Journal of Physical Education and Sport ® (JPES), 17(2), Art 97, pp.648 - 655, 2017
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Comparative characteristics of psychophysiological indicators in the representatives of cyclic and game sports

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Published online: June 30, 2017
(Accepted for publication June 13, 2017)
DOI:10.7752/jpes.2017.02097

Abstract:
The aim of the work is to determine the characteristics of the speed of reaction in representatives of cyclic sports (swimmers) in comparison with representatives of game sports (basketball players) and to reveal the differences in the speed of simple and complex reactions in swimmers and basketball players of different qualifications. Material and methods. In this study, methods were used to determine the psychophysiological abilities of athletes in terms of time indicators of a simple and complex reaction. Tests were conducted on the computer program "Psychodiagnostics". The following measurements were made: measurement of the simple reaction rate of the light stimulus; measurement of the simple reaction rate to the sound stimulus; the measurement of the complex reaction of choosing one of three objects; the measurement of the complex reaction of selecting two objects from three; in response to the appearance on the monitor screen of the animal's image should be as soon as possible to press and release the right mouse button. In the study to determine the differences between the reaction rate indicators, swimmers and basketball players were attended by 22 qualified swimmers and 24 qualified basketball players. In determining the comparative evaluation of the indicators of psycho-physiological functions of swimmers of different qualifications, 6 masters of sports and masters of sports of international class in swimming and 10 athletes of the 1st category and candidates for master of sports were used. In determining the comparative evaluation of the indicators of psycho-physiological functions of basketball players of various qualifications, 11 sports masters (athletes of international level) in basketball and 12 athletes of the 1st category and candidates for the master of sports (athletes of regional level) were tested. Results. On the indicators of psycho-physiological testing revealed significant differences between basketball players and swimmers. Qualified basketball players have significantly less time for a simple reaction to a light stimulus, for a sound stimulus, the response time for selecting one element out of three, and the response time for selecting two elements out of three. In swimmers, the time of simple reaction to the light stimulus and the reaction time to the auditory stimulus decrease as the skill level increases. The time of a complex selection reaction is not significantly different in swimmers of different qualifications. This testifies to the importance of psychophysiological abilities not only for representatives of game sports, but also for cyclical ones, for example, for swimming. Basketball players of higher qualification (masters of sports) significantly less time of both simple and complex reactions in comparison with basketball players of the 1st category and candidates for the master of sports. Conclusions. It has been revealed that, in almost all indicators of psychophysiological functions, basketball players are significantly different from swimmers in fins. With the improvement of the swimmers' skills, the time of simple reactions decreases. Basketball players with higher qualifications have less time for simple and complex reactions.
Key words: psychophysiological indicators, basketball, swimming, speed of reaction.

Introduction

Sport activity makes the most diverse demands on the speed of human thought processes. This is true for working in conditions of time deficit against the background of constantly changing situations. Such work

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causes the highest neuropsychic tension. This is also true for prolonged monotonous work, which significantly reduces the tone of the nervous system.

The speed of thought processes has various manifestations. Jensen (2006), Kuang (2017) Korobeynikov, Korobeynikova (2003, Korobeynikov, Mazmanian, Korobeynikova, Jagiełło (2010) Believe that this is one of the psycho-physiological parameters. Psychophysiology (from the greek ψήχή, psȳkhē, «breath, life, soul», φύσις, physis, «nature, origin» and -λογία, -logia) is a branch of psychology that deals with the physiological bases of psychological processes. Although psychophysiology was a broad field of research in the 1960s and 1970s, it has now become quite specialized and branched into such narrow specializations as social psychophysiology, cardiovascular psychophysiology, cognitive psychophysiology, and cognitive neuroscience. As noted Cacioppo, Tassinary, Berntson (2007), psychophysiology is closely related to the area of neuroscience which primarily relates to the relationship between psychological events and brain responses. Psychophysiology is also associated with a medical discipline known as psychosomatics (Glynn, Christenfeld, Gerin, 2002; Hussein, Hussain, AlZoubi, Calvo, D'Mello, 2011; Stemmler, Wacker, 2010).

Recently, psychophysiology has been at the junction of psychological and medical science, and its popularity and importance have expanded in proportion to the realization of the relationship between mind and body (Gross, Canteras, 2012; Bos, Dijksterhuis & Van Baaren, 2012; Fabiani, 2012). Within the framework of psychophysiology, certain areas are identified that are associated with the development of particularly important problems, among which psychophysiology is sensory - the psychophysiology of sense organs, sensations and perceptions; psychophysiology of the organization of movements; psychophysiology of activity; psychophysiology of arbitrary actions; psychophysiology of attention, memory and learning; psychophysiology of speech and thinking; psychophysiology of motivation and emotions; psychophysiology of sleep, psychophysiology of stress; psychophysiology of functional states and others (Greenland, Xenias & Maio, 2012; Kakarot, Mueller & Bassarak, 2012; Kircanski, Morazavi, Castriotta, Baker, Mystkowski, Yi & Craske,2012).

One of the methods of psychophysiology is, by definition Lipps, Galecki, Ashton-Miller (2011), Ravenzwaaij, Brown (2011), "mental chronometry." Mental chronometry is the use of response time in perception-movement problems to determine the content, duration and temporal sequence of cognitive operations. Mental chronometry is one of the main paradigms of experimental and cognitive psychology and has found application in various disciplines, including cognitive psychophysiology, cognitive neuroscience and behavioral neuroscience, in order to identify the mechanisms underlying cognitive processing.

Mental chronometry is studied using measurement of the reaction time, which is the elapsed time between the presentation of the sensory stimulus and the subsequent behavioral response. The reaction time is limited not only by the signal transmission rate in the white matter, but also by the properties of synaptic and neuronal processing in cortical gray matter (Parker, Lamichhane, Caetano Narayanan, 2013).

The response time is the sum of the reaction time and the time of motion. Usually, the research focuses on the reaction time. There are several methods of measurement: the time of a simple reaction, the time of a complex reaction, the reaction time to a moving object, and others (Korobeynikov, Korobeynikova, 2003; Korobeynikov, Mazmanian, Korobeynikova, Jagiełło, 2010).

Of particular importance is the definition of reaction time in sports activities. The conditions of competitive activity make different demands for the development of psycho-physiological functions for representatives of different sports (Kozina, Iermakov 2015; Ilnytska, Kozina, Kaвatska, Kostiukevych, Goncharenko, Bazilyuk, Al-Rawashdeh, 2016; Kozina, Repko, Kozin, Kostyrko, Yermakova & Goncharenko, 2016; Kozina, Ryepko, Prusik, Cieślicka, 2013; Galan, Zoriy, Briskin, & Pityn, 2016). According to the results of research by a number of authors (Kozina, Sobko, Klimenko, Sak, 2013; Kozina, Sobko, Yermakova, Cieslicka, Zukow, Chia, Goncharenko, Goncharenko Korobeinik, 2016) The conditions of wrestling in situational sports (sports games, martial arts), cause a person in a heightened neuropsychic tension and require a high level of development of psycho-physiological indicators. This is due to the large amount of information that the athlete must process in the shortest time, often in tenths and hundredths of a second.

Sobko, Kozina, Iermakov, Muszkieta, Prusik, Cieślicka, Stankiewicz (2014); Kozina, Sobko, Kolomiec, Jagiełło, Jagiełło (2015) Showed the importance of technical and tactical training, which depend on psychophysiological functions, for the competitive activity of basketball players with hearing impairments. Kozina, Sobko, Bazulyk, Ryepko, Lachno, Ilintskaya (2015), Kozina, Prusik, Prusik (2015) proposed the concept of individualization of training athletes, in which an important place is the psychophysiological organization of the individual. In studies Kozina, Ol'khovyj, Temchenko (2016) is shown the role of information technologies that cause the activation of cognitive activity, the effectiveness of the training process of student football players. In the works Kozina, Repko, Ionova, Boychuk, Korobeinik (2016), Kozina, Jagiello, Jagiello (2015) are presented mathematical models of development of physical qualities, based on the features of psychophysiological processes and other indicators characterizing the individual characteristics of athletes. The features of the application of medicinal plants for restoring the performance of athletes with different psychophysiological parameters (Kozina, 2015; Kozina, Iermakov, Kuzmin, Kudryavtsev, Galimov, 2016). have been conducted studies that showed a high connection between physiological and mental processes in people of

different ages (Kozina, Iermakov, Kadutskaya, Sobyanin, Krzeminski, Sobko, Ryepko, 2016) and in people with different anthropometric data (Kozina, Sergii, Crețu, Kadutskaya, Sobyanin, 2017). Studies have been conducted in which the influence of the development of motor abilities on the functional state of the organism is indirectly shown, one of the parameters of which is thought processes (Arziutov, Iermakov, Bartik, Nosko, & Cynarski, 2016; Ivashchenko, Khudolii, Iermakov, Lochbaum, Cieslicka, Zukow, Yermakova, 2016; Nosko, Razumeyko, Iermakov, & Yermakova, 2016; Podrigalo, Iermakov, Rovnaya, Zukow, & Nosko, 2016; Boichuk, Iermakov, Nosko, 2017).

However, until now it remains unclear the question of how necessary for competitive activity is the level of development of psycho-physiological functions in cyclical sports in comparison with representatives of game sports (Kozina, Delova, Liashenko, & Kolomiec, 2006). Therefore, the definition of the developmental characteristics of psycho-physiological indicators in representatives of cyclic sports and the comparison of the obtained data with the level of development of psychophysiological indicators in representatives of game sports is timely and relevant.

The aim of the work is to determine the characteristics of the speed of reaction in representatives of cyclic sports (swimmers) in comparison with representatives of game sports (basketball players) and to reveal the differences in the speed of simple and complex reactions in swimmers and basketball players of different qualifications.

Materials and methods

In this study, methods were used to determine the psychophysiological abilities of athletes in terms of time indicators of a simple and complex reaction. Tests were conducted on the computer program "Psychodiagnostics" (Kozina, Iermakov 2015; Ilnytska, Kozina, Kaвatska, Kostiukevych, Goncharenko, Bazilyuk, Al-Rawashdeh, 2016; Kozina, Repko, Kozin, Kostyrko, Yermakova & Goncharenko, 2016; Kozina, Ryepko, Prusik, Cieślicka, 2013). There is a large number of analogues of this program, for example DirectRT, MediaLab (Ritesh, Karia,. Tejas, Ghuntla, Hemant, Mehta, Pradnya, Gokhale, Shah, 2012) and others.

The following measurements were made:

- Measurement of the simple reaction speed to the light stimulus: in response to the appearance of any image on the monitor, it was necessary to press and release the left mouse button as soon as possible;
- Measurement of the simple reaction speed to the sound stimulus: in response to the sound, you should press and release the left mouse button as soon as possible;
- measuring the complex reaction of selecting one of three objects: in response to the appearance on the monitor screen of a picture of a geometric figure or animal, it was necessary to press and release the left mouse button as soon as possible;
- measuring the complex reaction of choosing two objects from three: in response to the appearance on the monitor screen of the image of the geometric figure, it was necessary to press and release the left mouse button as soon as possible; In response to the appearance on the monitor screen of the animal's image should be as soon as possible to press and release the right mouse button.

An average of 30 attempts was recorded for each subject.

Methods of mathematical statistics. When processing the test results, the arithmetic mean ($\bar{x}$), the standard deviation (S), the arithmetic mean value error (m) were determined. The comparison of the averages was carried out by Student's method for independent samples. Differences between samples were considered reliable at $p < 0.05$. The mathematical processing of the results was carried out using computer programs SPSS and EXCEL.

In the study to determine the differences between the reaction rate indicators, swimmers and basketball players were attended by 22 qualified swimmers and 24 qualified basketball players. In determining the comparative evaluation of the indicators of psycho-physiological functions of swimmers of different qualifications, 6 masters of sports and masters of sports of international class in swimming and 10 athletes of the 1st category and candidates for master of sports were used. In determining the comparative evaluation of the indicators of psycho-physiological functions of basketball players of various qualifications, 11 sports masters (athletes of international level) in basketball and 12 athletes of the 1st category and candidates for the master of sports (athletes of regional level) were tested.

Results

The results of a comparative analysis of psychophysiological indicators in swimmers and basketball players have shown that basketball players are significantly different from swimmers in virtually all of the indicators studied (Table 1). Significant differences were revealed in the tests "Time of a simple reaction to a light stimulus" "Time of a simple reaction to a sound stimulus", "Response time when one element is selected from three", "Response time when two elements are selected from three" (Table 1).

Table 1. Psychophysiological indicators of qualified basketball players (n = 24) and swimmers (n = 22)

Indicators	Groups	$\bar{x}$	S	m	t	p
Response time to light stimulus, ms	swimmers	266,23	21,43	4,57	2,39	0,023
	basketball players	248,38	28,92	5,90		
Response time to sound stimulus, ms	swimmers	244,41	26,60	5,67	4,44	0,000
	basketball players	213,75	19,33	3,95		
The time of a complex reaction when selecting 1 element out of 3, ms	swimmers	559,05	24,93	5,32	16,7	0,000
	basketball players	433,38	26,01	5,30		
The time of a complex reaction when 2 elements are selected from 3, ms	swimmers	570,68	24,08	5,13	19,8	0,000
	basketball players	432,00	23,19	4,73		

The results of the comparative analysis of psychophysiological indicators of swimmers of different qualifications have shown that, despite the fact that the development of psychophysiological indicators for swimmers is not as significant as for representatives of situational sports, for example, basketball players, highly qualified swimmers (masters of sports and masters of sports of international class) On the indicators of psycho-physiological testing from first-riders and candidates for master of sports. Such indicators include: "Time of a simple reaction to a light stimulus" (p = 0.000), "Time of a simple reaction to a sound stimulus" (p = 0.000), (Table 2). This indicates that the speed of a complex reaction is not significant for swimming. At the same time, the presence of reliable differences in the time exponents of simple reactions to light and the sound of a master of sports and a master of sports (athletes of international level) of international class are significantly different from first-timers and candidates for master of sports (athletes of regional level). This indicates that the indicators of simple reactions are significant for swimmers, since these indicators increase with the training of athletes.

In basketball masters of sport, the time of a simple reaction to a light stimulus, the reaction time to a sound stimulus, the time of a complex reaction of choosing one element out of three, and the time of a complex reaction of choosing two elements from three is significantly less compared to basketball players of the first ranks and candidates for a master of sports 3).

Table 2. Psychophysiological indicators of swimmers of different qualifications

Indicators	Groups	N	$\bar{x}$	σ	m	t	p
Response time to light stimulus, ms	athletes of international level	6	363,5	26,95	11,00	5,29	0,000
	athletes of regional level	10	459,2	45,33	14,33		
Response time to sound stimulus, ms	athletes of international level	6	227	26,29	10,73	5,08	0,000
	athletes of regional level	10	296	26,25	8,30		
The time of a complex reaction when selecting 1 element out of 3, ms	athletes of international level	6	549,15	19,45	7,94	0,53	0,551
	athletes of regional level	10	555,01	24,08	7,61		
The time of a complex reaction when 2 elements are selected from 3, ms	athletes of international level	6	565,16	21,17	8,64	0,59	0,818
	athletes of regional level	10	572,18	25,4	8,03		

Table 3. Psychophysiological indicators of basketball players of various qualifications

Indicators	Groups	N	$\bar{x}$	S	m	t	p
Response time to light stimulus, ms	athletes of international level	11	216,4	16,54	4,99	5,57	0,000
	athletes of regional level	12	253,5	15,31	4,42		
Response time to sound stimulus, ms	athletes of international level	11	192	14,14	4,26	7,04	0,000
	athletes of regional level	12	235	15,16	4,38		
The time of a complex reaction when selecting 1 element out of 3, ms	athletes of international level	11	439,15	19,16	5,78	5,75	0,551
	athletes of regional level	12	485,01	19,03	5,49		
The time of a complex reaction when 2 elements are selected from 3, ms	athletes of international level	11	442,12	21,00	6,33	6,47	0,818
	athletes of regional level	12	502,18	23,52	6,79		

Discussion

Thus, it was obtained that, in almost all psychophysiological indicators, basketball players outperform swimmers in fins. This fact can be explained by the fact that in sports games the effectiveness of sports activities is determined not only by the functionality, but also by the possibility of processing information. Along with improving the skills of motor activities, sportsmen-players develop skills of tactical thinking - a specialized form of mental activity. And tactical thinking - from individual actions in attack and defense to group and command - requires a high level of development of the visual-motor reaction, reaction of choice, reaction to a moving object, to sound. This is due to the fact that the lack of standard sports programs in motor sports requires high attention to current conditions. Therefore, in situational sports, the main form of brain activity is not the development of motor stereoscopic types, but the "creative" function. This is associated with the great importance of the processes of perception and processing of information by a central neural system.

The fact of revealing reliable differences in psychophysiological indicators among swimmers of different qualifications is new, since until the present study it was believed that the development of psychophysiological indicators is significant only for representatives of situational sports (sports games, martial arts). In our study, reliable differences in the indices of psychophysiological functions among swimmers of different qualifications, i.e. At representatives of cyclic kinds of sports. The received data testify that psychophysiological indices are a reflection of the level of coherence of functioning of the whole organism, and therefore they improve as the sports qualification of not only representatives of game sports, but also cyclical, in particular, swimming, increases.

From this point of view, it can be assumed that the inclusion in the training session of swimmers exercises aimed at the development of psycho-physiological indicators will contribute to improving the effectiveness of the training process due to a more comprehensive impact on various aspects of the training process for swimmers. Basketball players of higher qualification also have significantly lower times of simple and complex reactions compared to less qualified basketball players. Unlike swimmers, in basketball players, as training is progressing, there is a decrease in the time of both simple and complex reactions. This can be explained by the fact that basketball makes high demands on the speed of thought processes in the face of constantly changing conditions.

The data obtained are consistent with the results of Liudovyk, Kozibroda, Romanchuk, Dunets, Lesko (2016). The study showed a reliable improvement of simple and complex visual-motor reactions, intellectual functioning, visual sensitivity to the impact of the application of a special program of professionally-applied physical training.

The results of the study are also consistent with the data obtained by Jain, Bansal, Kumar and Singh (2015), Karia, Ghuntla, Mehta, Gokhale, Shah (2012), Badwe, Patil, Yelam, Vikhe, Vatve, Badwe, Patil, Yelam, Vikhe , Vatve (2012), Shelton, Kumar. (2010), Shelton1, Kuma (2010). In the studies of these authors it was shown that the speed of reaction to sound is higher than the speed of reaction to light in medical students. Male medical students have a faster response rate than medical women for auditory and visual stimuli. Regularly practicing sports, medical students have a higher response rate compared to medical students with a sedentary lifestyle. Thus, it is confirmed that any exercise by physical exercises increases psychophysiological possibilities. In our study, it is shown that playing sports does not only affect the speed of simple reactions, but also the speed of complex reactions.

Regarding complex reactions, it should be noted that Balakrishnan, Uppinakudru, Singh, Bangera, Raghavendra and Thangavel found that when responding to objects of different colors, the response time to green and red colors is less than to yellow. The authors attribute this to the fact that the process of visual processing of yellow color is more complicated than yellow and red. In our study, the data of these authors concerning the complex reactions of choice to the received facts about the existence of differences in the response rate in people engaged in different sports and in athletes of different qualifications are expanded.

Ritesh, Karia, Tejas, Ghuntla, Hemant, Mehta, Pradnya, Gokhale, Shah (2012), showed that the reaction time in boys is less than in girls. In our study, gender comparisons were not conducted. However, the results of a comparative analysis of representatives of game and cyclic sports showed the existence of differences in the speed of simple and complex reactions of the groups surveyed. Speed reaction is an indicator that is not amenable to development. In this regard, it should be noted that in certain types of sports people are selected with the necessary parameters of the speed of simple and complex reactions. On the other hand, as indicated by Liudovyk, Kozibroda, Romanchuk, Dunets, Lesko (2016), Ilnytska, Kozina, Kavatska, Kostiukevych, Goncharenko, Bazilyuk, Al-Rawashdeh (2016); Kozina, Repko, Kozin, Kostyrko, Yermakova & Goncharenko (2016), Kozina, Ryepko, Prusik, Cieślicka (2013), psychophysiological indices are amenable to development with a targeted impact through various types of motor activity.

Thus, the results of many studies indicate the possibility of developing psychophysiological functions and the speed of thought processes as one of the indicators in psychophysiology, determined by the reaction rate. These facts are explained by structural changes in the brains of athletes (Jocelyn Faubert, 2013). The author points out that high-level athletes have more thickness of the cerebral cortex in the areas responsible for perception of movement and socially significant stimuli.

Conclusions

1. On the indicators of psychophysiological testing revealed significant differences between basketball players and swimmers. Qualified basketball players have significantly less time for a simple reaction to a light stimulus, for a sound stimulus, the response time for selecting one element out of three, and the response time for selecting two elements out of three.

2. In swimmers, the time of simple reaction to the light stimulus and the reaction time to the sound stimulus decrease as the skill is advanced. The time of a complex selection reaction is not significantly different in swimmers of different qualifications. This testifies to the importance of psychophysiological abilities not only for representatives of game sports, but also for cyclical ones, for example, for swimming. Basketball players of higher qualification (masters of sports, athletes of international level) significantly less time of both simple and complex reactions in comparison with basketball players of the 1st category and candidates for the master of sports (athletes of regional level).

References

Arziutov, G., Iermakov, S., Bartik, P., Nosko, M., & Cynarski, W. J. (2016). The use of didactic laws in the teaching of the physical elements involved in judo techniques. *Ido Movement for Culture*, *16*(4), 21-30. doi:10.14589/ido.16.4.4

Badwe, N., Patil, K.B., Yelam, S.B., Vikhe, B.B., & Vatve, M.S. (2012). A comparative study of hand reaction time to visual stimuli in students of 1 st MBBS of a rural medical college. *Pravara Med Rev. 4*, 4–6.

Balakrishnan, G., Uppinakudru, G., Girwar Singh, G., Bangera, S., Dutt Raghavendra, A., & Thangavel, D. (2014). A Comparative Study on Visual Choice Reaction Time for Different Colors in Females. *Neurology Research International*, *2014*, 1–5. https://doi.org/10.1155/2014/301473

Boichuk, R., Iermakov, S., Nosko, M. (2017). Pedagogical conditions of motor training of junior volleyball players during the initial stage *Journal of Physical Education and Sport*, *17*(1), 327 - 334. doi:10.7752/jpes.2017.01048

Bos, M. W., Dijksterhuis, A., & Van Baaren, R. (2012). Food for thought? Trust your unconscious when energy is low. *Journal of Neuroscience, Psychology, and Economics*, *5*(2), 124-130.

Cacioppo, John; Tassinary, Louis; & Berntson, Gary. (2007). "25". *Handbook of Psychophysiology* (3rd ed.). Cambridge University Press.

Fabiani, M. (2012). It was the best of times, it was the worst of times: A psychophysiologist's view of cognitive aging. *Psychophysiology*, *49*(3), 283-304.

Faubert, J. (2013). Professional athletes have extraordinary skills for rapidly learning complex and neutral dynamic visual scenes. *Scientific Reports*, *3*. https://doi.org/10.1038/srep01154

Galan, Y., Zoriy, Y., Briskin, Y. & Pityn, M. (2016). Orienteering to optimize the psychophysical wellbeing of young teens (13 to 14-year-old). *Journal of Physical Education and Sport*, 16 (3), 914–920. DOI:10.7752/jpes.2016.03144

Glynn, L. M. (2002). The Role of Rumination in Recovery from Reactivity: Cardiovascular Consequences of Emotional States. *Psychosomatic Medicine*, *64*(5), 714–726. https://doi.org/10.1097/01.PSY.0000031574.42041.23

Greenland, K., Xenias, D., & Maio, G. (2012). Intergroup anxiety from the self and other: Evidence from self-report, physiological effects, and real interactions. *European Journal of Social Psychology*, *42*(2), 150-163.

Gross, C. T., & Canteras, N. S. (2012). The many paths to fear. *Nature Reviews Neuroscience*, *13*(9), 651–658. https://doi.org/10.1038/nrn3301

Hussein, M.S, Hussain, M. S., AlZoubi, O., Calvo, R. A., D'Mello, S. K. (2011). Affect Detection from Multichannel Physiology during Learning Sessions with AutoTutor. *Artificial Intelligence in Education. Auckland, New Zealand: Springer, LNAI, 6738,* 131–138.

Ilnytska, G., Kozina, Z., Kabatska, O., Kostiukevych, V., Goncharenko, V., Bazilyuk, T., & Al-Rawashdeh, A. -. (2016). Impact of the combined use of health-improving fitness methods ("Pilates" and "Bodyflex") on the level of functional and psychophysiological capabilities of students. *Journal of Physical Education and Sport, 16*(1), 234-240. doi:10.7752/jpes.2016.01037

Ivashchenko, O., Khudolii, O., Iermakov, S., Lochbaum, M. R., Cieslicka, M., Zukow, W., . . . Yermakova, T. (2016). Intra-group factorial model as the basis of pedagogical control over motor and functional fitness dynamic of 14-16 years old girls. *Journal of Physical Education and Sport, 16*(4), 1190-1201. doi:10.7752/jpes.2016.04190

Jain, A., Bansal, R., Kumar, A., & Singh, K. (2015). A comparative study of visual and auditory reaction times on the basis of gender and physical activity levels of medical first year students. *International Journal of Applied and Basic Medical Research, 5*(2), 124. https://doi.org/10.4103/2229-516X.157168

Jensen, A. R. (2006). *Clocking the mind: Mental chronometry and individual differences*. Amsterdam: Elsevier.

Kakarot, N., Mueller, F., & Bassarak, C. (2012). Activity–rest schedules in physically demanding work and the variation of responses with age. *Ergonomics, 55*(3), 282-294.

Karia, R.M., Ghuntla, T.P., Mehta, H.B., Gokhale, P.A., & Shah, C.J. (2012). Effect of gender difference on visual reaction time: A study on medical students of Bhavnagar region. *IOSR-PHR, 2*, 452–454.

Karia, R.M., Ghuntla, T.P., Mehta, H.B., Gokhale, P.A., Shah, C.J. (2012). Effect of gender difference on visual reaction time: A study on medical students of Bhavnagar region. *IOSR PHR. 2*, 452-4.

Kircanski, K., Morazavi, A., Castriotta, N., Baker, A. S., Mystkowski, J. L., Yi, R., & Craske, M. G. (2012). Challenges to the traditional exposure paradigm: Variability in exposure therapy for contamination fears. *Journal of Behavior Therapy and Experimental Psychiatry, 43*(2), 745-751.

Korobeynikov, G., Korobeynikova, L. (2003). Physical development and psychical function states in junior schoolchildren. *Bratislavske Lekarske Listy, 104*(3), 125-129.

Korobeynikov, G., Mazmanian, K., Korobeynikova, L., Jagiełło, W. (2010). Psychophysiological states and motivation in elite judokas. *Archives of Budo, 6*(3), 129-136.

Kozina Z.L., Jagiello, W., & Jagiello, M. (2015). Determination of sportsmen's individual characteristics with the help of mathematical simulation and methods of multi-dimensional analysis. *Pedagogics, psychology, medical-biological problems of physical training and sports, 12,* 41–50. http://dx.doi.org/10.15561/18189172.2015.1207

Kozina, Z. (2015). Recovery functional condition of sportsmen using individual non-traditional means of rehabilitation. *Journal of Physical Education and Sport, 15*(4), 634-639. doi:10.7752/jpes.2015.04096

Kozina, Z., Iermakov, S., Crețu, M., Kadutskaya, L., & Sobyanin F. (2017). Physiological and subjective indicators of reaction to physical load of female basketball players with different game roles. *Journal of Physical Education and Sport. 17(1),* 1428 – 1432. doi:10.7752/jpes.2017.01056

Kozina, Z., Repko, O., Ionova, O., Boychuk, Y., & Korobeinik, V. (2016). Mathematical basis for the integral development of strength, speed and endurance in sports with complex manifestation of physical qualities. *Journal of Physical Education and Sport, 16*(1), 70-76. doi:10.7752/jpes.2016.01012

Kozina, Z., Repko, O., Kozin, S., Kostyrko, A., Yermakova, T., & Goncharenko, V. (2016). Motor skills formation technique in 6 to 7-year-old children based on their psychological and physical features (rock climbing as an example). *Journal of Physical Education and Sport, 16*(3), 866-874. doi:10.7752/jpes.2016.03137

Kozina, Z., Sobko, I., Yermakova, T., Cieslicka, M., Zukow, W., Chia, M., . . . Korobeinik, V. (2016). Psycho-physiological characteristics of female basketball players with hearing problems as the basis for the technical tactic training methodic in world level teams. *Journal of Physical Education and Sport, 16*(4), 1348-1359. doi:10.7752/jpes.2016.04213

Kozina, Z.L., & Iermakov, S.S. (2015). Analysis of students' nervous system's typological properties, in aspect of response to extreme situation, with the help of multi-dimensional analysis. *Physical education of students. 3,* 10-19. http://dx.doi.org/10.15561/20755279.2015.0302

Kozina, Z.L., Iermakov, S.S., Kadutskaya, L.A., Sobyanin, F.I., Krzeminski, M., Sobko, I.N., & Ryepko, O.A. (2016). Comparative characteristic of correlation between pulse subjective indicators of girl students' and school girls' reaction to physical load. *Physical education of students. 4.* 24–34. doi:10.15561/20755279.2016.0403

Kozina, Z.L., Iermakov, S.S., Kuzmin, V.A., Kudryavtsev, M.D., Galimov, G.J. (2016). Change of cortisol and insulin content in blood under influence of special workability recreation system for students with high motor functioning level. *Research Journal of Pharmaceutical, Biological and Chemical Sciences, 7*(2), 15-28.

Kozina, Zh.L. Sobko, I.N., Klimenko, A.I., & Sak N.N. (2013). Comparative characteristics of psychophysiological features skilled basketball players-women with hearing and skilled basketball players healthy. *Pedagogics, psychology, medical-biological problems of physical training and sports, 7,* 28-33. doi:10.6084/m9.fgshare.735962

Kozina, Zh.L., Delova, I., Liashenko, A., & Kolomiec, N.A. (2006). Kharakteristika psikhofiziologicheskikh pokazatelej u plovcov v lastakh i basketbolistov [Characteristics of psychophysiological indicators in swimmers in fins and basketball players]. *Fizicheskoe vospitanie studentov tvorcheskikh special'nostej. 6,* 20-26.

Kozina, Zh.L., Ol'khovyj, O.M., & Temchenko, V.A. (2016). Influence of information technologies on technical fitness of students in sport-oriented physical education. *Physical education of students*, *1,* 21–28. http://dx.doi.org/10.15561/20755279.2016.0103

Kozina, Zh.L., Prusik, Krzysztof, & Prusik, Katarzyna (2015). The concept of individual approach in sport. *Pedagogics, psychology, medical-biological problems of physical training and sports, 3,* 28-37. http://dx.doi.org/10.15561/18189172.2015.0305

Kozina, Zh.L., Ryepko, O.A., Prusik, Kr., & Cieślicka, Mirosława. (2013). Psychophysiological possibility of mountaineers and climbers specializing in speed climbing and climbing difficulty *Pedagogics, psychology, medical-biological problems of physical training and sports, 10,* 41-46.

Kozina, Zh.L., Sobko, I.N., Kolomiec, N.A., Jagiełło, Władysław, & Jagiełło, Marina. (2014). Allocation algorithm for athletes group to form tactical tasks in game team sports using the methods of multivariate analysis (illustrated women Ukrainian team basketball with hearing impairments). *Pedagogics, psychology, medical-biological problems of physical training and sports, 12,* 40-48. doi:10.15561/18189172.2014.1208

Kuang, S. (2017). Is reaction time an index of white matter connectivity during training? *Cognitive Neuroscience*, *8*(2), 126–128. https://doi.org/10.1080/17588928.2016.1205575

Lipps, D. B., Galecki, A. T., & Ashton-Miller, J. A. (2011). On the Implications of a Sex Difference in the Reaction Times of Sprinters at the Beijing Olympics. *PLoS ONE*, *6*(10), e26141. https://doi.org/10.1371/journal.pone.0026141

Liudovyk, T., Kozibroda, L., Romanchuk, S., Dunets, A., & Lesko, O. (2016). Efficiency of professionally applied physical preparation program and its influence on the psychophysiological function level of students studying "microand nanoelectronics". *Journal of Physical Education and Sport, 16*(3), 927-931. doi:10.7752/jpes.2016.03146

Nosko, M., Razumeyko, N., Iermakov, S., & Yermakova, T. (2016). Correction of 6 to 10-year-old schoolchildren postures using muscular-tonic imbalance indicators. *Journal of Physical Education and Sport, 16*(3), 988-999. doi:10.7752/jpes.2016.03156

Parker, K. L., Lamichhane, D., Caetano, M. S., & Narayanan, N. S. (2013). Executive dysfunction in Parkinson's disease and timing deficits. *Frontiers in Integrative Neuroscience*, *7*. https://doi.org/10.3389/fnint.2013.00075

Podrigalo, L., Iermakov, S., Rovnaya, O., Zukow, W., & Nosko, M. (2016). Peculiar features between the studied indicators of the dynamic and interconnections of mental workability of students. *Journal of Physical Education and Sport, 16*(4), 1211-1216. doi:10.7752/jpes.2016.04193

Shelton, J., & Kumar, G. P. (2010). Comparison between Auditory and Visual Simple Reaction Times. *Neuroscience & Medicine*, *01*(01), 30–32. https://doi.org/10.4236/nm.2010.11004

Shelton, J., & Kumar, G.P. (2010). Comparison between auditory and visual simple reaction times. *Neurosci Med. 1*, 30–2.

Sobko, I.N., Kozina, Zh.L., Iermakov, S.S., Muszkieta, Radosław, Prusik, Krzysztof, Cieślicka, Mirosława, & Stankiewicz. Błażej. (2014). Comparative characteristics of the physical and technical preparedness of the women's national team of Ukraine and Lithuania basketball (hearing impaired) before and after training to Deafympic Games. *Pedagogics, psychology, medical-biological problems of physical training and sports, 10,*. 45-51. doi:10.5281/zenodo.10490

Stemmler, G., & Wacker, J. (2010). Personality, emotion, and individual differences in physiological responses. *Biological Psychology*, *84*(3), 541–551. https://doi.org/10.1016/j.biopsycho.2009.09.012

van Ravenzwaaij, D., Brown, S., & Wagenmakers, E.-J. (2011). An integrated perspective on the relation between response speed and intelligence. *Cognition*, *119*(3), 381–393. https://doi.org/10.1016/j.cognition.2011.02.002

Zhanneta, K., Irina, S., Tatyana, B., Olena, R., Olena, L., & Anna, I. (2015). The applying of the concept of individualization in sport. *Journal of Physical Education and Sport, 15*(2), 172-177. doi:10.7752/jpes.2015.02027