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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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REVIEW: INTEGRATIVE COORDINATION ABILITIES OF COACHES IN WELLNESS TYPES OF GYMNASTICS

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ABSTRACT

Background. The coordination development level influences the execution of any human activity, which is very important for the general perception of this activity and behavior in general. It is especially relevant for to coaches in wellness and sports gymnastics. The aim of the present study was the identification of the coordination skills of coaches of different types of gymnastics, which would improve the process of their professional training.

Material and Methods. This review presents a synthesis of research conducted by the author. The following methods of theoretical research were used: abstract and axiomatic methods, analysis and synthesis, induction and deduction, idealization, comparison and generalization, and projecting.

Results. The coaches' training in different types of gymnastics includes the development of a wide range of professional skills: the tandem of *communicative* and *motor* skills that determine one type of complex coordination. The realization of complex coordination presupposes the participation of sensor systems (analyzer systems), which are visual, auditory, tactile, vestibular, and motor systems. The basic speech component of complex coordination in coaches' activity/behavior determines his/her communicative orientation in the process of teaching. It is explained by the connection between the cultivation of complex coordination skills with the congenital and genetic, anatomical and physiological particularities of the human organism. We determined the coordination abilities, the formation of which contributes to the development of complex coordination skills.

Conclusion. Development of integrative coordination abilities is an important part of professional activity of coaches of gymnastics, which requires such preparation.

Keywords: coordination, professional skills, coach, gymnastics, aerobics.

INTRODUCTION

Coordination, as a psycho-motor ability, is present in different spheres of human activity. To a certain degree, the coordination development level influences the style and execution manner of any activity and human behavior, which is very important for the general perception of this activity and behavior in general. In this context Vadim Zeland, a former physicist, and now a writer, suggests the notion of coordination principle (*Зеланд*, 2004) stating that *coordination makes the shortest and the optimal path to an aim*. It is especially relevant to physical education specialists, particularly, to coaches in wellness and sports types of gymnastics.

During the lessons of wellness/fitness aerobics or other group oriented gymnastics activity the coach has not only to adjust the coordinated combination of his/her muscle efforts under musical accompaniment, make a logical transition from one motor assignment to another, but he/she also has to carefully watch the execution of physical activities of the exercisers to offer them methodological recommendations if needed. That is why the coaches must possess musical-rhythmic/motor skills that are a necessary condition for the realization of these lessons (Aftimiciuc, 1997; Aftimiciuc & Gönczi-Raicu, 1999; Liberman & Mattingly, 1985; Scheid & Eccles, 1975; Schoen, 1945/ 2000).

METHODS

This review presents a synthesis of research conducted by the author. In this work we used the following methods of theoretical research: abstract and axiomatic methods, analysis and synthesis, induction and deduction, idealization, comparison and generalization, projecting and modeling.

RESULTS

Integrative coordination abilities as professional skills. The coaches' training of different types of gymnastics involves the formation of a wide range of professional skills: the tandem of *communicative* and *motor* skills that determine one type of complex coordination (Aftimiciuc, 2002; Craijdan & Aftimiciuc, 2013; Galantucci, Fowler, & Turvey, 2006; Liberman & Mattingly, 1985). Furthermore, when we speak about the activity of loco-motor system, we also suppose the participation of sensor systems (analyzer systems), namely visual, auditory, tactile, vestibular, motor, which allow us to perform the transfer and processing (analysis and synthesis) of afferent information at the regulation of body movements and postures by perception. From this position the coaches of gymnastics sports must possess and use this complex set (integrative) of coordination in their professional activity, which presupposes the following types presented in Figure 1 (Gönczi-Raicu, Aftimiciuc, & Danail, 2014).

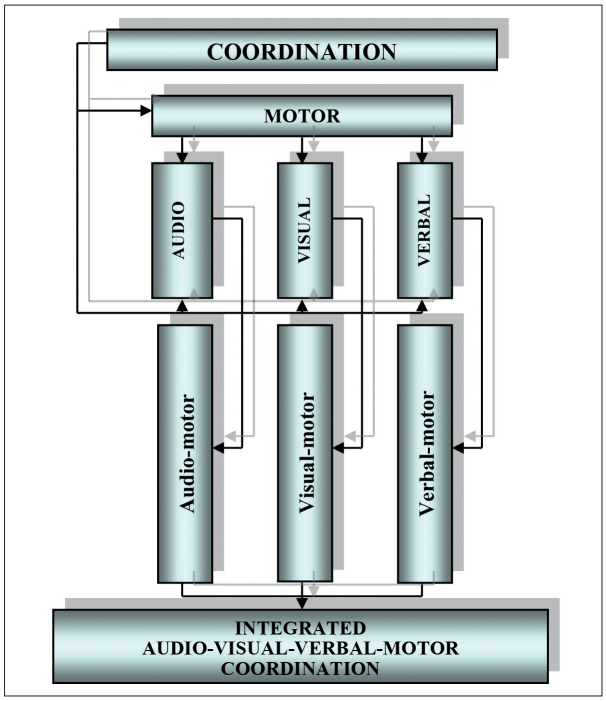


Figure 1. **Types of complex coordination (Gönczi-Raicu, Aftimiciuc, & Danail, 2014)**

It should be marked that there is a certain differentiation in the content of this set of abilities for the specialists in certain types of gymnastics. For example, the possession of these abilities by the coaches of sport gymnastics is expressed in two forms. In the first case – it presupposes *work with the group* or the process of *competitive composition development* (Figure 2). The second case can appear when the coach undertakes the obligation for *choreography realization* (Figure 3).

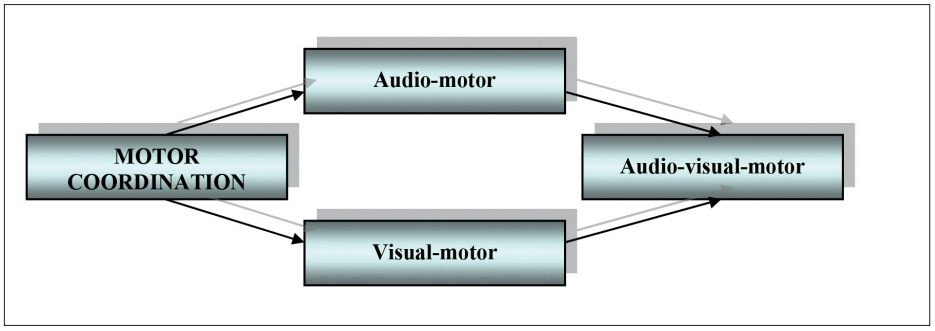


Figure 2. **Variety of motor coordination during the work with the group (Faur, Aftimiciuc, & Danail, 2014)**

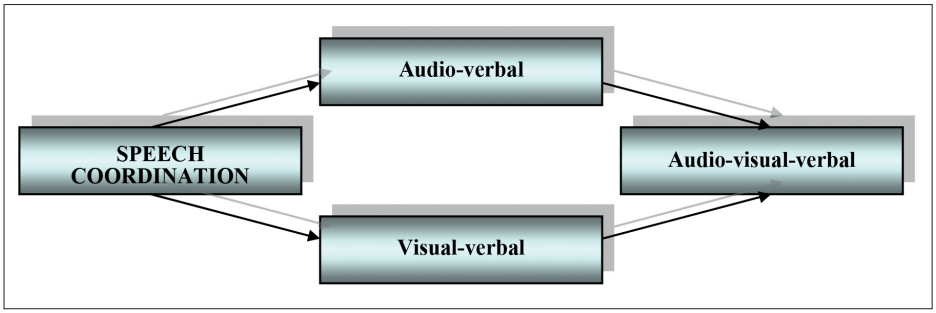


Figure 3. **Types of speech coordination of the coach of sports gymnastics (Aftimiciuc, 2007)**

As we can see, in the first case the basic form of coordination is **motor,** which presupposes training and program elaboration (Figure 2).

Motor coordination is a one of the substantial components of motor preparation. The high level of its development is the basis of success not only in sport, but in any other professional activity (Aftimichuk & Kuznețova, 2015; Bennett & Riemer, 1995; Côté-Laurence, 2000; Gönczi et al., 2002; Siegenfeld, 2009). Without doubt, the level of coordination development determines the positive result of the professional activity of the coach of different types of gymnastics, where the final result of his work is determined by the level of technical competence.

The sports practice shows that the world-class sportsmen include coordination exercises that act upon specific coordination abilities for improving the processes of technique economization, deliberately emphasizing its basic components as harmonizing means that compensates the monotony of the training "for endurance" in their training programs (Лях, 1999). At the same time, the analysis of the existent literature on the problem of professional preparation of the specialists in the field of physical education did not reflect the moments of task oriented to training of coordination abilities for future coaches. Probably this is caused by the fact that in different fields of physical activity different coordination requirements are required objectively from both the coach and athlete.

In the second case basic is the ***speech*** component of complex coordination, which reflects the character of coaches' activity/behavior, which, in its turn, determines his/her communicative orientation during training (Figure 3). The presented position presupposes speech support of the execution of motor assignments that imply explanation, objections, methodological indications, etc. (Aftimiciuc, 2007).

Besides the ability to make the exercises match the musical and rhythmic composition, the following skills including the *speech component* are also related to them (Figure 4):

- execution of rhythmic counting in conformity with the musical dimension;
- timely issue of instructions and special gestures for the start and finish of the exercises;
- realization of methodological discrepancies and indications in conformity with the rhythm of the exercises.

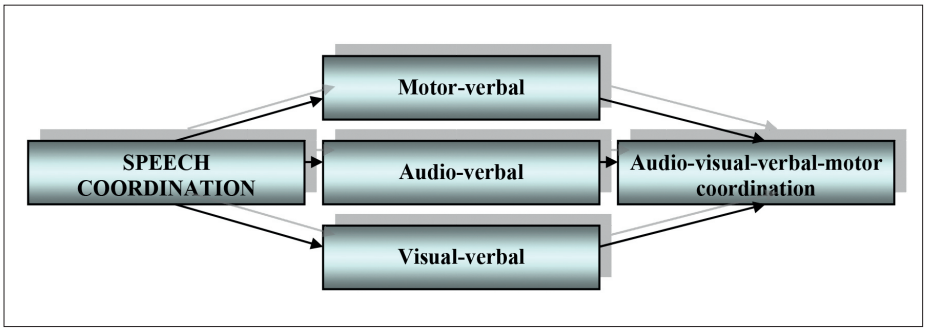
Only in this case the effect of the classes will be seen immediately. Such an integrated management of their own activities and the activities of the exercisers is seen in the skill of complex coordination (Ljach, Sadowski, & Witkowski, 2005; Raczek, Juras, & Waśkiewicz, 2001; Starosta, 1997).

Therefore, along with general pedagogical skills the coach of sport and wellness gymnastics must possess specific skills that precondition the existence of a set of coordination abilities, which altogether precondition the notion of ***coordination.***

For the foregoing reasons the *coordination* of a coach should be considered not only as one of the characteristics of his motor and coordination capabilities. Coordination is the result of harmonized combination of movements/actions/behavior in conformity with the goal set, state of the organism and activity conditions. It has a different level of expression for a concrete person. The level of individual coordination is discovered in a successful and qualitative singularity of the organization and regulation of movements/actions or behavior altogether. At the appreciation of the coordination degree of a person it is rational to use a set of criteria (qualities) that reflect the variety of coordination abilities.

The natural basis of coordination abilities is the *potential* by which the congenital and hereditary anatomical and physiological particularities of the organism are understood (Ильин, 2003). They include the properties of the nervous system (strength, mobility, balance of excitation and inhibition); individual variants of cerebral cortex

Figure 5. **Content of the specialized perceptions/"senses" (Craijdan & Aftimiciuc, 2013)**



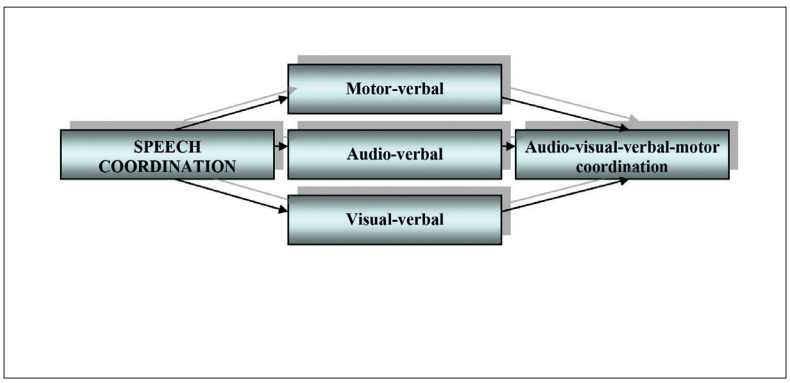


Figure 4. **Types of speech coordination of a coach of the therapeutic gymnastics (Aftimichuk, 2015)**

structure; maturity degree of its parts and other sections and other parts of the central nervous system; level of the development of separate analyzers (sensor systems); particularities of construction and functioning of neuromuscular apparatus; productivity ability of mental processes (sensations, perception, memory, representation, attention, thinking); temper; character; regulation and self-regulation particularities of mental state, etc.

As we can see, the aptitude for different types of coordination is determined by a set of psycho-physiological factors, and the level of their preparation first of all depends on genetic particularities of the organism, which are successfully developed.

It is commonly known that the *coordination abilities* include:

- differentiation of different movement parameters (time, space, strength etc.);
- spatial orientation;
- balance maintaining;
- movement reforming;
- movement connection (combination);
- adaptation to a changing situation and unusual task assignment;
- execution of tasks with the given rhythm;
- time control of motor reactions;
- forestalling (anticipation) of different features of movements, conditions of their execution and track of changes altogether;
- rational relaxation of muscles.

All the above mentioned abilities do not manifest in pure form, but in a complex interaction. The majority of them are determined as *specialized perceptions* or *"senses"* (Figure 5).

As it is known, movement control is related to *time parameters.* They are expressed by the movement *tempo* and *rhythm*. Very often these notions replace one another in literature despite the different characteristics of movement. *Tempo* characterizes the amount of movements of one type in a unit of time. That is why there is the notion of high, middle and low tempo, i.e. to fast, moderate and slow tempo (Афтимичук, 2011). Basically the tempo is mentioned when the time of movements and the intervals between them are permanent. *Rhythm* can characterized not only by the constancy but also the variability of both the intervals between movements and the movements themselves, and its separate phases, for example, when one movement is made quickly, and the other, which is first in the combination, slowly, or when the phases of one and the same movements occupy different periods of time.

Rhythm reproduction is related to the appreciation of time intervals. In this regard such qualities as *sense of time* and *sense of rhythm* are to be considered. The sense of time represents a certain interaction between analyzer systems (visual, auditory, kinesthetic) in the process of physical actions and activity execution, which generally determines the notion of *sensory-motor coordination* (Zapała et al., 2014; Ильин, 2003). In sport practice the sense of rhythm is understood as the ability to reproduce the given rhythm of motor action exactly or adequately vary it depending on the changed conditions. The sense of rhythm is expressed by the exact reproduction of the *direction, speed, acceleration, frequency* and other characteristics of movement. Rhythm reflects the *accuracy degree* of the made effort, *alternation of* relaxation and stress *phases.*

Vestibular tolerance is presented by the equilibrium sense, i.e. the ability to keep the vertical position of the body irrespective of the external influence. There is static and dynamic body balance. Balance is viewed as a multicomponent motor-coordinating quality which includes:

- rational positioning of parts of the body;
- minimization of the number of freedom degrees of the moving system;

- dosage and redistribution of muscular effort for the overcoming of the inertial force;
- space orientation.

Orientation in space is determined by the sense of space and is associated with the perception, assessment and management of spatial parameters of movement: distance to a certain object (aim); area dimension or obstacles; amplitude; direction; movement form etc. An important role in the development of the space orientation is played by the directed action in the process of physical education on the function of the analyzer systems.

The last two coordination abilities show the professional behavior of a specialist at the lessons of therapeutic aerobics. The level of their development will determine the level of methodological and practical preparation of the coach. It manifests itself in the specific character of exercise execution in aerobic regime with sufficiently intensive strength, and also in the application of methodological and didactical principles in the organization and realization of the lessons, which requires the improvement of the vestibular system of the teacher-coach.

The basis of the *sense of the object/projectile* is the interrelation of the functions of the analyzers tandem depending on the type of the activity or kind of sport. Following up the above mentioned facts it is worth concluding that as the classes of wellness aerobics are carried out with musical accompaniment, the specialist in this field must also possess a *sense of music* and *musical memory*, thin to feel complete musical phrases in order to correctly construct movement phrases and the whole composition.

CONCLUSION

Development of integrative coordination abilities is an important part of professional activity of the coaches of gymnastics which requires such preparation. For the purposeful development of professional motor and speech skills we suggest adding the "Musical and Rhythmic Education" working into the system of vocational preparation of coaches of the gymnastic sport as well as adopting verbal software in its content in the educational and training process of teachers and specialists in fitness.

REFERENCES

Aftimiciuc, O., & Gönczi-Raicu, M. (1999). *Probleme actuale privind formarea calităţilor integrative de coordonare în cadrul disciplinei „Educaţia ritmico-muzicală"*. Timişoara: Analele Universităţii de Vest din Timişoara.

Aftimichuk, O., & Kuznețova, Z. M. (2015). Rhythm importance in the system of professional pedagogical and sports training. *Pedagogical-psychological and medico-biological problems of physical culture and sports*, *2*(35), 6–14. doi: 10.14526/01_1111_04

Aftimiciuc, O. (1997). Mijloacele expresivităţii muzicale în formarea vorbirii la profesorul de cultură fizică: Tendinţe şi orientări în evoluţia ştiinţei sportului şi a educaţiei fizice: Sesiune de comun. ştiinţ. *Craiova*, 40–43.

Aftimiciuc, O. (2002). *Ritmul vorbirii şi capacitatea de coordonare în activitatea comunicativă a profesorului de cultură fizică: Impactul civilizaţiei moderne asupra educaţiei fizice şi sportului – implicaţii şi direcţii*. Bucureşti.

Aftimiciuc, O. (2007). Specificul comunicării profesionale a specialistului de aerobică. *Problematica educaţiei în mileniul III.* Galaţi.

Aftimichuk, O. (2015). Theory and practice of rhythm in the professional training system for athletes and teaching staff. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports*, *9*, 69–74. Retrieved from http://dx.doi.org/10.15561/18189172.2015.0911

Bennett, J. P., & Riemer, P. C. (1995). *Rhythmic activities and dance.* USA: Human Kinetics.

Côté-Laurence, P. (2000). The Role of Rhythm in Ballet Training. *Research in Dance Education*, *1*(2), 173–191.

Craijdan, O., & Aftimiciuc, O. (2013). Educarea capacităţilor coordonative la etapa iniţială a pregătirii sportive în gimnastica ritmică. Ştiinţa culturii fizice*: Pregătire profesională, antrenament sportiv, educaţie fizică, recuperare, recreaţie*, *15*/3, 10–18.

Faur, M.-L., Aftimiciuc, O., & Danail, S. (2014). *Ritmul activităţii motrice în sistemul pregătirii profesionale pedagogice a profesorului de educaţie fizică*. Chişinău: Valinex.

Galantucci, B., Fowler, C. A., & Turvey, M. T. (2006). The motor theory of speech perception reviewed. *Psychonomic Bulletin & Review*, *13*(3), 361–377.

Gönczi-Raicu, M., Aftimiciuc, O., & Danail, S. (2014). *Competenţe de coordonare complexă în cadrul activităţii didactice integrative a profesorilor de educaţie fizică*. Chişinău: Valinex.

Gönczi, M., Danail S., & Aftimiciuc, O. (2002). *Argumentarea conţinutului mijloacelor educaţiei ritmico-muzicale orientate spre formarea activităţii didactice*

cu structura ritmică de coordonare complexă: Impactul civilizaţiei moderne asupra educaţiei fizice şi sportului – implicaţii şi direcţii: A XII-a sesiunii anuală de comun ştiinţ. Bucureşti: Univ. Ecologică Bucureşti, FEFS.

Liberman, A. M., & Mattingly, I. G. (1985). The motor theory of speech perception revised. *Cognition*, *21*(1), 1–36.

Ljach, W., Sadowski, J., & Witkowski, Z. (2005). Problems of coordination fitness control in sports (as exemplified by sports games and combat sports). In Sadowski J. (ed.), *Coordination motor abilities in scientific research* (pp.70–82). University School of Physical Education, Warsaw, Faculty of Physical Education, Biała Podlaska.

Raczek, J., Juras, G., & Waśkiewicz, Z. (2001). The diagnosis of motor coordination. *Journal of Human Kinetics*, *6*, 113–125.

Scheid, P., & Eccles J. C. (1975). Music and speech: Artistic functions of the human brain. *Psychology of Music*, *3*, 21–35.

Schoen, M. (2000). *The understanding of music.* N.Y.: Harper & Brothers.

Siegenfeld, B. (2009). Standing down straight: Jump rhythm technique's rhythm-driven, community-directed approach to dance education. *Journal of Dance Education*, *9*(4), 110–119.

Starosta, W. (1997). Correlation between co-ordination and physical abilities in the theory and practice of sport training. In P. Blaser (Ed.), *Proceedings book of fifth international scientific conference of International Association for Sport Kinetics. Magdeburg Theories of human motor performance and their reflection in practice* (pp. 57–69). Hamburg.

Zapała, D., Zabielska-Mendyk, E., Cudo, A., Krzysztofiak, A., Augustynowicz, P., & Francuz, P. (2014). Short-term kinesthetic training for sensorimotor rhythms: Effects in experts and amateurs. *Journal of Motor Behavior*, *47*(4), 312–318.

Афтимичук, О. Е. (2011). Значение развития координационных способностей у будущих специалистов по оздоровительной аэробике: Оздоровительная аэробика. Теория и методика. Кишинэу: Valinex.

Зеланд, В. (2004). Трансерфинг реальности [Электронный ресурс]**.** Режим доступа: http://zelands.ru/

Ильин, Е. П. (2003). Психомоторная организация человека. СПб.: Питер.

Лях, В. И. (1999). О концепциях, задачах, месте и основных положениях координационной подготовки в спорте. Теория и практика физической культуры, *5*, 40–46.

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EMPATHY AND ITS FACTORS: EMPIRICAL STUDY

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ABSTRACT

Background. The level of personality's empathy largely determines altruistic behaviour and the quality of interpersonal relationships rendering the relevance of research indubitable. In psychology, empathy is classified into emotional/affective, cognitive and predictive. This study analyses affective empathy and aims to find out which personality traits related to self-perception, effectiveness in interpersonal relationships and sociodemographics are linked to empathy.

Methods. Research participants were schoolchildren, students, unemployed and employed individuals, inmates of imprisonment institutions and other young people. The target group was youth from 17 to 27 years of age, M =19.7, N =1400. An original measurement technique the psychometric quality indicators of which were sufficient (Cronbach's alpha reached .81) was used to research empathy.

Results. The means of Spearman's correlation coefficients revealed that empathy was related to self-irony (r = .19, $p \leq .001$), externality (r = .14; $p \leq .05$), positive self-evaluation (r = .47; $p \leq .001$), leadership disposition (r = .17; $p \leq .05$), etc. Mann-Whitney and Kruskal-Wallis tests revealed that women (Mean Rank = 274.88) were more empathic than men (Mean rank = 139.78; $p \leq .001$), young people with higher education (Mean Rank = 234.62) were more empathic than those with no or some education (Mean Rank = 161.06; $p \leq .001$), etc.

Conclusion. Research revealed that empathy was related to personal-psychological traits: self-irony, externality, positive self-evaluation, leadership disposition, general state of health, etc. The research highlighted the differences of empathy in different genders and revealed that women were more empathic than men. The research participants with high educational achievements exhibited the highest level of empathy.

Keywords: self-perception, interpersonal relationship effectiveness factors, sociodemographic factors.

INTRODUCTION

Relevance of research on personality and empathy is indubitable. It is an individual trait that often conditions altruistic behaviour, high-quality interpersonal relationships and aspirations to help people around. Thus, empathy plays a vital role in an individual's life as it allows the individual to interact effectively in social situations (Nanda, 2014). Range of researched questions is very wide – from whether it is a congenital or an acquired trait, to locating factors related to empathy.

The concept of empathy is treated rather ambiguously in psychology. The term, firstly used in the writings of an American psychologist E. B. Titchener, was interpreted as motor mimicry (movement imitation) (Goleman, 2001). Later, the understanding of this concept was expanded. Currently, empathy may be defined as a deep feeling of another individual's emotional state (*Psichologijos žodynas*, 1993). According to Baron-Cohen (2011), empathy is an ability to identify what someone else is thinking or feeling and to respond to these thoughts and feelings with an appropriate emotion. Dictionary of Psychology (*Psichologijos žodynas*, 1993) indicates that we may talk not only about emotional empathy (based on the aforementioned mechanism of imitating affective reactions) and cognitive

empathy (based on intellectual processes), but also about predictive empathy (ability to foresee affective reactions of a particular person in specific situations). Unfortunately, empathy researchers do not always clearly define how they perceive empathy, i.e. which component is central to their research. It must be acknowledged that certain confusion about concurrent concepts exists. For example, the concept of emotional intelligence is akin to empathy. As Mayer, Roberts, & Barsade (2008) claim, the concept of emotional intelligence encompasses key aspects of empathy – especially that understanding of empathy which highlights the recognition of other individual's feelings. Some authors regard empathy as an undeniable indicator of high emotional intelligence and treat it as one of the components of EQ, e.g. one of the most famous research methodologies – EI-i, TEIQue – includes empathy as a factor of EI (Bar-On & Parker, 2000; Petrides, Furnham, & Sanchez-Ruiz, 2008). However, these two concepts are not equivalent. Empathy differs from emotional intelligence by lower reflexivity and confinement to direct emotional experience, whereas emotional intelligence is always characterised by a pronounced cognitive component. In this study, empathy will be treated as compassion (empathising with feelings of others or with emotional states of others by identifying with them).

Even though many studies of empathy were conducted in order to find connections with demographic, personal and behavioural factors, their ambivalent results motivate scientists to delve further into this problem.

The purpose of this article was to present empirically validated relations between empathy, and self-perception, effectiveness of interpersonal relationships and sociodemographic factors among Lithuanian youth.

METHODS

Subjects. A total of 1400 subjects were interviewed. The target group involved young people from 17 to 27 years of age (M = 19.7, SD = 3.29); 43.2% of men and 55.5% of women participated in the survey (1.3% have not specified their gender). A total of 1092 subjects who were studying were surveyed: 11–12th grade secondary school and gymnasium students (n = 371), vocational school (n = 384), college (n = 158) and university (n = 399) students. Other interviewees were the unemployed; imprisoned young people, representatives of some unions and social movements, and others.

Instruments:

- "Empathy" scale was comprised of 19 statements, e.g. "*I am saddened when I see a lonely stranger surrounded by other people*", "*I become upset myself when I see a crying person*", "*Sometimes songs about love provoke many feelings*", etc. Some statements were constructed in such a way that they needed to be transcoded in reverse order by giving evaluations of the opposite sign when calculating the study results. Subjects evaluated statements on a four-point scale from "Certainly not" to "Certainly yes" (coded as 0 to 3 in the data matrix). In the "empathy" scale M = 1.85, SD = 0.41 and SE = 0.02. Psychometric quality of the "empathy" scale was tested: internal consistency index Cronbach's α was sufficiently high and equalled to .81, while resolution index i/tt was always higher than .24.
- "Self-perception factors" block was comprised of three scales: 1) *Locus of control scale:* A scale of 16 statements was designed in order to determine properties of internality and externality. It was multiplexed into two factors of "internality" and "externality" using factor analysis. Calculated KMO index equalled to .79, both factors explain 34.70% of the general dispersion. Cronbach's α of "externality" and "internality" scales were respectively .75 and .65, resolution index i/tt varied from .32 to .53 and from .20 to .43. Examples of statements in this scale: "*Intelligence, will and work determine person's success, not fate or good connections*", "*I think that many events in my life take place by chance*". Subjects evaluated statements on a six-point scale from 0 to 5. In the "internality" scale M = 3.50, SD = 0.68 and SE = 0.03; the "externality" scale M = 2.19, SD = 0.82 and SE = 0.04. 2) *Leadership scale:* 13 statements reflecting person's leadership disposition were presented in this research instrument, e.g. "*I enjoy demonstrating initiative and I am not afraid to suggest new ideas*", "*When surrounded by people I would not feel shy to start a discussion or express my opinion about something I know well if asked* ", etc.

Subjects evaluated statements on a five-point scale from 0 to 4. In the "leadership" scale $M = 2.70$, $SD = 0.53$ and $SE = 0.03$. Internal consistency index was sufficiently good, Cronbach's α equalled to .80; resolution index i/tt varied from .23 to .63. 3) *Self-irony scale:* It was comprised of five statements, e.g. "*It would cause me a lot of laughter if I appeared in public wearing a sweater inside-out*". Subjects evaluated statements on a scale from 0 to 5. In the "self-irony" scale $M = 3.25$, $SD = 0.90$ and $SE = 0.04$; internal consistency index Cronbach's α equalled to .79, resolution index i/tt varied from .46 to .65, thus psychometric qualities of the scale were good. 4) *Self-evaluation scale*: 48 personality traits were presented, e.g. "*brave*", "*bitter*", and "*understanding*". Subjects were asked to evaluate whether these traits were characteristic of them on a scale from 0 to 6. Traits clearly fell into two categories of factors reflecting positive and negative traits after factor analysis of the scale was completed; KMO index equalled to .86, while both factors explained 28.80% of the general dispersion. In the "positive self-evaluation" subscale $M = 4.32$, $SD = 0.71$ and $SE = 0.03$; in the "negative self-evaluation" subscale $M = 2.93$, $SD = 0.77$ and $SE = 0.04$. Psychometric calculations revealed that in the "positive self-evaluation" subscale internal consistency index Cronbach's α equalled to .90, resolution index r/itt varied from .27 to .70; in the "negative self-evaluation" subscale Cronbach's α equalled to .84, r/itt index varied from .20 to .59.

- "Interpersonal relationship effectiveness factors" block was comprised of strategies of conflict resolution and extroversion-introversion scales. 1) *Strategies of conflict resolution scale:* 25 statements revealing the mode of behaviour in a conflict situation were evaluated on a scale from 0 to 5, e.g. "*I put off contentious issues until situation calms down*", "*I can stand for myself*". Factor analysis was used to multiplex statements into five subscales: "cooperation" ($M = 3.35$, $SD = 0.78$, $SE = 0.04$), "compromise" ($M = 3.36$, $SD = 0.84$, $SE = 0.04$), "evasion" ($M = 2.99$, $SD = 0.86$, $SE = 0.04$), "adaptation" ($M = 2.81$, $SD = 0.72$, $SE = 0.03$) and "competition" ($M = 2.55$, $SD = 0.82$, $SE = 0.04$). Internal consistency index Cronbach's α of these subscales varied from .67 to .75. 2) *Extroversion - introversion scale* was comprised of 19 statements that subjects evaluated on a scale from 0 to 4. Examples of statements: "*I feel strained and restless when I am in company*", "*I like to stand out using my appearance – clothes, hairstyle and similar*", etc. In the "introversion" subscale $M = 1.79$, $SD = 0.66$ and SE = 0.03; in the "extroversion" subscale $M = 2.45$, $SD = 0.59$ and $SE = 0.03$. Internal consistency indexes in these subscales were satisfactory, Cronbach's α varied from .67 to .70.
- **"Sociodemographic factors" block** was comprised of the following characteristics of a subject: gender, main activity, present occupation, etc. Questions about academic achievements of young people were also presented in this part of the questionnaire.

RESULTS

Correlation between personality's empathy and self-perception indexes demonstrated significant statistical relations (see Table 1) that differed by their strength and reliability. Especially strong and statistically significant relation was established between empathy and positive self-evaluation ($r = .47$, $p \leq .001$). Weak, however statistically significant relation linked empathy and locus of control variable – externality. Also, a seldom strong connection was found with leadership and self-irony scales.

The study of empathy and interpersonal relationship effectiveness indexes also revealed many statistically significant relations. Since introversion and extroversion are opposite constructs and expressions, it is obvious that their relation with empathy, at least theoretically, should be opposite as

Table 1. **Correlation (Spearman's Correlation Coefficient) between empathy and self-perception scales**

	SCALES					
	Leadership	**Self-irony**	**Locus of control**		**Self-evaluation**	
			Internality	**Externality**	**Positive**	**Negative**
EMPATHY	.17 *	.19 **	.17	.14 *	.47 ***	**.09**

Note. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$.

well. Obtained results (see Table 2) confirmed this assumption: positive relation with extroversion and negative one with introversion were found.

Table 2 also demonstrates that empathic personalities tended to choose most peaceful conflict resolution strategies – cooperation, compromise and adaptation. These strategies were most closely related to ability to empathise with emotions of others (r varies from .35 to .24, $p \leq .001$).

Table 3 shows data of the importance of some sociodemographic factors to empathy. Statistically significant differences were established between males and females, different activity youth groups, inhabitants of different cities, some education indexes, e.g. well-educated youth (i.e. university, college, gymnasium students) were more empathic than less-educated youth (vocational school and secondary school students). Also, high-ability students demonstrated higher levels of empathy than low-ability students. It was found that subjects who were better at languages were more empathic than the ones studying hard sciences. Also,

Table 2. **Correlation (Spearman's Correlation Coefficient) between empathy and interpersonal relationship effectiveness scales**

	SCALES						
	Extroversion	**Introversion**	**Conflict resolution strategies**				
			Cooperation	**Compromise**	**Evasion**	**Adaptation**	**Competition**
EMPATHY	.31 ***	–.16 **	.35 ***	.28 ***	.18 **	**.24** ***	**–.07**

Note. *p ≤.05, **p ≤ .01, ***p ≤ .001.

Table 3. **Relation between sociodemographic variables and empathy according to Mann-Whitney and Kruskal-Wallis, duplex model, $p \leq .05$**

Sociodemographic variables		**Mean Rank**	Asymp.Sig. **Kruskal-Wallis χ2**	**Mann-Whitney *U*** **Kruskal-Wallis χ2**
Gender:	Female Male	274.88 139.78	$p \leq .0001$	846.4
Subject group:	Professionals Students of vocational schools	267.75 161.06	$p \leq .0001$	33.25
City of residence:	Vilnius Klaipėda	284.10 165.74	$p \leq .0001$	26.50
Evaluation of grades:	High-ability student Low-ability student	234.64 160.96	$p \leq .001$	14.88
Favourable subjects in school:	Languages Hard sciences	239.70 184,99	$p \leq .0001$	19.31
Field of study:	Social sciences-humanities Working-class professions	210.08 116.21	$p \leq .0001$	53.39
Level of education:	High Low	234.62 161.06	$p \leq .0001$	1111.65

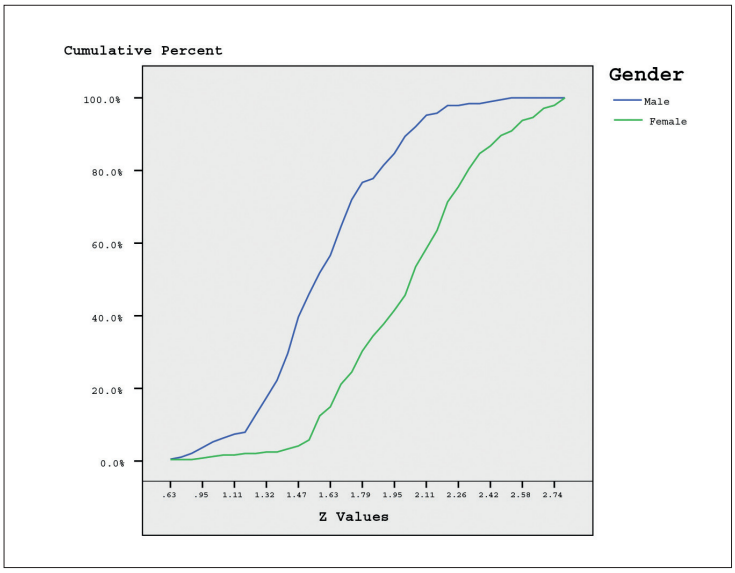

Figure. **Comparison of empathy between males and females**

representatives of working-class professions were characterised by low empathy levels. Highest levels of empathy were manifested by young subjects who studied social sciences or humanities.

Figure demonstrates repeated comparison of empathy according to the gender of subjects. Cumulative percentage distribution was applied in order to compare the groups. Cumulative frequency curve informatively demonstrates the differences between these groups.

DISCUSSION

Empathy and self-perception. Hypothetically thinking, it was possible to assume that empathy was related to one of the dimensions of locus of control – internality, therefore this assumption was tested in this study.

Locus of control is a constant individual characteristic that forms during the process of socialisation. Personalities who possess external locus of control attribute responsibility to external forces, i.e. it is believed that their successes or failures are determined by external factors, whereas internal type personalities take responsibility for themselves, their own abilities and efforts. Interestingly, the study has revealed that empathy is more related to externality even though various studies demonstrate significant relations between internality and emotional intelligence of which empathy is a component (Antinienė and Lekavičienė, 2015; Bellamy, Gore & Sturgis, 2005 (accepted for publication)). This discrepancy may be explained by the fact that in this study empathy was defined as compassion, i.e. empathising with the emotional states of others by identifying with them. This indicates lower reflexivity and imitation of affective reactions, whereas emotional intelligence is linked with cognitive empathy. It is therefore likely that empathic individuals are limited by direct emotional experience when perceiving a situation, while intellectual processes are not distinctly expressed. The latter feature is more characteristic of internal personalities. Nevertheless, relation established in the study was weak ($r = .14$, $p \leq .05$).

No significantly stronger relation was found between empathy and leadership ($r = .17$, $p \leq .05$). Emotional dimension is very important to the idea of leadership. As James and Connolly (2000) note, all principles of leadership are based on the notion that the emotional level of leadership is the most important. According to Ryback (1998), successful leaders always adjusted in accordance with human interaction and their decisions were full of emotional sensitivity. Many empirical studies that found some sort of positive relations between the main emotional intelligence factors (empathy as one of them) and leadership potential were conducted (Batool, 2013; Esfahani & Soflu, 2011; Hur, van den Berg, & Wilderom, 2011; Lam & O'Higgins, 2013). This study found statistically significant but not high correlation scores. It is likely that the scores would be higher if empathy was defined as a cognitive process and the study methodology was constructed accordingly.

Analysis of scientific literature has revealed that humour is associated with various psychological functions, interpersonal interaction, methods for combating stress, and psychological and social benefits (Martin, 2003; Yip & Martin, 2006). On the other hand, not many studies analysing relations between emotional dimension and humour were conducted (Gignac, Karatamoglou, Wee, & Palacios, 2014). Humour that is directed towards the joking person, i.e. self-irony is researched even more rarely. Therefore, it was interesting to evaluate such relation among empathic personalities. As many studies demonstrate, personalities with higher emotional competence are more likely to use humour to better social relationships without harm to themselves or others (Gignac et al., 2014). This study revealed that empathic personalities tended to make fun of themselves. It may be related to cultural environment and additional studies should be conducted to examine this hypothetical statement.

As various studies show, better emotional skills allow the personality to accept environment and themselves more positively, i.e. such individuals have higher self-evaluation levels (Lee, 2011; Petrides & Furnham, 2006; Yılmaz, Hamarta, Arslan, & Deniz, 2013). Relations revealed by this study confirmed insights of other authors – a relative high correlation coefficient was established ($r = .47$, $p = .001$). Positive attitude towards oneself allows the person to pay more emotional attention to others rather than to self-criticism and unproductive self-analysis.

Empathy and interpersonal relationship effectiveness. Success of interpersonal relationships of an individual may be conditioned by many various factors. This study researched two factors – extroversion/introversion of a personality and the choice of conflict resolution strategies. It is stereotypically usual to assume that self-oriented introverted

individuals are able to experience emotions of themselves and others more effectively. Our study revealed a negative dependency, i.e. personality is less empathic as introversion features are more pronounced. However, correlation was not strong ($r = –.16$, $p \leq .01$). On the contrary, empathy was demonstrated by extroverted-type individuals who under the stereotypical notion are more superficial in interpersonal relationships, inattentive to others and so on. Here, correlation was stronger ($r = .34$, $p \leq .001$). Results of this study mirror the works of Ghiabia and Besharatb (2011), Johnson, Batey and Holdsworth (2009), and others. Some scientists explain better emotional skills of extroverts by claiming that information of emotional nature stimulates them, whereas introverts are affected by emotional information in an opposite way – disorganisation, misbalancing and so on (Rosete & Ciarrochi, 2005, cited in Mayer et al., 2008). It is worthwhile noting that some studies found opposite results (Law, Wong, & Song, 2004).

The empirical study revealed that empathic personalities demonstrated strategies of cooperation, compromise and adaptation when in conflict. It is obvious that all three strategies are oriented towards maintenance rather than destruction of the relationship. Other authors also agree that empathy is not related to aggressive competition strategy, for example, Lee (2011) found that empathy reduced and inhibited aggressive behaviours. On the other hand, studies show that individuals who score high in emotional intelligence are not afraid to choose the competition strategy, they do not anticipate in advance which strategy they will choose in conflict and are more likely to seek for a positive end to a conflict (Chan, Sit, & Lau, 2014; Fernandez-Berrocal, Etremera, Lopes, & Ruiz-Aranda, 2014). It is likely that the difference between the results arises due to the fact that emotional intelligence is associated with cognitive empathy, whereas this study analysed emotional empathy.

Empathy and sociodemographic factors. Higher levels of empathy among women are confirmed in this study as in many other studies, e.g. Hojat et al. (2002), Baron-Cohen & Wheelright (2004) and so on. The most convincing evidence for gender differences in empathy is provided by studies using self-report measures to assess empathy (Rueckert, 2011). Results of some studies show that differences in empathy between genders may have a biological base. For example, Rueckert and Naybar (2008) investigated the relationship between activation of the right cerebral hemisphere (RH) and empathy. A correlation was found between RH activation on the face task and empathy for women only ($p = .037$), suggesting a possible neural basis for gender differences in empathy. Earlier studies did not record differences of such type. For example, in their meta-analysis, Wager, Phan, Liberzon, & Taylor (2003) did not find any significant difference in brain activity between men and women in response to emotional stimuli.

On the other hand, authors note that different results may be obtained depending on the methodology of a study. For example, data analyses revealed no significant gender differences in behavioural performance, but females rated themselves as more empathic than males in the self-report questionnaires (Derntl et al., 2010).

No other studies on the relation between empathy and quality of education among youth, high/low level of education and similar were located, but partial confirmation of some results may be found in the works of other authors. For example, Hojat et al. (2002) determined that personas' empathy significantly differed depending on their career, which may be oriented towards technology or people with higher levels of empathy among the latter (Wilks' lambda = 0.94, related multivariate $F_{(20,661)} = 2.25$, $p < .01$). This study revealed similar results: students of social sciences, humanities or those who were more successful when learning languages instead of hard sciences demonstrated higher levels of empathy.

Revealed fact that city inhabitants statistically significantly differ by their level of empathy is hard to interpret. According to Baron-Cohen (2011), culture and socialisation may play an important role in the development of empathy. Additional studies should be conducted to examine this statement.

CONCLUSIONS

The study has revealed that personality's empathy is related to various self-perception and interpersonal relationship effectiveness factors. More empathic subjects usually demonstrated more positive self-evaluation, better leadership skills, and familiarity with self-irony. Also, such individuals are more often extroverted and tend to attribute responsibility for events to external forces that do not depend on them. Such individuals usually choose strategies of cooperation, compromise and adaptation in order

to resolve conflicts. All aforementioned relations are statistically significant even though correlation coefficients are not high (from .14 to .47).

This study has confirmed statistically significant relations between empathy and sociodemographic factors. The importance of gender to empathy was empirically proved: women scored higher than men. It was empirically proved that higher levels of empathy were manifested by high-ability students of social sciences and humanities.

REFERENCES

Antinienė, D., & Lekavičienė, R. (2015). *Emocinis intelektas: Lietuvos jaunimo tyrimas:* monografija. Kaunas: Technologija (priimta spaudai).

Baron-Cohen, S., & Wheelright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high-functioning autism and normal sex differences. *Journal of Autism and Developmental Disorders*, *34*, 163–175.

Baron-Cohen, S. (2011). *Zero degrees of empathy: A new theory of human cruelty and kindness*. London: Penguin.

Bar-On, R., & Parker, J. D. A. (Eds.) (2000). *The Handbook of emotional intelligence: Theory, development, assessment, and application at home, school, and in the workplace*. San Francisco: Jossey-Bass.

Batool, B. F. (2013). Emotional intelligence and effective leadership. *Journal of Business Studies Quarterly, 4*(3), 84–94.

Bellamy, A., Gore, D., & Sturgis, J. (2005). Examining the relevance of emotional intelligence within educational programs for the gifted and talented. *Electronic Journal of Research in Educational Psychology*, *6*(3*),* 53–78. Retrieved from http://www.investigacion-sicopedagogica.org/revista/articulos/6/english/Art_6_68.pdf

Chan, J. C. Y., Sit, E. N. M., & Lau, W. M. (2014). Conflict management styles, emotional intelligence and implicit theories of personality of nursing students: A cross-sectional study. *Nurse Education Today*, *34*, 934–939.

Derntl, B. Finkelmeyer, A., Eickhoff, S. Kellermann, T., Falkenberg, D. Schneider, F. & Habel, U. (2010). Multidimensional assessment of empathic abilities: Neural correlates and gender differences. *Psychoneuroendocrinology, 35*(1), 67–82. doi: 10.1016/j.psyneuen.2009.10.006

Esfahani, N., & Soflu, G. H. (2011). Relationship between emotional intelligence and transformational leadership in physical education managers. *Procedia-Social and Behavioral Sciences*, *30,* 2384–2393.

Fernández-Berrocal, P., Etremera, N., Lopes, P. N., & Ruiz-Aranda, D. (2014). When to cooperate and when to compete: Emotional intelligence in interpersonal decision-making. *Journal of Research in Personality*, *49,* 21–24.

Ghiabia, B., & Besharatb, M. A. (2011). An investigation of the relationship between personality dimensions and emotional intelligence. *Procedia-Social and Behavioral Sciences 30*, 416–420.

Gignac, G. E., Karatamoglou, A., Wee, S., & Palacios, G. (2014). Emotional intelligence as a unique predictor of individual differences in humour styles and humour appreciation. *Personality and Individual Differences*, *56*, 34–39.

Goleman, D. (2001). *Emocinis intelektas*. Vilnius: Presvika.

Hojat, M., Gonnella, J. S., Nasca, T. J., Mangione, S., Veloksi, J. J., & Magee, M. (2002). The Jefferson scale of physician empathy: Further psychometric data and differences by gender and specialty at item level. *Academic medicine*, *77*(10), 58–60.

Hur, J. H., van den Berg, P. T., & Wilderom, C. P. M. (2011). Transformational leadership as a mediator between emotional intelligence and team outcomes. *The Leadership Quarterly*, *22*(4), 591–603.

James, Ch., *&* Connolly, U. (2000). *Effective change in schools*. London: Routledge Falmer.

Johnson, S. J., Batey, M., & Holdsworth, L. (2009). Personality and health: The mediating role of Trait Emotional Intelligence and Work Locus of Control. *Personality and Individual Differences 47,* 470–475.

Lam, C.-S., & O'Higgins, E. (2013). Emotional Intelligence and Leadership Styles in China. *Asia Pacific Management Review*, *18*(4), 441–467.

Law, K. S., Wong, C., & Song, L. (2004). The construct and criterion validity of emotional intelligence and its potential utility for management studies. *Journal of Applied Psychology, 89,* 483–496.

Lee, Ch.-J. (2011). Communication Competence, Empathy, and Self-Esteem. *Journal of Humanities Therapy, 2,* 83–94.

Martin, R. A. (2003). Sense of humor. In S. J. Lopez & C. R. Snyder (Eds.), *Positive psychological assessment: A handbook of models and measures* (pp. 313–326), Washington, DC: American Psychological Association.

Mayer, J. D., Roberts, R. D., & Barsade, S. G. (2008). Human abilities: emotional intelligence. *Annual Review of Psychology.* 59, 507–536.

Nanda, S. (2014). Are there Gender Differences in Empathy? *Undergraduate Journal of Psychology*, *7*, Retrieved from http://ujpb.org/research/volume-7/are-there-gender-differences-in-empathy

Petrides, K. V., Furnham, A., & Sanchez-Ruiz, M. J. (2008). TEIQue Development Report. Advanced People

Strategies. Retrieved from: http://www.advancedpeoplestrategies.co.uk /files/_TEIQue%20%20Sample%20Report.pdf

Petrides, K. V., & Furnham, A. (2006). The role of trait emotional intelligence in a gender-specific model of organizational variables. *Journal of Applied Social Psychology, 36,* 552–569.

Psichologijos žodynas. (1993). Red. R. Augis, R. Kočiūnas. Vilnius: Mokslo ir enciklopedijų leidykla.

Rueckert, L. (2011). Gender differences in empathy. In *Psychology of Empathy* (pp. 221–234). Chicago, Illinois, USA: Illinois University.

Rueckert, L., & Naybar, N. (2008). Gender differences in empathy: The role of the right hemisphere. *Brain and Cognition, 67*(2), 162–167.

Ryback, D. (1998). *Putting emotional intelligence to work: Successful leadership is more than IQ.* Boston: Butterwork-Heinemann.

Wager, T. D., Phan, K. L., Liberzon, I., & Taylor, S. F. (2003). Valence, gender and lateralization of functional brain anatomy in emotion: A meta-analysis of findings from neuroimaging. *NeuroImage*, *19*, 513–531.

Yılmaz, H., Hamarta, E., Arslan, C., & Deniz, M. E. (2013). An investigation of loneliness, self-esteem and emotional intelligence skills in university students. *International Journal of Academic Research Part B*, *5*(1), 205–209.

Yip, J. A., & Martin, R. A. (2006). Sense of humor, emotional intelligence, and social competence. *Journal of Research in Personality*, *40*, 1202–1208.

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MOVEMENT GAMES IN VARIOUS KINDS OF SPORT (EXPERIENCES OF COACHES STUDYING AT LASE)

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ABSTRACT

Background. Practice game contributes to the development of coordinated motor skills needed for later game playing or sport. When coaches know and use movement games corresponding to the specific sport to increase athlete's interest and pleasure about sport and sport pedagogue's knowledge about the scientifically based movement games, they promote the acquisition of skills at higher levels. Research aim was to ascertain the knowledge of coaches about movement games in sport classes, in order to research the use of movement games in the training process in different sports and to investigate how games are applied in the training process in Latvia.

Methods. The methods of research were analysis of the literature corresponding to the research problem, questionnaire and discussions with coaches, statistical methods. The study was conducted in 2010 – 2012 in Riga, LASE. There were 96 research participants – simultaneously practicing coaches and the extramural students of the LASE.

Results. In the study process we investigated and evaluated the knowledge of coaches and their opinions regarding movement games: development of physical abilities, improvement of the sport technique, development of social skills, and the experience in using movement games in training classes. Responses to the first three questions were compared with those obtained in the questionnaire survey in 1994.

Conclusions. The questionnaire survey showed that coaches were willing to apply movement games. Some of them also were sceptic about using movement games in sport activities; 94% admitted that games facilitated physical abilities, 87.5% agreed that games aided in the development of sport techniques, and 85% of respondents were confident that games contributed to building up social skills. In the questionnaire of 1994, the number of those who considered that games were essential in training was similar to those in the questionnaire survey of 2012 – respectively 80 and 84%. In total, movement games were applied by 61% of different sports coaches (1994) in comparison with 79% today. Changes in indices were statistically significant ($p < .05$). Even 18% more respondents gave preference to games in the questionnaire survey of 2012 than in the questionnaire survey of 1994.

Keywords: coaches, questionnaire survey, knowledge, movement games.

INTRODUCTION

The **purpose** of the research was to ascertain the knowledge of coaches about movement games in sport classes in order to research the use of movement games in the training process in different sports. Research idea was to investigate how games were applied in the training process in Latvia based on the coaches' knowledge and practical experience in the use of movement games. Movement games are games with motion and possibly with competitive activities, with previously developed and known content, rules, goal, organisation and pleasure (Dravniece, 2013; Laizane, 1981). This definition is similar to the definitions_given by other authors (Dauer & Pangrazi, 1989; H. Haag & G. Haag, 2003). In every sport children should be interested to enjoy movement in the first place. The best way to do it is to use movement games. Interesting and

varied physical activities establish positive attitude towards sport that ensures willingness to continue excercising. Games permit children to practise their competencies and acquired skills in a relaxed, pleasurable way. Play involves the repetition of behaviour when new skills are learned or when physical or mental mastery and coordination of skills are required for games in sports. Practise play contributes to the development of coordinated motor skills needed for later game playing (Santrock, 2001). As an integral part of the physical education program, games need to be scrutinized carefully and evaluated in terms of what they offer to children. Children and teachers can create and modify games and adjust them to various needs by changing the rules and combining games with each other (Dauer & Pangrazi, 1989; Dravniece, 2013; H. Haag & G. Haag, 2003). Coaches should view games as a valuable contribution to the child's overall development. While playing children can apply newly learned skills in a meaningful way. Many games help develop large muscle groups and enhance the child's ability to run, dodge, start and stop under control while sharing space with others. Cognitive development also enhances as children learn, understand and follow rules. By applying strategy in games, children learn the importance of alertness and the mental aspect of participation (Dauer & Pangrazi, 1989). A game in sport is a method and means, as well as the way of movement activity organization; a game is a necessary part of movement activity, especially with pupils and adolescents. Games include several important tasks: developmental, educational, upbringing and health promoting (Dauer & Pangrazi, 1989; Dravniece, 1999; Dzintere & Stangaine, 2007; Jansone & Fernāte, 2009; Santrock, 2001). When coaches know and use movement games corresponding to a specific sport to increase athlete's interest and pleasure about sport and sport pedagogue's knowledge about the scientifically based movement games, they promote the acquisition of skills for the right kind of sport at a higher level.

METHODS

The subject of the research was the investigation of coaches' knowledge and experience in the use of movement games in the training process in various kinds of sport and comparing these data with those obtained in the questionnaire survey of 1994. We used theoretical, empirical and statistical research **methods** in the study. The methods of research were analysis of the literature corresponding to the research problem, questionnaire survey and discussions with coaches of different kinds of sport. In the statistical processing of the data we used *t*-test and the Spearman's rank correlation coefficient. The study was conducted in 2010 – 2012 in Riga, LASE.

Research participants. For the purposes of the survey 96 persons (n = 96) were surveyd, namely, practicing coaches which simultaneously were the extramural students of the LASE (n = 56) or the students of the first cycle higher professional education programme "Educational and sport teaching specialist" (n = 40). They were coaches who were working in sport but still without sports education. In order to increase the objectivity, the questionnaire survey was conducted before the beginning of the course of games. The surveyed coaches represented 37 kinds of sport, which were combined in 14 groups of related sports, i.e. 15 represented track-and-field, 15 – wrestling sports, boxing, power-lifting, ten – gymnastics, fitness, aerobics, yoga, nine – football, eight – basketball, seven – volleyball, five – ice hockey, five – floorball, four – swimming, two – rowing, two – skiing, two – tennis, two – handball, two – orienteering, and one in cycling, riding, shooting, climbing, parachuting, chess, lacrosse and motorsport. When the individual kind of sport was represented only by one respondent, the answers were considered only as informative and could not be generalized to the common situation in a particular kind of sport. The survey involved men and women aged 19 to 56 years. There was a tendency that in older age groups there were more women than men. Among the students over 30 years of age, 55% were women and 45% were men. There were 46 respondents from Riga and 50 respondents from other Latvian cities; 71% of respondents were in the age group under 25 years, 20% were 26–39 years old, 9% – over 40 years old. We compared the responses to the first three questions with those obtained in the questionnaire survey in 1994. In 1994 the answers were given by 129 respondents (n = 129) representing different sports, mostly basketball players, athletes, rowers, wrestlers, gymnasts, swimmers and skiers.

Instruments. The questionnaire was anonymous, in general it was a mixed type of questionnaire - questions were both close and open ended. The hard copy of the questionnaire for coaches included 11 questions. The first 6 questions were closed and responses were used in aggregated form

only. Responses were limited to the stated alternatives; one of the alternatives was simply "yes" or "no". The questionnaires were prepared well in advance, they were structured and testable, and they had definite and concrete questions. The questions were the same in 1994 and 2012. The questionnaire comprised questions in total relating to the use of games in the training process, as well as about educational, developmental and upbringing functions of games. In this article we analysed replies given in six questions relating to the application of movement games in different sports. These questions were the following:

1. Were movement games included in your training classes (when you were training)?
2. Do you include movement games in your training classes?
3. In your opinion, are movement games essential in the training process?
4. Is it possible to develop physical abilities using movement games?
5. Is it possible to improve the sport technique using movement games?
6. Is it possible to develop social skills using movement games?

RESULTS

We investigated and evaluated the knowledge of coaches and their opinions regarding the movement games and the experience in the use of movement games in the training classes in different sports. Responses to the first three questions were compared with those obtained in the questionnaire survey in 1994. These replies were summarized in Tables 2, 3, 4.

The summary of responses to questions one, two and three in 2012 is given in Table 1.

Responding to the first question: "Were movement games included (when you were training)?" the majority of respondents (65.6%) gave an affirmative answer, while 34.4% said no. Movement games in the course of training mostly were applied by basketball (87.5%), volleyball (85.7%), ice hockey (80%) coaches, as well as in skiing, handball and in orienteering. Surprisingly, only 55.6% of football, 73.3% of track-and-field, 66.7% of wrestling, 60% of floor-ball coaches applied movement games in their coaching practice. There were several sports such as yoga, parachuting, possibly some other sports, where

Table 1. **Responses to questions 1–3 (The questionnaire survey of 2012)**

	Responses (n)	Games were included				Games are included				Games are essential			
		Yes		No		Yes		No		Yes		No	
		Abs. No	%	Abs. No	%	Abs. No	%	Abs. No	%	Abs. No	%	Abs. No	%
Track-and-field	15	11	73.3	4	26.67	11	73	4	27	12	80	3	20
Wrestling	15	10	66.7	5	33.33	11	73	4	27	12	80	3	20
Gymnastics	10	7	70.0	3	30.0	8	80	2	20	8	80	2	20
Football	9	5	55.6	4	44.44	7	78	2	22	7	78	2	22
Basketball	8	7	87.5	1	12.5	8	100	-	100	8	100	-	-
Volleyball	7	6	85.7	1	14.29	6	86	1	14	7	100	-	-
Ice hockey	5	4	80.0	1	20.0	5	100	-	100	5	100	-	-
Floor-ball	5	3	60.0	2	40.0	3	60	2	40	3	60	2	40
Swimming	4	2	50.0	2	50.0	3	75	1	25	4	100	-	-
Rowing	2	1	50.0	1	50.0	2	100	-	0	1	50	1	50
Skiing	2	2	100.0	-	-	2	100	-	0	2	100	-	-
Tennis	2	1	50.0	1	50.0	2	100	-	0	2	100	-	-
Handball	2	2	100.0	-	-	2	100	-	0	2	100	-	-
Orienteering	2	2	100.0	-	-	2	100	-	0	2	100	-	-
Cycling	1	-		1	100.0	-		1	100.0	1	100.0	-	
Riding	1	-		1	100.0	-		1	100.0	-		1	100.0
Shooting	1	-		1	100.0	1	100,0	-		1	100.0	-	
Climbing	1	-		1	100.0	1	100,0	-		-		1	100.0
Parachuting	1	-		1	100.0	-		1	100.0	1	100.0	-	
Chess	1	-		1	100.0	-		1	100.0	1	100.0	-	
Lacrosse	1	-		1	100.0	1	100,0	-		1	100.0	-	
Motorsport	1	-		1	100.0	1	100,0	-		1	100.0	-	
Total:	**96**	**63**	**65.6**	**33**	**34.4**	**76**	**79,2**	**20**	**20.8**	**81**	**84.4**	**15**	**15.6**

Table 2. **Responses to the question "Were movement games included in your training classes?" in 1994 and 2012**

Kind of sport	Responses in 1994					Responses in 2012				
	Responses (*n*)	Yes		No		Responses (*n*)	Yes		No	
		Abs. No	%	Abs. No	%		Abs. No	%	Abs. No	%
Track-and-field	14	11	78.6	3	21.4	15	11	73.3	4	26.7
Wrestling	12	11	91.7	1	8.3	15	10	66.7	5	33.3
Gymnastics	10	5	50.0	5	50.0	10	7	70.0	3	30.0
Football	7	4	57.1	3	42.9	9	5	55.6	4	44.4
Basketball	32	19	59.4	13	40.6	8	7	87.5	1	12.5
Volleyball	5	2	40.0	3	60.0	7	6	85.7	1	14.3
Ice hockey	2	2	100.0	-	-	5	4	80.0	1	20.0
Floor-ball	-	-	-	-	-	5	3	60.0	2	40.0
Swimming	10	7	70.0	3	30.0	4	2	50.0	2	50.0
Rowing	12	4	33.3	8	66.7	2	1	50.0	1	50.0
Skiing	8	4	50.0	4	50.0	2	2	100.0	-	-
Tennis	-					2	1	50.0	1	50.0
Handball	4	3	75.0	1	25.0	2	2	100.0	-	-
Orienteering	7	4	57.1	3	42.9	2	2	100.0	-	-
Cycling	3	2	66.7	1	33.3	1	-	-	1	100.0
Riding	-	-	-	-	-	1	-	-	1	100.0
Shooting	3	1	33.3	2	66.7	1	-	-	1	100.0
Climbing	-	-	-	-	-	1	-	-	1	100.0
Parachuting	-	-	-	-	-	1	-	-	1	100.0
Chess	-	-	-	-	-	1	-	-	1	100.0
Lacrosse	-	-	-	-	-	1	-	-	1	100.0
Motorsport	-	-	-	-	-	1	-	-	1	100.0
	129	**79**	**61.2**	**50**	**38.8**	**96**	**63**	**65.6**	**33**	**52.4**

movement games due to specific reasons or age limitations of athletes were not essential, indeed. Several coaches admitted that they used movement games in training children when they started their sport activities – in the preparatory stage of the training process.

In questionnaire of 1994, some kinds of sport such as tennis, floor-ball, climbing, parachuting, riding and motorsport were not included. During the last few years, lacrosse, street gymnastics, yoga, fitness became increasingly popular.

In questionnaire survey of 1994 it was found that games were included in the training activities by 61% of respondents in comparison to 66% today, an affirmative answer was given by 79 and 63 respondents representing different sports, mostly hockey players, wrestlers, athletes and handball players (Table 2, Figure 1). There are no statistically significant differences between positions of respondents ($a = .05$). The differences were evaluated by *t*-test.

Responses to the second question "Do you include movement games in your training classes?" the answers of coaches were more positive than to the first question. An affirmative answer was given by 79% while 21% of respondents said no. Today games in the course of training are applied by all coaches (100%) in basketball, hockey, rowing, skiing, tennis, handball, and orienteering, the majority of volleyball (86%), gymnastics (80%), football (78%) and swimming (75%) coaches. Even those who were not trained by applying games, as coaches included these games in their work. Like in answers to the first question, games were not applied by yoga, parachuting and riding coaches.

18 years ago movement games were mostly used by volleyball, handball, wrestling, football, rowing and swimming (100%) and basketball (93%) coaches. In total, then movement games were applied by 61% of different sports coaches in comparison with 79% today (Table 3, Figure 1). Changes in indices are statistically significant ($p < .05$). 18% more respondents gave preference to games in the questionnaire survey of 2012 than in the questionnaire survey of 1994.

Table 3. **Responses to question 2 "Do you include movement games in your training classes?" in 1994 and 2012**

Kind of sport	Responses in 1994					Responses in 2012				
	Responses (*n*)	Yes		No		Responses (*n*)	Yes		No	
		Abs. No	%	Abs. No	%		Abs. No	%	Abs. No	%
Track-and-field	14	13	92.9	1	7.1	15	11	73.3	4	26.7
Wrestling	12	11	91.7	1	8.3	15	11	73.3	4	26.7
Gymnastics	10	4	40.0	6	60.0	10	8	80.0	2	20.0
Football	7	6	85.7	1	14.3	9	7	77.8	2	22.2
Basketball	32	27	84.4	5	15.6	8	8	100.0	-	-
Volleyball	5	3	60.0	2	40.0	7	6	85.7	1	14.3
Ice hockey	2	2	100.0	-	-	5	5	100.0	-	100.0
Floor-ball	-					5	3	60.0	2	40.0
Swimming	10	8	80.0	2	20.0	4	3	75.0	1	25.0
Rowing	12	8	66.7	4	33.3	2	2	100.0	-	-
Skiing	8	8	100.0	-	-	2	2	100.0	-	-
Tennis	-					-	2	100.0	-	-
Handball	4	4	100.0	-	-	2	2	100.0	-	-
Orienteering	7	5	71.4	2	28.6	2	2	100.0	-	-
Cycling	3	3	100.0	-	-	1	-	-	1	100.0
Riding	-	-	-	-	-	1	-	-	1	100.0
Shooting	3	1	33.3	2	66.7	1	1	100.0	-	-
Climbing	-	-	-	-	-	1	1	100.0	-	-
Parachuting	-	-	-	-	-	1	-	-	1	100.0
Chess	-	-	-	-	-	1	-	-	1	100.0
Lacrosse	-	-	-	-	-	1	1	100.0	-	-
Motorsport	-	-	-	-	-	1	1	100.0	-	-
	129	**79**	**61.2**	**50**	**38.8**	**96**	**76**	**79.2**	**20**	**20.8**

Responses to the third question "In your opinion, are movement games essential in the training process?" were quite unambiguous – movement games are an essential part of the training process. This statement was supported by 84% of coaches, but 16% did not agree. All basketball, volleyball, hockey, swimming, skiing, tennis, handball, orienteering coaches agreed that movement games were essential, especially in the work with children. Some track-and-field, wrestling, floor-ball, rowing coaches claimed that games should be used in the preliminary training stages. Good tendency is that even those coaches (in cycling, parachuting, and chess) who did not use games in their training work admitted that games were an important part of the training process.

Like 18 years ago, there was a positive tendency – although only 79% of coaches applied movement games in their practical work, the number of coaches who wanted to implement games in their work was growing (84%) (Table 4, Figure). There are no statistically significant differences between positions of respondents (a = .05). The differences were evaluated by t-test.

Summary of responses to questions 1–3 in 1994 in comparison with 2012 is given in Figure. The picture shows that the role of games increased, especially in responses to question 2 "Do you include movement games in your training classes?" where 18% more respondents gave preference to games in the questionnaire survey of 2012 than in the questionnaire survey of 1994.

The summary of responses to questions four, five and six (in 2012) is given in Table 5.

Answering question 4 "Is it possible to develop physical abilities with movement games?" 94% of respondents gave an affirmative answer, confirming that movement games help develop physical abilities and only 6% of respondents thought otherwise. An affirmative answer was given by

Table 4. **Responses to question 3 "In your opinion, are movement games essential in the training process?" in 1994 and 2012**

Kind of sport	Responses in 994					Responses in 2012				
	Responses (n)	Yes		No		Responses (n)	Yes		No	
		Abs. No	%	Abs. No	%		Abs. No	%	Abs. No	%
Track-and-field	14	13	92.9	1	7.1	15	12	80.0	3	20.0
Wrestling	12	11	91.7	1	8.3	15	12	80.0	3	20.0
Gymnastics	10	4	40.0	-	-	10	8	80.0	2	20.0
Football	7	6	85.7	1	14.3	9	7	77.8	2	22.2
Basketball	32	27	84.4	5	15.6	8	8	100.0	-	-
Volleyball	5	3	60.0	2	40.0	7	7	100.0	-	-
Ice hockey	2	2	100.0	-	-	5	5	100.0	-	-
Floor-ball	-					5	3	60.0	2	40.0
Swimming	10	8	80.0	2	20.0	4	4	100.0	-	-
Rowing	12	8	80.0	2	20.0	2	1	50.0	1	50.0
Skiing	8	8	100.0	-	-	2	2	100.0	-	-
Tennis	-					2	2	100.0	-	-
Handball	4	4	100.0	-	-	2	2	100.0	-	-
Orienteering	7	5	71.4	2	28.6	2	2	100.0	-	-
Cycling	3	3	100.0	-	-	1	1	100.0	-	-
Riding	-					1	-		1	
Shooting	3	1	33.3	2	66.7	1	1	100.0	-	
Climbing	-					1	-		1	100.0
Parachuting	-					1	1	100.0	-	
Chess	-					1	1	100.0	-	
Lacrosse	-					1	1	100.0	-	
Motorsport	-					1	1	100.0	-	
	129	**103**	**79.8**	**26**	**20.2**	**96**	**81**	**84.4**	**15**	**15.6**

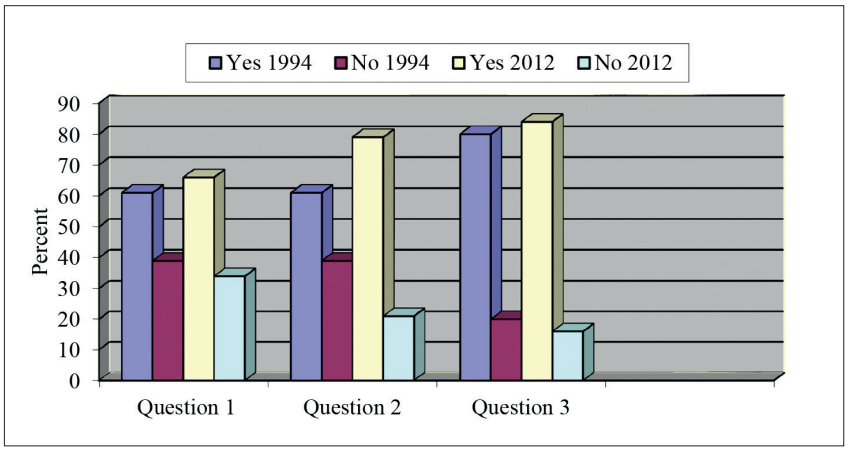

Figure 1. **Responses to questions 1–3 in 1994 and 2012 (Summary of Tables 2, 3, 4)**

all gymnastics, football, basketball, volleyball, floor-ball, swimming, rowing, skiing, tennis and orienteering coaches and 40% of hockey coaches.

Answering question 5 "Is it possible to improve the technique with movement games?" 87.5% of respondents said "yes" and 12.5% said "no". The majority of respondents agreed that movement games facilitated the development of sport technique, while 33% of football, 20% of track-and-field, wrestling and hockey coaches, 14% of volleyball, and 10% of gymnastics coaches thought otherwise.

Answering question 6 "Is it possible to develop social skills with movement games?" 85% of

Table 5. **Responses to questions 4–6 (in 2012)**

	Responses (n)	Develops physical abilities				Improves the technique				Develops social skills			
		Yes		No		Yes		No		Yes		No	
		Abs. No.	%	Abs No.	%	Abs. No.	%	Abs. No.	%	Abs. No.	%	Abs. No.	%
Track-and-field	15	13	86.7	2	13.3	12	80.0	3	20.0	12	80.0	3	20.0
Wrestling	15	14	93.3	1	6.7	12	80.0	3	20.0	13	86.7	2	13.3
Gymnastics	10	10	100.0	-	-	9	90.0	1	10.0	9	90.0	1	10.0
Football	9	9	100.0	-	-	6	66.7	3	33.3	7	77.8	2	22.2
Basketball	8	8	100.0	-	-	8	100.0	-	0	8	100.0	-	-
Volleyball	7	7	100.0	-	-	6	85.7	1	14.3	5	71.4	2	28.6
Ice hockey	5	2	40.0	3	60.0	4	80.0	1	20.0	5	100.0	-	-
Floor-ball	5	5	100.0	-	-	5	100.0	-	0	5	100.0	-	-
Swimming	4	4	100.0	-	-	4	100.0	-	0	2	50.0	2	50.0
Rowing	2	2	100.0	-	-	2	100.0	-	0	2	100.0	-	-
Skiing	2	2	100.0	-	-	2	100.0	-	0	2	100.0	-	-
Tennis	2	2	100.0	-	-	2	100.0	-	0	2	100.0	-	-
Handball	2	2	100.0	-	-	2	100.0	-	0	2	100.0	-	-
Orienteering	2	2	100.0	-	-	2	100.0	-	0	2	100.0	-	-
Cycling	1	1	100.0	-		1	100.0	-		1	100.0	-	
Riding	1	1	100.0	-		1	100.0	-		-		1	100.0
Shooting	1	1	100.0	-		1	100.0	-		1	100.0	-	
Climbing	1	1	100.0	-		1	100.0	-		-		1	100.0
Parachuting	1	1	100.0	-		1	100.0	-		1	100.0	-	
Chess	1	1	100.0	-		1	100.0	-		1	100.0	-	
Lacrosse	1	1	100.0	-		1	100.0	-		1	100.0	-	
Motorsport	1	1	100.0	-		1	100.0	-		1	100.0	-	
Total:	**96**	**90**	**93.8**	**6**	**6.3**	**84**	**87.5**	**12**	**12.5**	**82**	**85.4**	**14**	**14.6**

respondents gave an affirmative answer, but 15% did not agree to that. Basketball, hockey, floor-ball players, rowers, skiers, tennis, handball players and orienteering athletes were fully confident about the significance of movement games in forming social skills. A negative answer was received from swimmers (50%), volleyball players (29%), athletes (20%), wrestlers (13%) and gymnasts (10%).

DISCUSSION

Based on the questionnaire survey we ascertained the knowledge of coaches about movement games and their practical experience in the use of movement games in the training process in different sports. We established how games were applied in the training process in Latvia, and compared results with those obtained in the questionnaire survey in 1994. In general, the questionnaire survey showed that coaches (84%) were willing to apply movement games. However, some of them also were sceptic about the use of movement games in sport activities. While 94% admitted that games facilitated physical abilities, some of them (87.5%) claimed that games aided in the development of sport techniques, and only 85% of respondents were confident that games contributed to building up social skills. These statements are in contradiction to those mentioned in literature and those proved in the training practice. Physical Education including games and sports plays a tremendous role in the development of youth. It enables an individual to live in an ever-changing world. Physical Education makes children psychologically, physically and physiologically active (Ajay, 2011). Games can help children develop physically, mentally and socially. Games are perfect means in the development of physical abilities, they facilitate sport techniques and they in the best way may contribute to developing social skills. Enough physical activity in the childhood, adolescence and youth is extremely important.

Children master those motor skills that form the basis of all other physical activities lifelong in the childhood (Porozovs & Klavina, 2014). By playing children improve their abilities to cooperate, to help each other, increase their individual responsibility and ability to work in a team. They learn to find solutions in different situations, to support each other, to encourage, to listen to, etc. (Vazne, 2006). Communication or exchange of information is considered to be the basic kind of interconnection. Interaction is the very first activity that a child masters in his/her development. Children's interaction and the development of competences occur as a result of social experience, especially in the interaction between a child and an adult. A child feels great satisfaction from common games where the process of information exchange takes place. Communicative competence includes a human's ability to solve communicative tasks with the help of language, voice as well as body language within the interconnection in different situations of the intercourse. It is possible to judge the level of a child's communicative competence considering the child's skill to communicate, i.e. to have common talks as well as the skill to listen, to collaborate with playmates in real life and imaginary situations. Within the interaction a child learns to imitate various real life situations through the game, to perform a role play, learns to apprehend as well as coordinate his/her actions with the playmates (Stangaine, 2010). Some respondents have mentioned that in professional sports games perfectly help to relieve psychological stress that accrues during the long and exhausting sport season that is a very important aspect. The fact that affirming responses to the second question "Do you include movement games in your training classes?" (79%) prevail over those given to the first question (66%) shows a positive dynamics. Responses to the third question are even more favourable – 84% of respondents consider games to be essential part of the training process. We are sure that the students of LASE should master the games and their methodology which in turn should facilitate their implementation in the training process in the way which is best suited for particular kind of sports. There are some kinds of sports where the games are not used at all. Probably the sports become more and more professional and less space remains for games. It should be also taken into account that the questioned respondents are still students who have not yet obtained the higher education degree in the sport pedagogy; they have only both positive and negative experience including experience in applying games in training process, which is gained from their own coaches. In our opinion, the movement games should be more implemented in some sports such as track-and-field, wrestling, football, gymnastics, floor-ball and swimming since the element of a game in these sports is very important. Probably the sports become more and more professional and less space remains for games.

Physical education professionals seek out avenues via which skills and interests developed within school can be pursued further, certainly in the case of those children who are keen and/or show notable talent in sport. We can readily recognise that learning and involvement in physical activity and sport happens in many places and various times. Arguably there is a need for greater recognition that learning related to health and physical education needs to be ongoing for all young people, responsive to their ever changing life circumstances, needs and interests, and is by no means the sole concern or domain of those currently identified as physical education teachers (Penney & Jess, 2004). Physical literacy serves as an important foundation for many sport and education policies. It is clear, therefore, that physically literate individuals not only move efficiently, but they also move creatively, competently, ethically, enthusiastically, and in socially responsible ways. Hence, individuals who are physically literate have the knowledge, skills, and attitudes to lead healthy lifestyles for themselves, and also assist others in acquiring these skills as well (*Mandigo, Francis, Lodewyk,* & Lopez, 2009*).*

CONCLUSIONS

In 2012 movement games in sport classes were applied by coaches for 18% more than in 1994 ($a < .05$). The results indicate positive tendency in practical application of movement games. In addition, in the questionnaire survey of 1994 (80%) as well as in the questionnaire survey of 2012 (84%) we noticed one more positive tendency that the coaches considered movement games to be essential and wanted to apply them more in future than at the time of the questionnaire survey (61 and 79%). We hope that when the coaches get pedagogical education at LASE, study game organization and management methodologies, as

well as understand the tremendous role of games in the educational process, they will use them more in various kinds of sports.

Respondents' views on the use of games confirm the beneficial effects of close and medium correlation between the results of questionnaire in various kinds of sports ($a < .05$), what confirms the stated hypothesis. When coaches know and use movement games corresponding to the specific sports kind to increase athlete's interest and pleasure about sport and sport pedagogue's knowledge about the scientifically based movement games, they promote the acquisition of skills for specific kinds of sport at a higher level (Dravniece, 1999). Overall, students' attitude to movement games was positive. The feedback and comments of the students were encouraging.

To compare the results it is possible to make a questionnaire for different age group coaches with higher education.

REFERENCES

Ajay, K. (2011). Importance of physical education, games & sports activities. *VSRD Technical & Non-Technical Journal, 2*(11), 570–573.

Dauer, V. P., & Pangrazi, R. P. (1989). *Games. Dynamic Physical Education for elementary School Children.* New York: Macmillan Publishing Company.

Dravniece, I. (1999). *Kustī*bu rotaļas sporta veidu apguvē*: Doctoral dissertation.* Riga: LASE.

Dravniece, I. (2013). Rotaļas LSPA studiju procesā – kustību rotaļas vai kustību spēles? *LASE Scientific and methodological papers 2013. Annual issue in Sport Science* (13). Riga: LASE. Retrieved form http://www.lspa.eu/files/research/2013/2013_Dravniece_2_13.pdf

Dzintere, D., & Stangaine, I. (2007). *Rotaļa – bērna dzīves prasmju sekmētāja*. Riga: Raka.

Haag, H., & Haag, G. (2003). Game in *Dictionary Sport – Physical Education – Sport Science* (768). Kiel: Institut f**ü**r sport un Sportwissenschaften.

Jansone, R., & Fernāte, A. (2009). *Kustību apguves un fizisko spēju attīstīšanās sporta stundās* Rīga: ISEC. Retrieved from http://isec.gov.lv/pedagogiem/metmat/kust_apguves.pdf

Laizāne, S. (1981). *Kustību rotaļas [Movement games]* (120). Rīga: Zvaigzne.

Mandigo, J., Francis, N., Lodewyk, K., & Lopez, R. (2009). *Position paper physical literacy for educators.* PHE Canada: Brock University. Retrieved from https://www.phecanada.ca/sites/default/files/pl_position_paper.pdf

Penney, D., & Jess, M. (2004). Physical education and physically active lives: A lifelong approach to curriculum development. *Sport, Education and Society*, *9*, 2269–2287. Retrieved from http://www.castonline.ilstu.edu/henninger/Pdf/KNR%20419/SESPennycurriculardev.pdf

Porozovs, J., & Kļaviņa, A. (2014). Role of natural sciences in sports pedagogy. In *Natural Sciences and pedagogy: Monograph* (pp. 195–224). Riga: RTTEMA, University of Latvia.

Santrock, J. W. (2001). *Child development*. University of Texas at Dallas. McGraw-Hill Higher Education.

Stangaine, I. (2010). Pieaugušā un bērna sociālā mijiedarbība rotaļā pirmsskolēna komunikatīvās kompetences sekmētāja. In *Theory for practice in the education of contemporary society, 5th International Scientific conference* (pp. 312–317). Riga: LSPA.

Vazne, Ž. (2006). *Teorētiskās nostādnes sporta pedagoga pedagoģiskajai praksei*. Riga: LSPA.

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PARENTS' PERCEPTIONS OF THE IMPORTANCE OF PHYSICAL ACTIVITY AND THEIR CHILDREN´S ABILITY

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ABSTRACT

Background. It is well known that parents influence physical activity of their children. Determining the factors related to parents' perception of the importance of physical activity and physical fitness enables enhancing the promotion of physical activity among children in the future.

Methods. A total of 237 parents of children aged between 5 and 10 years participated in the study. Confirmatory factor analysis was used to estimate factor structure of the questionnaire "Parents Perceptions of the Importance of Physical Activity and Their Children´s Ability Questionnaire". To investigate the differences between groups Independent-sample *t*-test was used. Cohen's *d* was used to estimate effect size.

Results. Confirmatory factor analyses showed that the eight-issue two-factorial model psychometric parameters were acceptable in order to assess parents' perception of the importance of physical activity and ability (*RMSEA* = .072; *NFI* = .97; *CFI* = .98; *NNFI* = .98). Parents who were physically active in the past and were active in the present evaluated the importance of physical activity more than inactive parents. Parents' assessments of the importance of physical activity and ability were not significantly different depending on parents' education, university or secondary/ high education.

Conclusion. The questionnaire used is a valid measure of parents´ assessments of the importance of physical activity and physical ability of the Estonian school students. The questionnaire enables us to identify parents' assessments of the importance of physical activity and physical ability, which may be considered as one of the factors related to children's physical activity.

Keywords: parents' evaluations, physical activity, children, confirmation factor analysis.

INTRODUCTION

Parents strongly influence physical activity of their children and are considered to be most important persons responsible for their participant in physical activity (PA) promotion (Erkelenz, Kobel, Kettner, Drenowatz, & Steinacker, 2014; Giles-Corti, Kelty, Zubrick, & Villanueva, 2009). A great amount of children's free time prior to the adolescence is spent with family and therefore family socialization is a contributor to children's PA participation. According to the parental socialization framework of Eccles, two important predictors of children's participation in PA exist: children's expectation for success and subjective task value (Fredericks & Eccles, 2004). Subjective task value encompasses intrinsic value (enjoyment of PA), utility value, attainment value and costs of engagement. Children will appreciate PA highly if they believe that PA is important to their goals, perceive themselves as physically capable and enjoy the physical exercise. For children the behaviour of parents is also important in forming their attitude toward certain activity. Fuemmeler, Anderson, and Masse (2011) investigating the parent-child correlation in accelerometer derived measures of physical activity found that from different intensity of PA

vigorous PA was significantly related. Children, who are physically active, are likely to be active also in adult life (Kunin-Batson et al., 2015) that in turn may have positive impact on their children's physical activity.

According to Fredericks and Eccles (2004, 2005), parents who have high perception of children's physical ability and deliver messages about the value of participating in PA, that is high perception of importance of children's PA, will have physically active children. The feedback provided by the parents can positively affect the attitudes towards exercise activities, while the unrealistic expectation and pressure may bring negative consequences (Martinent, Naisseh, Ferrand, Bois, & Hautier, 2013). Increasing the awareness of the importance of physical activity in parents and reducing the overestimation of children's physical abilities are the some possibilities to increase children's participation in physical activity (Corder, Crespo, Van Sluijs, Lopez, & Elder, 2012).

Recently, Martinent et al. (2013) developed and validated a questionnaire to measure parent's perceptions of physical activity importance and their children's ability (PPPAICAQ) among Caucasian French families. The final version of this questionnaire (see items in Appendix) consisted of the two scales: parent's perceived importance of their children's PA (PPICPA) and parent's perceptions of their children's ability in PA (PPCAPA), The scale of PPICPA included four items (e.g. "How important is it to you that your child participates in sport and /or PA for better health?") and scale of PPCAPA also had four items (e.g. "Do you think that it is easy for your child to participate in sport and/or PA?"). Seven-point Likert scale ranging from (1) "not at all important/ not good at all to (7) "very important/ very good" was used to estimate the parents' responses.

The primary purpose of the present study was to test the validity of the factor structure of the final version of PPPAICAQ in the Estonian sample. The secondary aim was to investigate whether the parents' perceptions of the importance of their children's PA and their children's ability were related to their educational level and their own physical activity.

METHODS

Research Design. A total of 237 parents of children aged between 5 and 10 years (13.1% – 5 years old, 13.6% – 6 years old, 18.2% – 7 years old, 18.2% – 8 years old, 27.1% – 9 years old, 9.7% –10 years old) voluntarily participated in the study. The participants of the study were from one city with a population of 30.000 inhabitants. Standardized back-translation techniques (Brislin, 1986) were used to translate the English version questionnaire into Estonian.

The factorial validity of the questionnaire "Parents Perceptions of the Importance of Physical Activity and Their Children's Ability Questionnaire" (PPPAICAQ) developed by Martinent et al. (2013) was tested by confirmatory factor analysis (CFA). The validity of the CFA model was evaluated by using multiple goodness-of-fit indexes: comparative fit index (CFI), the non-normed fit index (NNFI), normed fit index (NFI), and the root mean square error of approximation (RMSEA). A cut-off value greater than .95 for the CFI, NFI, and NNFI, and a cut-off value less than or equal to .08 for the RMSEA indicated adequate model fit (Hu & Bentler, 1999).

The item values were summarized and divided by four to estimate the mean value of the scale and then Independent-sample *t*-test was used to investigate the differences between groups. Cohen's *d* was used to estimate effect size.

Parent's characteristics. Parents reported their level of education (basic, secondary or university) and PA. In a single item parents were asked whether they were currently physically active or not and whether they were physically active during their adolescence period or not.

RESULTS

The CFA model of the (PPPAICAQ) is presented in Figure. The results of the CFA showed that goodness-of-fit indices were on acceptable level: $\chi^2 = 42.12$, $df = 19$, $CFI = .98$, $NNFI = .98$, $NFI = .97$, and $RMSEA = .072$. The reliability coefficient for the scale PCAPA was .853 and for PPICPA it was .789.

Mean values of perceived importance of children's physical activity and physical ability in respect to parental physical activity and educational level are presented in Table.

Physically active parents better perceived the importance of their children's PA than not physically active parents. Similarly, parents who experienced physical activity in the past perceived also the importance of their children's PA better than those who were not physically active during the adolescence period. In respect to perceived

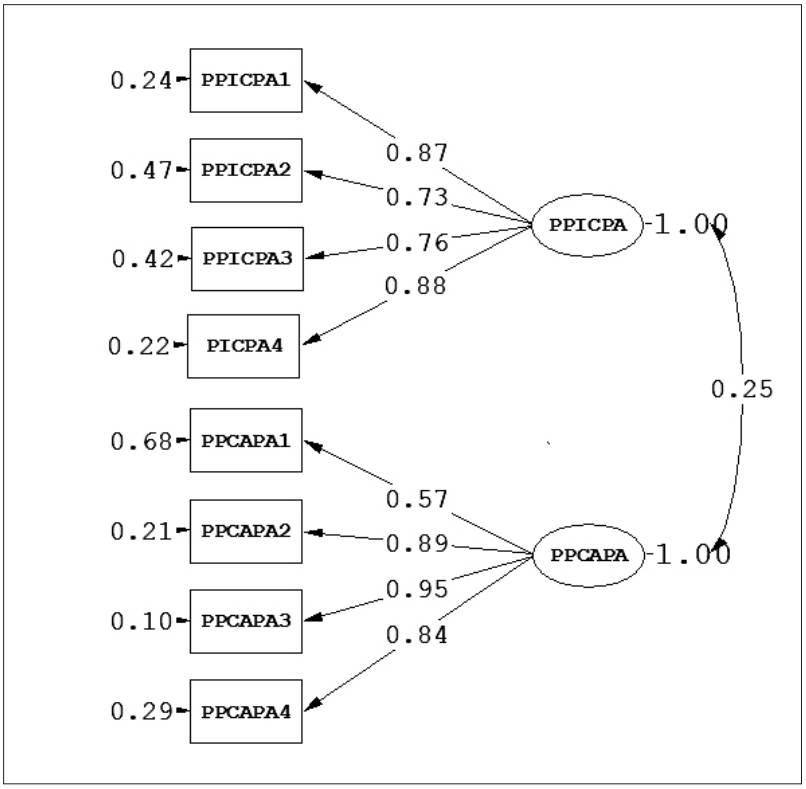

Figure. **The factor structure of the questionnaire "Parents Perceptions of the Importance of Physical Activity and Their Children's Ability Questionnaire" (PPPAICAQ)**

Measures	M	SD	M	SD	p	Effect size Cohen's *D*
	Currently physically active		**Not physically active**			
PPICPA	6.40	0.61	6.17	0.80	.02	.32
PPCAPA	5.56	0.87	5.58	0.85	ns	
	Physically active during adolescence period		**Not physically active during adolescence period**			
PPICPA	6.36	0.66	6.08	0.82	.003	.37
PPCAPA	5.65	0.83	5.46	0.87	ns	
	Education – secondary /high level		**Education – university level**			
PPICPA	6.24	0.66	6.33	0.79	ns	
PPCAPA	5.60	0.80	5.49	0.97	ns	

Table. **Mean values of perceived importance of children's physical activity and physical ability in respect to parents' physical activity and education**

Note. PPICPA – parent's perceived importance of their children's PA, PPCAPA – and parent's perceptions of their children's ability in PA.

physical ability no statistically significant difference was observed between groups.

Parents with different educational level did not perceive the importance of their children's PA and physical ability differently.

DISCUSSION

The aims of this study were to test the validity of the factor structure of the PPPAICAQ and to find out whether the parents' perceptions of the importance of their children's PA and their children's ability were related to their educational level and their own physical activity.

The results of the CFA confirmed the appropriateness of the PPPAICAQ to investigate the Estonian parents' perceptions of physical activity importance and their children's ability. All psychometrical parameters were on acceptable level. It is worth to note that covariance (.25) between the two subscales (PPCAPA and PPICPA) was very similar with values (.23) reported by Martinent et al. (2013). Thus, the results of CFA supported the use of this as a valid instrument

in other cultural context, too. The existence of the invariance of parameter estimates of this instrument across the mother and father samples as well as girls' and boys' samples was former established by Martinent et al. (2013) and therefore the variation of the parameters were not under the interest of this study. However, further validity evidence in the sample of parents of children aged between 12 and 17 years is highly warranted.

The results of the present study showed that physically active parents highlighted the importance of PA significantly more than physically non active parents. Obviously, it allows suggesting that parents' positive values toward physical activity will have effect on children's attitudes toward physical activity behaviour, which in turn may lead the physical activity behaviour. However, both active and non-active parents evaluated their children's physical ability similarly. It was interesting that the mean score of the PPCAPA scale was lower than that of the PPICPA scale in spite of parents' physical activity and educational level. The findings of the present study indicated that physically active parents valued the importance of children's physical activity more than non-physically active parents are consistent to some extent with the previous results of several researchers who highlighted the modelling role of parents' behaviour among children (Fuemmeler et al., 2011; Moore et al., 1991).

CONCLUSIONS

PPPAICAQ will be a useful and valid instrument to examine the issues regarding the topic of parental influence on their children's physical activity and to compare research findings across studies. Physically active parents evaluated the importance of physical activity of their children more than physically non-active parents.

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REFERENCES

Brislin, R. W. (1986). The wording and translation of research instruments. In W. J. Lonner & J. W. Berry (Eds.), *Field methods in educational research* (pp.137–164). Newbury Park, CA: Sage.

Corder, K., Crespo, N. C., Van Sluijs, E. M .F., Lopez, N. V., & Elder, J. P. (2012). Parent awareness of young children's physical activity. *Preventive Medicine, 55*, 201–205.

Erkelenz, N., Kobel, S., Kettner, S., Drenowatz, C., & Steinacker, J. M. (2014). Parental activity as influence on children's BMI percentiles and physical activity. *Journal of Sports Science and Medicine, 13,* 645–650.

Fredricks, J., & Eccles, J. (2005). Family socialization, gender, and sport motivation and involvement. *Journal of Sport & Exercise Psychology, 27*, 3–31.

Fredricks, J., & Eccles, J. (2004). Parental influences on youth involvement in sports. In M. R. Weiss (Ed.), *Developmental sport and exercise psychology: A lifespan perspective,* (pp.145–164). Morgantown, W. V: Fitness Information Technology, Inc.

Fuemmeler, B. F., Anderson, C. B., & Masse, L. C. (2011). Parent-child relationship of directly measured physical activity. *International Journal of Behavioral Nutrition and Physical Activity, 8*(17), 1–9.

Giles-Corti, B., Kelty, S. F., Zubrick, S. R., & Villanueva, K. P. (2009). Encouraging walking for transport and physical activity in children and adolescents: How important is the built environment? *Sports Medicine, 39*(12), 995–1009. doi: 10.2165/11319620-000000000-00000

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariancestructure analysis: Conventional criteria versus new alternatives. *Structural Equation Modelling, 6,* 1–55. http://dx.doi.org/10.1080/10705519909540118.

Kunin-Batson, A. S., Seburg, E. M., Crain, A. L., Jaka, M. M., Langer, S. L., Levy, R. L, & Sherwood, N. E. (2015). Household factors, family behavior patterns, and adherence to dietary and physical activity guidelines among children at risk for obesity. *Journal of Nutrition Education and Behavior.* doi:org/10.1016/j.jneb.2015.01.002.

Martinent, G., Naisseh, M., Ferrand, C., Bois, J. E., & Hautier, C. (2103). Development and evaluation of

the psychometric properties of the parents' Perceptions of Physical Activity Importance and their Children's´ Ability Questionnaire (PPPAICAQ). *Psychology of Sport and Exercise*, *14*, 719–727.

Moore, L. L., Lombardi, D. A., White, M. J., Campell, J. L., Oliviera, S. A., & Ellison, R. C. (1991). Influence of parent's physical activity levels on activity levels of young children. *Journal of Pediatrics, 118*(2), 215–219.

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Appendix.
Parents Perceptions of Physical Activity Importance and their Children's Ability Questionnaire

PPICPA 1 How important is it to you that your child participates in a sport and /or PA after school?

PPICPA 2 Compared to other activities (music, art, etc.), how important is it to you that your child participates in a sport and /or PA?

PPICPA 3 How important is it to you that your child participates in a sport and /or PA for better health?

PPICPA 4 Do you think that doing a sport and PA is useful to your child?

PPCAPA 1 Do you think that it is easy for your child to participate in sport and/or PA?

PPCAPA 2 In general, do you know your child's level of ability in sport and/or PA?

PPCAPA 3 Compared to other children of his/her age, how good is your child in sport and/or PA?

PPCAPA 4 Compared to other children of his/her age, do you think that your child is one of the best in sport and /or PA?

THE OPTIMISM EXPRESSION FOR MIDDLE SCHOOL AGE STUDENTS IN PHYSICAL EDUCATION CLASSES

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ABSTRACT

Background. The paper strives to answer the question what is optimism expression for middle school age students in physical education classes. The following hypothesis was tested: optimism expression of boys would be higher than those of girls. *The aim* of our study was to examine the optimism expression for middle school age students in physical education classes.

Methods. The independent random sample consisted of 214 students of middle school age (108 girls and 106 boys). According to the attendance of physical education classes respondents by were divided into two groups: those who did not attend physical education classes for one month or more were assigned to the group of students not attending physical education classes, and others – the group of students attending physical education classes. The measure of optimism expression was evaluated using Dember's Optimism/Pessimism Scale.

Results. The hypothesis that optimism expression of boys would be higher than that of girls was confirmed. The comparison of optimism expression between boys and girls revealed that optimism expression for boys of middle school age was higher ($p < .05$) than that of girls. The comparison of optimism expression among students attending and not attending physical education classes revealed that middle school age students (boys, girls) attending physical education classes were more optimistic ($p < .05$).

Conclusions. It was found that the optimism of middle school age boys was higher in physical education classes comparing them to girls of the same age, and middle school age students (boys and girls) who attended physical education classes were more optimistic.

Keywords: physical education classes, the optimism expression, middle school age.

INTRODUCTION

Scientific studies carried out over the past decade on the behaviour, lifestyle and health of students in Lithuania have shown that mental health of school age children has a tendency to become worse in recent years (Petrauskienė & Matulevičiūtė, 2007). Comparing the indicators of Lithuania and other European countries, it was observed that mental health condition of Lithuanian students was unsatisfactory. Our country's children and teenagers are diagnosed with a lot of mental health disorder symptoms: the feeling of loneliness, stress, depression and suicidal thoughts. Lithuania is listed among countries where students do not feel safe at schools and are not happy when thinking about their current life. The suicide risk indicators of youth in Lithuania are very high and are still increasing, therefore this problem must be solved immediately and comprehensively (Zaborskis, 2001).

Physical activity positively affects mental health. Regular physical activities decrease cases of household and professional problems, as well as stress. Everyday problems can be managed more calmly when a person is in a good physical condition and is feeling great. Physical activity can be an excellent measure for temporarily relief

of stress, improvement of the feeling of wellbeing making task planning easier and preventing the spread of fear and depression. Physical activity is a good distraction from everyday problems, and this helps overcome stressors (Poderys, 2000).

Studies confirm (Masiulis, 2006; Treben, 2006) that physical activity has a positive effect on emotions. Even a ten minute walk evokes optimism, the feeling of happiness, makes personal problems easier to solve and improves physical wellbeing (Thayer, 1987).

Optimism is a tendency to notice the positive sides of life and to positively assess reality (Keinys, 2003). In this article optimism is equated to positive self-esteem, positive emotions and lack of emotional problems.

Optimism provides self-confidence, strength and determines a positive attitude towards the environment, one's problems and the future (Chang & Sanna, 2001). Optimists have more control over various situations, they are able to deal with stressful events more easily, and they are healthier and generally in a better mood (Scheier & Carver, 1992). They achieve better results at work, in the academic field and in sports. They are more popular and often enjoy good relationships with other people (Peterson & Steen, 2005).

Middle school age (adolescence) student group is unique. It is characterized by social, psychological and physiological development of personality activity (Barkauskaitė, 2000). That is why this age span requires careful research in the context of physical education classes.

Goldberg and Chandler (1995) believe that various physical education programmes intended to fully educate middle school age children during physical education classes should aim to: a) create an atmosphere that would encourage positive emotions, so that students would know that they are evaluated depending on their improvement; b) help set realistic physical activity, learning and professional goals, as well as be aware of the importance of other roles regarding the future career; c) emphasize the improvement of skills as an achievement; d) develop emotional balance and restraint without arguing with other students; e) promote respect for one another.

Physical education philosophers and teachers often encourage middle school age students to rely on the principles and ideals of the Olympic Movement. According to Stoliarov (Столяров, 1998), Olympic education aims to familiarize children and youth with the Olympic ideals that focus on compassionate and humanistic sport-related values that support the spirit of optimism. They are used to try to influence the knowledge system and form positive attitudes towards physical education classes. Šukys (2001) notes that the spiritual education of an athlete depends both on the values of the activity itself, as well as on the communication between the learner and the authoritative figures out of which physical education teachers receive the most important role. Therefore, interpersonal relations are of great importance. Good results can only be ensured by balanced mutual activities between the learner and the educator, i.e., communication that is based on acceptance and mutual respect, mutual sincerity and openness, as well as the promotion of an optimistic attitude (Šukys, 2001).

It is pointed out (Himberg, Hutchinson, & Roussell, 2003) that physical education based on a narrow perspective aims to only develop the physical features, but when education is based on a broader perspective, the aim of physical education is to achieve greater results. Physical education teachers should be pedagogically prepared to develop an optimistic attitude of students toward the environment, especially of students who are between 12–18 years of age when their intellectual development is open to pedagogical intervention in physical education classes (Ostasevičienė, 2001).

Literature indicates that students also have certain feelings of low self-esteem (Pivorienė & Jurkonytė, 2008). The awareness of personal imperfections forces to move forward, promotes growth and improvement. Problems start to arise when low self-esteem is very strong and a student starts to evaluate himself/herself pessimistically or thinks that he/she is worthless. In this case the student searches for ways to adapt or compensate his/her condition. Low self-esteem when there is a lack of optimism can be twofold: the student is passive, shy, reserved and distant or on the contrary – he/she is aggressive, arrogant and even cynical. Such student tends to humiliate and abuse others (Pivorienė & Jurkonytė, 2008).

Optimism and positive personal self-esteem are like a social vaccine that builds an immune system to help overcome violence, bullying and inability to learn (Bulotaitė, 1995). Since positive perception of self-esteem regulates the behaviour of an individual in various areas of life, strongly affects his/her interpersonal relationships, activity

aims, direction selection, its effectiveness and determination in crisis situations, then it can be assumed that student's further development will depend on an optimistic attitude towards oneself during physical education classes (Malinauskas &Klizas, 2009). How teachers evaluate children can be best presented by statistics. According to studies carried out in the US, the emotional relationship with oneself and one's life is positive for over 80 percent of kindergarten students (typical optimism), however, this number decreases down to 5 percent in the 12th grade (Bulotaitė, 1995).

Cognitive abilities that increase during the middle school age period enable the student to understand and evaluate the significance of change and to think about future events, they encourage thinking about one's career, life and other important choices. The perception of one's own competence of these children depends on the feeling of their self-esteem; therefore it is important to maintain a positive optimistic attitude in physical education classes. It is believed (Weiss & Amorose, 2005) that teenagers whose perceived competence is good in most areas are optimistic and have a positive self-worth, it is easier for them to accept the challenges of life, the learning process becomes interesting to them and they are not afraid to face difficulties.

When analysing the relation between general self-esteem and the perception of personal competence in various areas (academics, sports, social acceptance, physical appearance), it is stated that self-perception and esteem tend to increasingly change during the middle school age period: the perception of personal competence in various areas is at its lowest during early adolescence, and it starts to become adequate only during late adolescence. According to Navaitis (2001), due to variations in maturity and self-comparison with peers or icons which is typical of teenagers, it is hard for them to eavluate themselves adequately. Excessively good or poor self-esteem may be the incentive of aggressive or depressive behaviour and may lead to neurotic reactions.

The self-esteem amplitude of students in physical education classes is very wide. It fluctuates from side to side. It was observed that persons with similar abilities and achievements often evaluated themselves differently. Some tended to notably emphasize even their smallest achievements, they flaunted themselves and wanted their achievements to be mentioned as often as possible. While others acted completely differently - they did not feel proud of their achievements nor like it when people talked about them. There were also those who were talented and gifted, but appeared to be very unhappy with themselves, constantly blamed and condemned themselves even for the slightest mistakes or failures, considered themselves losers, felt distressed and tormented (Žemaitis, 1995). Thus, we can say that there is a certain esteem scale with two extremes: self-over-esteem (when a person is overly optimistic, has too much self-confidence and overestimates his possibilities) and self-under-esteem (when a person is pessimistic and has no self-confidence). Positive self-esteem can be distinguished among these extremes. A student who tends to overestimate himself/herself often undermines others, views them as objects or means to reach his/her own objectives, and often initiates conflicts with people when they try to evaluate him/her objectively and treat him/her accordingly. During physical education classes, these students see themselves as much better than others, they think that they are stronger and more intellectual.

Low self-esteem in physical education classes creates not only a pessimistic mood, but also establishes a very negative relationship with oneself which can be called self-contempt. Self-contempt is expressed through self-hatred, condemnation, humiliation and disdain (Žemaitis, 1995). After discussing these extremes, a conclusion can be made that middle school age students estimating themselves in both of these cases do not know themselves very well. When a student reaches "balanced" self-esteem, it becomes easier for him/her to overcome difficulties, avoid unnecessary disappointments or negative emotions during physical education classes. Such a person is satisfied with the fact that he/she is the way he/she is. He/she is an optimist, self-confident and is doing well. He/she is not plagued by jealousy or the feeling of insecurity; he/she does not have the loser complex. Such a person feels his/her own self-esteem (Kendall, 2001).

It is necessary to emphasized that positive self-esteem and optimism during physical education classes have a particularly significant value to a person's moral development, the development of his/her spiritual world, self-confidence, self-criticism, modesty, self-esteem and the development of other important moral traits. Positive self-esteem is one of the most important goals of education, as it has an effect on the motivation of students in

physical education classes and on the quality of task performance. Self-esteem, optimism and self-confidence, – all these terms are used by physical education teachers who want to help their students form a better opinion about themselves. Additional student physical education development in schools could also help form positive self-esteem (Blauzdys & Šinkūnienė, 2005). For example, a person's self-esteem in the area of physical education can be very low, however, if this area is not important to him/her, it will have no negative effect on his/her self-esteem. Self-esteem depends not only on a person's skills in the area, but also on his/her belief on how others evaluate him/her (Horn, 2004). Therefore, if a student experiences success and believes that others acknowledge his/her competence, this can have a positive effect on his/her self-esteem and evoke optimism.

Perceived competence or perceived skills during physical education classes are not as consistent as self-esteem, since they can change over time depending on the person's achievements (Horn, 2004). At the beginning of the school year, a student may fully realize his/her physical competence, however he/she may have less success during physical education classes in secondary school compared to primary school.

Positive self-esteem and optimism are often analysed with the help of questionnaires. Research subjects must evaluate themselves on a five-point scale, by comparing with other research subjects of the same gender and age. Answers are marked. The result is determined by counting all the marked points (Auweelle, Bakker, Biddle, Durand & Seiler, 1999). It is specified that self-esteem during the middle school age period is especially low. The self-esteem curve takes the form of the letter U (Marsh, 1989). Self-esteem and optimism start to decrease during the middle school age period, but they start to once again increase during late adolescence and cease to increase or decrease during youth. This tendency is characteristic of both genders. Sudden decrease in self-esteem begins from the age of 7–8 years and continues until about 11. Changes in self-esteem start to appear at the beginning of puberty, when the ability to more adequately evaluate oneself increases (Marsh, 1989). Self-esteem level decreases during early puberty. Self-esteem and perception of personal competence start to increase from around 13–14 years of age (Lintunen, Leskinen, Oinonen, Salinto, & Rahkila, 1995), and physical education teachers should pay attention to this.

Researchers point out that it is necessary to strengthen optimism and positive self-esteem, as this is the guarantee of good mental health (Auweelle et al., 1999). It is stated that sometimes even illusory positive self-esteem is better than negative self-esteem. Optimism and positive illusions can be beneficial to middle school age students who often receive negative feedback in physical education classes (Lintunen et al., 1995). In this case, positive self-esteem does not mean that the image of oneself is distorted (Rosenberg, 1985). A realistic opinion of oneself appears during youth. It is a good thing when schools emphasize a realistic opinion of oneself as an educational goal. Of course, optimism and positive self-esteem show a person's psychological maturity.

Middle school age students start to realize their abilities, interests and goals, and this happens both consciously as well as subconsciously. Personal and social processes enable for the basic needs to develop during this age period, including the need for physical activity. These processes determine the development of the motivation structure and the personal needs of middle school age students, including the most important ones: self-confidence and anxiety control, optimism and positive self-esteem needs.

In the personal motivation structure of a middle school age student, satisfaction with physical activity is related to the teenager's newly achieved ideal self-image directed towards the realisation of physical activities in physical education classes, as well as the objectives of social identity. The emergence of this need changes the behaviour of students in this age group and increases their optimism and competence in activities that interest them (Немов, 2001). The pursuit of a goal encouraged by the need to be satisfied with one's life lies in real changes of personality and behaviour that comply with the development of abilities.

The need for optimism, self-confidence, positive self-esteem and anxiety control is related to a person's self-actualization (Palujanskienė, 2003). This personal need broadens the individualization and socialization processes of middle school age students. The development of self-confidence, anxiety control and optimism of middle school age students during physical education classes is of motivational nature. Optimism, positive self-esteem, ideal self-image and inner motivation activate the

need for self-confidence and anxiety control. The inner motivation of the perception of personal self encourages active physical activity and becomes the most significant, due to the fact that when a person has strong inner motivation, it is easier for him/her to preserve self-esteem and the ability to adapt which strengthen self-confidence and anxiety control (Palujanskienė, 2003; Милякова, 2006). This means that the realisation of the need of self-confidence and anxiety control during physical education classes is not possible without positive self-esteem and optimism. Thus it can be stated that self-confidence and anxiety control, positive self-esteem and optimism during physical education classes are the foundation of the personal needs structure of a middle school age student.

Today, international scientific publications still lack data on optimism expression among middle school age students (boys and girls) in physical education classes. Data regarding such studies in Lithuania could not be obtained; therefore the relevance of the research on optimism expression among middle school age students in physical education classes is beyond doubt.

Research problem – what kind of optimism expression is among middle school age students (boys and girls) in physical education classes.

Research aim was to reveal the optimism expression for middle school age students (boys and girls) in physical education classes.

METHODS

Research participants. Research subjects were selected randomly. The research included middle school age (14–15 years old) students from Kaunas "Tadas Ivanauskas" secondary school, "S. Darius and S. Girėnas" gymnasium and Kaunas District Garliava Jonučiai progymnasium. The research sample consisted of 214 students from general education schools who were in the 8–9th grades (108 girls and 106 boys). The respondents were split into two groups according to their attendance of physical education classes: those who did not attend classes for a month or longer were categorized under the group of students who did not attend classes, while others were categorized under the group of students who attend physical education classes. Permission No. SMTEK-04 to carry out the research was granted by the Research Ethics Committee of the Lithuanian Sports University.

Measures. Dember, Martin, Hummer, Howe & Melton's (1989) questionnaire was applied in order to evaluate optimism. Research subjects were provided with 56 statements that were rated on a 4-point Likert scale. Later, all the evaluations were summed and the final optimism indicator was obtained. Scale reliability was sufficient: optimism Cronbach's alpha was 0.79.

Statistical analysis. In order to check the statistical hypotheses (for difference reliability among middle school age girls and boys), a Student's *t* criterion was applied. The results were considered statistically significant if $p < .05$.

RESULTS

Using the Student's *t* criterion, we have analysed the reliability of optimism differences for middle school age girls and boys in physical education classes. A statistically significant difference was found among students – boys and girls – who attended and did not attend physical education classes: middle school age students who attended physical education classes were more optimistic ($p < .05$) (Table 1).

Table 1. **The statistical indicators of the optimism expression among boys and girls attending and not attending physical education classes (*M* ± *SD*)**

Gender	Variable	Attending physical education classes	Not attending physical education classes	Scores of Student's *t*-test	*p*
		***n* = 72**	***n* = 34**		
Boys	Optimism (*M* ± *SD*)	50.86 ± 6.07	48.24 ± 6.12	–2.06	$p < .05$
	Pessimism (*M* ± *SD*)	43.82 ± 5.98	42.85 ± 6.67	–0.72	$p > .05$
Girls		*n* = 66	*n* = 42		
	Optimism (*M* ± *SD*)	49.23 ± 5.98	46.76 ± 6.01	–2.16	$p < .05$
	Pessimism (*M* ± *SD*)	44.26 ± 6.22	43.08 ± 6.17	–0.98	$p > .05$

Note. (*M* ± *SD*) – mean and standard deviation.

Variable	Attending physical education classes	Not attending physical education classes	Scores of Student's *t*-test	*p*
	***n* = 138**	***n* = 76**		
Optimism (*M* ± *SD*)	50.03 ± 6.17	47.52 ± 6.06	–2.11	$p < .05$
Pessimism (*M* ± *SD*)	43.82 ± 5.84	42.96 ± 6.09	–0.94	$p > .05$

Table 2. **The statistical indicators of the optimism expression among students attending and not attending physical education classes (*M* ± *SD*)**

Note. (*M* ± *SD*) – mean and standard deviation.

Variable	Boys	Girls	Scores of Student's *t*-test	*p*
	***n* = 106**	***n* = 108**		
Optimism (*M* ± *SD*)	49.58 ± 6.01	47.97 ± 5.98	1.96	$p < .05$
Pessimism (*M* ± *SD*)	43.34 ± 6.33	43.67 ± 6.20	–0.39	$p > .05$

Table 3. **The statistical indicators of the optimism expression among boys and girls in physical education classes (*M* ± *SD*)**

Note. (*M* ± *SD*) – mean and standard deviation.

After combining the data of both boys and girls during the analysis, it was found that the optimism of middle school age students who attended physical education classes was expressed more clearly ($p < .05$) (Table 2).

When analysing the data of both boys and girls without splitting them into groups of those who attended classes and those who did not, it was found that the optimism of middle school age boys was higher in physical education classes compared to the optimism of girls of the same age ($p < .05$) (Table 3).

DISCUSSION

The results of this research have confirmed that there is a connection between optimism and the attendance of physical education classes, as well as higher physical activity in physical education classes. The results of this research comply with the conclusions of similar studies carried out by other authors, who discovered a positive correlation between physical activity and optimism (Hamid, 1990; Herero & Extremera, 2010; Kavussanu & McAuley, 1995). The fact that students start to think more optimistically when their physical activity increases mostly complied with the research data of Kavussanu and McAuley (1995).

The hypothesis that the optimism of boys is higher than the optimism of girls in physical education classes has been proven, as it was found that the optimism of middle school age boys was expressed more clearly in physical education classes compared to the optimism of girls of the same age ($p < .05$). Similar results were obtained when studying the effect of educational consultations provided for older students during physical education classes (Rakauskienė & Kardelienė, 2010): it was found that the emotions of boys are more positive, whereas the emotions of girls are more unbalanced. Based on the research results of Malinauskas and Malinauskienė (2007) who studied boys and girls engaged in sports activities, it was found that the emotions of boys engaged in sports activities were more positive ($p < .05$) compared to girls of the same age also engaged in sports activities.

Our research data was different than the data obtained by Malinauskas and Klizas (2009), based on which a statistically significant difference was found between boys and girls according to their emotional comfort level in physical education classes: the emotions of girls in physical education classes were more positive, and they felt better ($p < .05$).

Studies carried out both in foreign countries and in Lithuania suggest that regular physical activity among teenagers (boys and girls) is positively related to positive emotions (optimism) and lack of emotional problems (Malinauskas & Klizas, 2009; Penedo & Dahn, 2005; Rakauskienė & Kardelienė, 2010; Sagatun, Søgaard, Bjertness, Selmer, & Heyerdahl, 2007; Tao et al., 2007).

Teenagers who participate in sports experience fewer emotional (Desha, Ziviani, Nicholson, Martin, & Darnell, 2007; Donaldson & Ronan, 2006) and behavioural problems (Donaldson & Ronan, 2006). According to the data of similar studies (Malinauskas & Malinauskienė, 2007;

Vojcik & Brtkova, 2002), students (boys and girls) who do not avoid physical self-development are able to better control their emotions.

We agree to the position of researchers that if positive self-esteem of a middle school age student decreases, then the efforts of such a student in physical education classes or during physical exercises lose their value. Thus, positive self-esteem and self-image must be compatible with each other; otherwise the individual experiences regression (Ussher, Owen, Cook, & Whincup, 2007). When failing to find a pillar of social support for self-confidence, positive self-esteem and optimism based on the respect of other people or the respect of a physical education teacher, then there is an increase in anxiety and the development of a depressive state occurs (opposite to optimism), which leads to behavioural changes and deterioration of performance resulting in low self-esteem (Кон, 2003). This also creates communication difficulties and other psychological consequences (adaptive aggression), as well as decreases the level of psychosocial adaptation (Кон, 2003). The refinement of needs for positive self-esteem leads to negative strategies, mechanisms and tactical actions for adaptation: rationalization, tendency for self-deception and lying, and this impedes student self-confidence and anxiety control in physical education classes (Klizas, 2009). Therefore, the development of optimism and self-esteem in physical education classes or during physical exercises is one of the measures of adaptation. This determines the student's interests, goals and wishes, serves as a source for appropriate development activities and invokes the remaining priority needs of the student. And since the orientation of middle school age students on active physical activities is strong, the general self-esteem of a student as well as the self-esteem of students in physical education classes is very important as it affects the student's level of psychosocial adaptation (Klizas, 2009).

To sum up, it can be stated that the physical activity of middle school age students is significantly correlated with positive emotions (optimism) and lack of emotional problems. However, a more detailed and more comprehensive research in this field is the object of further scientific studies since there is still a lack of studies that analyse the correlation between physical activity and positive emotions (optimism) in teenagers (Goldfield et al., 2011).

CONCLUSIONS

When evaluating optimism expression in physical education classes, it was found that middle school age students who attended physical education classes were more optimistic. When analysing the data of boys and girls separately, it was revealed that both boys and girls who attended physical education classes tended to feel more optimistic.

It was found that the optimism of middle school age boys was higher in physical education classes ($p < .05$) comparing them to girls of the same age.

REFERENCES

Auweelle, Y. V., Bakker, F., Biddle, S., Durand, M., & Seiler, R. (1999). *Psychology for physical educators*. Champaign, IL: Human Kinetics.

Barkauskaitė, M. (2000). *Paauglių tarpusavio santykių sociopedagoginė dinamika* (Habilitacinis darbas). Vilnius: VPU.

Bulotaitė, L. (1995). *Apie moksleivių savęs vertinimą*. Vilnius: Simfonija.

Blauzdys, V., & Šinkūnienė, D. (2005). *Mokinių papildomojo fizinio ugdymo plėtra mokykloje*. Vilnius: VPU.

Chang, E. C., & Sanna, L. J. (2001). Optimism, pessimism, and positive and negative affectivity in middle-aged adults: A test of a Cognitive-Affective Model of Psychological Adjustment. *Psychology and Aging*, *16*(3), 524–531.

Dember, W. N., Martin, S. H., Hummer, M. K., Howe, S. R., & Melton, R. S. (1989). The measurement of optimism and pessimism. *Current Psychological Research and Reviews, 8*, 109–119.

Desha, L. N., Ziviani, J. M., Nicholson, J. M., Martin, G., & Darnell, R. E. (2007). Physical activity and depressive symptoms in American adolescents. *Journal of Sport & Exercise Psychology*, *29*(4), 534–543.

Donaldson, S. J., & Ronan, K. R. (2006). The effects of sports participation on young adolescents' emotional well-being. *Adolescence*, *41*(162), 369–389.

Goldberg, A. D., & Chandler, T. (1995). Sports counseling: Enhancing the development of the high school student athlete. *Journal of Counseling & Development*, *74,* 39–45.

Goldfield, G. S., Henderson, K., Buchholz, A., Obeid, N., Nguyen, N., & Flament, M. F. (2011). Physical activity and psychological adjustment in adolescents. *Journal of Physical Activity and Health*, *8*, 157–163.

Hamid, P. N. (1990). Optimism and the reporting of flu episodes. *Social Behavior and Personality, 18,* 225–234.

Herero, V. G., & Extremera, N. (2010). Daily life activities as mediators of the relationship between personality variables and subjective well-being among older adults. *Personality and Individual Differences, 49*, 124–129.

Himberg, C., Hutchinson, G., & Roussell, J. (2003). *Teaching secondary physical education: Preparing adolescents to be active for life*. Champaign, IL: *Human Kinetics*.

Horn, T. S. (2004). Developmental perspectives on self-perceptions in children and adolescents. In M. R. Weiss (Ed.), *Developmental sport and exercise psychology: A lifespan perspective* (pp.101–144). Morgantown, WV: Fitness Information Technology.

Kavussanu, M., & McAuley, E. (1995). Exercise and optimism: Are highly active individuals more optimistic? *Journal of Sport and Exercise Psychology*, *17*(3), 246–258.

Kendall, F. (2001). *Ypatingi tėvai – ypatingi vaikai.* Vilnius: Andrena.

Keinys, S. (2003). *Dabartinės lietuvių kalbos žodynas*. Vilnius: Lietuvių kalbos instituto leidykla.

Klizas, Š. (2009). *Viduriniojo mokyklinio amžiaus moksleivių psichosocialinė adaptacija ir jos stiprinimas per kūno kultūros pamokas* (Daktaro disertacija). Kaunas: LKKA.

Lintunen, T., Leskinen, E., Oinonen, M., Salinto, M., & Rahkila, P. (1995). Change, reliability, andstability in self-perceptions in early adolescence – A four year-follow-up study. *International Journal of Behavioral Development*, *18*, 351–364.

Malinauskas, R., & Klizas, Š. (2009). Vidurinio mokyklinio amžiaus moksleivių psichosocialinė adaptacija per kūno kultūros pamokas. *Jaunųjų mokslininkų darbai*, *1*(22), 114–117.

Malinauskas, R., & Malinauskienė, V. (2007). Sportuojančių jaunuolių psichikos sveikata ir vidinė darna. *Sveikatos mokslai*, *3*(50), 936–938.

Marsh, H. W. (1989). Age and sex effects in multiple dimensions of self-concept: Preadolescence to early adulthood. *Journal of Educational Psychology*, *81*, 417–430.

Masiulis, N. (2006). Fizinio aktyvumo poveikis stresui, nerimui ir depresijai mažinti. Šiuolaikinių technologijų analizė. *Fizinis aktyvumas ir sveikata*. Kaunas: LKKA.

Navaitis, G. (2001). *Psichologinė parama paaugliui*. Vilnius: Kronta.

Ostasevičienė, V. (2001). *Neįgalių paauglių dorybių ugdymas taikomosios kūno kultūros užsiėmimuose* (Daktaro disertacija). Kaunas: LKKA.

Palujanskienė, A. (2003). Savęs vertinimo ir savijautos sąsajos ugdymo procese. *Ugdymas. Kūno kultūra. Sportas, 4,* 41–45.

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry, 18,* 189–193.

Peterson, Ch., & Steen, T. A. (2005). Optimistic Explanatory Style. *Handbook of positive psychology*. Oxford: Oxford University Press.

Petrauskienė, A., & Matulevičiūtė, D. (2007). Abiturientų mokymosi krūvio ir savijautos sąsajos. *Medicina*, *43*(4), 323–337.

Pivorienė, J., & Jurkonytė, R. (2008). Moksleivių smurtas prieš pedagogus mokyklose. *Socialinis darbas, 7*(2), 76–82.

Poderys, J. (2000). *Asmens sveikatos ugdymas.* Kaunas: LKKA.

Rakauskienė, V., & Kardelienė, L. (2010). Paauglių elgesio ir emocijų pokyčiai, taikant trumpalaikį konsultavimą. *Jaunųjų mokslininkų darbai*, *1*(26), 175–179.

Rosenberg, M. (1985). *Society and the adolescent self-image.* New York: Princeton University Press.

Sagatun, A., Søgaard, A. J., Bjertness, E., Selmer, R., & Heyerdahl, S. (2007). The association between weekly hours of physical activity and mental health: A three-year follow-up study of 15-16-year-old students in the city of Oslo, Norway. *BMC Public Health*, *7,* 155–164. doi:10.1186/1471-2458-7-155

Scheier, M. F., & Carver, C. S. (1992). Effects of optimism on psychological and physical wellbeing: Theoretical overview and empirical update. *Cognitive Therapy and Research*, *16,* 201–228.

Šukys, S. (2001). *Sportinė veikla kaip paauglių vertybinių orientacijų, asmenybės savybių ir socialinio elgesio formavimosi veiksnys* (Daktaro disertacija). Kaunas: LKKA.

Tao, F. B., Xu, M. L., Kim, S. D., Sun, Y., Su, P. Y., & Huang, K. (2007). Physical activity might not be the protective factor for health risk behaviours and psychopathological symptoms in adolescents. *Journal of Paediatrics and Child Health*, *43*(11), 762–767. doi: 10.1111/j.1440-1754.2007.01217.x

Thayer, R. E. (1987). Problem perception, optimism, and related states as a function of time of day (diumal rhythm) and moderate exercise: Two arousal systems in interaction. *Motivation and Emotion*, *11*, 19–36.

Treben, M. (2006). *Kasdienis stresas.* Vilnius: Algarvė.

Ussher, M. H., Owen, C. G., Cook, D. G., & Whincup, P. H. (2007). The relationship between physical activity, sedentary behaviour and psychological wellbeing among adolescents. *Social Psychiatry and Psychiatric Epidemiology*, *42,* 851–856. doi: 10.1007/s00127-007-0232-x

Vojcik, M., & Brtkova, M. (2002). Longitudinal observation of the influence of yoga exercises and autotraining in training of young basketball players - man. *TVS Telesna Vychova & Sport*, *12*(2), 15–18.

Weiss, M. R., & Amorose, J. A. (2005). Children's self-perceptions in the physical domain: Between - and within-age variability in level, accuracy, and sources of perceived competence. *Journal of Sport & Exercise Psychology*, *227*(2), 226–244.

Zaborskis, A. (2001). *Moksleivių psichikos sveikata. Nacionalinis sveikatos tarybos pranešimas.* Vilnius: Baltijos kopija.

Žemaitis, V. (1995). *Dorovinis savęs vertinimas.* Vilnius: Ethos.

Кон, И. С. (2003). Психология самосознания. Самара: Бахрах.

Милякова, Е. (2006). Психосоциальная адаптация личности девочки-подростка в системе адекватнного потребностно-мотивационного содержания физической культуры (Дисертационная работа канд. пед. Наук). Кишинёв: НИФВСРМ.

Немов, Р. С. (2001). Психология. Москва: ВЛАДОС.

Столяров, В. И. (1998). Актуальные провлемы теории и практики олимпиисково щброзования детеи и молодежы. Физическая Культура: Воспитарие, Образование, Тренировка, *4*, 13–19.

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MATRIX ANALYSIS OF ECG PARAMETERS MAY BE A WAY TO IMPROVE QUALITY OF FUNCTIONAL STATE MONITORING DURING EXERCISING

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ABSTRACT

Research background. The aim of this study was to compare the peculiarities of dynamics of cardiovascular functional state indices during bicycle ergometry by applying the steep or slow increase in workload.

Methods. Twenty five males attending health promotion sport clubs took part in two cardiovascular testing procedures performing graded exercise stress, i.e. increasing the workload every min, and increasing the workload every 6 min. They exercised till the inability to continue the task or when distressing cardiovascular symptoms supervened. 12 Lead ECG was recovered and analysed.

Results. The steep increase of registered cardiovascular parameters was observed at onset of exercising and the rate of it depended on the increase rate in workload. Registered maximal changes of heart rate, JT interval, and the ratio JT/RR as a functional state index at the moment of refusing to continue the graded exercise test were of the same level while applying the steep or slow increase in workload.

Conclusions. The rate of increase in workload determines the mobilization rate but not the degree of increase of ECG parameters. Maximal changes of heart rate, JT interval, and the ratio JT/RR as functional state index at the moment of refusing to continue the graded exercise test were the same level while applying the steep or slow increase in workload.

Keywords: cardiovascular system, graded exercise stress, functional state.

INTRODUCTION

Feedback while exercising is a way to achieve the effect of health promotion. Various types of heart rate (HR) monitors were widely used for over 30 years (Achten & Jeukendrup, 2003). But training session has two purposes at least. Firstly, the workload should impact appropriate internal body changes and secondly, the workload should not overreach individual physiological abilities of patient by creating the risk for his or her health. This problem cannot be solved only by monitoring HR (Gademan et al., 2012) and requires new modern solutions.

The complex system model of fatigue suggests that activity during exercise occurs in an integrative manner, where internal signals from a number of different physiological systems, which are in a constant state of flux, are used by an integrative "governor system" to continuously modulate exercise by regulating power output, and therefore pacing strategy, to levels appropriate to the capacity of each different physiological system relative to the level of intensity of the fatiguing exercise being performed (Gibson, 2008). Each adjustment in power output results in changes to all physiological systems, and therefore a specific

period of time is required for afferent information to be able to assess the result of these changes in the physiological systems that will enable further adjustments in power output. This time lag requirement creates fluctuations in power output and in the different physiological systems (Gibson, 2008; Torrents & Balague, 2006).

Analytical approach has been successful in describing the physical world but it is not the same when we have to handle the treatment or couching related issues, i.e. by applying it to living objects (Hristovski, Venskaityte, Vainoras, Balague, & Vazquez, 2010; Mayer-Kress, 2001; Torrents & Balague, 2006). Human body during exercising in fact represents a much more complex phenomenon reflecting the nonlinear processes of body's general functional state and its fatigability in a fractal or chaotic manner (Hristovski et al., 2010; Torrents & Balague, 2006; Tulppo et al., 2001). Interrelation mechanisms of body systems and components' interactions are essential in determining how body functions as a whole as a complex dynamic adaptive system. The aim of this study was to complement an analytical approach by new methodology of data sequences analysis of cardiovascular indices under conditions of increasing fatigue.

METHODS

The participants of the study were 10 healthy adult males attending health promotion sport, and two elite athletes. One of these athletes was a leader in long distance running and a winner a lot of races this year and other athlete shortly stopped the intensive training because of the medical diagnosis "Overtraining".

Each participant had spent 20 min seated and after registration of the base-line values of ECG they underwent a 50W increase in workload every 6 min (60 revolutions/min), i.e. graded exercise test (*bicycle ergometry*) and they exercised till the inability to continue the task or unless distressing cardiovascular symptoms supervened. The ECG registered continuously during the exercising and first 5 min of recovery. The RR interval, i.e., heart rate (HR), duration of QRS and ST-segment depression were taken for further analysis. For comparison of different processes the new diagnostic technology was created. Those technologies have a possibility to get maximal amount of diagnostic information by using minimal amount of recorded processes. The software performs in real time data pre-processing (*noise reduction, artefact suppression*) and recognition of parameters from continuously registered ECG.

Theoretical background. For investigation of two objects interaction two synchronous numerical time series $(x_n; n = 0,1,2,...)$ and $(y_n; n = 0,1,2,...)$ representing exploratory object must be formed. Here x_n and y_n are real numbers and they represent results of some measurements. Usually it is electrocardiogram signals (or some parameters of signals) of one or two associated persons. The statistical time series investigation methods are very popular and in this case elements of time series are random variables (Dahlhaus, Kurths, Maass, & Timmer, 2008). When elements of series are determined variables, information about object of investigation can be described using mathematical relationships (Arnold, 1998). In this paper the method based on matrix theory is proposed.

Let two numerical time series $(x_n; n = 0,1,2,...)$ and $(y_n; n = 0,1,2,...)$ be given. Then the matrix time series $(A_n; n = 0,1,2,...)$ can be formed. Here $A_n := \begin{bmatrix} a_n & b_n \\ c_n & d_n \end{bmatrix}$ and coefficients $a_n := x_n$, $b_n := \alpha(x_{n-1} - y_{n-1})$, $c_n := \beta(x_{n+1} - y_{n+1})$, $d_n := y_n$, when parameters α, β are at choice dependent on properties of time series $(x_n; n = 0,1,2,...)$, $(y_n; n = 0,1,2,...)$. In the simplest case, coefficients are $\alpha = \beta = 1$.

So, in this case four time series $(a_n; n = 0,1,2,...)$,... $(d_n; n = 0,1,2,...)$ and one matrix time series $(A_n; n = 1,2,3,...)$ are obtained. Of course these series can be formed using other mathematical relationships. Time series scheme is shown in Figure 1.

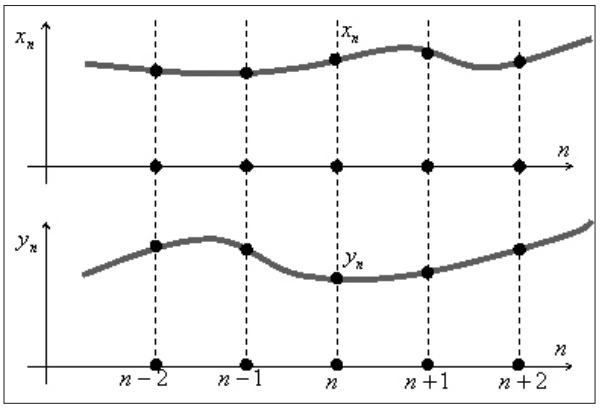


Figure 1. **The scheme of time series**

Different methods for analysis of obtained series can be used. In this investigation of matrix

time series the numerical characteristics of second order matrices and main components of matrices A_n were used:

1. $\mathrm{Tr}A_n := a_n + d_n$ (trace of matrix A_n),
2. $\mathrm{dfr}A_n := a_n - d_n$ (difference),
3. $\mathrm{cdp}\,A_n := b_n \cdot c_n$ (co-diagonal product),
4. $B_n := \begin{bmatrix} \frac{\mathrm{dfr}A_n}{2} & b_n \\ c_n & -\frac{\mathrm{dfr}A_n}{2} \end{bmatrix}$ (main component of matrix A_n).

From these initial parameters follow characteristics which have more applicative sense:

5. $\mathrm{dsk}\,A_n = (\mathrm{dfr}A_n)^2 + 4\,\mathrm{cdp}\,A_n$ (*discriminate*)
6. $\det A_n = \frac{1}{4}\left((\mathrm{Tr}A_n)^2 - \mathrm{dsk}\,A_n\right)$ (*determinant*),
7. $\lambda_{1,2} = \frac{1}{2}\left(\mathrm{Tr}A_n \pm \sqrt{\mathrm{dsk}\,A_n}\right)$ (*eigenvalues of matrix* A_n),

Two important types of matrices in matrix analysis are important: the matrix I is called idempotent (matrix of stable power), if $I^2 = I$ and the N - nilpotent (matrix losing power), if $N^2 = \mathbf{0}$, where $\mathbf{0}$ is zero matrix.

If discriminates of matrices A_n become to zero then matrices A_n from idempotent become to nilpotent. Mathematically, if the limits $\mathrm{dsk}A_n \to 0$, $b_n \to \bar{b}, c_n \to \bar{c}$, satisfying condition $\bar{b} \cdot \bar{c} \le 0$ exist, then $B_n \to \begin{bmatrix} \pm\sqrt{|\bar{b} \cdot \bar{c}|} & \bar{b} \\ \bar{c} & \mp\sqrt{|\bar{b} \cdot \bar{c}|} \end{bmatrix} := \bar{B}$, and $\bar{B}^2 = \mathbf{0}$.

It shows that chosen time series $(x_n; n = 0,1,2,...)$ and $(y_n; n = 0,1,2,...)$ become similar and describe more associated system. The sequence of idempotent matrices $\left(\sqrt{\mathrm{dsk}A_n} \cdot I_n; n = 0,1,2,...\right)$ if the limit transitions $|\lambda_n - \mu_n| \to 0$, $\sqrt{\mathrm{dsk}A_n} \cdot I_n \to \bar{B}$ exists can be formed, and this sequence shows evolution of matrix sequence $(A_n; n = 0,1,2,...)$.

From definitions of matrix characteristics the main interest have discriminates of matrices A_n, accordingly the time series $(\mathrm{dsk}A_n; n = 0,1,2,...)$ investigation is important.

The elements of matrices can be formed in more complicated way:

$$b_n := \alpha_1(x_{n+1} - y_{n+1}) + \alpha_2(x_{n+2} - y_{n+2}),$$

$$c_n := \beta_1(x_{n-2} - y_{n-2}) + \alpha_2(x_{n-1} - y_{n-1}).$$

Here $\alpha_1 + \alpha_2 = 1, \alpha_1 > \alpha_2 > 0$, $\beta_1 + \beta_2 = 1$, $\beta_1 > \beta_2 > 0$.

On purpose to escape noise influence, the elements can be averaging. Then terms of time matrices $a_n := \sum_{j=-k}^{l} \gamma'_j x_{n+j}$, $d_n := \sum_{j=-k}^{l} \gamma''_j y_{n+j}$,

$b_n := \sum_{j=1}^{l} \sigma'_j (x_{n+j} - y_{n+j})$, $c_n := \sum_{j=-k}^{-1} \sigma''_j (x_{n+j} - y_{n+j})$.

If number of terms in sums increases, the sequence of discriminates become smoother, but its character is the same. From numerical investigation it is obtained that changing of parameters α, β has influence only to amplitude of sequence, but not for character, because in further calculations the simplest case of matrices formation were used. The initial data was normalized using formula

$$x_{new\ value} = \frac{x_{old\ value} - x_{\min}}{x_{\max} - x_{\min}},$$

where $x_{\min}$ and $x_{\max}$ are minimal and maximal physiological values of parameter.

RESULTS

Working capacity. The task for the participants of this study was to continue exercising as much as they can, i.e. till the inability to continue it. All participants of the study were able to perform the workload up to 17 minute (workload 150W) and the highest performance in non-athletes cohort demonstrated by one participant was 27 minutes (the stage of 250W). The averaged data of performance abilities can be depicted by mentioning that non-athletes were able to continue the task of increasing workload for 23.5 ± 2.4 min. The arrows with figures in Figure 2 show the number of participants who were able further to continue the increasing workload.

The elite athletes demonstrated the better muscular performance, i.e. they were able to continue the increasing workload up to 35th minute (*first athlete*) and up to 31.5th minute (*second athlete*).

HR changes. The HR changes were related to the increase in workout as it was shown in Figure 2 or in Figures 3 – 6 where RR intervals of ECG were presented in grey (background of figure). No one of all these cases can reveal the transition of body states such as anaerobic threshold or when the workload became not physiological. Gradually the increase of HR without steep changes can reveal if

the essential and important body changes occurred or if it is difficult to say at what moment they did.

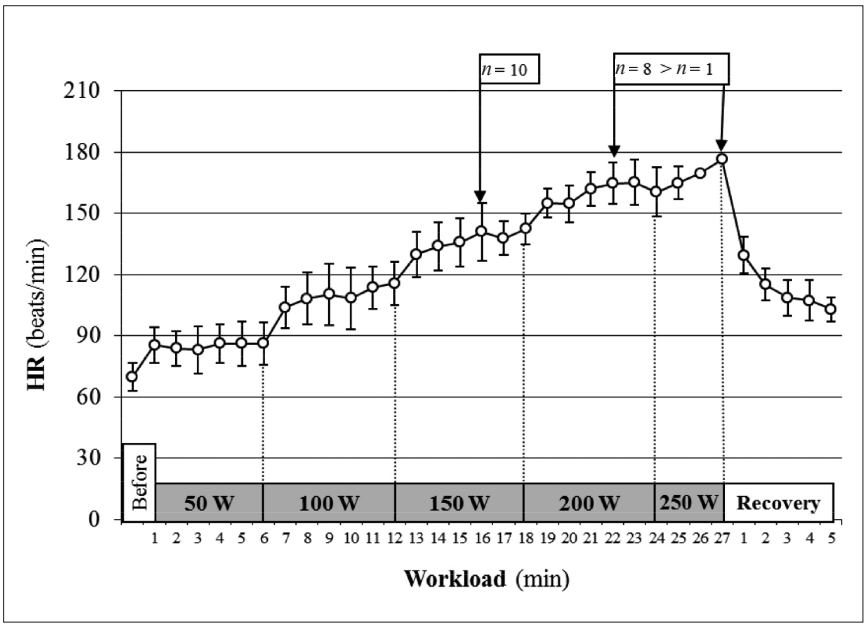
Discriminant changes. The matrix analysis of the ECG parameters has the aim to more precisely answer the question if discriminate changes call reveal the essential changes of functional state while exercising, i.e. under the conditions of increasing fatigue. Aiming to answer this question the analysis of individual cases could be useful for analysis.

Figure 3 presents the dynamics of discrimination between RR intervals and ST-segment depression during incremental exercise test and recovery. As we can see form Figure 3, the discriminant changes go parallel with the HR changes.

The different dynamics of discrimination between RR intervals and QRS during incremental exercise test were found when the data of two athletes runners were compared (Figure 3). The essential difference between these two cases was that discriminant values of the second athlete with medical diagnosis "Overtraining" were significantly higher during exercising (Figure 3–A). The first elite athlete not only was able to demonstrate better muscular performance, i.e. continue exercising longer, but the discriminant values were low and only at the end of exercising the discriminant values showed a steep increase (Figure 3–B).

Figure 5 presents the dynamics of discrimination between the amplitude of R wave and RR intervals during incremental exercise test and recovery of elite athlete. What was important about the the dynamics of discrimination during exercising under the conditions of increasing fatigue, that a steep change of discriminant values was observed in the middle of the exercise test.

Figure 2. **Dynamics of HR during incremental exercise test and recovery**



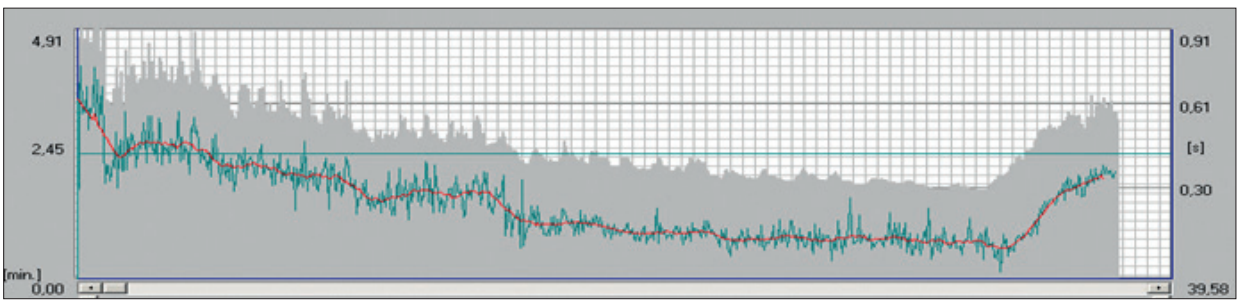
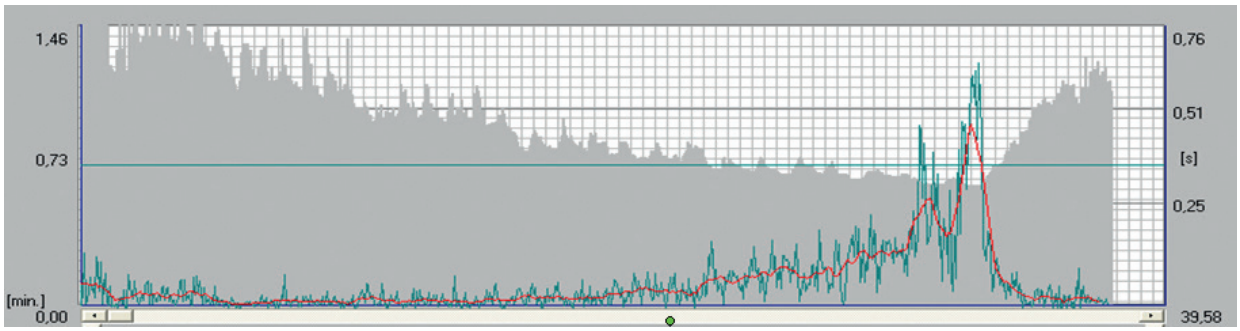
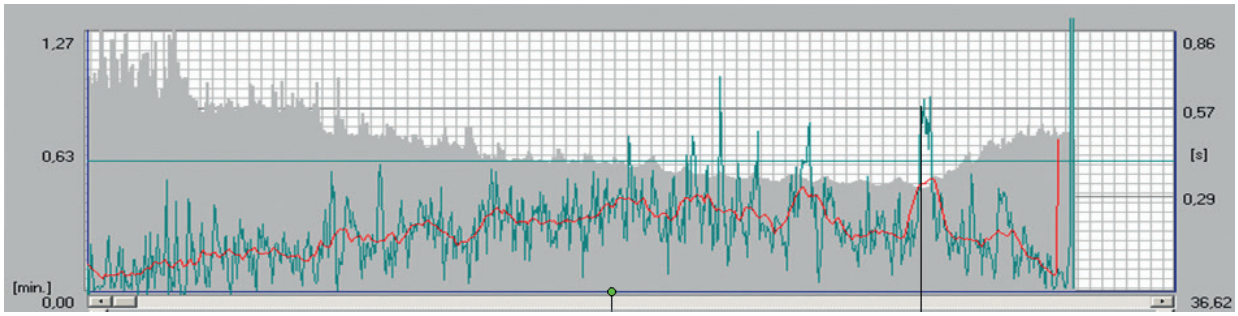


Figure 3. **Dynamics of discriminants between RR intervals and ST-segment depression during incremental exercise test and recovery**

Notes. X axis – discriminant value (left); RR intervals, s (right). **Y** axis – time, min
Grey (background) shows dynamics of RR intervals of ECG;
Green line – discriminant; red line – discriminant averaged of 10 figures.



A



B

Figure 4. **Dynamics of discriminants between RR intervals and QRS during incremental exercise test and recovery of elite athlete (A) and other athlete with medical diagnosis "Overtraining"(B).**

Notes. X axis – discriminant value (left); RR intervals, s (right). **Y** axis – time, min
Grey (background) shows dynamics of RR intervals of ECG;
Green line – discriminant; red line – discriminant averaged of 10 figures.

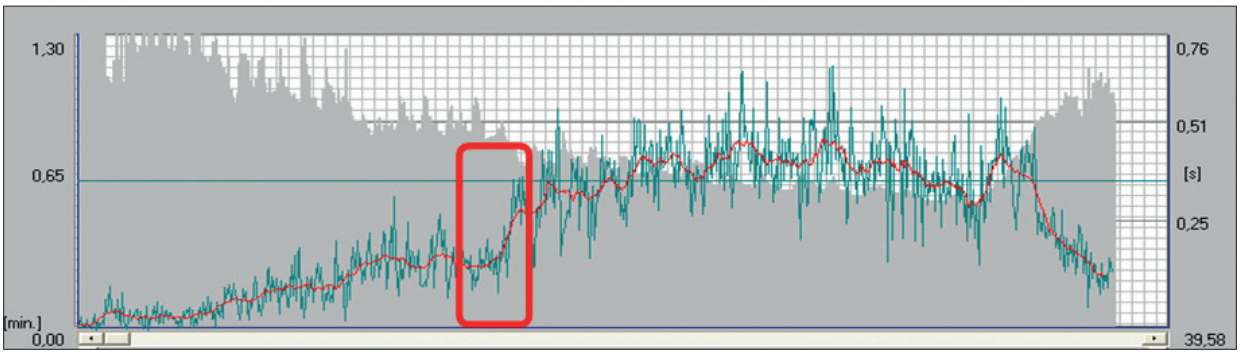


Figure 5. **Dynamics of discriminants between amplitude of R wave and RR intervals during incremental exercise test and recovery of elite athlete**

Notes. X axis – discriminant value (left); RR intervals, s (right). **Y** axis – time, min
Grey (background) shows dynamics of RR intervals of ECG;
Green line – discriminant; red line – discriminant averaged of 10 figures.

DISCUSSION

Exercise dosage control and feedback during exercising is a relevant problem that required a new modern solution. There are various methods of measuring the body reactions to workloads and physical exertion, but their applicability and value are widely discussed and analysed (Boettger et al., 2010). Functional state could be recognized by assessing the reactions to exercising workload (Mailey et al., 2010), but the question about indices and criteria for assessment and formation of feedback remains on agenda of scientific studies.

At onset of exercise all body systems adapt with a series integrated responses to meet the metabolic demands of exercising muscles (Enoka & Duchateau, 2008; Hughson & Tschakovsky, 1999; Vainoras, 2002). During exercising all levels of body structure, i.e. sub cellular, cellular, tissue, organs, systems are activated and all physiological systems

appear to show similar non-monotonic activity at all times and at all functional levels (Gibson, 2008). For investigation of these peculiarities in time, various mathematical methods are applied in order to estimate a human like a complex system (Costa, Peng, & Goldberger, 2008; Gademan et al., 2012). The human body is a complex system. Particularly, it is possible to assess the functional peculiarities while investigating elements of this system and its relationships (Hristovski et al., 2010). Fatigue arises through the interaction of the component processes and causes the reduction of low activity in the neurobiological system. Although specific physiological mechanisms are probably highly task-dependent (Enoka & Duchateau, 2008), there is the non-linear dynamic system theory that enables to indicate specific causes of fatigue and provides knowledge of the phenomenon of critical instability. Lately, an integrative point of view on the process of fatigue suggests that the origin of the fatigue or optimal functional state is related to the interaction between the physiological systems, between various physiological mechanisms.

Different parameters of ECG can describe various physiological processes. According to the model of "Integral assessment of body during exercising" (Vainoras, 2002), HR changes can be treated as a regulatory signal requiring changes in the activity of cardiovascular response; ST-segment depression as indicator of functional ischemic episodes in cardiac musculature (Gademan et al., 2012; Guldenring et al., 2012; Jernberg, Lindahl, & Wallentin, 1999; Taglieri et al., 2011) can be treated as a metabolic signal. The results obtained during matrix analysis showed that discrimination between RR intervals and ST-segment depression during incremental exercise test and recovery was parallel to the HR changes (Figure 3). It can be concluded that regulatory signals are strictly interconnected with the cardiac metabolism. If we want to follow the model "Integral assessment of body during exercising", the QRS complex of ECG can be treated as a signal for the contraction of cardiac musculature. The small values of discrimination between RR intervals and QRS during incremental exercise test of elite athlete (Figure 3 **A**) indicate a good adjustment between the regulatory signals of the system and organ levels, and the steep increase of discriminants at the end of incremental exercise test indicate the concatenation between these fractal levels of the body was lost.

The actual problem is how to catch a small but essential change in functional state of the body during the training session. Some intensity of exercising is physiological and impacts positive body changes, but when the intensity of exercising exceeds the physiological limits, the continuation of exercising is damaging. Monitoring HR cannot find and reveal such important points, e.g. at what moments the body responses to exercise workout become not physiological. It is difficult to handle the data obtained by matrix analysis of ECG parameters because there not a lot such studies. Studies designed to analyse the peculiarities of dynamics of cardiovascular, muscular or other physiological indices during exercising point out that sudden change of discriminant values indicate the internal reorganization within the physiological mechanisms. Figure 5 showed the dynamics of discrimination between the amplitude of R wave and RR intervals during incremental exercise test. The characteristic feature in this dynamics was a sudden increase of discrimination at some moment of increasing workload. There were no significant changes in HR dynamics at this moment. So we can state that the matrix analysis, i.e. concatenation between ECG parameters, can be more sensitive to define the critical changes within the body. The more detailed studies are needed to find out what ECG parameters or cardiovascular parameters are more useful for outlining the dynamics of internal body changes during exercising for health purposes or during elite training sessions.

CONCLUSION

It is difficult to make a decision about physiologically suitable intensity of exercising or at what a moment exercising becomes not physiological and damaging. Individual assessment the dynamics of concatenation between ECG parameters suggests the usefulness of such approach in the field of functional state monitoring and feedback formation during exercising. Matrix analysis of ECG parameters may be a way to improve the quality of functional state monitoring during exercising.

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REFERENCES

Achten, J., & Jeukendrup, A. E. (2003). Heart rate monitoring: Applications and limitations. *Sports Medicine, 33*(7), 517–538.

Arnold, D. (1998). *Methods in the theory of time series analysis. Fundamental Principles of Mathematical Science* (Vol. 1430). New York: Springer-Verlag.

Boettger, S., Puta, C., Yeragani, V. K., Donath, L., Muller, H. J., Gabriel, H. H., & Bar, K. J. (2010). Heart rate variability, QT variability, and electrodermal activity during exercise. *Medicine and Science in Sports and Exercise, 42*(3), 443–448. doi: 10.1249/MSS.0b013e3181b64db1

Costa, M. D., Peng, C. K., & Goldberger, A. L. (2008). Multiscale analysis of heart rate dynamics: entropy and time irreversibility measures. *Cardiovascular Engineering, 8*(2), 88–93. doi: 10.1007/s10558-007-9049-1

Dahlhaus, R., Kurths, J., Maass, P., & Timmer, J. (2008). *Mathematical methods in time series analysis and digital image processing (Understanding complex systems series).* Springer Verlag.

Enoka, R. M., & Duchateau, J. (2008). Muscle fatigue: What, why and how it influences muscle function. *The Journal of Physiology, 586*(1), 11–23. doi: 10.1113/jphysiol.2007.139477

Gademan, M. G., Uberoi, A., Le, V. V., Mandic, S., van Oort, E. R., Myers, J., & Froelicher, V. F. (2012). The effect of sport on computerized electrocardiogram measurements in college athletes. *European Journal of Preventive Cardiology, 19*(1), 126–138. doi: 10.1177/1741826710392669

Gibson, A. S. C. (2008). *Complex System Control of Activity During Fatiguing Exercise*. 2nd International Congress of Complex Systems in Sport (2nd ICCSS), 10th European Workshop of Ecological Psychology (10th EWEP). Madeira, Portugal.

Guldenring, D., Finlay, D. D., Nelwan, S. P., Nugent, C. D., Donnelly, M. P., & Bond, R. R. (2012). Estimation performance of a reduced lead system during continuous 12-lead ECG ST-segment monitoring. *Journal of Electrocardiology, 45*(6), 604–608. doi: 10.1016/j.jelectrocard.2012.08.012

Hristovski, R., Venskaityte, E., Vainoras, A., Balague, N., & Vazquez, P. (2010). Constraints-controlled metastable dynamics of exercise-induced psychobiological adaptation. *Medicina, 46*(7), 447–453.

Hughson, R. L., & Tschakovsky, M. E. (1999). Cardiovascular dynamics at the onset of exercise. *Medicine and Science in Sports and Exercise, 31*(7), 1005–1010.

Jernberg, T., Lindahl, B., & Wallentin, L. (1999). ST-segment monitoring with continuous 12-lead ECG improves early risk stratification in patients with chest pain and ECG nondiagnostic of acute myocardial infarction. *Journal of the American College of Cardiology, 34*(5), 1413–1419.

Mailey, E. L., White, S. M., Wojcicki, T. R., Szabo, A. N., Kramer, A. F., & McAuley, E. (2010). Construct validation of a non-exercise measure of cardiorespiratory fitness in older adults. *BMC Public Health, 10*, 59. doi: 10.1186/1471-2458-10-59.

Mayer-Kress, G. J. (2001). *Complex systems as fundamental theory of sports coaching?* Retrieved from http://arxiv.org/html/nlin/0111009).

Taglieri, N., Marzocchi, A., Saia, F., Marrozzini, C., Palmerini, T., Ortolani, P., . . . Rapezzi, C. (2011). Short- and long-term prognostic significance of ST-segment elevation in lead aVR in patients with non-ST-segment elevation acute coronary syndrome. *The American Journal of Cardiology, 108*(1), 21–28. doi: 10.1016/j.amjcard.2011.02.341

Torrents, C., & Balague, N. (2006). Dynamic system theory and sports training. *Education. Physical Training. Sport, 1*(60), 72–82.

Tulppo, M. P., Hughson, R. L., Makikallio, T. H., Airaksinen, K. E., Seppanen, T., & Huikuri, H. V. (2001). Effects of exercise and passive head-up tilt on fractal and complexity properties of heart rate dynamics. *American Journal of Physiology. Heart and Circulatory Physiology, 280*(3), H1081–1087.

Vainoras, A. (2002). Functional model of human organism reaction to load evaluation of sportsmen training effect. *Education. Physical training. Sport, 44*, 88–93.

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PHYSICAL, PHYSIOLOGICAL AND PSYCHOLOGICAL FITNESS OF INDEPENDENT ACTIVE AND NON-ACTIVE OLDER FEMALE ADULTS

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ABSTRACT

Background. Aging represents period of life when human body undergoes great changes affecting people's condition and overall health. The aim of the research was to determine differences of motor and functional abilities along with satisfaction and quality of life between active and non-active female older adults.

Methods. Twenty-one elderly female adults were classified in two groups: thirteen active (mean age 66.54 ± 4.59 years; mean height 158.08± 5.35 cm; mean weight 75.47 ± 13.52 kg; mean body mass index 30.18 ± 0.49 kg/m^2) and eight non-active (mean age 71.81 ± 7.15 years; mean height 160.55 ± 6.34 cm; mean weight 74.40 ± 14.06 kg; mean body mass index 28.84 ± 0.35 kg/m^2) female adults. For the purpose of this study, all participants were asked to complete senior fitness test protocol prescribed by Rikli and Jones (2013), which consisted of eight tests: 30-second chair stand test, 30-second arm curl test, 2-minute step test, chair sit-and-reach test, back scratch test, 8-foot up-and-go test, height and weight. Along with that, participants filled in Croatian version of WHOQOL-BREF questionnaire (Pibernik-Okanović, 2001) including four domains (physical health, psychological health, social environment and environment) with two additional questions about their satisfaction with health and their quality of life on the Likert scale ranging from 1to 5. The differences between active and non-active groups were examined using Man-Witney *U*-test. Significance was set at $p < .05$.

Results. Results showed significant differences in four fitness tests: 30-second arm curl test ($p = .03$), 2-minute step test ($p = .00$), chair sit-and-reach test ($p = .02$), 8-foot up-and-go test ($p = .01$) and two questionnaire domains: psychological health ($p = .04$) and environment ($p = .01$). No statistical differences were found among perception of the quality of life and health satisfaction between non-active and active participants ($p > .05$).

Conclusion. This study showed that older female adults had better achievements in motor and psychological tests, which could be translated to better physical overall fitness and preparedness of doing everyday activities in comparison to non-active group. Research showed the importance of exercising in older age, but further studies on bigger samples need to be performed for better understanding of aging and differences in levels of fitness.

Keywords: geriatrics, conditioning abilities, satisfaction with life, aging.

INTRODUCTION

The aging process is of course a biological reality which has its own dynamics, largely beyond human control. However, it is also subject to the constructions by which each society makes sense of old age. In the developed world, chronological time plays a paramount role. The age of 60 or 65 roughly equivalent to retirement ages in most developed countries is said to be the beginning of old age (Gorman, 1999). According to Nelson et al. (2007), in future several decades, the world population is predicted to face a large increase in proportion of older adults. Because of that older individuals experience impairments and disabilities in overall functioning, especially increasing incidence of chronic health problems, like cardiovacular diseases and osteoporosis. Statistics suggest that many older people do not get the amount of exercise they need and that

42% of those over 65 are experiencing functional limitations in common everyday activities. Those numbers have not improved over the past decade (Federal Interagency Forum on Aging-Related Statistics, 2010). As a result, although average life expectancy continues to increase, so does the possibility of living more years with physical limitations. Many older adults, often because of their sedentary lifestyles, are functioning dangerously close to their maximum ability during normal activities of daily living (Rikli & Jones, 2013). One of the best ways for preventing such conditions is physical activity. In elderly, it is important for physical functioning and allows performance of more integrated functional tasks (Dipietro, 1996). Longitudinal studies have reported that physical activity improves survival (Bath & Morgan, 1998; Blair & Wei, 2000; Glass, Mendes de Leon, Marottoli, & Berkman, 1999; Simonsick et al., 1993) and functional abilities (Blair & Wei, 2000), such as muscle strength and power, balance, flexibility, endurance and mobility (Taylor et al., 2004). Surgeon General's report of 1996 encourages all adults to participate in 30 minutes of moderate physical activity in most days of the week (i.e. $\geq$ 5 days a week). Although physical activity has positive impact on physical and physiological functioning, evidence is also emerging for its positive effects on mental health, more specific the quality of life (QOL).In mainstream psychology, quality of life is defined as a conscious cognitive judgment of satisfaction with one's life (Pavot & Diener, 1993).It refers to behavioral functioning or the ability not only "to do" stuff but also live long enough to do it (Kaplan, 1994) and reflects the perceived degree to which individuals are able to satisfy their psychophysiological needs (Berger, Pargman & Weinberg, 2007). Old population often deal with psychological disabilities, which are defined as any disturbance in the capacity to perform a mental activity considered normal for a human being (Fougeyrollas et al., 1998). They have been associated with participation restriction (Desrosier et al., 2004), social isolation (Charmaz, 1983) and depression (Horowitz, Reinhardt, Boerner, & Travis, 2003). It is agreed that well-being, considered as the way people see and feel about their lives, is a multifaceted phenomenon (Gauvin & Spence, 1996), especially in the aging population (Spirduso & Cronin, 2001). Rejeski and Mihalko (2001) have concluded that physical activity can improve health-related quality of life. Moreover, the effect of a physical activity may be moderate considering the functional ability in a person's life. Maintaining the health of older people is therefore of increasing importance to public health.

The aim of the present study was to investigate differences in physical, physiological and phychological parameters between active and non-active older female adults who were independent.

METHODS

Participants. The sample consisted of twenty-one elderly female adults living independently, classified in two groups. The first group included 13 healthy, active female adults (mean age 66.54 ± 4.59 years; mean height 158.08 ± 5.35 cm; mean weight 75.47 ± 13.52 kg; mean body mass index 30.18 ± 0.49 kg/m^2) and second group of eight healthy, but non-active female adults (mean age 71.81 ± 7.15 years; mean height 160.55 ± 6.34 cm; mean weight 74.40 ± 14.06 kg; mean body mass index 28.84 ± 0.35 kg/m^2). The term "active" means doing organised physical activity minimum twice a week for one hour and "non-active" – that adults do not participate in any kind of organised physical activity. Participation in the study was voluntary, and each of the participants could withdraw from the study at any time.

Procedure. In the beginning, twenty-one participants participated in the study and everyone completed Senior Fitness Test (SFT) along with WHOQOL-BREF questionnaire. No participants suffered from any kind of chronic disease and met the criteria. One expert filled in the questionnaire with each subject separately (only read the questions and circled the numbers on Likert scale), while the second expert first demonstrated and explained each test separately and then measured SFT prescribed by Rikli and Jones (2013). The testing protocol was held between 17:00–19:00 p.m. because their cardiac rhythms should not be disturbed, and the air temperature ranged from 22 to 26ºC.

Anthropometric measures. Anthropometric variables were measured according to the guidelines of the International Biological Program. Body height was measured to the nearest 0.1 cm by the anthropometric equipment called anthropometer. Body weight was measured to the nearest 0.01 kg using a digital scale. Body mass index (BMI) was calculated using the formula BMI = body mass (kg)/(body height [m])^2.

Senior Fitness Test (SFT). Senior Fitness Test (SFT) is used to assess physical fitness in older adults across a wide range of groups and ability levels. For a fitness test to be appropriate for older adults, it must reflect the major physical parameters associated with functional mobility and be safe and feasible for use in the field settings. (1) The first test was called "30-second chair stand test" and it was used to assess lower body strength. The test involved counting the number of times, within a 30-second period, that a person could come to a full stand from a seated position with arms folded across the chest. This test showed great intraclass correlation (*ICC* = .89 for all participants; *ICC* = .86 for men and *ICC* = .92 for women). (2) 30-second arm curl represented the second test as a general measure of upper-body strength. The test involved counting the number of times a person could curl a hand weight, more specific 5 pounds (2.3 kg) for women and 8 pounds (3.6 kg) for men, through the full range of motion in 30 seconds. Test-retest also showed great intraclass correlation for all participants (*ICC* = .81; *ICC* = .81 for men and *ICC* = .80 for women). (3) Next was 2-minute step test as an alternative measure of aerobic endurance when space limitations prohibited the use of the 6-minute walk test. The whole protocol involved determining the number of times in 2 minutes that a person could step in place, raising the knees to a height halfway between the patella (knee cap) and iliac crest (front hip bone). Intraclass correlation showed great reliability between test-retest (*ICC* = .90 for all participants; *ICC* = .90 for men and *ICC* = .89 for women). (4) The purpose of the chair sit-and-reach test was to assess lower-body flexibility, particularly hamstring flexibility, which is important for good posture and mobility. The test involved sitting at the front edge of a stable chair with one leg extended and the other foot flat on the floor. With hands on top of each other and arms outstretched, the participant reached as far forward as possible toward the toes. The score is the number of inches (in our case centimetres), either plus or minus, between the tips of the middle fingers and the toes. The test was measured two times in our study to see significance between measures. Speaking about significance, this test showed very good intraclass correlation within all participants (*ICC* = .95; *ICC* = .92 for men and *ICC* = .96 for women). (5)The purpose of the back scratch test was to assess upper-body flexibility, particularly shoulder flexibility. The test involved reaching one hand over the shoulder and down the back as far as possible and the other hand around the waist and up the middle of the back as far as possible, trying to bring the fingers of both hands together. The score is the number of inches (for us centimetres), either plus or minus, between the extended middle fingers. The test was measured two times in our study. Test-retest significance showed great intraclass correlation (*ICC* = .96 for all participants; *ICC* = .96 for men and *ICC* = .92 for women). (6) 8-foot up-and-go test had the purpose to assess agility and dynamic balance. The test involved getting up from a seated position and walking as quickly as possible around the cone that is 8 feet (2.4 m) away and returning to the seated position. The test, as the chair sit-and-reach and back scratch test, was measured on two occasions. Test-retest showed great significance among all participants (*ICC* = .95; *ICC* = .98 for men and *ICC* = .90 for women). All test-retest significance and test descriptions were taken from Rikli and Jones (2013).

Quality of Life Questionnaire by World Health Organization (WHOQOL-BREF). For the purpose of this study, World Health Organization questionnaire was used (WHOQOL-BREF), which was shorter version of WHOQOL-100 (World Health Organization, 2002). Twenty-four items from the original questionnaire were chosen, one from each domain which described the quality of life in general and for the overall health. So, the questionnaire was comprised of twenty-six items. As a result of WHOQOL-BREF questionnaire, quality of life profile was got which explained the quality of life through four domains: physical health, psychological health, social relationship and environment. The result in each domain was expressed as the average answers in items which described each domain. Items of general quality of life and general health were considered independent. Answers in each item were given on a Likert scale ranged from 1to 5, where 1 represented the lowest agreement with the individual item, and 5 represented the biggest agreement with the single item (Martinis, 2005). The answers were transformed on a scale from 0 to 20. According to Skevington, Lotfy and O'Connell (2004), the questionnaire showed great discriminant validity for each of the domains, and the most successful difference was between healthy and sick persons in physical and psychological health domains.

Statistical analysis. STATISTICA (Statsoft, Inc., Tulsa, OK. Version 10) was used for the statistical analysis. Descriptive statistics were calculated

for all included variables. Differences between individual variable between active and non-active group were determined using Man-Withney *U*-test. Statistical significance was set at $p < .05$.

RESULTS

Kolmogorov-Smirnov test showed that data weren't normally distributed. Thirteen active female adults comprised 62% of total sample and non-active female adults 38%. No statistically significant differences were obtained in physical measures between two groups ($p < .05$) showed in table 1.

Table 1. **Basic descriptive physical parameters (means ± standard deviations)**

Variables	Active (n = 13)	Non-active (n = 8)
Age (years)	66.54 ± 4.59	71.81 ± 7.15
Height (cm)	158.08 ± 5.35	160.55 ± 6.34
Weight (kg)	75.47 ± 13.52	74.40 ± 14.06
BMI (kg/m^2)	30.18 ± 0.49	28.84 ± 0.35

Note. *$p < .05$.

Results presented in Table 2 showed basic descriptive parameters and main differences between active and non-active female adults in SFT. As the tests measured two times, Cronbach's α showed great significance between two attempts (chair sit-and-reach test α = .99; back scratch test α = .99; 8-foot up-and-go test α = .98). There were significant differences between four senior fitness tests: 30-second arm curl test ($p = .03$), 2-minute step test ($p = .00$), chair sit-and-reach test ($p = .02$) and 8-foot up-and-go test ($p = .01$). Other tests showed no significant differences between the analyzed groups. Values in 30-second arm curl test also showed that active female adults had almost 23% better results than non-active group, also like in 2-minute step test (better results up to 45%), chair sit-and-reach test (up to 134%) and in 8-foot up-and-go test (up to 34%).

Active and non-active female groups also showed differences between two out of four psychological domains represented in WHOQOL-BREF questionnaire. The main differences were between psychological health ($p = .04$) and environment ($p = .01$), whether in other two domains the groups showed no statistical differences ($p > .05$) (Table 3). No statistical differences were found between perception of quality of life and health satisfaction between non-active and active participants ($p > .05$).

DISCUSSION

Aging, as part of the whole-life process, represents biological changes in people. Overall efficiency of doing everyday activities is decreasing primarily because of sedentary way of life and lack of physical activity. On the contrary, evidence from our study showed how people can improve physical activity or at least maintain physical performance and psychological health. Functional fitness performance enables people to perform normal everyday activities safely and independently without undue fatigue (Rikli and Jones, 2013).

Variables	Active (n = 13)	Non-active (n = 8)
30-second chair stand test (repetitions)	17.77 ± 4.34	14.87 ± 4.12
30-second arm curl test (repetitions)	20.10 ± 4.55*	15.5 ± 4.17
2-minute step test (repetitions)	83.77 ± 16.97*	46.00 ± 15.08
Chair-sit-and-reach test (cm)	5.75 ± 7.84*	–1.97 ± 5.60
Back scratch test (cm)	–6.83 ± 9.85	–1.28 ± 11.79
8-foot up-and-go test (sec)	5.60 ± 0.59*	7.49 ± 2.25

Table 2. **Basic descriptive physiological parameters (means ± standard deviations)**

Note. *$p < .05$.

Variables	Active (n = 13)	Non-active (n = 8)
Physical health domain	17.63 ± 2.26	16.14 ± 2.91
Psychological health domain	17.17 ± 1.79*	14.92 ± 2.89
Social environment	17.43 ± 2.80	15.67 ± 2.83
Environment	18.81 ± 1.31*	16.31 ± 2.46

Table 3. **Basic descriptive psychological parameters (means ± standard deviations)**

Note. *$p < .05$.

Many independent older adults, often due to their sedentary lifestyles, function dangerously close to their maximum ability level during normal activities. Unfortunately, more than one-third of community-dwelling older adults are at risk for mobility problems and falls. It is generally known that physical activity is decreased during the period of aging and physical activity is associated with the maintenance or improvement of physical fitness (Dwyer & Davis, 2005; Riebe et al., 2009).

Results showed that two groups differed in 30-second arm curl test, 2-minute step test, chair sit-and-reach test and 8-foot up-and-go test ($p < .05$), when looking their fitness profile. In other fitness variables, no significant differences were found ($p > .05$). This means that active older women who participated in our study had better aerobic endurance, upper body strength, lower body flexibility, agility and dynamic balance than non active older women.

In our study active women achieved significantly higher scores in upper body strength (30-seconds arm curl test) in comparison to non-active group, probably because of the training program included in their everyday activities. In general, Bassey (1998) reported an average loss of upper-arm strength of 2% per year for women aged 65 years and older. Based on these findings, older men and women could lose between one-quarter and one-third of muscle strength over a 10-year period, which would make a considerable impact on the quality of life and the ability to remain independent from other people. Also, elderly women lost 4% more strength in lower (14%) compared to upper limbs (10%) (Milanović et al., 2013). Decrease in muscle strength has been shown to relate with aging and muscle-mass loss, and also with more physical inactivity.

As in 30-second arm curl test, obtained scores on aerobic endurance (2-minute step test) also showed statistical differences among groups ($p < .05$). VO_2max is not constant through lifespan. According to American College of Sports Medicine (1998), VO_2max decreases approximately 5 to 15% per decade beginning at 25–30 years of age. This decline in VO_2max can be attributed to age-related reductions in both maximal cardiac output and maximal arteriovenous oxygen (a-v O2) difference. Study showed that older persons could adapt to a program of regular aerobic training as well as their younger counterparts. Older adults can achieve the same 10 to 30% increase in VO2max in response to endurance exercise training as young adults. Also, study showed that maximal heart rate (HR_{max}) declined at a rate uninfluenced by exercise training or sex of approximately 3–5% per decade (Wiebe, Gledhill, Jamnik, & Ferguson, 1999). As said before, physical activity improves overall fitness, and speaking about that cardiovascular fitness more specifically. Pate et al. (1995) recommended light- to moderate-intensity physical activity on a more frequent basis to optimise health, but that changes are insufficient for improving VO_2max.

Flexibility is important for maintaining good posture and reducing the risk of injuries and back problems. It is also critical for task of daily living such as tying shoes, kneeling down to pick up objects from the floor, putting on overhead garments and combing hair (Cicioglu, 2010). Scores in chair sit-and-reach test showed that active female adults had better flexibility range of motion than their non-active colleagues ($p < .05$). In general, there are incidences in age-related changes in flexibility among men and women, where woman's flexibility deterioration starts earlier than in men (at the age of approximately 63 opposed to 73 years old in men) (Statkohostas, Little, Vandervoort, & Paterson, 2012; Statkohostas, McDonald, Little, & Paterson, 2013). Active group had better results (+ 7.72 cm) than non-active group, which indicates that physical activity had positive impacts on flexibility. However, significant differences were not found in the performance of back scratch test ($p > .05$). Studies have shown improvements in back scratch performance after resistance training alone (Cavani, Mier, Musto, & Tummers, 2002) and resistance-balanced programs (DiBrezzo, Shadden, Raybon, & Powers, 2005). It means that regular physical activity has positive effects on flexibility, but, as mentioned before, differences were not found, perhaps because of the small number of subjects participated in the study.

Balance and agility are important for a number of common mobility tasks such as walking, negotiating curbs, climbing stairs and making quick movements needed to avoid hazards in environment (Cicioglu, 2010). Performance on the 8-foot up-to-go test between groups showed significant differences between them ($p < .05$). Past evidence also indicated that performance on the 8 foot up-and-go test could discriminate among various functional categories in older adults and was responsive to changes resulting from increased levels of physical activity (Podsiadlo &

Richardson, 1991; Tinneti, Speechley, & Ginter, 1988). Studies also showed that this test was an excellent discriminator of performance changes and could detect expected differences between highly active and inactive older adults. Results showed that the average 8 foot up and go test scores of highly active older people were considerably better than those of inactive group (Rikli & Jones, 2001), which is similar to our results.

Although, there were no significant differences in the results on 30-second chair stand test, lower body strength is the main predictor of balance, physical performance and mobility. Results indicated that lower body strength decreased by 30–50% between ages of 50–70 years (American College of Sports Medicine, 1998).

There are many known psychological changes associated with planned and structured, habitual exercise (Berger, 1996) mainly in four broad areas: enhanced mood, stress reduction, more positive self-concept and higher quality of life. Results in our study confirmed that active female participants had better results on two out of four quality of life domains compared to non-active female participants: psychologicalhealthandenvironment.

In order to maximize psychological benefits of exercise some major requirements should be met (Berger, 1996). Exercise should be pleasant and enjoyable, aerobic (or should influence breathing patterns), closed, predictable and spatially certain; conducted at moderate intensity and in duration of at least 20–30 minutes. Also, there should be absence of interpersonal competition and exercise must be conducted on a regular basis. Active female participants in our study were involved in such recommended type of exercise on regular basis (2 times a week, 60 minutes, moderate intensity). They reported significantly higher levels of psychological health than non-active female participants and were also more pleased with their environment. Previous research have shown that this kind of exercise can have great impact on participant's mood alteration, especially short-term decreases in anxiety, depression, anger and fatigue as well as increased well-being, alertness, vigour, clear thinking and energy (Berger, 1996).Also, exercise can serve as stress management technique alowing participants time to relax after busy day, think and problem solve or just enjoy in experiencing body in movement (Berger at al., 2007). Physical activity can be related to participant's self-concept, self-esteem, self-efficacy, self-awareness and self-knowledge (Berger, 1996).

As health-enhancement and disease-prevention models of exercise suggest that through exercise participants can increase their vigour and vitality, decrease fatigue and improve mobility as well as prevent numerous diseases such as coronary artery disease, osteoporosis, obesity and cancer (Berger at al., 2007). Especially for older people, physical activity can pay important role in the prevention and management of chronic diseases, reduction of physical decline, maintaining functional ability and prevention of injuries (Cyarto, Moorhead, & Brown, 2004; Singh, 2002). Although active life is considered necessary in order to retain and improve one's physical health, our study showed no significant difference in this domain or in the single question about health satisfaction between active and non-active older females.

When people stop working they can experience decrease in their social relationships and support due to the reduced number of people they meet on everyday basis. As they get older their children get more independent and many of their friends pass away, so it is easy to become socially isolated. Research conducted by Woolham, Daly and Hughes (2013) in the UK found that living alone, not enjoying life, needing help with personal care and not being in touch with people as often as one would like predicted loneliness among people aged 55 and over. This is why involving in some sort of organized physical activity can have important role in socialization for older adults. It can provide them opportunities to meet and socialize with people on a regular basis and possibly reduce isolation and feelings of loneliness. However, our study did not find significant difference in social relationships between active and non-active participants – both groups reported similar levels of satisfaction with their personal relationships, social support and sexual activity.

The significant difference was found in the scores of the environment scale, which suggested that active older women perceived their financial resources, home environment, health and social care, freedom, safety, security, transport as well as their participation in and opportunities for recreation and acquiring new information and skills better that those not involved in regular physical activity. The findings are not surprising if we consider some of the barriers to exercise older people often report (Berger et al. 2007; Schultzer & Graves, 2004): poor health, environment lacking exercise opportunities, lack of knowledge and

understanding of the relationship between moderate exercise and health, lack of exercise companion, fear of being injured, lack of time and need to exercise, etc. Older people also tend to underrate their physical abilities, they believe that they are more active than they really are, exaggerate the dangers of physical activity and enrol in age related stereotypes (Berger et al., 2007).

CONCLUSION

According to World Health Organization, health represents overall physical, psychological and social well-being, not only the absence of disease or decrepitude. From the obtained results, overall fitness and psychological components were higher among active older female adults because they, along with everyday activities, participate in organized aerobic physical activities. Because of that, physical activity and being active prolonged the state of mental health and kept their conditioning abilities at such level that allowed them to overcome everyday barriers. Even though the process of aging is natural and inevitable, an adequate level of physical activity should slow down the loss of functional and physical abilities and help maintain a healthy way of life for elderly people.

REFERENCES

American College of Sports Medicine (ACSM) Position Stand. (1998). Exercise and physical activity for older adults. *Medicine and Science in Sports and Exercise*, *30*, 992–1008.

Bassey, E. J. (1998). Longitudinal changes in selected physical capabilities: Muscle strength, flexibility and body size. *Age & Ageing*, *27*(3), 12–16.

Bath, P. A., & Morgan, K. (1998). Customary physical activity and physical health outcomes in later life. *Age & Ageing*, *27*(3), 29–34.

Berger, B. G, Pargman, D., & Weinberg, R. S. (2007). *Foundations of exercise psychology.* Fitness information technology. Morgantown, USA.

Berger, B. G. (1996). Psychological benefits of an active life style: What we know and what we need to know. *Quest*, *48*, 330–353.

Blair, S. N., & Wei, M. (2000). Sedentary habits, health, and function in older women and men. *American Journal of Health Promotion*, *15*(1), 1–8.

Cavani, V., Mier, C. M., Musto, A. A., & Tummers, N. (2002). Effects of a 6-week resistance-training program on a functional fitness of older adults. *Journal of Aging and Physical Activity*, *10*, 443–452.

Charmaz, K. (1983). Loss of self: A fundamental form of suffering in the chronically ill. *Sociology of Health and Illness*, *5*, 168–195.

Cicioglu, I. (2010). Assessment of physical fitness levels of elderly Turkish males over 60 years. *Collegium Antropologicum*, *34*(4), 1323–1327.

Cyarto, E. V., Moorhead, G. E., & Brown, W. J. (2004). Updating the evidence relating to physical activity intervention studies in older people. *Journal of Science and Medicine in Sport*, *7*(1), 30–38.

Desrosier, J., Noreau, L., Robichaud, L., Fougeyrollas, P., Rochette, A., & Viscogliosi, C. (2004). Validity of the assessment of life habits in older adults. *Journal of Rehabilitation Medicine, 36*, 177–182.

DiBrezzo, R., Shadden, B. B., Raybon, B. H., & Powers, M. (2005). Exercise intervention designed to improve strength and dynamic balance among community-dwelling older adults. *Journal of Aging and Physical Activity*, *13*(2), 198–209. PUBMED ID 15995265

Dipietro, L. (1996). The epidemiology of physical activity and physical function in older people. *Medicine & Science in Sports & Exercise, 28*, 596–600.

Dwyer, G. B., Davis, S. E. (2005). *ACSM's health-related physical fitness assessment manual.* Philadelphia: Lippincott Williams & Wilkins.

Federal Interagency Forum on Aging-Related Statistics. (2010). *Older Americans 2010 – Key indicators for well-being.* Retrieved from http://www.nia.nih.gov/

Fougeyrollas. P., Noreau, L., Bergeron, H., Cloutier, R., Dion, S. A., & St-Michel, G. (1998). Social consequences of long term impairments and disabilities: conceptual approach and assessment of handicap. International Journal of Rehabilitation Research, *21*, 127–141.

Gauvin, L., & Spence, J. C. (1996). Physical activity and psychological well-being: Knowledge base, current issues, and caveats. *Nutrition. Reviewes*, *54*, 53–65.

Glass, T. A., Mendes de Leon, C., Marottoli, R. A., & Berkman, L. F. (1999). Population based study of social and productive activities as predictors of survival among elderly Americans. *BMJ*, *319*, 478–84.

Gorman, M. (1999). Development and the rights of older people. In Randel, J. et al. (Eds.) *The ageing and development report: Poverty, independence and the world's older people* (pp. 3–21), London, Earthscan Publications Ltd.

Horowitz, A., Reinhardt, J. P., Boerner, K., & Travis, L. A. (2003). The influence of health, social support quality and rehabilitation on depression among disabled elders. *Aging & Mental Health*, *7*(5), 342–350.

Kaplan, R. M. (1994). The ziggy theorem: Toward an outcomes-focused health psychology. *Health Psychology, 13*, 451–460.

Martinis, T. (2005). Quality of life perception in age functioning (Master's theses (in Croatian)). University of Zagreb.

Milanović, Z., Pantelić, S., Trajković, N., Sporiš, G., Kostić, R., & James, N. (2013). Age-related decrease in physical activity and functional fitness among elderly men and women. *Clinical Interventions in Aging*, *8*, 549–556.

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., … Castaneda-Sceppa, C. (2007). Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise*, *39*, 1435–1445.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., … Wilmore, J. H. (1995). Physical activity and public health: A recommendation from the Centre for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association, 273*, 402–407.

Pavot, W., & *Diener,* E. (*1993*). Review of the Satisfaction with Life Scale. *Psychological Assessment*, *5*, 164–172.

Pibernik-Okanović, M. (2001). Psychometric properties of the World Health Organization quality of life questionnaire (WHOQOL-100) in diabetic patients in Croatia. *Diabetes Research and Clinical Practice*, *51*, 133–143.

Podsiadlo, D., & Richardson, S. (1991). The timed "up & go": A test of basic functional mobility for frail elderly persons. *Journal of the American Geriatrics Society*, *39*, 142–148.

Rantanen, T., Era, P., & Heikkinen, E. (1997). Physical activity and the changes in maximal isometric strength in men and women from the age of 75 to 80 years. *Journal of the American Geriatrics Society, 45*(12), 1439–1445.

Rejeski, W. J., & Mihalko, S. L. (2001). Physical activity and quality of life in older adults. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *56*, 23–35.

Riebe, D., Blissmer, B. J., Greaney, M. L., Garber, C. E., Lees, F. D., Clark, P. G. (2009). The relationship between obesity, physical activity and physical function in older adults. *Journal of Aging and Health*, *21*(8), 1159–1178.

Rikli, R., & Jones, J. (1999). Development and validation of a functional fitness test for community-residing older adults. *Journal of Aging and Physical Activity*, *7*, 129–161.

Rikli, R. , & Jones, C. (2013). *Senior fitness test manual* (2nd edition). Champaign, Il: Human Kinetics.

Schutzer, K. A., & Graves, B. G. (2004). Barriers and motivations to exercise in older adults. *Preventive Medicine*, *39*(5), 1056–1061.

Simonsick, E. M., Lafferty, M. E., Phillips, C. L., Kasl, S. V., Seeman, T. E., Fillenbaum, G., … Lemke, J. H. (1993). Risk due to inactivity in physically capable older adults. *American Journal of Public Health*, *83*, 1443–1450.

Singh, F. M. (2002). Exercise comes of age: Rationale and recommendations for a geriatric exercise prescription. *Journals of Gerontology. Series A: Biological Sciences and Medical Sciences*, *57*(5), 262–282.

Skevington, S. M., Lotfy, M., & O'Connell, K. A. (2004). The World Health Organisation's WHOQOL-BREF Quality of Life Assessment: Psychometric properties and results of the international field trial- A report from the WHOQOL Group. *Quality of Life Research*, *13*(2), 299–310.

Spirduso, W. W., & Cronin, L. (2001). Exercise dose-response effects on quality of life and independent living in older adults. *Medicine & Science in Sports and Exercise*, *33*(6), 598–608.

Stathokostas, L., Little, R. M., Vandervoort, A. A., & Paterson, D. H. (2012). Flexibility training and functional ability in older adults: A systematic review. *Journal of Aging Research, 2012*, 1–30.

Stathokostas, L., McDonald, M. W., Little, R. M. D., Paterson, D. H. (2013). Flexibility of older adults aged 55–86 years and the influence of physical activity. *Journal of Aging Research, 2013*, 743–843.

Taylor, A. H., Cable, N. T., Faulkner, G. E., Hillsdon, M., Narici, M., & Van der Bij, A. K. (2004). Physical activity and older adults: A review of health benefits and theeffectiveness of interventions. *Journal of Sports Sciences*, *22*, 703–725.

Tinetti, M., Speechley, N., & Ginter, S. (1988). Risk factors for falls among elderly persons living in the community. *New England Journal of Medicine, 319*, 1701–1707.

U. S. Department of Health and Human Services. (1996). *Physical activity and health.* National Center for Chronic Disease Prevention and Health Promotion, The President's Council on Physical Fitness and Sports.

Wiebe, C. G., Gledhill, N., Jamnik, V. K., & Ferguson, S. (1999). Exercise cardiac function in young through elderly endurance trained women. *Medicine and Science in Sports and Exercise, 31*, 684–691.

Woolham, J., Daly, G., & Hughes, E. (2013). Loneliness amongst older people: Findings from a survey in Coventry, UK. *Quality in Ageing and Older Adults*, *14*(3), 192–204.

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A DESCRIPTIVE PROFILE OF ISOMETRIC MUSCLE STRENGTH AND MUSCLE STRENGTH IMBALANCE IN YOUNG TENNIS PLAYERS

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ABSTRACT

Background. Tennis is assumed as asymmetric sport, prolonged training practice could affect muscle strength imbalance. Muscle strength functional ratio imbalance could be a reason for poor posture, physical weakness and increased risk of injury. The purpose of the research was to evaluate young tennis players' main muscle group strength topography and to investigate the level of different muscles groups' bi-lateral and contra-lateral imbalance.

Methods. The participants of the study were six young right handed competitive tennis players (girls, age 11.4 ± 0.5 years, tennis experience 4.7 ± 0.6 years). Examination of main muscles groups was performed with an isokinetic dynamometer.

Results. Young tennis players have pronounced bi-lateral imbalance between shoulder joint extensors and flexors (25%), internal and external rotators (36%), left elbow flexors and extensors (58%), wrist pronator and supinator (the right hand 17%, left 48%), hip flexors and extensors (35%); knee joint flexors and extensors (60%); ankle dorsal flexors and plantar flexors (59%); spine and abdominal muscles (48%). It was detected that young tennis players have pronounced contra-lateral imbalance between right and left internal rotators of the shoulder joint (27%) and external rotators (26%), wrist joint supinators (41%).

Conclusions. To avoid the increase in muscle bi-lateral imbalance it is highly recommended to pay more attention to shoulder adductors and shoulder external rotators, elbow flexors and extensors, wrist supinators and extensors, knee extensors, ankle plantar flexors and spine flexors. For contra-lateral imbalance prevention in addition to train non-dominant upper extremity muscles: shoulder internal and external rotators, wrist supinators.

Keywords: bi-lateral imbalance, contra-lateral imbalance, maximal isometric torque, muscle functional ratio, asymmetry.

INTRODUCTION

Muscle strength plays an important role in sports where maximum power should be applied in transitional and fast movements, which are *throwing-like* movements (Bartonietz, 1994; Clements, Ginn, & Henley, 2000; Hay, 1992; Henry, 1960; Kopsic Segal, 2002). Tennis player performs about 380 strokes on average during one hour of play. Minimal time spent in trainings is two hours a day, tennis game in competition may last from one to five hours (Girard & Millet, 2008; Kovacs, 2006). To clarify the winner they have to play at least 48 matches in a game of three sets and 72 matches in a game of five sets (Christmass, Richmond, Cable, & Arthur, 1998; Mendez-Villanueva, Fernandez-Fernandez, Bishop, Fernandez-Garcia, & Terrados, 2007). Minimum number of stokes per game may fluctuate from 130 to 220 for which they need as many contractions of *working* muscles as possible. An ability to withstand great pressure depends on enormous muscle strength and endurance during the whole game, were we can observe a fatigue-

resistance phenomenon (Stephenson, Lamb, & Stephenson, 1998). The more powerful stroke is produced, the greater muscle effort is made. Not only wrist, elbow and shoulder joint muscles take part in the stroke generation, but also great input is produced by body core and lower limb muscles (Reid & Schneiker, 2008). The demands of tennis can lead to characteristic injury patterns and musculoskeletal system adaptation (Ellenbecker, Pluim, Vivier, & Sniteman, 2009).

The evaluation of young tennis players' muscle strength condition is important because of several points of view. First of all, muscle strength testing helps coaches control proper and harmonic muscle system evaluation and assess physical fitness of an athlete for strength training improvement (Andrade et al., 2013; Reid & Schneiker, 2008; Ulbricht, Fernandez-Fernandez, & Ferrauti, 2013; Zuša, 2013). Secondly, knowledge about muscle strength condition and functional ratio between agonist-antagonist (*bi-lateral imbalance*), dominant and non-dominant body side (*contra-lateral imbalance*) is vital for reducing and predicting the risk of injury because muscle strength imbalance could effect this (Alizadehkhaiyat, Fisher, Kemp, & Frostick, 2007; Andrade et al., 2013; Ellenbecker, Roetert, Sueyoshi, & Riewald, 2007; Hayot et al., 2014; Kovacs, 2006; Nagel & Avram, 2013; Saccol et al., 2010). In spite of common traumas and complains on different joint, back pain in sport, subject of muscle strength imbalance in different age athletes still has been not sufficiently studied (Everett, Strutton, & McGregor, 2008; Saccol et al., 2010).

The aim of the research was to evaluate young tennis players' main muscle group strength topography and to assess the level of bi-lateral and contra-lateral imbalance. We hypothesized that young tennis players have pronounced muscle strength bi-lateral imbalance between shoulder adductors and abductors, internal and external rotators, wrist supinators and pronators, and contra-lateral imbalance between dominant and non-dominant upper extremities shoulder adductors and internal rotators, wrist flexion, extension and supination muscles strength.

METHODS

Participants. The participants of the experiment were six healthy and competitive tennis players (girls, age 11.4 ± 0.5 years, mass 42.6 ± 4.6 kg, height 157.8 ± 5.2 cm, tennis experience 4.7 ± 0.6 years, weekly training 10 ± 2 h). All tennis players were right handed. The research was accepted by Latvian Academy of Sport Education local Ethics Commission (Resolution No. 11-D1).

Testing procedure. An isokinetic device (Rev-9000, Italy) was used for the determination of the maximum isometric torque in selected joint positions in the major muscle groups of young tennis players. The testing procedure was originated based on the recommendations of Davies, Ellenbecker and Brinks (2000). Before testing each participant was encouraged to perform a general 8–10 min warm-up. Maximal muscle strength testing procedure consisted of specific joint warm up of 60 s, followed by 6 x 3 s isometric muscle work (fixed joint angular position, with resistance 600 N·m and fixed speed at 0°/s) with 20 s passive rest and then 60 s cool down continuous passive motions.

Shoulder joint muscle strength testing. Shoulder joint flexion and extension testing was performed in supine position, upper extremity straight, 10° flexing in elbow joint is acceptable, 90° angle in shoulder joint. Shoulder joint adduction and abduction was performed in supine position, upper extremity straight, 10° flexing in elbow joint is acceptable, 60° angle in shoulder joint. Shoulder joint internal and external rotation testing was carried out in sitting position, elbow joint in 90° flexion and 60–75° abduction, 25° angle in shoulder joint.

*Elbow joint testing***.** Elbow joint flexion and extension was tested in sitting position with 90° in elbow joint, wrist was in supination position during flexion and in pronation position during extension exercise.

Wrist joint testing. Wrist flexion and extension was performed in sitting position with 60–70° flexion in elbow joint and 50° in wrist joint. Forearm pronation and supination performed in sitting position, a rotation axis was parallel to forearm, testing angle – 90°.

Hip joint testing. Hip flexion and extension were performed in supine position, testing angle – 80°. Hip adduction and abduction testing position was lying on one side with testing angle in hip joint of 45°.

Knee joint testing. Knee flexion and extension were performed in a sitting position, testing angle was 90°.

Ankle joint testing. Ankle joint dorsal flexion and plantar flexion were performed in supine position with knee flexed at 120°, testing angle in joint 15°. Ankle inversion and eversion was

measured lying on one side, knee slightly bended, testing angle of 45°.

Spine and abdominal muscle testing. Spine flexion and extension exercise was performed in a sitting position, testing angle – 50°.

Verbal and visual feedback was used to increase the motivation of the young tennis players. For data analysis we chose the best result for current player, an exception was the first repetition – if the best record was during the first repetition, we did not take it for the following data analysis – this is based on recommendation of Davies et al. (2000).

RESULTS

Young tennis players of the same age and qualification that were training in the same group took part in the research. Regardless of these circumstances, indicators of muscle group strength and their mutual relations were different for each participant.

Shoulder joint muscle strength. The measurements show that all participants of the experiment had more powerful shoulder extensors than flexors: right shoulder extensors 39.5 ± 9.9 N·m and left 40.6 ± 9.1 N·m, right shoulder flexors 29.9 ± 4.5 N·m and left 25.4 ± 3.0 N·m. The average result of right shoulder adductors was 24.15 ± 2.8 N·m, for abductors 23.15 ± 4.25 N·m, but for left shoulder adductors 26.22 ± 7.2 N·m and abductors 22.91 ± 5.07 N·m. Muscular pronounced bi-lateral imbalance was observed in shoulder joint internal and external rotators, averages for right shoulder internal rotators 25.91 ± 3.61 N·m and external rotators 16.31 ± 6.34 N·m, for left shoulder internal rotators 20.45 ± 5.88 N·m and external rotators 13.02 ± 4.39 N·m.

Elbow joint muscle strength. The average group indicator for right elbow joint flexors was 25.34 ± 3.96 N·m, for extensors 23.90 ± 6.99 N·m and for left elbow joint flexors was 21.58 ± 5.82 N·m, for extensors 26.10 ± 8.56 N·m.

Wrist joint muscle strength. The average group indicator of right wrist flexors was 5.33 ± 2.20 N·m and extensors 5.14 ± 1.52 N·m, for left wrist flexors 8.34 ± 1.34 N·m and extensors 4.01 ± 1.50 N·m. The analysis of wrist pronators and supinators testing results showed that right wrist pronator strength was 5.56 ± 1.47 N·m and for supinators 4.52 ± 0.48 N·m; for left wrist pronators it was 5.96 ± 1.97 N·m and for supinators it was 4.02 ± 2.37 N·m.

Hip joint muscles strength. The testing results of hip joint flexors and extensors maximum torque showed that flexors dominated over extensors, the average group torque indicator of right hip flexors was 116.63 ± 20.69 N·m and for extensors it was 73.32 ± 14.39 N·m, for left hip flexors 128.64 ± 25.86 N·m and for extensors 81.22 ± 11.49 N·m. Adductors of hip joint muscles were more powerful than abductors, right hip adductors torque average indicator was 77.46 ± 15.09 N·m, for abductors 66.39 ± 7.62 N·m and for left hip adductors 76. 63 ± 14.15 N·m, for abductors 65.41 ± 10.14 N·m.

Knee joint muscles strength. Right knee flexors torque was 131.58 ± 26.67 N·m, extensors 50.74 ± 6.04 N·m and for left knee joint muscles respectively flexors 130.00 ± 28.00 N·m and extensors 54.65 ± 12.67 N·m.

Ankle joint strength. The average indicators of the group for right ankle dorsal flexors was 80.02 ± 30.52 N·m, plantar flexors 33.04 ± 6.97 N·m and for left ankle dorsal flexors 83.40 ± 19.60 N·m, planar flexors 30.64 ± 8.00 N·m. The average torque of group right ankle invertors was 18.52 ± 4.05 N·m, evertors 15.66 ± 2.97 N·m and left foot respectively invertors 19.42 ± 4.38 Nm and evertors 14.23 ± 2.57 N·m.

Spine and abdominal muscle strength. There was the same tendency for all young tennis players – domination of spine extensors back muscles. The average indicators of maximum torque of abdominal muscles spine flexors were 94.47 ± 12.30 N·m and of extensors 185.40 ± 34.35 N·m respectively.

DISCUSSION

The main idea for investigating muscle strength topography is to understand the muscle strength condition of tennis specific and non-specific muscles, to find out critical level of muscle strength ratio and imbalance. The present study focused on the 11-year-old competitive tennis players – girls. Muscle strength topography of young tennis player reflects the functional state of different muscles at 11 years of age and the influence of tennis specific training. To be able to acquire and to perform stroke technique, it is important to have a specific muscle strength development level (Saccol et al., 2010) and this is the reason why during the training of young tennis players a particular attention (60–70% of all training time) needs to be paid to musculoskeletal system strengthening (Schönborn, 1998; Zuša,

2013) and promotion of all muscle group strength development.

There are limited resources on the subject of young tennis player muscle strength measuring. Strength deficits or muscle imbalance is assumed as one of several injury risk factors in sport (Alizadehkhaiyat et al., 2007; Almekinders & Temple, 1998). It has been suggested that the incidence of various types of overuse injuries may be reduced by performance of sport and motor-specific resistance training, potentially after measuring agonist and antagonist strength imbalances to identify any predisposition for injury (Alizadehkhaiyat et al., 2007; Ellenbecker, Roetert & Riewald, 2006; Fleck & Falkel, 1986), especially in young tennis players – injuries can involve virtually all anatomical regions of the body (Ellenbecker, 2014). It has been verified that during a period of 11–12 years children's physiological features do not show much muscle strength increase (Burnie, 1987; Degache, Richard, Edouard, Oullion, & Calmes, 2010; Gur, Akova, Punduk, & Kucucoglu, 1999; Sunnegardh, Bratteby, Nordesjo, & Nordgren, 1998). This fact allows us to assume that increase of the muscle strength could be connected with performing a regular physical exercise and tennis practice influence (Chandler, Kibler, Stracener, Zeigler, & Pace, 1992; Saccol et al., 2010; Zuša, Lanka, & Čupriks, 2012).

Upper extremity muscle strength, level of bi-lateral and contra-lateral imbalance. The role of upper extremity (shoulder, elbow and wrist joint) muscles during forehand stroke production has been studied by Bahamonde and Knudson (2003). Over-training, repetitive movements (Ellenbecker et al., 2006), training errors, poor and faulty stroke technique, inappropriate equipment or the level of expertise (Hayot et al., 2014), flexibility problems, poor circulation, strength deficit or muscle imbalance (Almekinders, & Temple, 1998) could progress such injury as swimmers' shoulder, lateral epicondylitis, lateral tendinosis, lateral epicondylopathy, tennis elbow, radial epicondylalgia, extensor tendinopathy and row elbow pain (Alizadehkhaiyat et al., 2007). A shoulder-elbow-wrist segment cooperation is very significant in tennis stroke production, a weak muscle of one joint will affect next segment, for example, a weakness of shoulder muscles will provide elbow muscle overuse because of compensation action, etc.

There are several studies (Chandler et al,, 1992; Ellenbecker, 1992; Julienne, Gauthier, Moussay, & Davenne, 2007; Yildiz, Aydin, Kirapl, Hazneci, & Kalyon, 2006;) which showed that competitive tennis players had upper extremity contra-lateral imbalance – dominant arm muscles are better developed in a comparison with non-dominant arm muscles. **Shoulder** internal / external rotators and adductors/abductors are often studied in tennis players, because these muscles are assumed as tennis specific – they play an important role in racquet acceleration in all tennis strokes (Bahamonde & Knudson, 2003; Julienne, Gauthier, & Davenne, 2012; Ryu, McCormick, Jobe, Moynes, & Antonelli, 1988; Saccol et al., 2010). All studies have similar results – tennis players have a significant contra-lateral imbalance in shoulder internal rotators (Chandler et al., 1992; Ellenbecker & Roetert, 2003; Ellenbecker, 1992; Nagel & Avram, 2013), this is assumed to be related with the tennis training demands and it is considered as an adaptation to the serving motion. The ratio values recommended to provide muscular balance are between 66–75%, such that shoulder external rotators are at least 2/3 the strength of the shoulder internal rotators in the concentric mode (Saccol et al., 2010), a conventional strength ratio of 2:3–3:4 (0.66–0.75) to prevent shoulder injuries (Ellenbecker, & Davies, 2000). The results of our study approved previous study trends – young tennis players have contra-lateral imbalance in shoulder internal rotators, which varied between 22–42% (only for one participant bi-lateral imbalance level was only 12%). In shoulder external rotators for 3 participants the level of contra-lateral imbalance was not higher than 11% and for other 3 – it varied between 44–52%. Contra-lateral imbalance in shoulder adductors was found for 3 participants (22–36%) and in flexors for 1 participant (36%). Level of bi-lateral imbalance highly varied between all participants: difference in internal and external rotators for right shoulder was 10–75%, for left shoulder 15–56%; in adductors and abductors for right shoulder 0–28%, for left shoulder 0–25%; in shoulder extensors and flexors for right 11–38% and for left 23–50%. Including a specific strength training program in tennis practice to avoid shoulder muscle strength imbalance proved a positive effect (Julienne et al., 2012; Niederbracht, Shim, Sloniger, Paternostro-Bayles, & Short, 2008).

Lack of **elbow joint** muscle strength or muscle strength imbalance could affect racquet orientation during stroke production (this will affect accuracy and efficiency of the stroke) and could be an injury predisposition (Bazzucchi, Riccio, & Felici, 2008; Elliott, 2003). Greater dominant arm strength in elbow extensors was found in junior elite tennis players (Ellenbecker, & Roetert, 2002). The results of our study showed that the trend of imbalance between elbow flexors and extensors was different for all participants, 2 participants had bi-lateral imbalance 21 and 31% of flexors dominance for right elbow joint; and 2 participants had bi-lateral imbalance 15, 27% of flexors dominance and 3 had 13, 32, 56% of extensors dominance for left joint. Level of contra-lateral imbalance varied between 13–64% for elbow flexors and between 9–74% for extensors. The data of the testing young tennis players differed from other similar studies (Bazzucchi et al., 2008; Howatson, & Someren, 2005) – indicators of young tennis players elbow flexors and extensors maximal torque are significantly lower and it could be explained with age differences of the participants.

Wrist is distal segment in tennis stroke upper extremity kinematic chain, tennis specialists named wrist as *weakest* part, because very often wrist muscle strength training stays behind physical condition training. During prolonged practice, repetitive high level of finger/wrist extensor muscle solicitations in all tennis strokes could provoke the overuse of these muscles and affect the tendinous tissue of their origins in the most extreme cases (Hayot et al., 2014). In similar study Salonikidis et al. (2009) measured WrF strength in adult high level tennis players (n = 6), handball players (n = 4) and University students (n = 10). Salonikidis et al. (2009) concluded that there was a high level of individual variation in the groups and maximal difference between groups muscle strength torque wasn't significant ($p > .05$). This proves that regular practice of tennis and handball doe not influence on wrist flexors strength development and to improve muscle strength it is necessary to perform specific exercises. Alizadehkhaiyat et al. (2007) and Hayot et al. (2014) found that wrist flexors were stronger than wrist extensors in healthy adults. Significantly greater dominant arm wrist flexors and extensors, as well as forearm pronation strength was found in highly skilled adult tennis players by Ellenbecker (1991). In our study the results of maximal torque in wrist flexors/extensors and pronators/supinators were low (in comparison with adult participants in other studies) and similar between each other. Significant trend for all participants was that wrist pronators were stronger than supinators: bi-lateral imbalance for right wrist joint varied between 8–29% and for left wrist joint – 25–73%. This fact could be explained with groundstroke, smash and serve stroke technique biomechanics – in finish part of *ball follow-through* phase the input of wrist pronators are essential. We found contra-lateral imbalance in wrist flexors, extensors, pronators and supinators – dominant arm muscles were stronger, this fact confirms previous researches data (Ellenbecker et al., 2006).

Low extremity muscle strength, level of bi-lateral and contra-lateral imbalance. There are certain opinions (Chow, Park, & Tilman, 2009; Ellenbecker & Roetert, 1995) that lower body part development in tennis players is as important as upper part physical development. The proper *foot work* provides enough quick stars, competent speed during running and start/stop movements (Ellenbecker et al., 2009). From biomechanical point of view strength of the muscles of the low body parts plays an important role in powerful stroke production (Elliott, 2006; Kopsic Segal, 2003; Zusa, 2013). All movements in tennis are initiated by the feet pushing against the ground, and a force and momentum transfer via the kinetic chain segments of the lower extremities to the trunk, upper extremities and, finally, the racquet. Tennis requires repetitive multidirectional movement patterns that can lead to lower extremity injury (Ellenbecker et al., 2007).

Young tennis players' **hip** joint muscle strength results showed, that level of extensors/flexors bi-lateral imbalance for right joint was between 19–45% and for left between 21–51% hip extensors dominance; contra-lateral imbalance for 4 participants was between 10–24% (left hip joint extensor and flexor muscles dominate on right hip joint muscle). For 3 participants, hip adductors were stronger than abductors – level of bi-lateral imbalance 16–36% for right side and between 14–36% for left side muscles, contra-lateral imbalance was not significant for hip adductors and abductors.

We found a significant difference in **knee** joint muscle strength indicators. For all participants, knee extensors were stronger than flexors: a level of bilateral imbalance for right leg was 51–65%

and for left leg 50–67%. Level of contra-lateral imbalance in these muscles was not significant – less than 14% for flexors and less than 24% for extensors. This data verifies previous researches – no significant difference exists between the dominant and non-dominant lower extremity for knee extensors and flexors strength in elite junior tennis players (Ellenbecker et al., 2007; Ellenbecker & Roetert, 1995) and adult tennis players (Read & Bellamy, 1990).

Ankle joint is assumed as *weakest* part in low extremity kinematic chain, proper *throw-like* movement production begins from ground reaction forces (Bartonietz, 2000; Lanka, 2000; Elliott, 2006; Ivancevic, Jovanovic, Djukic, & Lukman, 2011; Kopsic Segal, 2003) and ankle joint muscle strength here is vital as much, as during speed on-court movements and from injury prevention point of view. The results of our study showed the same trend for all participants – ankle dorsal flexors strength torque was bigger than plantar flexors, level of bi-lateral imbalance was between 31–66% for right foot and 54–70% for left foot. The results are in a conflict with Morrison & Kaminski's (2007) study – ankle plantar flexors were stronger than dorsal flexors for physical active adults (man n = 8, woman n = 18) and all plantar and dorsal flexors indicators for adults were much higher in comparison with our results, this could be explained with age difference of the participants. Ankle evertor and invertor indicators and level of bi-lateral and contra-lateral imbalance highly varied between all study participants.

Spine and abdominal muscle strength condition in different participants is a well-studied question among the researchers. Once of the motions that can particularly stress the spine in tennis players is the combined movements of extension, lateral flexion and rotation that are inherent in the loading phase of the tennis serve (Ellenbecker et al., 2009). Everett et al. (2008) and Sanchis-Moysi, Idoate, Dorade, Alayon and Calbet (2010) measured spine flexors and extensors in adult tennis players, runners, swimmers and non-athletes. The main conclusion of these two studies (Everett, Strutton, & McGregor, 2008; Sanchis-Moysi et al., 2010) was similar – abdominal muscles were significantly stronger than spine muscles in adult tennis players and spine extensors were stronger in non-athletes (Sanchis-Moysi et al., 2010). Similar results of spine flexors dominance for tennis players showed other specialists (Andersson, Swart, & Thrstensson, 1988; Roetert, McCormick, & Ellenbecker, 1996) who explained this with tennis technique specifics. Our study results are in conflict with previous mentioned – young tennis players' spine extensors were significantly stronger than flexors – the level of bi-lateral imbalance was between 42 and 55% for all participants. Our explanation could be only that, possibly, at the age of 11 the tennis specific topography in accordance of spine and abdominal muscle strength indicators has not developed yet, tennis player specific spine flexors dominance could be a result of the influence of several years training.

The data presented in this research provides descriptive muscle strength topography of 11-year-old tennis players. The main *limitations of the study* were a small number of participants, only girls, not tested body core rotator muscles, which plays an important role in powerful stroke generation.

CONCLUSIONS

1. The study pointed out that, in order to develop tennis specific muscle strength topography, young tennis players should train spine flexors, shoulder adductors, internal rotators and wrist pronators more.
2. To avoid the increase of muscle bi-lateral imbalance it is highly recommended to pay more attention to shoulder abductors and external rotators, elbow flexors and extensors (especially for the right hand), wrist supinators and extensors, knee extensors and ankle joint plantar flexors.
3. For contra-lateral imbalance, prevention in addition to work with non-dominant upper extremity muscles should be considered for shoulder joint internal and external rotators, wrist supinators.
4. It is highly recommended for 11-year-old tennis players to complete tennis practice with muscle strength development exercises and special musculoskeletal system strengthening programs – it could play a key role in injury prevention in young tennis players.

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REFERENCES

Alizadehkhaiyat, O., Fisher, A. C., Kemp, G. J., & Frostick, S. P. (2007). Strength and fatigability of selected muscles in upper limb: Assessing muscle imbalance relevant to tennis elbow. *Journal of Electromyography and Kinesiology, 17,* 428–436. doi: http://dx.doi.org/10.1016/j.jelekin.2006.04.007

Almekinders, L. C., & Temple, J. D. (1998). Etiology, diagnosis and treatment of tendonitis: An analysis of the literature. *Medicine & Science in Sport & Exercise*, *30,* 1183–1190.

Andersson, E., Swart, L., & Thrstensson, A. (1988). Trunk muscle strength in athletics. *Medicine Science in Sport Exercise, 20*, 587–593.

Andrade, M. S., Barbosa de Lira, C. A., Vancini, R. L., Almeida, A. A., Benedito-Silva, A. A., & Silva, A. C. (2013) Profiling the isokinetic shoulder rotator muscle strength in 13- to 36-year-old male and female handball players. *Physical Therapy in Sport, 14*, 246–252. http://dx.doi.org/10.1016/j.ptsp.2012.12.002

Bahamonde, R. E., & Knudson, D. (2003). Kinetics of the upper extremity in the open and square stance forehand. *Journal of Science and Medicine in Sport, 6*(1), 88–101.

Bartonietz, K. (1994) Training, technique and specific power in throwing events. *Modern Athlete and Coach*, *32*(1), 1–16.

Bartonietz, K. (2000). Javelin throwing: An approach to performance. In Vardo raidė. Zatsiorsky (Ed.), *Biomechanics in Sport: Performance Enhancement and Injury Prevention* (pp. 401–434). Oxford: Blackwell Science Ltd.

Bazzucchi, I., Riccio, M. E., & Felici, F. (2008). Tennis players show a lower coactivation of the elbow antagonist muscles during isokinetic exercises. *Journal of Electromyography and Kinesiology, 18*, 752–759.

Burnie, J. (1987). Factors affecting selected reciprocal muscle group ratios in preadolescents. *International Journal of Sports Medicine, 8*(1), 40–45.

Chandler, T. J., Kibler, W. B., Stracener, E. C., Zeigler, A. K., & Pace, B. (1992). Shoulder strength, power and endurance in college tennis players. *American Journal of Sports Medicine, 20,* 455–458.

Chow, J. W., Park, S. A., & Tilman, M. D. (2009). Lower trunk kinematics and muscle activity during different types of tennis serves. *Sports Medicine Arthroscopy Rehabilitation Therapy & Technology, 1*, 24. doi:10.1186/1758-2555-1-24

Christmass, M. A., Richmond, S. E., Cable, N. T., & Arthur, P. G. (1998). Straipsnis? *Journal of Sports Science, 16*, 739–747.

Clements, A. S., Ginn, K. A., & Henley, E. (2000) Correlation between muscles strength and throwing speed in adolescent baseball players. *Physical Therapy in Sport*, *2,* 4–14.

Davies, G. J., Ellenbecker, T. S. & Brinks, A. (2000). Test interpretation. In Lee, E. Brown (Ed.), *Isokinetic in Human Performance* (pp. 3–24). Human Kinetics, Florida Atlantic University.

Degache, F., Richard, R., Edouard, P., Oullion, R., Calmels, P. (2010). The relationship between muscle strength and physiological age: A cross-sectional study in boys aged from 11 to 15. *Manuals of Physical and Rehabilitation Medicine*, *53*, 180–188.

Ellenbecker, T. S. (1991). A total arm strength isokinetic profile of highly skilled tennis players. *Isokinetic Exercise Science, 1*, 9–21.

Ellenbecker, T. S., & Davies, G. J. (2000). The application of isokinetics in testing and rehabilitation of the shoulder complex. *Journal of Athletic Training, 35*, 338–350.

Ellenbecker, T. S. (2014). Musculo-skeletal examination of elite junior tennis players. *ASPETAR Sports Medicine Journal, 3*, 548–556.

Ellenbecker, T. S., Pluim, B., Vivier, S., & Sniteman, C. (2009). Common injuries in tennis players: exercises to address muscular imbalances and reduce injury risk. *Strength and Conditioning Journal, 31*(4), 50–58.

Ellenbecker, T. S., & Roetert, E. P. (2003). Age specific isokinetic glenohumeral internal and external rotation strength in elite junior players. *Journal of Science and Medicine in Sport, 6,* 65–72.

Ellenbecker, T. S., & Roetert, E. P. (1995). Concentric isokinetic quadriceps and hamstring strength in elite junior tennis players. *Isokinetic Exercise Science, 5*, 3–6.

Ellenbecker, T. S., & Roetert, E. P. (2002) Isokinetic profile of elbow flexion and extension strength in elite junior tennis players. *Journal of Orthopedics & Sports Physical Therapy, 33*, 79–84.

Ellenbecker, T. S., Roetert, E. P., & Riewald, S. (2006). Isokinetic profile of wrist and forearm strength in elite female junior tennis player. *British Journal Sports Medicine, 40,* 411–414.

Ellenbecker, T. S., Roetert, E. P., Sueyoshi, T., & Riewald, S. (2007). A descriptive profile of age-specific knee extension flexion strength in elite junior tennis players. *British Journal of Sports Medicine, 41*, 728–732.

Ellenbecker, T. S. (1992). Shoulder internal and external rotation strength and range of motion of highly skilled tennis players. *Isokinetic Exercise Science, 2,* 1–8.

Elliott, B. (2006). Biomechanics and tennis. *British Journal of Sports Medicine*, *40*, 392–396.

Elliott, B. (2003). The development of racquet speed. In *Biomechanics of advanced tennis* (pp. 33–47). ITF Ltd.

Everett, R., Strutton, P. H., & McGregor, A. H. (2008). Do asymmetries exist in trunk muscles and is this influenced by sporting task? *Isokinetic and Exercise Science, 16,* 255–262.

Fleck, S. J., & Falkel, J. E. (1986). Value of resistance training for the reduction of sports injuries. *Sports Medicine, 3*, 61–68.

Girard, O. & Millet, G. P. (2008). Neuromuscular fatigue in racquet sports. *Neurologic Clinics, 26,* 181–194.

Gur, H., Akova, B., Punduk, Z., & Kucucoglu, S. (1999). Effects of age on the reciprocal peak torque ratios during knee muscle contractions in elite soccer players.

Scandinavian Journal of Medicine & Science in Sports, 9, 81–87.

Hay, J. G. (1992). Mechanical basis of strength expression. In P. Komi (Ed.), *Strength and Power in Sport* (pp. 197–207). Oxford: Blackwell Science,.

Hayot, C., Vigouroux L., Rossi, J. Goislard de Monsabert, B., Barla, C., & Berton, E. (2014) Measurements of tennis players' forearm muscle force imbalance to assess the potential risk of lateral epicondylitis. *Procedia Engineering, 72,* 174–179.

Henry, F. M. (1960) Relationship between individual differences in strength and mass in the arm movement. *The Research Quarterly*, *31*(1), 24–31.

Howatson, G., & Someren, K. A. (2005). The reproducibility of peak isometric torque and electromyography activity in unfamiliarised subjects using isokinetic dynamometry on repeated days. *Isokinetics and Exercise Science*, *13*, 103–109.

Ivancevic, T., Jovanovic, B., Jovanovic, S., Djukic, & M, Lukman, A. (2011). *Paradigm shift for future tennis.* Berlin: Springer.

Julienne, R., Gauthier, A., & Davenne, D. (2012). Fatigue-resistance of the internal rotator muscles in the tennis player's shoulder: Isokinetic and electromyographic analysis. *Physical Therapy in Sport, 13*, 22–26.

Julienne, R., Gauthier, A., Moussay, S., & Davenne, D. (2007). Isokinetic and electromyographic study of internal and external rotator muscles of tennis player. *Isokinetic and Exercise Science, 15,* 173–182.

Kopsic Segal, D. (2003). *Tennis biodynamic system.* Buenos Aires: Indugraf SA.

Kovacs, M. S. (2006). Applied physiology of tennis performance. *British Journal Sports Medicine, 40,* 381–386.

Lanka, J. (2000). Shot putting. In Vardo raidė. Zatsiorsky (Ed.), *Biomechanics in sport: Performance enhancement and injury prevention* (pp. 435–457). Oxford: Blackwell Science Ltd.

Mendez-Villanueva, A., Fernandez-Fernandez, J., Bishop, D., Fernandez-Garcia, B., & Terrados, N. (2007). Activity patterns, blood lactate concentrations and ratings of perceived exertion during a professional singles tennis tournament. *British Journal of Sports Medicine, 41*, 296–300.

Morrison, K. E., & Kaminski, T. W. (2007). The reproducibility of an isokinetic testing technique at the ankle joint. *Isokinetic and Exercise Science, 15,* 245–251.

Nagel, A., & Avram, C. (2013). Reference values and gender differences of the functional parameters in Romanian elite junior tennis players. *Timisoara Physical Education and Rehabilitation Journal, 5*(10), 22–27.

Niederbracht, Y., Shim, A. L., Sloniger, M. A., Paternostro-Bayles, M., Short, T. H. (2008). Effect of shoulder injury prevention strength training program on eccentric external rotator muscle strength and glenohumeral joint imbalance in female overhead activity athletes. *The Journal of Strength and Conditioning Research, 22*, 140–145.

Read, M. T. F., & Bellamy, M. J. (1990). Comparison of hamstring/quadriceps isokinetic strength ratios and power in tennis, squash, and track athletes. *British Journal Sports Medicine, 24*, 178–182.

Reid, M., & Schneiker, K. (2008). Strength and conditioning in tennis: Current research and practice. *Science and Medicine in Sport, 11*, 248–256.

Roetert, E. P., McCormick, S. W. B., & Ellenbecker, T. S. (1996). Relationship between isokinetic and functional trunk strength in elite junior tennis players. *Isokinetics and Exercise Science, 6,* 15–30.

Ryu, R. K., McCormick, J., Jobe, F. W., Moynes, D. R., & Antonelli, D. J. (1988). An electromyographic analysis of shoulder function in tennis player. *American Journal of Sports Medicine, 16*, 481–485.

Saccol, M. F., Gracitelli, G. C., Teixeira da Silva, R., Laurino, C. F. S, Fleury, A. M., Andrade, M. S., & Carlos da Silva, A. (2010). Shoulder functional ratio in elite junior tennis players. *Physical Therapy in Sport, 11*, 8–11.

Salonikidis, K., Amiridis, I. G., Oxyzoglou, N., Saez de Villareal, E. S., Zafeiridis, A., & Kellis, E. (2009). Force variability during isometric wrist flexion in highly skilled and sedentary individuals. *European Journal of Applied Physiology, 107*, 249–254.

Sanchis-Moysi, J., Idoate, F., Dorade, C., Alayon, S., & Calbet, J. A. L. (2010). Large asymmetric hypertrophy of rectus abdominis muscle in professional tennis players. *PLOS ONE, 5*(12), 1–9.

Schönborn, R. (1998). *Tennis techniktraining.* Germany: Meyer & Meyer Sport, Aachen.

Stephenson, D. G., Lamb, G. D., & Stephenson, G. M. M. (1998). Events of the excitation-contraction-relaxation (E-C-R) cycle in fast and slow twitch mammalian muscle fibres relevant to muscle fatigue. *Acta Physiology Scandinavia, 162*, 229–245.

Sunnegardh, J., Bratteby, L. E., Nordesjo, L. O., & Nordgren, B. (1998). Isometric and isokinetic muscle strength, anthropometry and physical activity in 8- and 13-years-old children. *European Journal of Applied Physiology, 58,* 291–297.

Ulbricht, A., Fernandez-Fernandez, J., & Ferrauti, A. (2013). Conception for fitness testing and individualized training programs in the German tennis federation. *Sports Orthopaedics and Traumatology, 29*(3), 180–192.

Yildiz, Y., Aydin, T., Kiralp, M. Z., Hazneci, B., Kalyon, T. A. (2006). Shoulder terminal range eccentric antagonist / concentric agonist strength ratios in overhead athletes. *Scandinavian Journal of Medicine and Science in Sports, 16*, 174–180.

Zuša, A. (2013). *Dažādas kvalifikācijas tenisistu labā sitiena biomehānika un jauno spēlētāju mioskeletālās sistēmas izpēte* (Unpublished doctoral dissertation). Riga: Latvian Academy of Sport Education.

Zuša, A., Lanka, J., & Čupriks L. (2012). Glenohumeral joint muscle strength of the young tennis players. *Journal of Human Sport and Exercise, 7*(1), 8–16.

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Examples:

Books (print and online)

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

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

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

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Chapter in a book:

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

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

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

Journal and newspaper articles (print and online)

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

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

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

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

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