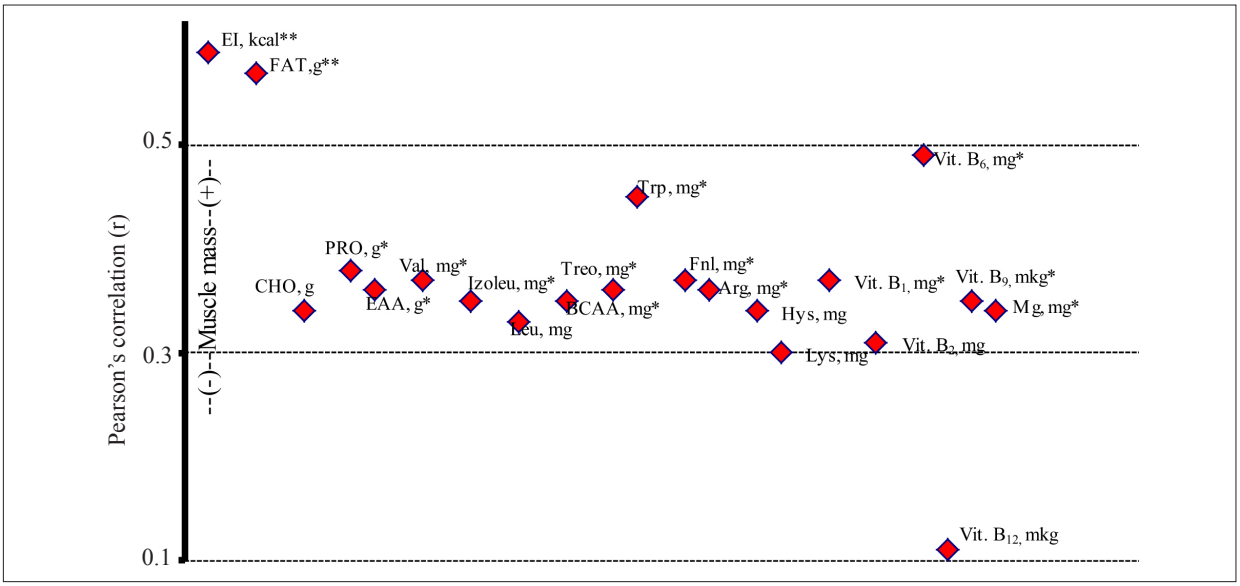
by using food containing sufficient energy value, high-fat, high-protein, EAA, B group vitamins (B_1, B_6, B_9) and magnesium. This was confirmed by a statistically significant relationship between higher muscle mass of athletes and the higher energy intake from food (r = 0.505, p = 0.002), higher intake of fat (r = 0.547, p = 0.001), protein (r = 0.361, p = 0.030), EAA (r = 0.338, p = 0.044), BCAA (r = 0.337, p = 0.044), threonine (r = 0.370, p = 0.026), tryptophan (r = 0.436, p = 0.008), phenylalanine (r = 0.345 p = 0.040), arginine (r = 0.385, p = 0.020), vitamin B_1 (r = 0.348, p = 0.038), B_6 (r = 0.470, p = 0.004), B_9 (r = 0.331, p = 0.048) and magnesium (r = 0.336, p = 0.050) (Figure 4).

Figure 3. **Vitamin and mineral intake of athletes (by gender)**



Note. Values are expressed as mean; RDI – Recommended Daily Intake; Zn –Zinc; Cu = Cooper; Mn – Manganese; Fe – Iron; P – Phosphorus; Mg – Magnesium; Ca – Calcium; K – Potassium; Na – Sodium.

Figure 4. **Correlation of muscle mass with dietary intake**



Note. Values are expressed as Pearson's correlation coefficient (r); ** – Correlation is significant at the 0.01 level; * – Correlation is significant at the 0.05 level; EI – Energy Intake; FAT – fat; CHO – carbohydrate; PRO – Protein; EAA – Essential Amino Acids; Val – Valine; Izole = Izoleucine; Leu – Leucine; BCAA – Branch Chain Amino Acids; Treo – Treonine; Trp – Triptofan; Fnl – Fenilalanine; Arg – Arginine; Hys – Hystidine; Lys – Lysine; Mg – Magnesium; Vit. – Vitamin.

DISCUSSION

Aiming at achieving good results in sport, athletes' physical development, which meets the optimal requirements for elite athlete, is of great importance, and it is based on the ratio of body weight and the individual components of body weight, muscle and fat mass (MFMI). Our research results revealed differences of athletes in the aspect of gender. Too low MFMI of male athletes was determined by a relatively high fat content, and too low MFMI of female athletes was associated with too little muscle mass. It can be argued that regardless of gender, physical development of kayakers-canoeists and rowers does not completely meet the requirements of medium MFMI.

After the evaluation of athletes' diets it appeared that energy value (EI) of kayakers-canoeists and rowers dietary did not cover the full expenditure of energy. A negative EI/EER ratio was established, which could due to the fact that athletes in the dietary intake survey did not fully indicate their food and dishes, and the physical activity coefficient was estimated with errors, the chemical composition data of the dietary intake were collected of only day, the chemical composition of food intake did not include the chemical composition of food supplements. It is obvious that carbohydrates and protein food supplementation helps to maintain the optimal EI/EER ratio which provides energy. We found that 73.9% of athletes used carbohydrate supplements, and 73.9% – protein food supplements.

Rowers and canoeists-kayakers demonstrated significant biochemical changes in the body associated with characteristic energy metabolism. The main source of energy in long-term or intense physical training is carbohydrates. As a result, rowers are recommended a daily intake of sufficient amount of carbohydrates equal to 7–10 g/kg body weight (Burke, 2010). Taking into consideration the Lithuanian Olympic team rowers' diets, we found that elite rowers and canoeists-kayakers representing Lithuania consumed too little carbohydrates and too much fat. Carbohydrate intake of our tested rowers is similar only to the previously tested athletes' intake which is less than the recommended amount of carbohydrates in Lithuania (Pečiukonienė et al., 2007), Poland (Łagowska, Jeszka, 2011) and Portugal (Teixeira et al., 2009). It is contrary to the Greek (Hassapidou, 2001), Spanish (Garcia-Rove et al., 2000), Australian (Hill, Davies, 2002), the USA (Edwards et al., 2011), New Zealand (Bond et al., 2012) athletes who use more carbohydrates (5.9–7.5 g/kg body weight).

Intake of fat exceeding the recommended amount, when the fat supply is 35–45% of the energy value, is typical of our athletes studied. Excess fat intake (fat supply accounts for 37–40% of the energy value) was found only in Spain and earlier in Lithuania investigating the diets of kayakers-canoeists (Garciá-Rovés et al., 2000; Pečiuokonienė et al., 2007; Baranauskas et al., 2009). According to other authors, most of the kayakers-canoeists consume the recommended amount of fat (the fat supply accounts for the energy value of 26–33%) (Garciá-Rovés et al., 2000; Hassapidou, 2001; Teixeira et al., 2009; Łagowska, Jeszka, 2011; Edwards et al., 2011; Bond et al., 2012).

It is important for athletes to consume the recommended amount of proteins. Kayakers-canoeists training their aerobic and anaerobic fitness are recommended an intake of proteins of 1.6–1.8 g/kg body weight, and rowers developing their aerobic fitness – 1.4–1.6 g/kg body weight (Kreider et al., 2010). Rowers and kayakers-canoeists in other countries consume more proteins than it is recommended, and more than our tested athletes.

Among the foreign rowers, the protein intake is generally 2.2–3.4 g/kg body weight (Hassapidou 2001; Edwards et al., 2011), and for kayakers-canoeists – 2.0–2.0 g/kg body weight (Garcia-Roves et al., 2000; Teixeira et al., 2009; Bond et al., 2012). Our obtained results showed that only kayakers-canoeists used proteins following the recommendations. On the other hand, women rowers consumed too little proteins, and men rowers – too much. Their intake of protein was 2.0 ± 0.9 g/kg body weight. The protein intake is recommended to enhance the muscle mass of athletes with the help of special training (Kreider et al., 2010). In Lithuania, for rowers it is important not only endurance training in the aerobic training zone, but also anaerobic alactic endurance and maximum glycolytic capacity building requiring sufficiently well-developed muscle mass (Balčiūnas, 2011). Research has shown that the specific muscle mass development is one of the factors that determine better sports results for rowers (Petkus et al., 2009).

Increasing muscle mass depends on the targeted physical activity and nutrition. Food must contain sufficient energy value, adequate protein

and EAA (Philips, 2013). This relates to our data demonstrating that Lithuanian elite kayakers-canoeists and rowers developed their increased muscle mass consuming food with higher energy value, more fat, proteins, EAA, B vitamins (B_1, B_6, and folic acid) and magnesium. It was observed that athletes, particularly men, developed large muscle mass using adequate amounts of proteins, but minimum amounts of carbohydrates. Our results agree with other research evidence that protein and EAA stimulates protein synthesis independently of carbohydrate consumption (Philips, 2013). However, rowing is an endurance sport that requires an adequate carbohydrate intake. Rowers' very low carbohydrate intake slows down their adaptation to endurance physical loads (Hawley et al., 2011), possibly weakens their immune system (Gleeson et al., 2004), and they soon start to feel fatigue during training sessions (Jeukendrup, 2011). In addition, elite rowers train every day for 3–4 hours per day and carry out physical loads in high intensity training zone, so low carbohydrate intake, not fully restored glycogen stores in the muscles between practice sessions require larger efforts of the central nervous system to deal with physical loads and it is a risk factor of overtraining (Petibois et al., 2003).

Summing up, it can be argued that the dietary intake of the Lithuanian Olympic team rowers and kayakers-canoeists diet does not meet nutritional requirements of athletes. Diets of high performance kayakers-canoeists and rowers must be optimized, adjusted and individualized.

CONCLUSIONS AND PERSPECTIVES

1. Nutrition status of kayakers-canoeists and rowers does not meet the requirements: the energy intake of food does not cover the energy expenditure, the diet lacks carbohydrates, dietary fibre, omega-3 fatty acids, vitamin D, there is too much fat, saturated fatty acids and cholesterol. Female athletes' diets do not contain enough folic acid, and male athletes' diets – manganese.

2. Basic food supplements taken by kayakers-canoeists and rowers contain carbohydrates, amino acids, minerals, vitamins and multivitamins. Less commonly used dietary supplements are omega-fatty acids, creatine, caffeine and herbal supplements. Food supplementation is determined by athletes' branch of sport and gender. Kayakers-canoeists compared with rowers more often use creatine and caffeine, and female athletes compared with males more often use herbal supplements.

3. Physical development of kayakers-canoeists and rowers does not fully comply with the requirements due to medium MFMI. Regardless of the developed muscle mass, too low MFMI of male athletes is determined by relatively high fat mass. Too low MFMI of female athletes is associated with small muscle mass.

4. Better physical development of male kayakers-canoeists and rowers is linked to higher muscle mass. Athletes develop their muscle mass purposefully on their own, consuming food high in fat and protein, essential amino acids, B vitamins (B_1, B_6, B_9) and magnesium. Diets of high performance kayakers-canoeists and rowers must be optimized, adjusted and individualized. In order to improve athletes' physical development and stimulate maximal adaptation of the body to physical loads during special training high-protein diet is recommended cutting down fat intake and doubling the carbohydrate intake.

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CORRELATIONS OF PHYSICAL ACTIVITY AND PSYCHOSOMATIC COMPLAINTS OF 10–15-YEAR-OLD SCHOOLCHILDREN

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ABSTRACT

Research background and hypothesis. The society is concerned not only about worsening student health, but also medically unexplainable psychosomatic complaints which can be the risk factor for various health and behavioural problems (WHO, 2006).

Research aim was to determine the dependence of psychosomatic complaints experienced by 10–15-year-old students on their physical activity, age and gender.

Research methods. With reference to the international questionnaire of student health and lifestyle (WHO, 2006), a questionnaire containing 31 questions was constructed for the research. Its answers about physical activity were coded from 1 – *never* to 5, 7, 8 – different variants of *often*. The questionnaire survey was conducted in February, 2012, in two schools of Kaunas city. The research participants were 293 V–VIII-grade 10–15-year-old students. The answers were analysed with reference to students' physical activity, age and gender.

Research results. Most respondents were moderately or intensively physically active: more of them were younger (10–12 years) than older (13–15 years), and there were more boys than girls. The students often exercised and did sports individually. Health self-assessment as good or even perfect was demonstrated by most physically active students. During the last 6 months they more rarely felt various psychosomatic complaints, especially related to negative emotions. Students of low physical activity felt more various psychosomatic complaints.

Conclusion. Physically more active students rarely experienced psychosomatic complaints, which show that physical activity is a significant factor reducing negative psychosomatic emotions.

Keywords: schoolchildren's physical activity, health self-assessment, psychosomatic complaints.

INTRODUCTION

The society is concerned about the worsening health of the students (WHO, 2006). According to the data of the international (HBSC) programme studies, in Lithuania every third 11, 13 and 15-year-old student evaluates his/her health as satisfactory or poor (Zaborskis, Vareikienė, 2008). Besides, students indicate various psychosomatic complaints, such as various pains (head, back, abdomen, etc.), chronic fatigue, infirmity, increased sensibility to various stimuli, sleep disorders and others (Naujokaitė, 2011; Januškevičiene et al., 2011). The symptoms, the origin of which are medically unexplainable, are not distinguished by organ pathology, they lack effective treatment ways and are attributed to psychosomatic area (Kelly et al., 2010; Madge et al., 2011) This can become a risk factor for the emergence of various problems of mental health and behaviour (Hesketh et al., 2010; Schrami et al., 2011). Eventually this can arouse real pathological disorders: cardiac, gut activity, skin abnormalities and other organ activity disorders (Eriksson, Sellstrom, 2010; Veek et al., 2010).

Numerous studies have proved that health of children and adolescents depend on the influence of casual physical activity (Janssen, LeBlanc, 2010).

In all cases, physical activity improves the quality of life, develops more positive self-perception, directly positively influences psychological health. In this case manifestation of physical activity is understood as active rest: doing sports, exercising, doing housework or any other activity related to energy consumption (Jankauskienė, 2008; Guthoid et al., 2010). Duration of physical activity, with reference to child's age, has to constitute 1/3–1/6 of time devoted to mental activity (Armonienė, 2007.) The data of various authors in Lithuania show that most students are not sufficiently physically active and the decrease of physical activity of adolescents can be observed (Blauzdys, Bagdonienė, 2007; Strukčinskienė et al., 2011).

Despite the fact that many Lithuanian researchers (Jankauskienė, 2008; Laskienė, 2008) paid much attention to the studies analysing physical activity and its influence on psychical health, there is still a lack of studies defining the correlations of student's physical activity and psychosomatic complaints in the aspect of students' different age and gender.

Hypothesis. Physical activity is one of the factors which will reduce negative emotions, and there will be fewer psyhosomatic complaints.

Research aim was to determine the dependence of the frequency of psychosomatic complaints experienced by V–VIII-grade (10–15-year-old) students on their physical activity.

RESEARCH METHODS

Participants. The study participants were 293 V–VIII-grade students of two schools of Kaunas city. Among them there were 121 boys and 172 girls, their age was from 10 to15 years. Analysing the frequency of psychosomatic disorders and physical activity of students, we divided them into two groups: younger V–VI grades (10–12 years) and older VII–VIII grades (13–15 years). At the beginning of the questionnaire survey we received the consent of school heads and students' parents. Students were interviewed in February, 2012.

Methods. The main research method employed was a questionnaire survey. The questionnaire was constructed with reference to the international questionnaire of student health and lifestyle (HBSC). There were 31 questions. The answers to the questions about physical activity were coded in 5-, 7-, 8-point scales: from 1 – *never* to 5, 7, 8 – different variants of *often*. Students' physical activity was assessed according to the coded number of points: from 6 to 10 –low physical activity, 11–13 points – moderate physical activity and 14–15 – intensive physical activity. All other questions were assessed according to subjective answer produced: for example, what complains they had or how they assessed their health, etc.

Statistical data analysis was performed using SPSS statistical packet, version 17.0. For the verification of the hypothesis, we used descriptive statistics, Pearson's correlation coefficients and chi squared test. The level of significance was set at $p < 0.05$.

RESEARCH RESULTS

It can be seen from Table 1 that physical activity depended on students' age and gender. Most participants were intensively or moderately active ($p < 0.00$). There were more younger (V–VI grades) participants who were intensively physically active, and there were significantly more older (VII–VIII grades) moderately physically active students. There were more intensively physically active boys than girls, the number was similar for moderately physically active ones, and there were more girls who were not so physically active ($p < 0.00$).

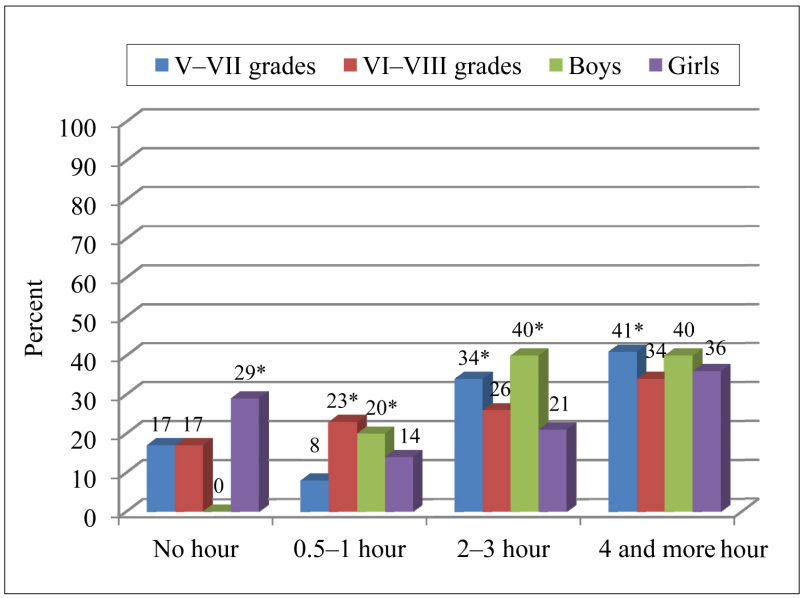
Table 1. **Schoolchildren's physical activity dependence on their age and gender**

Physical activity, %			
Group	**Intensive**	**Moderate**	**Little**
All subjects	42.3	46.1	12.6
V–VI grade	59.0*	35.0	6.0
VII–VIII grade	27.0	55.0*	18.0
Boys	50.0	46.0	4.0
Girls	35.0	75.0*	21.0

Note. * – $p < 0.01$.

Figure 1 reported on those students who exercised longer during their free time and were engaged in sports so that their breath would become rapid and they sweated, among them there were more younger (V–VI grades) than older (VII–VIII grades) students ($p < 0.00$), more boys than girls, ($p < 0.001$). More than one third of the boys exercised and did sports 4 and more hours in a week; one third of the girls (29%) did not spend any hours for that.

Figure 1. **Students exercising longer during their free time and engaged in some sport so that their breath would become rapid and they sweated frequently**



Note. * – p = 0.0005.

During their free time students usually exercised and did sports individually (33.8%), in sport clubs (33.1%), at home (33.4%) or with friends outdoors (16.4%).

Table 2. **Dependence of participants' health self-assessment on their physical activity**

Health self-assessment	Physical activity, %		
	Intensive	Moderate	Little
Excellent	40	54*	35
Good	60*	37*	65
Poor	0	9*	0

Note. * – p < 0.01.

Table 2 shows how the self-assessment of students' health depended on their physical activity. Most students whose physical activity was intensive assessed their health as good (p < 0.0001), those, whose physical activity was moderate, indicated that their health was good or even perfect (p < 0.001), although there were 9% of students among them who indicated that their health was poor. Younger and older students assessed their health in a similar way. With reference to gender, health assessments differed: more than half of the boys assessed their health as perfect, and only one third of the girls did the same. Besides, 7% of the participants indicated that their health was poor (p < 0.001).

Despite good self-assessment of health, most participants indicated that they experienced several psychosomatic disorders. Table 3 shows that during the last 6 months, one or several psychosomatic problems were experienced more often than once a week by students of different physical activity, age and both genders. Experiencing various psychosomatic problems was reported by more little physically active students (28.0%) than moderately (20.5%t) and intensively physically active students (21.6%), p < 0.00. Similarly often the complaints were expressed by both younger (36.8%) and older (39.2%t) respondents. The boys (6.0%), compared to the girls (24.9%) had psychosomatic problems significantly more often.

Figure 2 shows that psychosomatic complains which reflect respondents' negative emotions as nervous breakdown, moodiness, irritability, oppression, sadness or worry, were reported more often by students with low physical activity, while intensively physically active respondents rarely or never had negative emotions (p = 0.0001).

Pearson's correlation analysis demonstrated that the more physically active the students were, the higher was their subjective satisfaction with life (coefficient 0.377, p = 0.0001), they better assessed their health (0.296, p = 0.021), they more rarely experienced negative emotions (–0.304, p = 0.004).

Table 3. **The frequency of participants' psychosocial complaints more often than week in the period of 6 months**

Disorders	Physical activity, %			Grade, %		Gender, %	
	Intensive	Moderate	Low	V–VI	VII–VIII	Boys	Girls
Headache	0	10	35*	10	8	0	15*
Bellyache	20	7	13	27*	16	10	22*
Stomachache	30	28	32*	26	31	10	29*
Backache	10	9	32	18*	8*	19	36*
Moodiness	30	28	32	33*	26	19	36*
Nervous strain	10	27	43*	23	49*	0	14*
Sadness	40	28	35	43*	26	19	36*
Oppression	30	28	32	30	36	29	36*
Irritability	30	28	32	30	36	19	31*
Worry	40*	28	35*	23	35*	12	43*
Difficulty falling asleep	10	15	10	18	16	10	29*
Dizziness, weakness	10	10	13	5	12*	0	15*

Note. * – $p < 0.05$.

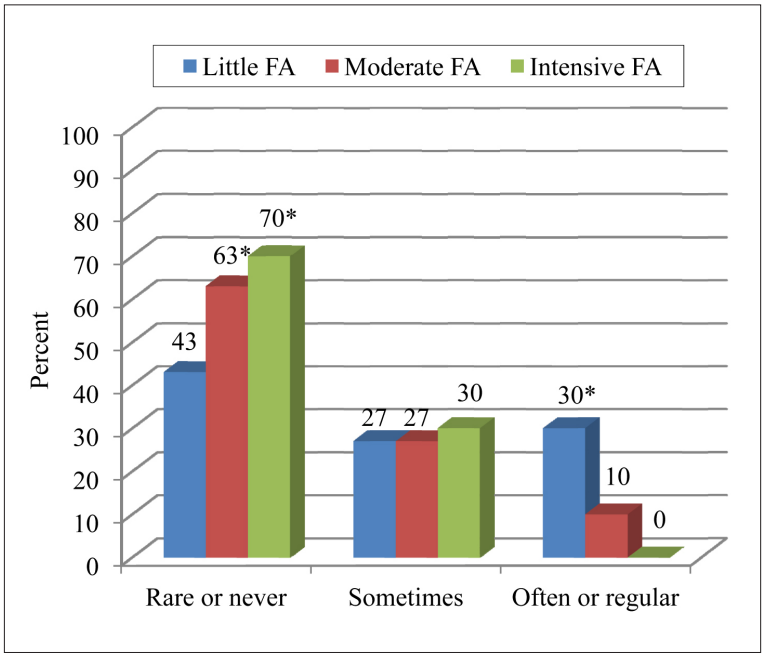


Figure 2. **Negative emotions felt in groups of different physical activity levels**

Note. p = 0.0001.

DISCUSSION

According to WHO recommendations, the minimum of young person's physical activity has to be 4 hours a week (Zaborskis et al., 1996). As studies of various authors show, most students are not sufficiently physically active (WHO, 2006; Guthoid et al. 2010; Janssen, LeBlanc, 2010). According to the data of B. Strukčinskiene et al. (2011), every third 11–15 year-old boy and every second girl are insufficiently physically active. The data of our accomplished study is similar. In the researched Kaunas city schools, the percentage of students who were insufficiently physically active was 12.6, moderately physically active – 46.1%, and intensively physically active – 12.3. Data distribution obtained was similar to that received by the authors mentioned above. Among younger students, there were more intensively physically active ones, and among older students there were more moderately and insufficiently physically active ones. This is related to the statement of V. Blauzdys and L. Bagdonienė (2007) that children's physical activity is higher before the sixth grade, in the older age it begins decreasing. Besides, among our researched boys, there were more intensively physically active research participants. While assessing the frequency of duration of student exercising and doing sports a week so as to make the breath more rapid and to sweat, we also observed a consistent pattern that younger students and boys allocated more time for that.

Referring to the analysis of WHO (HBSC), I. Raudoniūtė (2011) ascertained that in Lithuania most students assessed their health unfavourably. Health assessment of our respondents was related to their physical activity: both younger and older physically active students often indicated that their health was good or even perfect. More boys than girls indicated that as well. Similar data claiming that V–VIII grade boys statistically significantly assessed their health better than girls were reported by other authors as well (McCormick et al., 2008).

Recently, more often the attention has been paid to students' self-feeling both at school and during their leisure time, the spread of psychosomatic complaints, their causes, possibilities to decrease their spread and improve students' self-feeling (Hesketh et al., 2010; Veek et al., 2010; Schrami et al., 2011). Our respondent students indicated that they at least once a week experienced one or another psychosomatic problem. Among them, there were more of those who suffered from several disorders. The frequency of psychosomatic complaints of different character differed: less physically active students often complained about head and back pains, nervous strain and worries compared to intensively and moderately physically active students ($p < 0.05$). The majority of younger students complained about stomach ache, back pains, bad mood and sadness, and more of older students complained of nervous strain and anxiety. All those complaints were more characteristic of girls than boys ($p < 0.05$). Girls more often had headaches or dizziness, they were worried, felt nervous strain, and they had stomach-ache and back pains and found it difficult to go to sleep. Therefore, our study revealed that among secondary school students, psychosomatic complaints could be found quite often and that depended on students' physical activity. More physically active students better assessed their health, more rarely experienced psychosomatic complaints related to negative emotions. Those findings proved our hypothesis that more physically active students more rarely had psychosomatic complaints and physical activity was one of the factors of improving students' self-feeling.

CONCLUSIONS AND PERSPECTIVES

1. Physical activity of most students participating in our research was moderate or intensive, among them there were more younger than older students, more boys than girls.

2. More physically active students, younger than older, boys than girls more often indicated that their health was good or perfect.

3. More students who more often than once a week experienced psychosomatic problems were among less physically active ones, in senior classes and among the girls.

4. More physically active students more rarely experienced psychosomatic problems and that shows that physical activity is one of the factors reducing negative emotions.

Human Subject Approval Statement. Permission to recruit the research participants was given by the heads of the schools, all respondents of the school and by the schoolchildren's parents. All respondents gave informed consent to participate in the study. We also state that research reported above was undertaken in compliance with the Declaration of Helsinki.

The authors state no conflict of interest.

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THE EFFECT OF HATHA YOGA ON PSYCHOEMOTIONAL CHARACTERISTICS IN HEALTHY SUBJECTS

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ABSTRACT

Research background and hypothesis. There is a lack of evidence-based information about the effect of hatha yoga on psychoemotional characteristics of healthy people in recent scientific papers. Most of the researchers use self-reported methods to evaluate psychoemotional factors. We used objective method to find out what kind of effect could be found on psychoemotional characteristics of yoga practitioners. Hypothesis: hatha yoga practice has different effect on psychoemotional characteristics in beginners and advanced yoga practitioners.

Research aim was to evaluate the effect of hatha yoga on psychomotoric tone, extra-introversity, aggression, emotional lability and anxiety in healthy subjects.

Research methods. 40 healthy persons with no reported diseases participated in the research. Participants were divided into two groups: beginners (practicing yoga for not more than one year, n = 22) and advanced (practicing yoga for at least two years, n = 18) yoga practitioners. Psychoemotional characteristics: inborn and present psychomotoric tone, extra-introversity, aggression, emotional lability and anxiety were measured using the Myokinetic Psyhodiagnosis of D. Emilio Mira (Simon, 1943) test. The research data was compared with standard limits and between the beginners and advanced yoga practitioners groups.

Research results. Hatha yoga had general effect on psychoemotional status in the beginners and advanced yoga practitioners. Psychomotoric tone increased and emotional lability decreased in both groups ($p < 0.05$). Psychomotoric tone, extra-introversity and emotional lability were within the standard limits. Anxiety and aggression were lower in both groups in 6-months period. Aggression and emotional lability in the beginners' group was lower compared to those in the advanced yoga group ($p < 0.05$).

Discussion and conclusions. Almost all psychoemotional characteristics were within the standard limits in both groups of yoga practitioners. The bigger effect of hatha yoga was found in the yoga beginners' group. The evidence-based information in scientific literature about the effect of yoga on psychoemotional characteristics with objective measures is still missing.

Keywords: hatha yoga, psychomotoric test, psychoemotional characteristics.

INTRODUCTION

Numerous of articles about yoga can be found in popular literature in recent years. The popularity of yoga is increasing. Alternative lifestyles publications, mainstream magazines have featured numerous articles about yoga's effects on the mind, body and spirit. Current outpouring of publicity reflects that over the past few decades interest in this field has grown up. Popular periodicals and books make many assumptions about the benefits of yoga, crediting the practice with improving various aspects of physical health and psychological states (Lee, 2004)

Researchers have conducted clinical studies to substantiate the beneficial effects of yoga in healthy and ill subjects. Studies have shown that yoga practice can lead to improvements in handgrip strength, muscular endurance and flexibility. In

addition, increases in forced vital capacity, forced expiratory volume in 1 second and other spirometer values have also been observed (Mark, Tran, 2001).

Majority of the studies are putting focus on the relationship between yoga and physical fitness. Effect of yoga on healthy person's psychoemotional characteristics has rarely been evaluated. In most yoga studies psychoemotional factors are assessed using self-reported methods – questionnaires. Psychomotoric test gives a great opportunity to reveal natural psychological health status and to differentiate present and inborn psychoemotional characteristics. This method is an objective measure originally presented in 1996 by V. Jasiūnas and S. Bagočiūnas.

Research aim was to evaluate the effect of hatha yoga practice on healthy subjects' psychomotoric tone, extra-introversity, aggression, emotional lability and anxiety.

The participants of the study were healthy subjects with no signs or reported diseases and who were regularly practicing hatha yoga.

RESEARCH METHODS

The study was carried out in Lithuania, "Kauno jogos studija", in 2011–2013. We examined 40 healthy persons who were regularly practicing hatha yoga with the same yoga instructor. Participants were divided into two groups: beginners (regularly practicing yoga for not more than one year, 22 persons) and advanced (regularly practicing yoga for at least two years, 18 persons) yoga practitioners (Table 1). The measurements of yoga practitioners were accomplished before the start of yoga practice and again after three and six months of yoga practice (Figure 1). Yoga training sessions (two times per week) included postures and breathing techniques.

Psychoemotional characteristics were measured using the Myokinetic Psyhodiagnosis of D. Emilio Mira (Simon, 1943) test (Jasiūnas, Bagočiūnas, 1996; Tous, Viadé y Rubén Muiños, 2007). This test allows getting objective and visual information about the rate level of psychoemotional state (Jasiūnas, Bagočiūnas, 1996). We assessed five inborn and present psychoemotional characteristics: psychomotoric tone, extra-introversity, aggression, emotional lability and anxiety. The test was performed by asking the subject to draw 2 horizontal and 4 vertical lines 4 centimeters length as close as possible to the printed lines. At the beginning of the test the subject was allowed to see the lines, but later the eyes were closed and the subject continued the drawing. The idea of the test was to draw the lines as accurate as possible. The length, amplitude and deviation were measured and analyzed. Results of non-dominant arm present the inborn characteristics (temperament) that are usually conservative and stable. Results of dominant arm show the present condition of psychoemotional status.

Group	n	Age, years	Body height, cm	Body weight, kg	Practicing yoga, months
Beginners	22	26.55 ± 2	161.58 ± 7.73	60.95 ± 1.64	4.32 ± 0.57
Advanced	18	32.28 ± 22.02	173.56 ± 1.82	64.44 ± 2.65	37.33 ± 3.05
Female	28	28.75 ± 1.77	162.21 ± 6.04	58.93 ± 1.38	19.18 ± 3.76
Male	12	30 ± 2.8	178.08 ± 1.71	70.75 ± 2.62	19.17 ± 4.84
All	40	29.13 ± 1.48	166.97 ± 4.39	62.56 ± 1.52	19.18 ± 2.97

Table 1. **General characteristics of subjects in yoga groups (Mean ± SEM)**

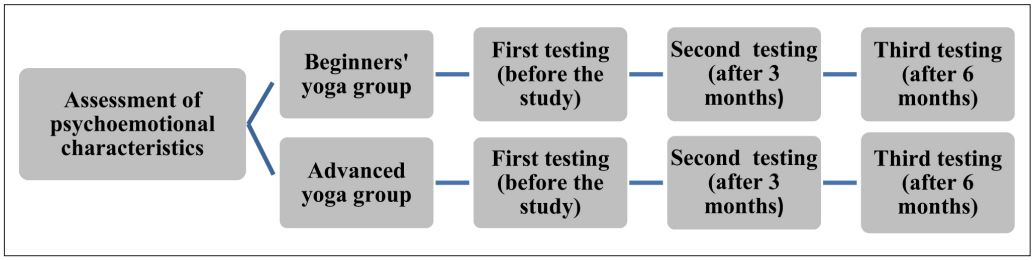


Figure 1. **Scheme of the study**

Statistical analysis was performed using *Microsoft Office Excel and* IBM SPSS software packages. In order to identify the differences between two independent groups we used the Mann-Whitney U test, between three related groups – Friedman test. The results are represented as arithmetic mean ± the standard error of the mean (SEM). Statistical significance was accepted when $p < 0.05$. Each measured and analyzed parameter in figures was presented comparing it with standard limits (45–55), revealed by Jasiūnas and Bagočūnas in 1996. The standard limits were estimated after measuring the number of athletes. The measurements were taken three times: at the beginning of the research, after 3 and 6 months of hatha yoga practice.

RESEARCH RESULTS

The significant improvement of inborn psychomotoric tone was observed in the beginners' yoga group after six months (from 51.27 ± 1.64 to 54.73 ± 0.73) of practice.

Present psychomotoric tone significantly increased ($p < 0.05$) in the period from three to six months of yoga in both groups. In advanced yoga practitioners' group after six months of practice psychomotoric tone increased compared with the results at the beginning of the study (Figure 2). There were no significant differences between the groups.

There were no statistically significant changes in inborn and present extra-introversity in any of the study groups ($p > 0.05$). In general, extra-introversity was within the standard limits (Figure 3).

Figure 2. **Present psychomotoric tone in the beginner and advanced yoga groups**

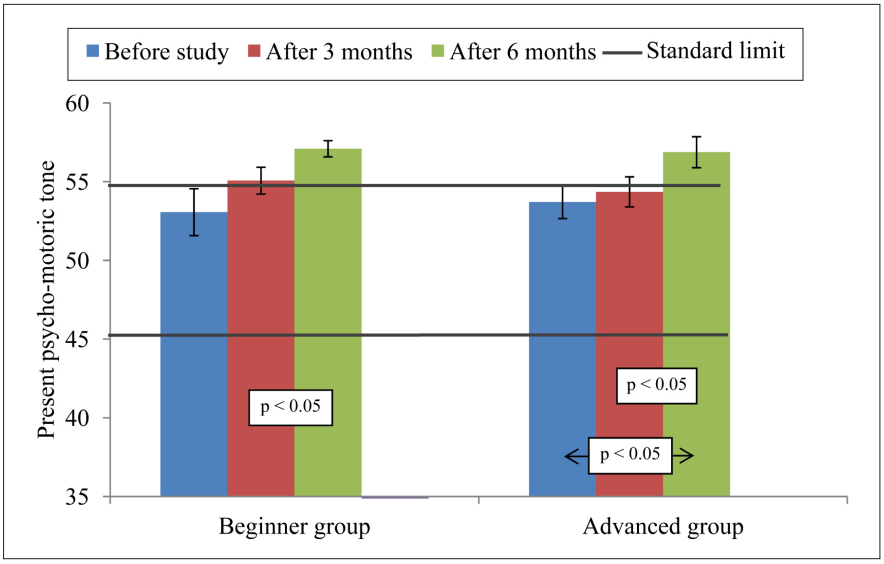
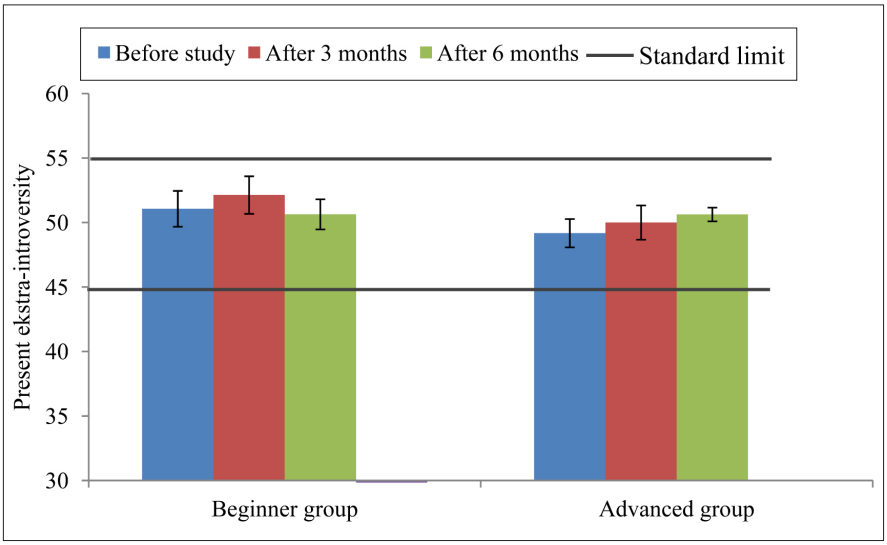


Figure 3. **Present extra-introversity in the beginner and advanced yoga groups**



Advanced yoga practitioners had significantly higher ($p < 0.05$) inborn aggression after three months and six months compared to the beginners. This parameter was lower than the standard limit in the beginner group and was within the standard limits in the advanced yoga group.

Changes of present aggression are presented in Figure 4. The lower present aggression was observed in the beginners' group compared to the advanced yoga practitioners after six months of hatha yoga. In both groups present aggression was lower than the standard limit.

In contrast, inborn emotional lability was at the same level and did not change in both groups. The inborn emotional lability was within the standard limits.

Present emotional lability gradually decreased ($p < 0.05$) in each measurement period. At the beginning and after 3 months of yoga this parameter was within the standard limits, after six months of yoga it was lower than the standard limit in the beginner group. Advanced yoga practitioners had higher ($p < 0.05$) values of present emotional lability after three months and six months of yoga compared with the beginners (Figure 5).

There were no significant changes in inborn and present anxiety. In both groups the level of anxiety was within the standard limits (Figure 6).

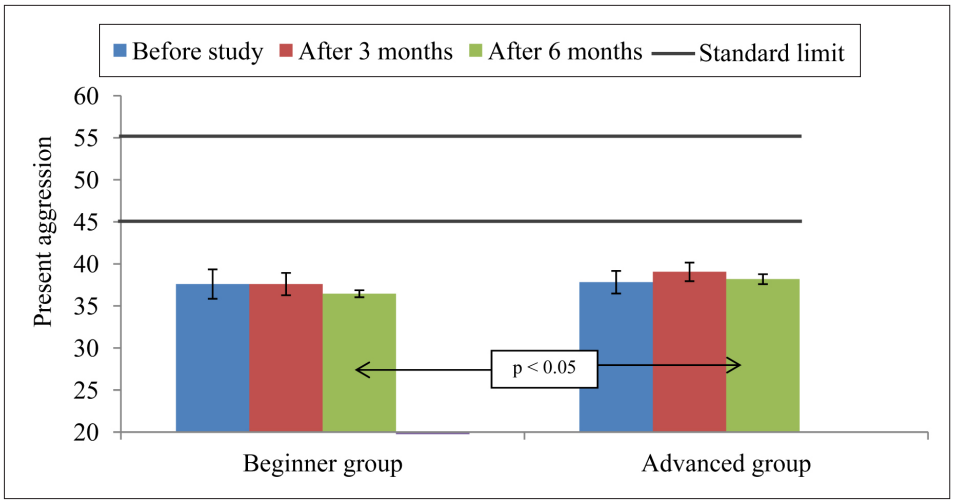


Figure 4. **Present aggression in the beginner and advanced yoga groups**

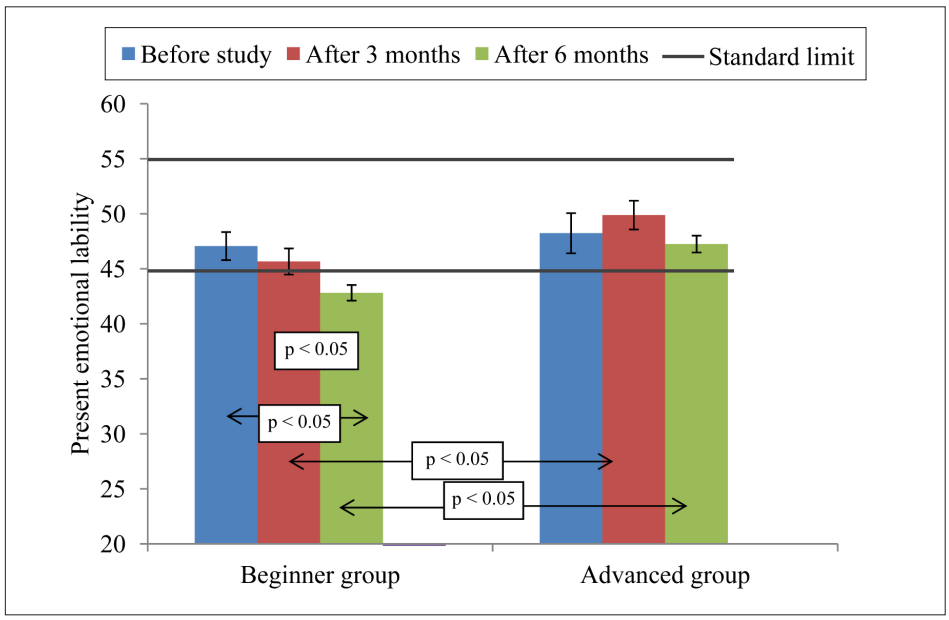
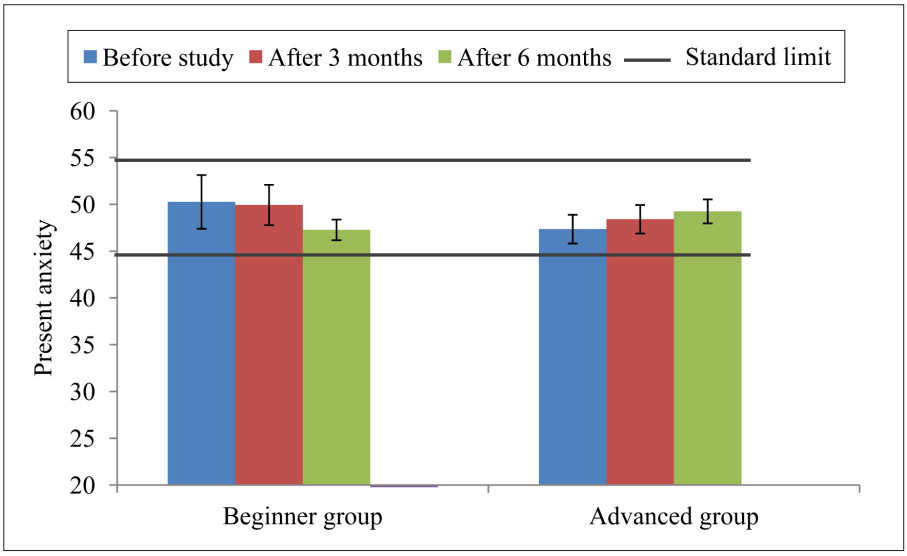


Figure 5. **Present emotional lability in the beginner and advanced yoga groups**

Figure 6. **Present anxiety in the beginner and advanced yoga groups**



DISCUSSION

The practice of yoga having favorable effects on different body systems has been convincingly shown by various studies from time to time. The present study was undertaken to see the effect of yoga practice on the level of psychomotoric tone, extra-introversity, aggression, emotional lability and anxiety.

From the results of the present study it is evident that yoga practice has a positive effect on psychoemotional characteristics. Various studies have reported similar findings. However, there is a lack of scientific papers about the effect of yoga on psychoemotional qualities. Most of the researchers measure psychoemotional state using self-reported questionnaires.

In 1996 V. Jasiūnas and S. Bagočiūnas presented a tool to measure psychoemotional qualities applying psychomotoric (*E. Mira y Lopez*) test. They investigated athletes. We have not found any research which used this test to assess the effectiveness of yoga.

R. K. Yadav et al. (2012) established significant improvement in personality by increased scores for extraversion. However, D. Eliseev et al. (2012) stated that extravertion, intravertion had not changed after yoga sessions two times per week for two years. After six months of yoga practice we did not find any significant changes in inborn and present extra-introversity in any of the study groups.

There was no research found about the effect of yoga on psychomotoric tone.

D. Eliseev et al. (2012) examined the efficacy of hatha yoga intervention in female students. At the end of the study participants tended to increase in emotional lability. Our study proved that present emotional lability was reduced after three and six months of yoga in the beginner group ($p < 0.05$).

S. Deshpande et al. (2008) evaluated the effect of yoga on the aggressiveness in normal healthy adults. Their study demonstrated that an eight-week, daily intervention of yoga decreased aggressiveness. In our research there were no significant changes in inborn and present aggressiveness. It could occur because the type of assessment tool used in that research study may not have been the most suitable one to bring out the subtle changes that may have occurred after the yoga practice.

It is known that yoga with its holistic approach uses several techniques to calm down the mind and reduce the anxiety state. R. Mehrotra et al. (2012) evaluated the effect of yoga on the anxiety score in young healthy individuals. They found statistically significant decrease in the anxiety score in females and males after three months of daily practice of yoga. N. Gupta (2006), R. K. Yadav et al. (2012) also estimated a significant reduction in state and trait anxiety after ten-day daily yoga sessions. C. Streeter et al. (2007) raised the hypothesis that yoga practice increased GABA levels in brain causing a decrease in anxiety. Reduction in anxiety also could be related to the reduction of sympathetic activity. In our study there were no significant changes ($p > 0.05$) in inborn and present anxiety after six months yoga practice. It could be affected by a small number of sessions during a week.

Probable mechanism underlying changes in psychoemotional qualities following yoga practice was voluntary slow deep breathing (our subjects performed pranayamas) wich functionally resets the autonomic nervous system through stretch-induced inhibitory signals and hyperpolarization currents propagated via both neural and non-neural tissue which synchronizes neural elements in the heart, lungs, limbic system and cortex as explained by R. Jerath et al. (2006).

There has been no study which has compared beginners and advanced yoga practitioners in the content of psychoemotional characteristics. In our study the data was compared with the standard limit. Before yoga classes everybody demonstrated the accurate level of psychoemotional qualities, so persons could choose the type of yoga according to the test results.

CONCLUSIONS AND PERSPECTIVES

Hatha yoga had an effect on psychoemotional qualities in beginners' and advanced yoga groups. Psychomotoric tone increased and emotional lability decreased in both investigated groups ($p < 0.05$). The level of psychomotoric tone, extra-introversity and emotional lability was within the standard limits. The level of anxiety and aggression was lower than the standard limits in both groups after six-month of yoga. The level of aggression and emotional lability was lower in the beginners' group compared to the advanced yoga practitioners ($p < 0.05$).

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EFFECT OF VARIOUS PHYSICAL THERAPY PROGRAMS ON THE QUALITY OF LIFE, BALANCE, KINEMATICS OF SPEED AND ACCURACY MOVEMENTS OF THE HAND IN PATIENTS WITH PARKINSON'S DISEASE

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ABSTRACT

Research background and hypothesis. Parkinson's disease is a relevant health problem in the way that the disease limits human movement to a great extent as well as degrades the quality of life and overall communication capabilities. We believe that by accelerating the pace of individual workouts on the treadmill in the gym, better results will be achieved than using individual physical therapy at home.

Research aim was to determine the effectiveness of various physical therapy programs on the quality of life, balance and kinematics of speed and accuracy movements of the hand in patients with Parkinson's disease.

Research methods. First group (n = 12) had individual physical therapy in the weightlifting gym. The second group (n = 12) had individual physical therapy at home. For the assessment of the quality of life, we selected the questionnaire PDQ-39 (Parkinson's Disease Questionaire-39), and the subjects filled it in independently. For the assessment of static and dynamic balance, Berg Balance Scale and balance confidence scale were applied. Walking speed was assessed by using the "Up and go" test. The original device developed by Lithuanian Sports University researchers and Ltd. Katra specialists - the dynamic parameter analyser of human arm and leg movements DPA-1 – was used to evaluate the characteristics of the kinematics of the dominant arm movement.

Research results. It was found that after 16 physiotherapy procedures, the quality of life statistically significantly improved in all eight areas ($p < 0.05$) in both groups under investigation. Mean Berg Balance Scale values after 16 physiotherapy procedures statistically significantly increased ($p < 0.05$) in Group I and Group II. A statistically significant improvement in balance ($p < 0.05$) was found in both groups. There was a statistically significant decrease ($p < 0.05$) in the test performance average time values of "Up and go" test in both groups. A statistically significant increase ($p < 0.001$) was established in the mean values of the six-minute walk distance. Kinematics of speed and accuracy movements statistically significantly increased ($p < 0.05$) in both groups.

Discussion and conclusions. Both physical therapy programmes were effective in improving the quality of life, balance and kinematics of speed and accuracy movements of the hand in patients with Parkinson's disease. Individual physical therapy programme at home was less effective, while acceleration of the pace of individual workouts on the treadmill in the gym had a greater impact.

Keywords: Parkinson's disease, quality of life, motor control, physical therapy, reaction time, complexity of task.

INTRODUCTION

Parkinson's disease is a chronic progressive neurodegenerative disease characterized by motor symptoms of the triad: resting tremor, bradykinesia and rigid muscles because of the lack of dopamine in extrapyramidal system (Weintraub et al., 2008; Hass et al., 2010; McNeely, Earhart, 2012).

Parkinson's disease is one of the most common progressive, degenerative, incurable diseases that affects the human nervous system (Tomlison et al., 2012).When birth and death ratio changes, changes in the population age structure emerge. The number of aging and old people is increasing (Daugėlienė, Tamošiūnas, 2007). Parkinson's disease is a disease of older people and thus, the likelihood of developing the disease increases. Even 6.3 million people in the world suffer from Parkinson's disease. According to the data of Lithuanian Institute of Hygiene Health Information Centre, in 2010, 10757 people in Lithuania suffered from Parkinson's disease. This is a relevant health problem as the disease limits human movements, degrades the quality of life and full-rate communication potential. Many people with Parkinson's disease require extensive rehabilitation application as sufferers face problems that are not fully controlled by medication: disorders of balance, mobility, activities of daily living, cognition, language, sleep as well as dysphagia, depression and fatigue. In spite of optimal pharmacological treatment motor functions progressively deteriorate, reducing patients' mobility, self-care, communication, and participation in the social environment. Physical therapy sessions are very important for patients with Parkinson's disease as they have a positive impact on patients' motor function and the quality of life, which vary with the progression of the disease (Filippin et al., 2010; Earhart, Williams, 2012). N. Filippin et al. (2010) argue that physical therapy is an effective non-pharmacological treatment which has a positive effect on mobility, daily activities and the quality of life for patients with Parkinson's disease.

The aim of the research was to determine the influence of various physical therapy programs on the quality of life, balance and kinematics of speed and accuracy of the hand in patients with Parkinson's disease. Our hypothesis is that by accelerating the pace of workouts on the treadmill, we will achieve better results than by using individual physical therapy at home.

The object of the research was changes in the quality of life, balance, kinematics of speed and accuracy movements of the hand.

RESEARCH METHODS

The patients were selected according to the modified M. M. Hoehn and M. D. Yahr scale (1967) with stages 1 and 2**.** The criteria for patient selection were the following:

1. Patients diagnosed with idiopathic Parkinson's disease;
2. Patients with stages 1 and 2;
3. The symptoms started on the right side of the body (damaged right side of the body);
4. The dominant arm – right;
5. The voluntary consent to participate in the study.

The criteria according to which the patients were not included in the research were as follows: the patients with Parkinson's disease who had severe concomitant diseases, disturbing movement or causing disability and significantly degrading the quality of life (stroke, osteoarthritis, the state after the endoprosthesis, rheumatoid arthritis).

The total sample consisted of 24 patients who were randomly divided into two groups: 12 females and 12 males. The patients were selected according to the modified M. M. Hoehn and M. D. Yahr (1967) stages scale, with 1-2 disease stages. Group I: 6 females and 6 males, age 63.13 ± 9.08 years, body mass 78.50 ± 12.14 kg, height 173.25 ± 10.50 cm and duration of the disease – 5.56 ± 2.13 years. Group II: 6 females and 6 males, age 65.63 ± 7.42 years, body mass 74.20 ± 10.83 kg, height 170.80 ± 5.89 cm and duration of the disease – 5.81 ± 3.32 years.

The subjects were tested twice: before and after a 4-week course of physiotherapy procedures. Physical therapy was applied four times a week. The duration of one procedure was 45 minutes. In the first group individual physical therapy procedures were performed by accelerating the pace of workout on the treadmill in weightlifting gym of Lithuanian Sports University, while the subjects in the second group had individual physical therapy sessions at home. Individual physical therapy at home was performed with gymnic balls, unstable platforms, sticks, theraband elastic bands and stepping exercises (15 minutes). Procedures were carried out in a steady rhythmic audio stimulation – giving orders, clapping and counting. Metronome and music were used in all procedures.

For the assessment of the quality of life the questionnaire PDQ-39 (Parkinson's Disease Questionnaire-39) was used. The following eight aspects were studied: mobility, daily living activities, emotions, disgrace, social support, cognitive function, communication, physical discomfort.

Berg Balance Scale was used for the assessment of static and dynamic balance. The tasks were grouped into static and dynamic to research the patients when sitting and standing as well as marching on the spot. For the assessment of

balance, Balance Confidence Scale was used. The "Up and Go" test was used to assess the walking speed, which is very often used in clinical studies as it is quick and easy to perform and does not require special equipment or performing skills. In order to perform the test a standard chair with a backrest and a stopwatch to capture test execution speed (in seconds) were used. The main feature of this test is that it consists of a number of trunk control and gait quality reflecting tasks: standing up from a chair, 3 meters walking straight, turning without losing balance, returning to the chair, spinning around its own axis and sitting down. The time for performing the test is assessed (Morris et al., 2006).

The study of reaction time and movement kinematics. The original device developed by Lithuanian Sports University researchers and Ltd. Katra specialists – the dynamic parameter analyser of human arm and leg movements DPA-1 – was used for the research. The right arm movement reaction time (RT) was recorded as well as the right arm maximum velocity (Vmax) at performing the tasks for reaction, speed and accuracy.

Functional assessment of the body capacity. The 6-minute walk test, which evaluates the overall body and individual systems' response to exercise (American Thoracic Society). The test measured the 6-minute walk distance across a long, smooth, straight corridor. The study was carried out according to the standard protocol – a walk distance in the corridor was marked and walk duration was measured with a stopwatch. Besides, the subjects' heart rate and arterial blood pressure using a blood pressure machine OMRON M3 were measured before and after the test.

Mathematical Statistics. Statistical data analysis was performed using SPSS 21.0 for Windows and Microsoft Office Excel 2010 statistical package. Depending on the data sample, mean values, standard deviations were calculated, the sample sizes were compared with Student's t-test, Chi-square and Wilcoxon and Kruscal–Wallis tests. Statistically significant differences were recorded at $p < 0.05$.

RESEARCH RESULTS

The results of the research revealed that after 16 physical therapy procedures the quality of life significantly improved in Group I and Group II in all eight areas of the quality of life ($p < 0.05$).

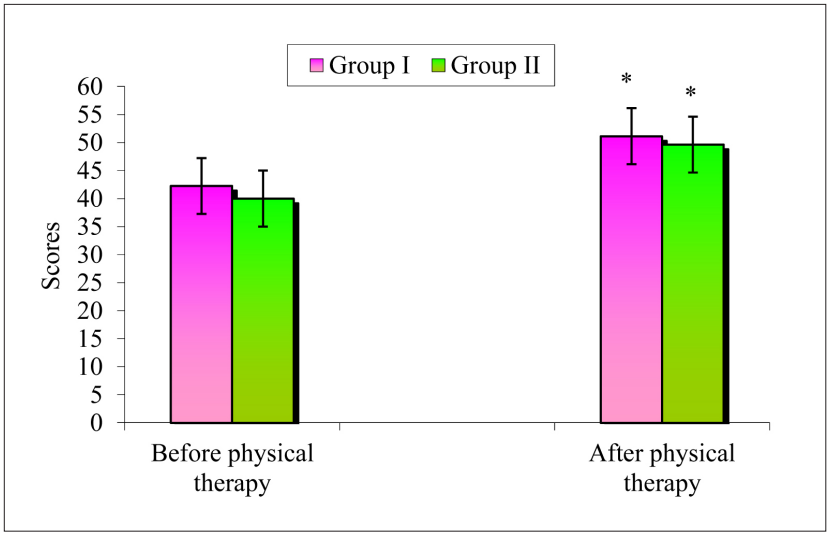
Mean Berg Balance Scale value after 16 procedures statistically significantly increased ($p < 0.05$): in Group I – from 41.25 ± 2.38 points to 52.38 ± 1.41 points, in Group II – 40.00 ± 2, 07 points to 49.75 ± 2.12 points (Figure 1).

Balance scale results in Group I before and after physical therapy improved by 16.07%. A statistically significant improvement was observed in balance ($p < 0.05$). Balance scale results in Group II before and after physical therapy improved by 20.52%. A statistically significant improvement was established in balance ($p < 0.05$).

The test performance average time values in the "Up and go" test statistically significantly decreased in both groups ($p < 0.05$) (Figure 2).

A statistically significant increase was found in the average values of walk distance in both groups ($p < 0.001$) after physical therapy sessions (Figure 3). Comparison of both groups revealed statistically significant differences in the average values of walk distance ($p < 0.001$)

Figure 1. **Mean Berg Balance Scale value in Group I and Group II before and after physical therapy**



Note.* – $p < 0.05$, comparing the results before and after physical therapy in different groups.

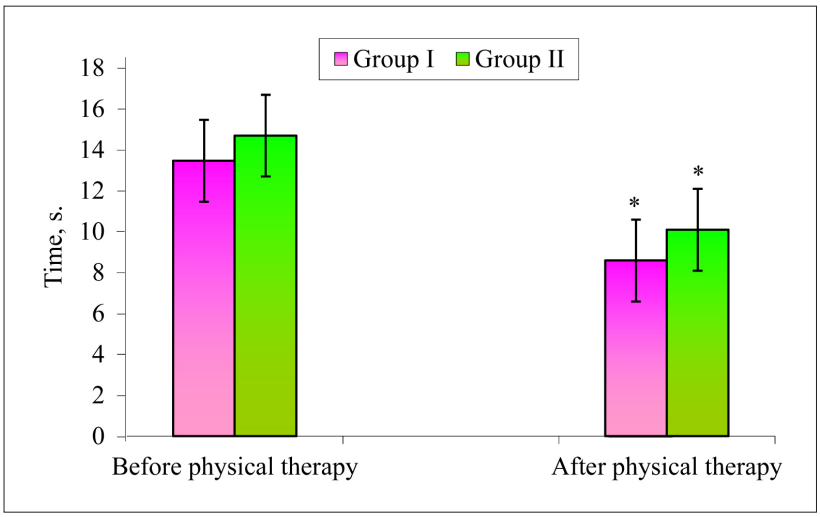


Figure 2. **Test performance average time values in the "Up and go" test before and after physical therapy**

Note. * – $p < 0.05$, by comparing the results before and after physiotherapy.

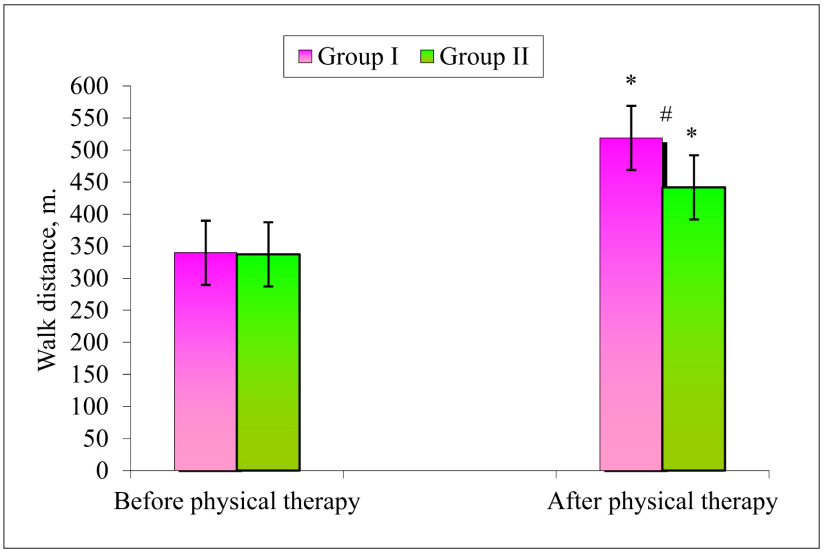


Figure 3. **The 6-minute walk distance in meters before and after physical therapy in Group I and Group II**

Note. * – $p < 0.001$, by comparing results before and after physical therapy in different groups; # – $p < 0.05$, for comparison of the results between the groups.

At the end of the study simple and complex task reaction time average in Group I statistically significantly improved ($p < 0.001$) and was 266 ± 58 ms (a simple task), and 278 ± 49 ms (a complex task). Simple and complex task reaction time average in Group II showed a statistically significant improvement ($p < 0.001$) and was 248 ± 53 ms (a simple task) and 286 ± 76 ms (a complex task).

Performing a simple task, when after hearing the sound the subjects had only to push the device handle, the maximum speed change statistically significantly improved only in Group I ($p < 0.05$) when results were compared before and after 16 physical therapy procedures.

Performing 5 series of the task after 20 repetitions in Group I, there was a statistically significant improvement ($p < 0.001$) in all 5 task series when the results before and after physical therapy were compared. A statistically significant improvement ($p < 0.05$) in Group II was established only in the first, second, third and fourth series.

Time to target average indices statistically significantly improved ($p < 0.001$) in both groups.

DISCUSSION

The hypothesis that physical therapy by accelerating the pace of individual workouts on the treadmill is more effective than physical therapy at home in the attempt to improve the quality of life, balance and kinematics of speed and accuracy movements of the hand in patients with Parkinson's disease was tested in the study.

The research revealed that both physical therapy programs after 16 procedures statistically

significantly increased the subjects' 6-minute walk distance. However, comparison of the two groups revealed that the average value in the 6-minute walk distance (by accelerating the pace of individual workout on treadmill) in Group I was statistically significantly higher than in Group II (physical therapy at home). G. Frazzitta et al. (2010) study shows that after the application of a 4-week physiotherapy, there was a statistically significant improvement in the gait and the 6-minute walk test results. Our results coincide with those carried out by the authors of the study.

Our study shows that physical therapy program by accelerating the pace of individual workout on the treadmill as well as individual physical therapy at home are effective for patients' with Parkinson's disease quality of life. When comparing the results before and after physical therapy in both groups statistically significantly higher levels were established in all areas of the quality of life. The comparison of the results in both groups revealed that the quality of life after physical therapy in all areas was evaluated higher by the subjects of Group I, however, statistically significant difference was not observed between the groups.

The research shows that the quality of life deteriorates only at the beginning of the disease. Those patients who have been suffering from Parkinson's disease for 5–9 years evaluate the quality of life in all areas much worse than those who have been suffering from this disease from 0.5 to 4 years (Valeikienė, Juozulynas, 2006). The subjects in Group I have been suffering from Parkinson's disease on average for 5.56 ± 2.13 years, while the subjects in Group II have been diagnosed in the disease for 5.81 ± 3.32 years. It was found that the quality of life before physical therapy was rated similarly by the subjects of both groups in all areas and statistically significant differences were not established. It was found that before physical therapy the worst quality of life was found in mobility and daily living activities. Results of our research coincide with the study carried out by V. Valeikienė et al. (2009) which showed that the worst quality of life among patients with Parkinson's disease was found in mobility and daily living activities.

Our study proves that both physical therapy programs were effective for developing balance in patients with Parkinson's disease. Improvement in static and dynamic balance was observed after physiotherapy in both groups. Analysis of static and dynamic balance changes showed that statistically significant differences were established after physical therapy in both groups. By applying the accelerating pace of workouts on the treadmill in Group I, static and dynamic balance increased by 11.13 points, while in the case of individual physical therapy at home in Group II, static and dynamic balance increased by 9.75 points. The research data show that static and dynamic balance increased more effectively when physical therapy by accelerating the pace of individual workout on treadmill was applied to the subjects, but statistically significant differences were not found. Similar improvements in the balance after 4 weeks of physical therapy were observed by G. Frazzitta et al. (2010). The results of their research indicate that the Berg Balance Scale score after physical therapy improved by 21%.

The results of our research suggest that both physical therapy programs are effective in training movement accuracy and speed for patients with Parkinson's disease. The speed and accuracy of movement after 16 procedures of physical therapy significantly improved.

The research carried out by E. Dereli and A. Yaliman (2010) suggests that physical therapy treatment at home under supervision of a physiotherapist is more effective than self-guided physical therapy programs at home. Our research has determined that physical therapy program by accelerating the pace of individual workout on the treadmill and individual physical therapy program at home are effective in treating patients with Parkinson's disease.

Comparison of the effect of two physical therapy programs on the quality of life, balance, kinematics of speed and accuracy of the hand in patients with Parkinson's disease, allows us to confirm our hypothesis. Both physical therapy programs were effective for the quality of life, balance, kinematics of speed and accuracy of the hand in patients with Parkinson's disease. Individual physical therapy program at home was less effective, while physical therapy program by accelerating the pace of individual workout on treadmill in the gym had a greater impact on patients with Parkinson's disease.

CONCLUSIONS AND PERSPECTIVES

1. After physical therapy procedures, a statistically significant improvement in the quality of life, balance, kinematics of speed and accuracy of the hand was found in the subjects who received physical therapy treatment at home.

2. After physical therapy procedures a statistically significant improvement in the quality of life, balance, kinematics of speed and accuracy of the hand was found in the subjects who received physical therapy treatment by accelerating the pace of individual workouts on the treadmill in the gym.

3. The subjects of the research, who received physical therapy treatment by accelerating the pace of individual workouts on the treadmill in the gym, rated the quality of life higher, better managed the rapid and accurate movements of the hand and were capable of keeping a more stable balance.

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CARDIAC FUNCTION AND MUSCULAR OXYGEN DESATURATION IN SPRINT AND ENDURANCE COHORTS DURING THE INCREMENTAL BICYCLE ERGOMETRY

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ABSTRACT

Research background and hypothesis. The objective of this study was to compare the velocity of changes of cardiac output and muscular oxygen desaturation during the graded exercise stress in endurance and sprint cohorts.

Research methods. The subjects, 13 long distance runners and 11 sprinters, underwent a 50W increase in workload every 6 minutes and they exercised till the inability to continue the workout. The heart rate (HR), cardiac output and oxygen desaturation (StO_2) in lateral head of the rectus femoral muscle were registered.

Research results. The averaged values of change in cardiac output at each stage of workout were similar for both cohorts. We found statistically significantly higher velocities of changes in StO_2 in the sprint cohort than in the endurance cohort. The lower physical performance abilities are typical of the sprint cohort compared to the endurance cohort but three was no difference between the averaged maximal HR values registered at the end of incremental ergometry. During the exercising with given work rate at stages which became subjectively hard, the StO_2 decreased to the same smallest level. This means that the same type of change and the same smallest degree of StO_2 occurs just before the inability to continue the exercising.

Discussions and conclusions. The endurance cohort features a more extensive slow augmentation and greater peak values of cardiac output compared to the sprint cohort. The same type of changes and the same degree of muscular oxygen desaturation occur at the point of the inability to continue the exercising, but faster changes in oxygen desaturation in muscular tissue are characteristic of the sprint cohort compared to the sprint cohort.

Keywords: bicycle ergometry, cardiac output, oxygen desaturation.

INTRODUCTION

Physical exercise or workload induces a cardiovascular system to increase delivery of oxygen and metabolic substrates to actively contracting skeletal muscles (Bangsbo, Hellsten, 1998; Saltin et al., 1998; Burgomaster et al., 2008; Gibala, 2012). The blood flow to muscles is generally proportional to their metabolic activity (Bangsbo, Hellsten, 1998; Hughson, Tschakovsky, 1999; Burgomaster et al., 2008).

The different effects of training on cardiovascular system undoubtedly reflect adaptations of various factors involved in the regulation of muscle blood flow and delivery of oxygen (Delp, 1998; Burgomaster et al., 2008; Buchheit et al., 2012). A lot of studies of the last years showed high effect of the sprint type of exercising on health benefits and oxygen consumption in muscular tissue (Davison, 2011; Buchheit et al., 2012; Hanon et al., 2012; Hazell et al., 2012). Why are the studies which allow comparing and understanding the peculiarities of acute and chronic effects on endurance and

sprint training so important? The one important question is how these body functions behave under conditions of increasing fatigue. The objective of this study was to compare the velocity of changes of cardiac output and muscular oxygen desaturation during the graded exercise stress in endurance and sprint cohorts.

RESEARCH METHODS

The subjects of this study were 13 long distance runners, aged 21.3 ± 1.31, body mass index 21.2 ± 0.49, and 11 sprinters, aged 20.9 ±1.15, body mass index 22.3 ± 0.32.

The bicycle ergometric method of incremental increase in workload (graded stress) was used. The subjects underwent a 50 W increase in workload every 6 minutes (60 revolutions/min) and they exercised it till the inability to continue the task or if the distressing cardiovascular symptoms supervened.

The heart rate and cardiac output were measured with tetrapolar chest rheography (RPG2-02, Medtekhnika, Moscow, Russia), a convenient and bloodless method based on the Kubicek procedure (Pushkar et al., 1977). The stroke volume was calculated from the impedance change information using a formula that relates impedance changes to volume changes in a conducting solid (Kubicek et al., 1966).

Near-infrared spectroscopy (NIRS) was used for the non-invasive monitoring of oxygen desaturation in tissues (StO_2). The InSpectra Standard System Model 325, which was developed by Hutchinson Technology Inc. (Hutchinson, MN, USA), was used for this purpose. This is a non-invasive monitoring system that was designed to measure an approximated percentage of StO^2. A 25 mm probe spacing (*between sending and receiving fibres*) on the tissue sample was used. StO_2 dynamical changes and recovery were monitored continuously (every 3.5 s). The InSpectra sensor was placed on the thigh, on the lateral head of the rectus femoral muscle.

The velocity of changes of registered indices was calculated in percent per one minute, i. e.:

$$\Delta_{1min.} = (m_n - m_{(n-1)})/m_{(n)} * 100,$$

where m_n – value of parameter at the moment, and $m_{(n-1)}$ – value of parameter recorded one minute before.

Statistical analysis was performed using the statistical software package SPSS, version 17.0. The recorded variables exhibited parametric and non-parametric distributions. Differences between certain stages were tested using Tukey's HSD test. The level of significance was conducted at $p < 0.05$.

RESEARCH RESULTS

Figure 1 A presents the dynamics of HR during the incremental increase in workload. A stepwise increase of HR depends on the work rate. The faster increase of HR was observed in the sprint than in the endurance cohort, but comparing the maximal HR values registered while performing the last stage of workout we found no statistically significant difference between the cohorts ($p > 0.05$).

The initial values of cardiac output obtained with tetrapolar chest rheography before the exercising was 5.3 ± 0.6 l/min in sprint and 6.1 ± 0.4 l/min in endurance cohorts. The cardiac output intensified depending on the work rate (Figure 2 B). The increase of cardiac output while performing the workload had the same tendency of stepwise increase with the each higher stage in both cohorts. This tendency was strongly observable during the first stages of the workout and weakened when exercising became subjectively hard, i.e. during the last stages of the workout. The highest values were registered during the last stages of the workout, i.e. in the endurance cohort up to 31.2 l/min, and in the sprint cohort up to 19.4 l/min.

Dynamics of StO_2 during the incremental exercising are presented in Figure 2. The type of curves indicates that these changes depended on the work rate and this was typical of both cohorts. The level to which StO_2 decreased when the exercising became subjectively hard was similar for both cohorts. During the recovery after the workload the StO_2 increased rapidly.

Velocities of changes of cardiac output and StO_2 during the incremental bicycle ergometry are presented in Table. The averaged values of change at each stage of workout were similar for both cohorts when the velocities of changes in cardiac output were compared ($p > 0.05$). We found statistically significant higher velocities of changes in StO_2 in the sprint cohort than in the endurance cohort ($p < 0.05$, see tinted parts of the Table) while the participants exercised at the stages of 150 W and 200 W.

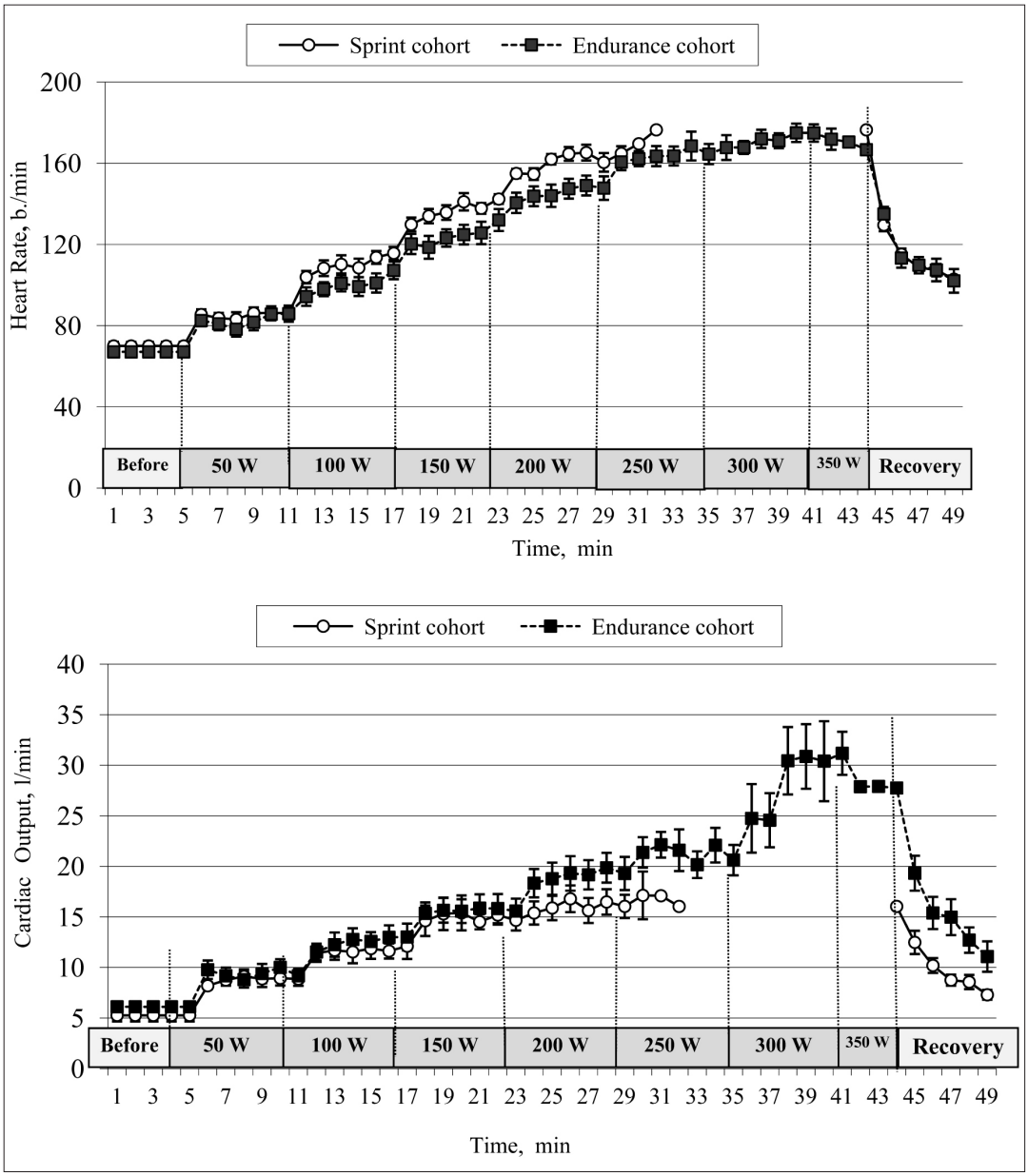

Figure 1. **Dynamics of HR (A) and cardiac output (B) during the incremental increase in workload**

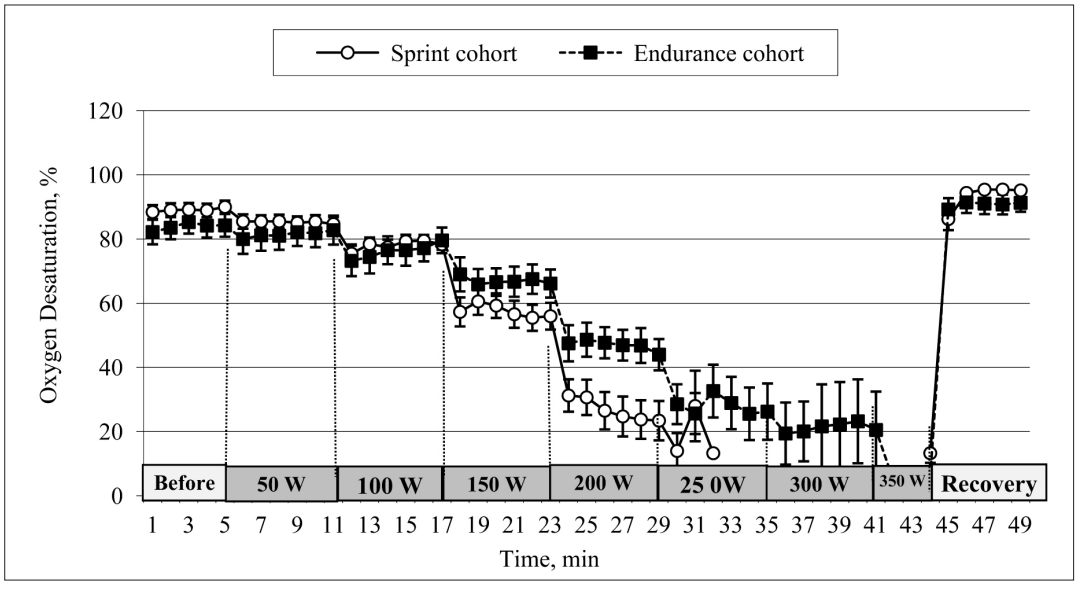

Figure 2. **Dynamics of oxygen desaturation (StO_2) during the incremental increase in workload**

Index	Cohort	Stage of incremental exercising			
		50 W 1–6 min	100 W 6–12 min	150 W 12–18 min	200 W 18–24 min
Cardiac output	Endurance	10.3 ± 0.92	4.5 ± 0.84	3.5 ± 0.86	3.1 ± 0.81
	Sprint	9.4 ± 1.03	4.9 ± 0.92	4.1 ±0.93	2.0 ± 1.01
	Difference between cohorts	p > 0.05	p > 0.05	p > 0.05	p > 0.05
StO_2	Endurance	0.09 ± 0.48	2.1 ±0.52	2.4 ± 0.68	4.7 ± 0.64
	Sprint	0.09 ± 0.51	2.0 ± 0.55	4.7 ± 0.68	7.8 ± 0.69
	Difference between cohorts	p > 0.05	p > 0.05	p < 0.05	p < 0.05

Table. **Velocity of changes of cardiac output and oxygen desaturation (StO_2) during incremental bicycle ergometry**

Note. The values in Table are given in percent per one minute.

DISCUSSION

The bicycle ergometric workload which was used in our investigation engaged a large muscle mass, so the functional capacity of the cardiovascular system plays an important role (Saltin et al., 1998; Burgomaster et al., 2008). It is the capacity of "resistance vessels" to alter dramatically their internal diameter that provides a rapid and effective means for regulating blood flow through the peripheral vasculature (Saltin et al., 1998; Hughson, Tschakovsky, 1999). During exercise at VO_2max, approximately 85% of cardiac output is directed toward the skeletal muscle (Rowel, 1993). Thus, an intense arterial circulation in active muscles is a good condition for the delivery of oxygen and metabolic substrates to, as well as removal of metabolic by-products and heat from actively contracting muscles (Delp, 1998). Blood flow increases in proportion to the intensity of exercise (Saltin et al., 1998) and these changes in muscle blood flow influence directly the intensity of oxidative metabolic processes (Bangsbo, Hellsten, 1998; Joyner, Proctor, 1999; Amann, Calbet, 2008).

The results obtained during this study showed a well-known feature of lower physical performance abilities of the sprint cohort in bicycle ergometry compared to the endurance trained athletes (Delp, 1996; Saltin et al., 1998; Gibala et al., 2012). The higher cardiac performance is one of the causes of that as it was shown during this study. The endurance cohort features a more extensive slow augmentation and greater peak values of cardiac output compared to the sprint cohort. We found statistically significantly higher velocities of changes in StO_2 in the sprint cohort while the participants of this study exercised at the stages of 150 W and 200 W. These two last stages were subjectively hard to all participants of the sprint cohort and only for a few participants form the endurance cohort, i. e. all of them were unable to continue the task. The majority of subjects from the endurance cohort demonstrated higher performance abilities, i. e. they exercised even at the stages of 250 W and 300 W, and namely at this moment StO_2 decreased to the same lowest level. This means that the same type of changes and the same smallest degree of StO_2 occur just before the moment of inability to continue the exercising. This correspond to the statement that work efficiency in humans is relatively fixed for a given work task (Wasserman et al., 2004), i. e. the slope of the relationship between oxygen consumption and cycle ergometer rate is approximately the same for all normal people.

CONCLUSIONS

1. The lower physical performance abilities are typical of the sprint cohort compared to the endurance cohort, but there were no differences between the averaged maximal HR values registered at the end of incremental ergometry.

2. The endurance cohort featured a more extensive slow augmentation and greater peak values of cardiac output compared to the sprint cohort.

3. The same type of changes and the same degree of muscular oxygen desaturation occur at the point of the inability to continue the exercising, but faster changes in oxygen desaturation in muscular tissue are characteristic of the sprint cohort compared to the endurance.

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POSTURAL DISORDERS IN YOUNG ATHLETES

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ABSTRACT

Research background and hypothesis. Athletes across all sports face sports injuries stemming from the overuse of specific muscle groups for that particular sport. It was hypothesised that athletes from each sport would show similar muscular-skeletal changes allowing a postural stereotype for each sport to be allocated.

The aim of this study was to determine the peculiarities of postural changes of young athletes in accordance with postural tone and phasic contraction muscles.

Research methods. The participants of this study were 92 young Latvian athletes aged 14–17 and having different preparation level, i. e. 20 swimmers, 20 ice-hockey players and 19 basketball players, 17 handball players and 16 cyclists. Tests were completed using methods of visual diagnostics (Васильева, 1996) and muscular functional testing (Kendall, M. O., Kendall, F. P., 1982).

Research results. The lower cross syndrome is a common feature for athletes of sports requiring complicated coordination at high rates of workloads on lower extremities. Individual decline from a neutral posture in the sagittal plane is a characteristic feature for individuals of various kinds of sport due to overload of some muscle groups.

Discussion and conclusions. The presence of a postural stereotype indicates that these muscular-skeletal changes are beneficial to athletes. How much benefit the athletes gain from these postural changes before injury occurs, is open to debate. It is purposeful to distinguish muscles according to their tone to postural and contracting muscles. The postural muscles that form posture have rather high tone, but if these muscles are overloaded, the tone pathologically increases and the muscle cannot contract nor relax effectively enough to allow the antagonist to work.

Keywords: sport event specifics, postural stereotypes, functional postural changes.

INTRODUCTION

Athletes across all sports face sports injuries stemming from the overuse of specific muscle groups for that particular sport. The overuse of specific muscle groups causes functional muscle imbalance leading to postural changes. These postural changes can provide benefits and advantages to athletes making them better adapted to their sport, therefore these changes are functional for athletes. Just as species have evolved through a series of adaptations over time, sports exercises, drills, and strengthening programs drive to adapt and evolve the athletes that participate in them. Despite the fact that in certain studies and literature we may find results that speak of changes in the spinal cord in athletes of different sports that involve large rotations, such as gymnastics, ballet, swimming, wrestling, javelin throwing, etc., it has not yet been determined that these activities lead to a direct acceleration or worsening of postural disorders (Tanchev et al., 2000; Wood, 2002; Slawinska, et al., 2006).

The problem that the professional/elite athletes face today is finding balance between sports advantage and injury: functionality versus detrimental change. This study is the first step in solving the problem of ensuring balance of functional muscular-skeletal changes and its advantages. It is hotly debated between coaches,

athletes and support staff about how and where that balance point is to be found and applied.

It was hypothesised that athletes from each sport would show similar muscular-skeletal changes allowing a postural stereotype for each sport to be allocated. The aim of this study was to determine the peculiarities of postural changes of young athletes in accordance with postural tone and phasic contraction muscles.

RESEARCH METHODS

The participants of this study were 92 young Latvian athletes aged 14–17 and having different preparation level, i. e. 20 swimmers, 20 ice-hockey players and 19 basketball players, 17 handball players and 16 cyclists. Tests were completed using methods of visual diagnostics (Васильева, 1996) and muscular functional testing (Kendall, H. O., Kendall, F. P., 1982; Janda, 1994). On the basis of these methods the program of assessment was developed (Solovjova, Upitis, 2008). The program integrated measurements of declines in 8 sagittal points from the vertical plane along with functional testing of 11 muscle groups.

Express-diagnostics of posture statics. The following points were marked on the athlete: the external ear opening, acromion, radial point, outer points of the palm, the highest point of the iliac crest, the trochanter, the upper end of the fibula bone and outer ankle. The subject stood at a vertical wall. The distance from the marked point to the vertical wall on the right and left side was measured.

Muscle functional tests. To state the postural tone and phasic contraction muscle functional condition, the major body and leg muscles that are involved in posture forming were tested according to H. O. Kendall and F. P. Kendall (1982). To indicate muscle shortening and weakening, muscles were tested at rest condition. Ten muscle groups were examined all together: the phasic muscles such as the blade fixators, m. rectus abdominis, m. m. medius, and the postural muscles such as m. m. erector cervicis, m. pectoralis major, m. iliopsoas, m. quadriceps femoris, hamstring muscles and m. triceps surae. The functional condition of the postural muscles was assessed in a 3 point system: 1 point was considered to be the norm, 2 and 3 points were considered to be changes.

RESEARCH RESULTS

Results obtained during this study indicate that all athletes have some functional muscular-skeletal changes at various skeletal points. Asymmetry of the point distance from the vertical line between the left and right sides was observed in two swimmers, one ice-hockey player and one basketball player. These measurements were averaged for ease of profiling.

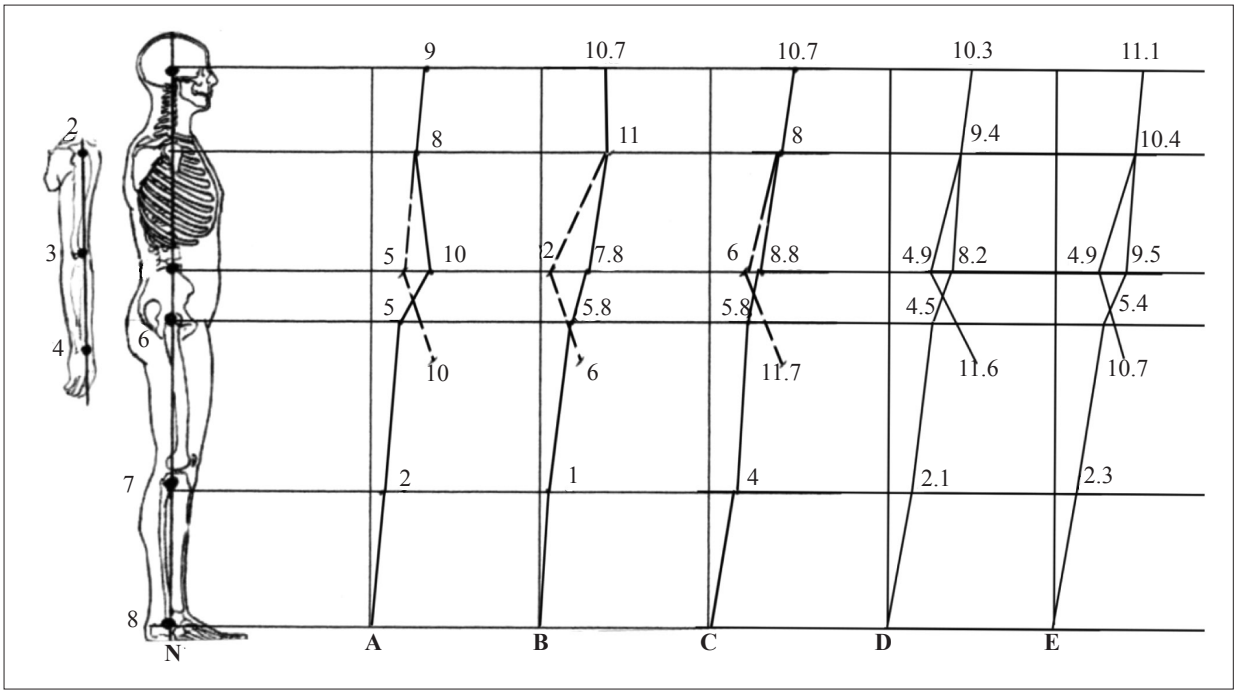
The following peculiarities of posture statics can be marked in the athletes' individual posture profile: the body deviation forward, so-called "body falling" forward was observed in athletes of all groups; the distance from the vertical line between the outer ankle and the auricle of the ear in group A was 9.1 cm, in group B – 5.5 cm, in group C – 10.7 cm; the hip rotation forward was observed in all athletes. It can be concluded that the difference between the highest point of the iliac crest (point 5 in Figure 1) and the trochanter, (point 6 on Figure 1) – in the ice-hockey players is 5.5 cm, swimmers – 2.0 cm and basketball players – 3.5 cm. The greatest distance from the vertical line in the swimmers is in the shoulder girdle (11 cm), ice-hockey players – the highest point of the iliac crest (8 cm), basketball players – the auricle of the ear point (10.7 cm), see Table 1, Figure 1.

In general the following peculiarities of posture statics can be marked in the athletes' individual posture profile. All sports profiles were found to fall forward, cyclists being the most pronounced. Swimmers have a round back and a slight forward rotation of the pelvis. Ice-hockey and handball players along with cyclists have explicit forward rotation of the pelvis.

Muscle testing results indicate that the greatest changes were found in the postural muscles – m. rectus femoris – in all 20 ice-hockey players and cyclists (100%), handball players (91,2%), basketball players (84.2%) and swimmers (41%).

Changes in the hamstring muscles were recorded in hockey players (64%) and handball players (64.7%), swimmers (60%), basketball players (57.9%) and cyclists (55.6%). The greatest changes of m. triceps surae were in the swimmers group (41%) and handball players (35.3%). Both ice-hockey players and cyclists recorded 22.3% change and basketball players – 21.1%.

Athletes in all groups have short pelvic muscles (A – 77.2%, B – 84%, C – 73%, D – 82.4%,



Note. N – optimal position; A – ice-hockey players (n = 20), B – swimmers (n = 20), C – basketball players (n = 19), D – handball players (n = 17) and E – cyclists (n = 16) average data, cm.

Figure 1. **Deviations of the body vertical line from the side, vertical line parameters in cm**

Table 1. **Distance of the body points from the vertical line**

Groups	1	2	3	4	5	6	7	8
Group A, ice-hockey players, n = 20	9.1 ± 0.5	8.3 ± 0.5	5.1 ± 0.6	10 ± 0.7	10.4 ± 0.7	5.2 ± 0.5	2.1 ± 0.6	0
Group B, swimmers, n = 20	5.5 ± 0.4	10.6 ± 0.4	2.4 ± 0.6	6.9 ± 0.9	7.8 ± 0.5	5.8 ± 0.3	1.7 ± 0.2	0
Group C, basketball players, n = 19	10.7 ± 0.6	8.0 ± 0.6	5.7 ± 0.7	11.7 ± 1.1	8.8 ± 0.6	5.8 ± 0.5	4.2 ± 0.4	0
Group D, handball players, n = 17	10.3 ± 0.5	9.4 ± 0.5	4.9 ± 0.6	11.6 ± 0.9	8.2 ± 0.4	4.5 ± 0.4	2.1 ± 0.4	0
Group E, bike riders, n = 16	11.1 ± 0.7	10.4 ± 0.8	4.9 ± 0.5	10.7 ± 1.1	9.5 ± 0.7	5.4 ± 0.4	2.3 ± 0.3	0

Note. 1 – Lower points of the auricle of the ear, 2 – major tubercle, 3 – elbow, 4 – outer points of the palm, 5 – highest point of the iliac crest, 6 – major trochanter, 7 – middle points of the knee joint side surface, 8 – outer ankle; average data of the groups, cm, X ± SD.

E – 83.4%) and hamstring muscles. The changes of the shoulder girdle muscle tone were as follows: m. pectoralis major 21% in 4 swimmers, 5% in 2 basketball players; ice-hockey players, handball players and cyclists do not have any changes (Figure 2). Handball players have the greatest number of changes in m. pectoralis major – 70.6%, swimmers have the smallest – 49%, but cyclists, basketball players and hockey players have changes respectively 66.7, 63.2 and 54.4%. See Figures 2 and 3.

Having the results of muscle testing we can see the changes in the phasic muscles when their effectiveness decreases, that is, they extend and are not able to contract effectively: m. rectus abdominis – 47% of swimmers and 77% of ice-hockey players, 47% of basketball players, 70.6% of handball players and 44.5% of cyclists. Swimmers have the lowest tone of the shoulder blade fixators – 70%, basketball players – 42%, cyclists – 61.2%, hockey riders – 54.4% and handball players – 41.2%. See Figure 4.

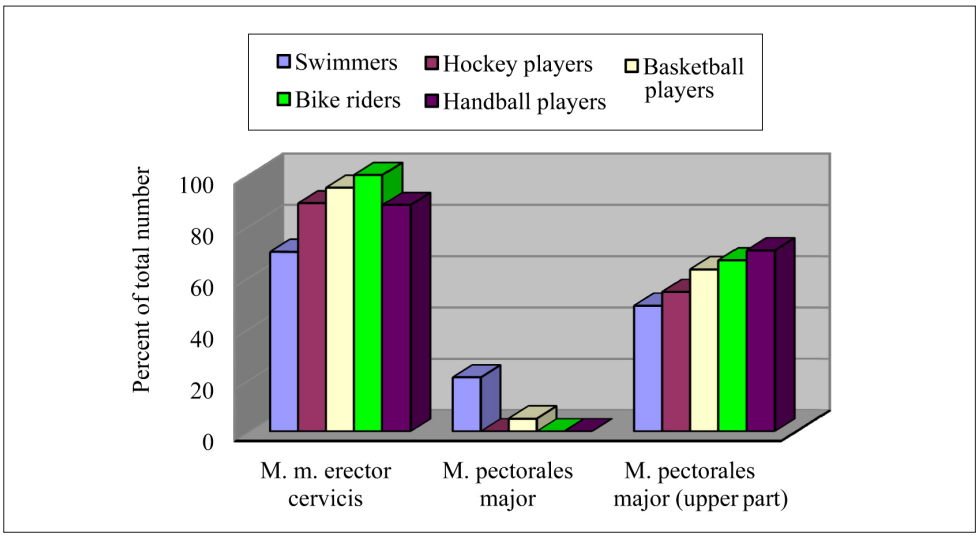


Figure 2. **Results of swimmer, ice-hockey, bike rider, handball player and basketball player postural muscle length**

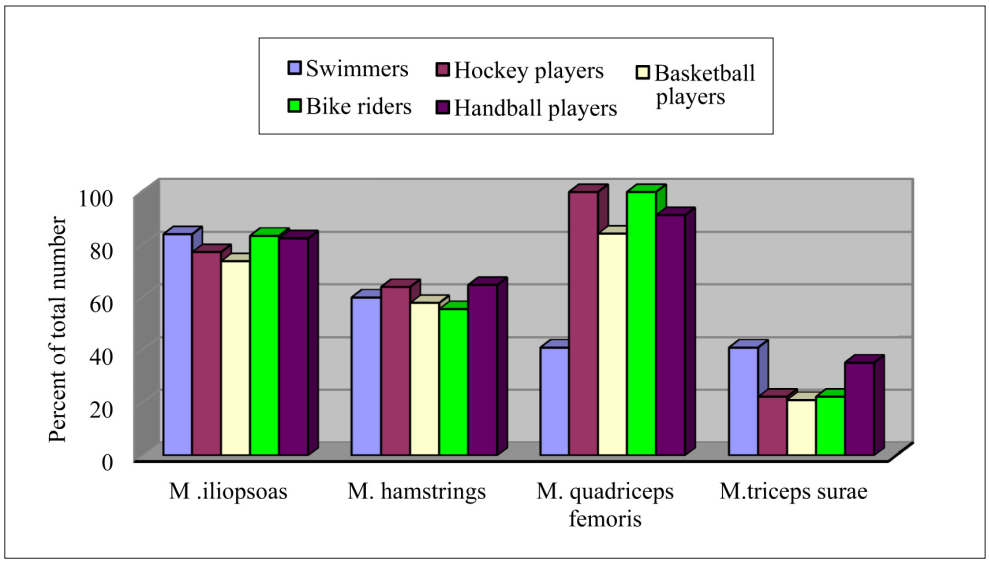


Figure 3. **Results of swimmer, ice-hockey, bike rider, handball player and basketball player postural muscle length**

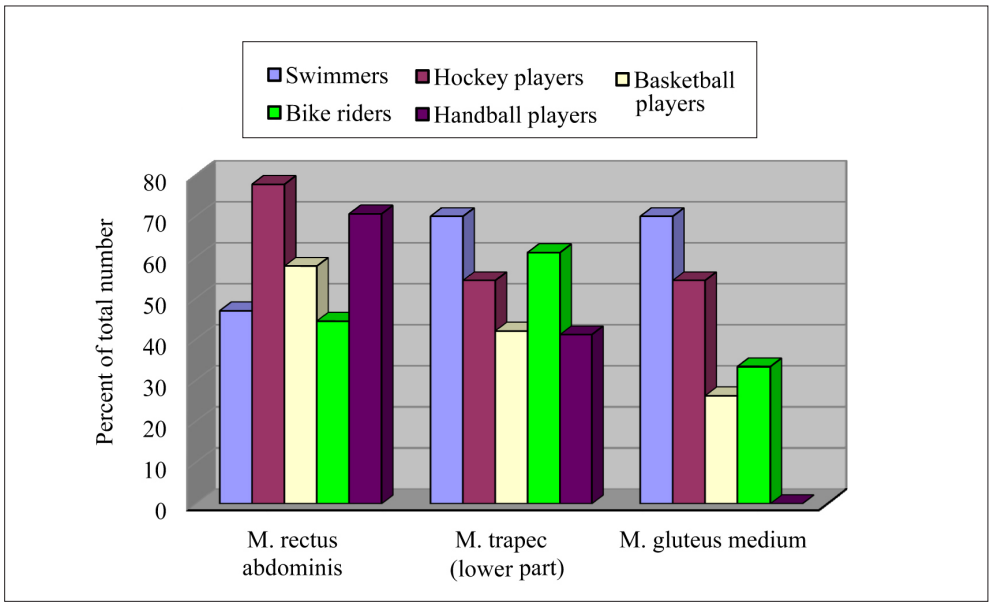


Figure 4. **Results of swimmer, ice-hockey and basketball player phasic muscle strength**

DISCUSSION

The muscles of trunk and core play a critical role in stabilizing the spine and pelvis during sports activities, protecting the cord and other body parts from injuries (Wood, 2002; Huxel Bliven, Anderson, 2013). Adding exercises to daily training routine that target to increase the strength of trunk and core is a foundation for advancing to a higher level of fitness and improved sports performance (Huxel Bliven, Anderson, 2013; Watanabe et al., 2014).

The measurements shown on the athlete profiles indicate that these changes occur at a young age during the training process as these athletes are aged between 14 and 17 years. For superior athletic performance, athlete posture profiles should be monitored throughout an athlete's development to indicate the speed that these changes occur. With the monitoring of the athletes' profiles, early intervention can be made to keep a more neutral posture and eliminate the chance of injury.

However, participation in any sport should not affect an athlete's posture to the extent that joint/muscle pain occurs due to muscle imbalance. If the correct training program is adopted (the one that incorporates strengthening of antagonistic muscles), a more neutral balanced posture should be maintained throughout the course of an athlete's career. This should allow the athlete to maintain superior athletic performances with minimal injuries due to posture changes. Yet, in order to achieve a neutral posture, athletes must spend equal time working on the antagonist muscle groups. This may not feasible due to time and physical limitations.

Spinal cord in athletes of different kind of sports that involve large rotations, such as gymnastics, ballet, swimming, wrestling, javelin throwing, etc., it has not yet been determined that these activities lead to a direct acceleration or worsening of postural disorders (Tanchev et al., 2000; Wood, 2002; Slawinska et al., 2006).

The results of this study showed that athletes of all groups had short pelvic (A – 77.2%, B – 84%, C – 73%, D – 82.4%, E – 83.4%) and hamstring muscles. If the leg and pelvic muscles are shorter, the lordosis of the lower back increases the function of the spine, amortisation decreases, as well as equal load division. If the body adaptation ability is low, it can cause pain in the lower back and knee joints. Basketball players' hamstring muscles have significantly higher tone than those of swimmers.

The shortened muscles of the shoulder girdle in group B – m. erector cervicis, m. pectoralis major and m. pectoralis minor indicate that these muscles are overloaded. The upper cross syndrome is characteristic of athletes in repetitive shoulder sports such as swimming and rowing (Коган et al., 1986; Иваничев, 1999). The loading of the sport on the shoulder girdle has shown the spine hyper-kyphosis of the chest part and the shortening of the small chest and upper trapezius muscles (Solovjova, a, b, 2004).

The lower cross syndrome is characteristic of athletes in sports requiring complicated coordination (e. g. Ice-hockey, basketball) with high loads on lower extremities: "body falling" forward, hyper-lordosis of the chest-pelvis area and the shortening of the pelvic muscles at weakened major hip muscles and m. rectus abdominis (Travell, Simons 1992).

CONCLUSIONS

1. It is purposeful to distinguish muscles according their tone to postural and contracting muscles. The postural muscles that form posture have rather high tone, but if these muscles are overloaded, the tone pathologically increases and the muscle cannot contract nor relax effectively enough to allow the antagonist to work. Contracting muscles that provide movements have lower tone than postural muscles.

2. Individual decline from a neutral posture in the sagittal plane is a characteristic feature for individuals of various kinds of sport due to the overload of some muscle groups.

3. The lower cross syndrome is a common feature for athletes of sports requiring complicated coordination at high rates of workloads on lower extremities.

4. Balanced strength of the phasic and postural muscles is one of the preconditions to form a correct posture. The adequate strength is a factor ensuring a correct stereotype variety of movements.

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