

## Influence of specifically aimed exercises and active games on indicators of the functional state of the vestibular sensory system in 10–16-year-old children with visual impairments

LUDMILA SHESTEROVA<sup>1</sup>, LILIANA RIADOVA<sup>2</sup>, ANDRII YEFREMENKO<sup>3</sup>, IRINA MASLIAK<sup>4</sup>,  
NATALIA KRYVORUCHKO<sup>5</sup>, TETIANA BALA<sup>6</sup>, MARGARITA MAMESHINA<sup>7</sup>, VYACHESLAV ZHUK<sup>8</sup>  
<sup>1,2,4,5,6,7,8</sup>Department of Theory and Methods of Physical Education, Kharkiv State Academy of Physical Culture,  
UKRAINE

<sup>3</sup>Department of Athletics, Kharkiv State Academy of Physical Culture, UKRAINE

Published online: September 30, 2019

(Accepted for publication: August 22, 2019)

DOI:10.7752/jpes.2019.03232

### Abstract:

*Purpose:* to determine the effect of specifically aimed exercises and active games on the indicators of the functional state of the vestibular analyzer in middle school schoolchildren with visual impairments. *Material:* The study was conducted on the basis of special general education boarding schools for children with visual impairments in Kharkov and Dnepropetrovsk. It was attended by 204 schoolchildren of grades 5-10, which were divided into classes of 6 experimental and 6 control groups. *Results.* The indicators of the functional state of the vestibular sensory system of 10–16-year-old schoolchildren with visual impairment before and after using specifically aimed exercises and active games are considered. Analyzed changes in the studied parameters depending on gender and age. The positive influence of specially directed exercises and outdoor games on the functional state of the vestibular analyzer is revealed. *Conclusions:* 1. Study of the primary indicators of the functional state of the vestibular analyzer in children of middle school age with visual impairments revealed a low level of its sensitivity and stability both before and after rotational loads. 2. As a result of the use of special exercises and mobile games, middle school schoolchildren with visual impairments of experimental groups significantly improved the stability indicators of the vestibular analyzer before and after rotational loads. The most significant changes in the stability of the vestibular analyzer, both before and after the spins in the Barani chair, were observed in boys 10–11 and girls 10–12 years old. 3. Indicators of the functional state of the vestibular analyzer of schoolchildren of control groups have not changed significantly and are not reliable ( $p>0,05$ ).

**Key words:** abnormalities in walking, functional state, schoolchildren with visual impairments, stability of the vestibular analyzer, vestibular sensory system. .

### Introduction

In the process of life, all analyzers do not function in isolation, but in continuous interaction with each other. This is necessary for a normal perception of the surrounding world (Azhippo, Kuzmenko, 2015; Shesterova, 2015). At the same time, the vestibular sensory system plays an important role in the interaction of other sensory systems (Kuzmenko, 2011).

A high level of the functional state of the human body is ensured by the perfect activity of the vestibular sensory system. It plays an important role in the formation of visual-spatial representations, motor skills and skills; motor management; development of motor skills; maintaining the balance of the body at rest and during movement; coordination of movements at rest and in the process of motor activity; orientation in space with active and passive movement. The vestibular sensory system provides the perception of information about acceleration or deceleration arising in the process of rectilinear or rotational motion, as well as when the position of linear and angular movements of the body and head in space changes (Yermakov, Yakunin, 2000; Solodkov, Sologub, 2008; Horlings, Kung, Bloem, Honegger, Van Alfen, Van Engelen, Allum, 2008; Rynkiewicz, urek, Rynkiewicz, Starosta, Nowak, Kitowska, Kos, 2010; Kuzmenko, 2011; Markova, Repš, 2013; Maslyak, 2015; Rovny, Ilyin, Lizogub, Rovnaya, 2015).

Children with visual impairments low stability of the vestibular analyzer is observed when exposed to various accelerations, turns, bends, coordination of movements, balance, orientation in space are significantly impaired, the ability to maximize the manifestation of motor qualities decreases (Demchuk, 2016).

Solodkov, Sologub, 2001, revealed that the normal development of this function is completed by the age of 14, and in children with visual impairments it continues to take shape until the age of 17.

The issues of changing the functional state of the vestibular sensory system under the influence of specially targeted exercises and outdoor games in healthy children were: Moiseenko, 2014—for preschoolers; Maslyak, 2007, 2008, 2015—for primary school children; Shesterova, 2002, 2004, 2008; Kuzmenko, 2010, 2011, 2013; Kuzmenko, Shesterova, 2011, 2012—among middle school schoolchildren; Maslyak, Shesterova, Kuzmenko, Bala and al., 2016 – among primary and secondary school schoolchildren; Rovny, 2001 – for volleyball players. Experts have identified their positive effect on the indicators of the functional state of the vestibular analyzer.

The influence of physical exercises and outdoor games on the functional state of the sensory systems of children with visual impairment of preschool and school age is devoted to the work of Lyakh, 1987; Matvova, 1991; Makarenko, 2000; Myasninkova, 2005; Osipova, 2010; Sedova, Shesterova, 2013; Ordinary, 2015, etc. At the same time, an insignificant amount of research has been revealed on the effect of specially directed exercises and outdoor games on the functional state of the vestibular sensory system of middle-school schoolchildren with visual impairments. All of the above led to the relevance of the problem being studied.

Purpose of the work is to determine the effect of specifically aimed exercises and active games on the indicators of the functional state of the vestibular analyzer of 10–16-year-old schoolchildren with visual impairments.

### **Materials and methods**

Research methods: analysis and synthesis of scientific and methodological literature, determination of the stability of the vestibular analyzer to rotational loads, pedagogical experiment and methods for statistical processing of results.

The stability indicators of the vestibular analyzer were investigated by the results of deviations in walking before and after rotational loads in the Barani chair. The subject was asked to stand with his eyes open to face the line drawn 5 m from the object, then close his eyes with a bandage and walk to the object. There was a deviation when walking with eyes closed. Then, the subject sat down in a Barani chair, lowered his head and closed his eyes. The researcher, with a five-fold rotation to the right in the Barani chair at a speed of 5 turns in 10 seconds, irritated the vestibular apparatus. Immediately after stopping, his subject got up, opened his eyes and looked at the subject. After that, he closed his eyes with a bandage and went to the object. Differences in walking deviations (cm) of the subject were assessed before and after the rotational load. The more pronounced the differences, the less resistant to rotational loads is the vestibular analyzer (Solodkov, 2011).

The study was conducted on the basis of general boarding schools for children with visual impairments in Kharkov and Dnepropetrovsk. It was attended by 204 middle school schoolchildren, who were divided into 6 experimental and 6 control groups.

Pedagogical experiment was conducted during the school year. It consisted in introducing into the content of the physical education lessons of middle school schoolchildren with visual impairment of experimental groups of special exercises and outdoor games aimed at improving the functional state of the vestibular analyzer. During the experiment, schoolchildren of middle classes of control groups in physical education classes were engaged in accordance with the Physical Culture Program for schoolchildren of 5–10 classes with reduced eyesight, developed by Sermeev, Pavlov, 1995.

Children participating in the experiment were supervised by school doctors, a pediatrician and an ophthalmologist.

In order to activate the functional state of the vestibular analyzer, the following were used: turns in place and in motion at 90°, 180°, 270° and 360° from various starting positions with further preservation of balance; jumping on the spot and advancing forward with turns of 90°, 180° and 360° from different starting positions, with a different starting position of the head and with further preservation of balance; turns 180° in motion; walking and running from different starting positions; varieties of walking and running with sudden turns, rotations and stops; rotation around its own axis independently and in pairs, in place and in motion, from different starting positions and with different head positions; acrobatic exercises; quick turns; various movements with a sharp change of direction; performing the above exercises in the presence and absence of visual control, etc.; developed, selected, modified mobile games, the contents of which included the above listed exercises: “Rotate”, “Reception – turn – pass”, “Team that rotates”, “Time to take a place”, “Charge after the ball”, “Obstacle course” and etc.

The number of repetitions of each exercise on average ranged from 4 to 15 times. The duration of outdoor games was 5–10 minutes.

Specifically aimed exercises were included in the preparatory, main and final parts of the lesson, active games - the main part of the variation modules are track and field, football, gymnastics, basketball, volleyball, and were selected taking into account their content and objectives of the lesson.

Exercises were conducted by playing and strictly regulated methods. The above exercises were included in the homework of schoolchildren with the subsequent verification of their implementation.

During the pedagogical experiment in physical education classes for schoolchildren of experimental groups, the load gradually increased. The dosage was changed by the number of repetitions of each exercise;

increase coordination complexity and speed of doing exercises and outdoor games; changes in the number of equipment, turning off visual control, etc. It differentiated taking into account the characteristics of the disease of the visual analyzer, age, sex, primary defect and secondary developmental disorders, health, physical fitness level and specific features of the individual development of middle school schoolchildren with visual analyzer disorders and degree of difficulty of the exercises.

### Result

Considering the primary indicators of stability of the vestibular analyzer before and after rotational loads in the Barani chair among middle-school schoolchildren with visual and experimental disorders of the control groups, it should be noted that there was no significant difference between them ( $p > 0.05$ ).

The study of the indices of deviations in walking before and after the spins in the Barani chair in the schoolchildren of the experimental groups before the experiment in the sexual aspect revealed that they are mostly significantly ( $p < 0.001$ ) better than the boys in girls. The exception is the results of the deviations after the spins of 6th and 8th grade schoolchildren. Indicators of boys are significantly ( $p < 0.01-0.001$ ) better than girls.

The dynamics of deviations in walking to rotations in the Barani chair with age indicates an increase in the results of schoolchildren of the experimental groups, after rotation - in boys, the results increase, in girls - they change in waves. The differences in the results are mostly reliable ( $p < 0.01-0.001$ ), except for indicators after rotational load in girls of the 5th and 8th grades.

The analysis of the indices of deviations in walking before and after the spins in the Barani chair showed that in girls of the control groups before the experiment, they were mostly significantly ( $p < 0.05-0.001$ ) better than boys. The exceptions are the results after the rotation of schoolchildren in grades 6 and 8, where they are significantly ( $p < 0.01-0.001$ ) better in boys.

Studies of the primary results of deviations in walking to rotations in the Barani chair in schoolchildren of the control groups in the age aspect indicate that they improve with age. After the spins, the boys' performance improves, and in girls - vary in different directions. The differences in the results are mainly reliable ( $p < 0.01-0.001$ ). Exceptions are indicators after vestibular irritation in boys of the 6th and 7th grades and in girls of the 5th and 8th grades, where there is no significant difference ( $p > 0,05$ ).

A comparative analysis of the results of the stability of the vestibular analyzer before and after the rotational loads of schoolchildren of experimental groups after the application of special exercises and active games aimed at changing the functional state of the vestibular analyzer indicates a significant ( $p < 0.001$ ) improvement.

As shown in Figure 1, the stability indicators of the vestibular analyzer in boys of the 5th grade of experimental groups after the experiment improved by 55.6 cm before the rotations in the Barani chair and by 142.3 cm after; grade 6 - at 37,6 cm and 75,7 cm, respectively; grade 7 - by 31,8 cm and 83,0 cm, respectively; grade 8 - by 27,9 cm and 60.4 cm, respectively; grade 9 - by 19,1 cm and 45,3 cm, respectively, and grade 10 - by 18.2 cm and 34,7 cm, respectively. In girls of the experimental groups, there was also an improvement in walking results. So, schoolgirls of grade 5 it was 43.3 cm before the spins in the Barani chair and 61,2 cm after; 28.4 cm and 123,8 cm; 26,6 cm and 43,0 cm; 20,2 cm and 56,2 cm; 14.5 cm and 42,7 cm and 11,9 cm and 32,3 cm, respectively, before and after rotational loads in grades 6, 7, 8, 9 and 10.

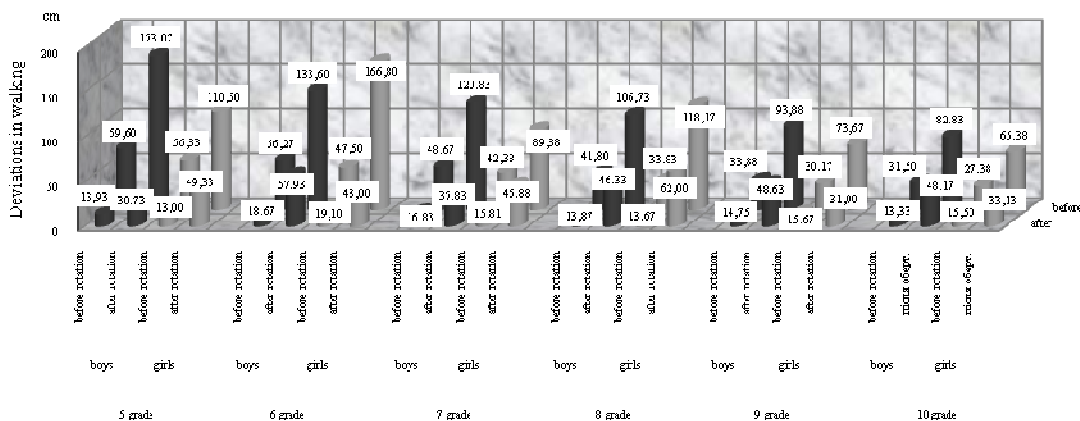


Fig. 1. Indicators of stability of the vestibular analyzer before and after rotations in the Barani chair of middle-school schoolchildren with visual impairments of experimental groups before and after the experiment

The most significant improvement in performance before the rotations in the Barani chair was observed in grade 5 schoolchildren, after - in boys 5 and girls in grade 6.

Considering repeated indicators of the stability of the vestibular analyzer before and after rotations in the Barani chair in children of middle school age of the experimental groups in the sexual aspect, it should be noted that by absolute average values before the rotations, they are better in boys, after rotations in girls. In the results of a deviation in walking up to vestibular irritation, the reliability of differences ( $p < 0.01$ ) is observed only in schoolchildren of the 10th grade, after - in the schoolchildren of all classes ( $p < 0.001$ ).

The dynamics of repeated indicators of the stability of the vestibular analyzer before and after rotation in the Barani chair in boys and girls of experimental groups changes in waves with age. The differences in the results are mostly reliable ( $p < 0.05 - 0.001$ ).

The analysis of repeated indicators of the functional state of the vestibular sensory system of schoolchildren of the control groups showed that after the experiment they did not change significantly and the significance of differences ( $p > 0.05$ ) was not observed.

Investigating the repeated results of deviations in walking before the spins in the Barani chair for schoolchildren of the control groups, it should be noted that in boys and girls in grade 5 they improved by 0,4 cm and 1,3 cm, respectively; grade 6 – by 0,2 cm and 2,8 cm, respectively; grade 7 – 1,5 cm and 0,7 cm, respectively; grade 8 – 0,7 cm and 0,4 cm, respectively; grade 9 – 1,4 cm and 0,5 cm, respectively, and grade 10 – 1,5 cm and 1,0 cm, respectively. The increase in indicators of vestibular stability after rotations in the Barani chair was 0,2 cm and 0.1 cm; 0,2 cm and 0,2 cm; 1,2 cm and 0,5 cm; 1.9 cm and 0.2 cm; 1,8 cm and 1,2 cm and 2,2 cm and 1,6 cm, respectively, in boys and girls of 5, 6, 7, 8, 9 and 10 grades (Fig. 2).

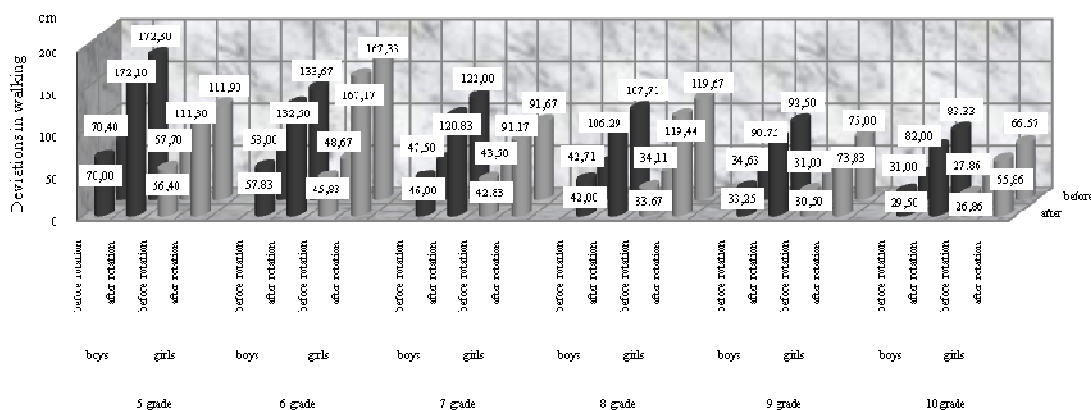


Fig. 2. Indicators of stability of the vestibular analyzer before and after rotations in the Barani chair of middle-school schoolchildren with visual impairments of control groups before and after the experiment

The most significant changes in the results of deviations in walking before the rotations in the Barani chair in the control groups were found in boys of grade 7, grade 10 and in girls of grade 6, and after spinning - in schoolchildren of grade 10.

Comparing the repeated indicators of the stability of the vestibular analyzer of schoolchildren of control groups in the sexual aspect, it was found that, before the spins in the Barani chair, they are better in girls. Reliability of differences is observed only in the indicators of schoolchildren in grades 5, 6, 8 ( $p < 0.001$ ). Analysis of the results of walking deviations after vestibular irritation in the Barani chair showed that they are generally significantly better in girls than in boys ( $p < 0.001$ ). The exceptions are the results of schoolchildren in grades 6 and 8, where they are significantly ( $p < 0.001$ ) better for boys.

Comparison of repeated results of the stability of the vestibular analyzer before and after rotational loads in schoolchildren of the control groups in the age aspect revealed that with age they change in waves. The differences in the results are mostly reliable ( $p < 0.05 - 0.001$ ).

Thus, the inclusion of middle-class schoolchildren with visual impairments in experimental groups of specially targeted exercises and outdoor games in the content of physical education lessons contributed to the improvement of the functional status of the vestibular sensory system. The most favorable period for training the vestibular analyzer in boys is 10–11 years old, in girls - 10–12 years old.

## Discussion

The results of the study made it possible to argue that the proposed specifically aimed exercises and active games had a positive effect on the indicators of the functional state of the vestibular sensory system. This confirms and complements the results of the research of Läha, 1987; Matveeva, 1991, who argue that the function of the vestibular analyzer can be influenced with the help of specially directed exercises.

According to Ermakov, Yakunin, 2000, an improvement in the functional status of the vestibular analyzer as a result of the systematic use of exercises can be explained by a sensitization process. Experts believe that rationally selected exercises for training analyzers have a positive effect on the functional state of sensory systems, which contributes to the improvement of their performance. The results of our research coincide with the views of Khudoley, 2008, who believes that the systematic use of special exercises aimed at stimulating the vestibular analyzer contributes to an increase in vestibular stability; confirm the data Maslyak, 2007; Moiseenko, Gorchanyuk, Pashchenko, 2015, who note the possibility of targeted training of the vestibular analyzer; Markova, Repsh, 2013, who indicate that during exercise the functions of the vestibular analyzer and its stability are improved; studies of middle school schoolchildren with normal vision Shesterova, 2002, 2004, 2008; Kuzmenko, 2010, 2011, 2013; Kuzmenko, Shesterovoy, 2011, 2012; Maslyak, Shesterova, Kuzmenko, Bala and al., 2016 regarding the effectiveness of the use of special exercises and outdoor games in physical education classes aimed at changing the functional state of the vestibular analyzer. Analysis of the stability indicators of the vestibular analyzer before and after rotational loads among schoolchildren of the control groups after the experiment showed that they also improved, but no significant differences were observed ( $p > 0.05$ ). The reason for this is that the specialists (Solodkov, Sologub, 2001) believe that the vestibular analyzer in children with visual impairment continues to take shape until the age of 17, and the absence of exercise in the current physical culture program for schoolchildren with visual impairment that purposefully influences the formation of the vestibular analyzer.

## Conclusion

The study of the primary indicators of the functional state of the vestibular analyzer in children of middle school age with visual impairments revealed a low level of its sensitivity and stability both before and after rotational loads. As a result of the use of specifically aimed exercises and active games for middle school schoolchildren with visual impairments in experimental groups, the indicators of stability of the vestibular analyzer were significantly improved before and after rotational loads. The most significant changes in the stability of the vestibular analyzer, both before and after the spins in the Barani chair, were observed in boys 10–11 and girls 10–12 years old. Indicators of the functional state of the vestibular analyzer of schoolchildren of control groups did not change significantly and are not reliable ( $p > 0.05$ ). *Prospects for further research in this direction are to determine the effect of specially directed exercises and outdoor games on the performance indicators of the other sensory systems of children aged 10–16 years with visual impairment.*

*Acknowledgments:* The study was conducted in accordance with the thematic plan of the research work of the Kharkov State Academy of Physical Culture for 2013-2015. on topic 3.5.29. "Theoretical and applied bases of building monitoring of physical development, physical fitness and physical condition of various groups of the population" and for 2016-2020. on the topic "Improving the process of physical education in educational institutions of various profiles" (state registration number 0115U006754).

**Conflict of interest.** The authors declare that there is no conflict of interest.

## Reference:

- Angelaki, D.E., Cullen, K.E. (2008). Vestibular system: the many facets of a multimodal sense. *Annual Review of Neuroscience*, 31, 125–150. DOI:10.1146/annurev.neuro.31.060407.125555.
- Azhypko, A.Yu., Kuzmenko, I.A. (2015). Factor structure of the functional state of the sensory systems of 6th grade students [Faktorna struktura funkcionalnoho stanu sensorynykh system uchniv 6-kh klasiv]. *Sports Science of Ukraine*, 1(55), 7–11. [inUkrainian].
- Demchuk, S. (2016). Features of the physical development of children of primary school age with the deprivation of hearing [Osoblyvosti fizychnoho rozvytku ditei molodshoho shkilnoho viku z deprivatsiieiu slukhu]. *Youth Scientific Herald of the Eastern European National University named after Lesia Ukrainian. Series: Physical Education and Sport: Journal. Comp. A.V. Tsos, A.I. Aleshin. Lutsk: Eastern European National University named after Lesia Ukrainian*, 21, 100–104. [inUkrainian].
- Ermakov, V.P., Yakunin, G.A. (2000). Fundamentals of educational levels: development, training and education of children with visual impairments [Osnovy tiflopedagogiki: razvitie, obuchenie i vospitanie detey s narusheniyami zreniya] : textbook allowance for stud. higher studies. institutions. M.: Tumanit, ed. center VLADOS, 240. [in Russian].
- Guide to practical classes in human physiology: studies. manual for universities of physical culture (2011). [Rukovodstvo k prakticheskim zanyatiyam po fiziologii cheloveka]. Under total ed. A.S. Solodkova; NSU them. P.F. Lesgavta. 2nd ed., rev. and add. M.: Soviet sport, 200. [in Russian].

- Horlings, C.G., Kung, U.M., Bloem, B.R., Honegger, F., Van Alfen N., Van Engelen, B.G., Allum, J.H. (2008). Identifying deficits in balance control following vestibular or proprioceptive loss using posturographic analysis of stance tasks. *Clinical Neurophysiology*, 119, 2338–2346. DOI: 10.1016/j.clinph.2008.07.221
- Khudoley, A.N. (2008). General foundations of the theory and methodology of physical education [Zahalni osnovy teorii i metodyky fizychnoho vykhovannia] : textbook allowance. second ed., corr. Kharkiv: "Department of Internal Affairs", 406. [inUkrainian].
- Kuzmenko, I.A. (2010). Changes in the level of development of individual coordination abilities of middle-school students under the influence of specially directed exercises [Zmina rivnia rozvytku okremykh koordynatsiinykh zdibnostei shkoliariv serednikh klasiv pid vplyvom spetsialno spriamovanykh vprav]. *Young Sports Science of Ukraine : sat. sciences. works in the field of physical culture and sports. L.: LSUPC*, 14, 2, 124-130. [inUkrainian].
- Kuzmenko, I. (2011). Influence of specially directed exercises on the functional state of the visual and vestibular analyzers of middle school students [Vplyv spetsialno spriamovanykh vprav na funktsionalnyi stan zorovoho ta vestibuliarnoho analizatoriv shkoliariv serednikh klasiv]. *Young Sports Science of Ukraine. Lviv*, 2, 110–114. [inUkrainian].
- Kuzmenko, I.A., Shesterova, L.E. (2011). Changes in the functional state of the sensory systems of middle-school students under the influence of specially directed exercises [Izmeneniya funktsionalnogo sostoyaniya sensorynykh sistem shkolnikov srednikh klassov pod vliyaniem spetsialno napravlenykh uprazhneniy]. *High technologies, fundamental and applied research in physiology, pharmacology and medicine: a collection of articles of the II International. scientific-practical conf. St. Petersburg: ed. Polytechnic University*, 1, 48–50. [in Russian].
- Kuzmenko, I.A., Shesterova, L.E. (2012). Development of coordination abilities of schoolchildren of 5–9th grades taking into account the functional state of analyzers [Razvitie koordinatsionnykh sposobnostey shkolnikov 5–9-kh klassov s uchetom funktsionalnogo sostoyaniya analizatorov]. «Dny vědy – 2012». – Díl 95. Tělovýchova a sport : materiály VIII mezinárodní vědecko–praktická conference. Praha : Publishing Hous «Education and Science» s.r.o., 96 stran. [in Russian].
- Kuzmenko, I.A. (2013). Development of the coordination abilities of middle-school schoolchildre, taking into account the functional state of sensory functions [Rozvytok koordynatsiinykh zdibnostei shkoliariv serednikh klasiv z urakhuvanniam funktsionalnogo stanu sensorynykh funkttsii] : author's abstract. dis. for the degree of candidate sciences in physical culture and sports : 24.00.02 "Physical Education, physical education of different groups of the population." Kharkiv: KSAPC, 20. [inUkrainian].
- Lyakh, V.I. (1987). Development of coordination abilities at school age [Razvitie koordinatsionnykh sposobnostey v shkolnom vuzraste]. *Physical Education in School*, 5, 25–28. [in Russian].
- Makarenko, O.I. (2000). Rehabilitation of visually impaired children aged 13–15 years in a boarding school setting by means of physical education [Reabilitatsiya slabovidyashchikh detey 13–15 let v usloviyakh shkoly-internata sredstvami fizicheskogo vospitaniya] : dis. for the degree of candidate pedagogical sciences : spec. 13.00.04 "Theory and methods of physical education, sports training, recreational and adaptive physical culture." SPb., 119. [in Russian].
- Markova, T.O., Repsh, N.V. (2013). Sensory systems of a person [Sensornye sistemy cheloveka] : textbook. Ussuriysk : (School of Education), 1, 36. [in Russian].
- Maslyak, I.P. (2007). Changes in the level of physical fitness of younger schoolchildren under the influence of special exercises aimed at improving the functional state of the analyzers [Zmina rivnia fizychnoi pidhotovlenosti molodshykh shkoliariv pid vplyvom spetsialnykh vprav, spriamovanykh na pokrashchennia funktsionalnogo stanu analizatoriv] : author's abstract. dis. for the degree of candidate sciences in physical education and sports : spec. 24.00.02 "Physical culture, physical education of different groups of the population." Kharkiv: KSAPC, 22. [inUkrainian].
- Maslyak, I.P. (2008). Dynamics of the level of physical fitness of younger students under the influence of special exercises aimed at improving the functional state of the analyzers [Dynamika rivnia fizychnoi pidhotovlenosti molodshykh shkoliariv pid vplyvom spetsialnykh vprav, spriamovanykh na polipshennia funktsionalnogo stanu analizatoriv]. *Theory and methods of physical education and sports*, 4, 47–51. [inUkrainian].
- Maslyak, I.P. (2015). Influence of indicators of vestibular resistance on the manifestation of speed in younger schoolchildren [Vliyanie pokazateley vestibulyarnoy ustoychivosti na proyavlenie bystroty u mladshikh shkolnikov]. *Naukovy Chronicle NPU named after M.P. Dragomanov*, 10(65), 101–105. [in Russian].
- Maslyak, I.P., Shesterova, L.Ye., Kuzmenko, I.A., Bala, T.M., Mameshina, M.A., Krivoruchko, N.V., Zhuk, V.O. (2016). The influence of the vestibular analyzer functional condition on the physical fitness of school-age children. *Sport science : International scientific journal of kinesiology. Travnik, Bosnia and Herzegovina*, 9, 2, 20–27.
- Matveev, L.P. (1991). Theory and methods of physical culture (general principles of the theory and methods of physical education; theoretical and methodological aspects of sports and professional-applied forms of physical culture) [Teoriya i metodika fizicheskoy kultury (obshchie osnovy teorii i metodiki fizicheskogo

- vospitaniya; teoretiko-metodicheskie aspekty sporta i professionalno-prikladnykh form fizicheskoy kultury)] : textbook for institutes of physical culture. M. : Physical Culture and Sport, 543. [in Russian].
- Moiseenko, E.K. (2014). Influence of specially directed exercises on the functional state of sensory systems and motor fitness of preschool children [Vliyanie spetsialno napravlenykh uprazhneniy na funktsionalnoe sostoyanie sensorykh sistem i dvigatelnyu podgotovlennost detey doshkolnogo vozrasta]. Sport games, 10, 91–97. [in Russian].
- Moiseenko, O.K., Gorchanyuk, Yu.A., Pashchenko, N.A. (2015). The dynamics of the indicators of the vestibular analyzer of children 5-6 years old under the influence of specially directed exercises [Dynamika pokaznykh vestibuliarnoho analizatora ditei 5–6 rokov pid vplyvom spetsialno spriamovanykh vprav]. Actual problems of physical education of various segments of the population: materials of the I All-Ukrainian scientific-practical conference (Kharkiv, May 20, 2015) [Electronic resource]. Kharkiv: KSAPC, 75–77. [in Ukrainian].
- Myasnikova, L.V. (2005). The development of touch and fine motor skills in younger schoolchildren with visual impairment in the process of their correctional education [Razvitie osyazaniya i melkoy motoriki u mladshikh shkolnikov s narusheniem zreniya v protsesse ikh korrektsionnogo obucheniya] : dis. cand. pedagogical. Sciences : spec. 13.00.03 “Correctional pedagogy (tiflopedagogy, surdopedagogy and oligophrenopedagogy and speech therapy)”. M., 185. [in Russian].
- Osipova, L.B. (2010). The development of touch and fine motor skills as a means of compensating visual impairment in younger preschoolers with visual impairment [Razvitie osyazaniya i melkoy motoriki kak sredstva kompensatsii zritelnoy nedostatochnosti u mladshikh doshkolnikov s narusheniyami zreniya] : dis. cand. pedagogical sciences : spec. 13.00.03 “Correctional pedagogy (tiflopedagogy, surdopedagogy and oligophrenopedagogy and speech therapy)”. Chelyabinsk, 263. [in Russian].
- Physical education program for low vision students: grades 5–10. (1995) [Prohrama z fizychnoi kultury dlia uchniv zi znyzhenym zorum : 5–10 klasy]. Comp. B.V. Sermeev, Yu.V. Pavlov [et al.]. K., 56. [in Ukrainian].
- RiADOVA, L.A. (2015). Changes in the indicators of the functional state of the hearing analyzer of children of middle school age with visual impairments under the influence of specially directed exercises and outdoor games [Zmina pokaznykh funktsionalnoho stanu slukhovoho analizatora ditei serednoho shkilnoho viku z vadamy zoru pid vplyvom spetsialno spriamovanykh vprav i rukhlyvykh ihor]. Bulletin of the Chernihiv National Pedagogical University. Chernigov: ChNPU, 129, 3, 282–286. [in Ukrainian].
- Rovnyi, A.S. (2001). The mechanism of sensory control of the precise movements of athletes during a training session [Mekhanizm sensorykh kontroliu tochnykh rukhiv sportyivnykh protiahom trenovalnoho zaniattia]. Theory and methods of physical education and sport, 1, 31–34. [in Ukrainian].
- Rovnyi, A.S., Ilyin, V.N., Lizogub, V.S., Rovnaya, A.A. (2015). Physiology of sports activities [Fiziologiya sportyvnoi diialnosti]. Kharkov : KNARU, 556. [in Ukrainian].
- Rynkiewicz, T., Żurek, P., Rynkiewicz, M., Starosta, W., Nowak, M., Kitowska, M., Kos, H. (2010). The characteristics of the ability to maintain static balance depending on the engagement of visual receptors among the elite sumo wrestlers. Archive of Budo, 6, 3, 159–164.
- Sedova, A., Shesterova, L. (2013). Investigation of indicators of the functional state of the sensory systems of children with visual impairments [Doslidzhennia pokaznykh funktsionalnoho stanu sensorykh sistem ditei z vadamy zoru]. Slobozhansky sports science bulletin scientific theory. Journals. Kharkiv : KSAPC, 3, 72–75. [in Ukrainian].
- Shesterova, L.E. (2002). Study of the influence of the functional state of sensory systems on the level of development of speed-power abilities of schoolchildren 11–15 years old [Issledovanie vliyaniya funktsionalnoho sostoyaniya sensorykh sistem na uroven razvitiya skorostno-silovykh sposobnostey shkolnikov 11–15 let]. Slobozhansky sports science bulletin. Kharkiv, 5, 16–18. [in Russian].
- Shesterova, L.Ye. (2004). The influence of the level of activity of sensory functions on the improvement of the motor abilities of middle school students [Vplyv rivnia aktyvnosti sensorykh funktsii na udoskonalennia rukhovyykh zdibnostei shkolariv serednykh klasiv] : author's abstract. dis. to receive sciences. degree of candidate sciences in physical education and sport : spec. 24.00.02 "Physical culture, physical education of different groups of the population" Kharkov: KSAPC, 20. [in Ukrainian].
- Shesterova, L.E. (2008). Influence of specially directed exercises on the level of activity of individual sensor systems [Vliyanie spetsialno-napravlenykh uprazhneniy na uroven aktivnosti otdelnykh sensorykh sistem]. Modern olympic and paralympic sport and sport for all: mes. report XII Intern. scientific congress. Moscow, 3, 162–163. [in Russian].
- Shesterova, L. (2015). Influence of parapsiss is on the separate indexes of the functional state of the sensory systems of schoolboys of middle classes. Slobozhanskyi herald of science and sport. Kharkiv : KSAPK, 4, 46–51.
- Solodkov, A.S., Sologub, E.B. (2001). Human physiology [Fiziologiya cheloveka. Obshechaya. Sportivnaya. Vozrastnaya]. Overall. Sports. Age : textbook. M. : Terra-Sport, Olympia Press, 520. [in Russian].