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Development of motor skills of children aged 9-10 years with visual analyzer impairment
Desarrollo de las habilidades motoras de niños de 9 a 10 años con deterioro del analizador visual

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Abstract. The objective is to increase the level of coordination abilities of schoolchildren diagnosed with myopia. Methods: The study was conducted in the period from September 2022 to June 2023 at secondary school number 13 in the Kirov region. A group (n=21) of 4th grade students was formed to conduct a pedagogical experiment. These are boys and girls aged 10-11 years with a mild degree of myopia (up to 3 diopters) – myopia of the first degree. The level of development of coordination abilities was determined by a 3x10 meter Shuttle run, a long jump from a place with the right and left sides, Balance on 1 leg and Dynamic coordination of movements. Results: In experimental group in the shuttle run test, the indicators became higher from 9.36±0.16 to 8.72±0.09 ($p<0.05$), an increase of 6.8%. The long jump with the right side increased by 10.4% ($p<0.05$), and with the left side by 7.3% ($p<0.05$). In the balance on one leg test, the indicators became 13.3% higher ($p<0.05$), and in the dynamic coordination test, the indicators improved from 8.83±0.89 to 10.05±0.16 ($p<0.05$), the increase in indicators was 13.8%. Conclusion: The results obtained allow us to conclude that our proposed method of using general developmental exercises with objects as a means of developing coordination abilities in children 9-10 years old diagnosed with myopia is effective, which is achieved through regular use of exercises in physical education lessons, as well as by stabilizing the course of myopia during the school day.
Keywords: School children's health, Physical education, Myopia, Visual impairment, Coordination abilities.

Resumen. El objetivo es aumentar el nivel de habilidades de coordinación de los escolares diagnosticados con miopía. Métodos: El estudio se realizó en el período comprendido entre septiembre de 2022 y junio de 2023 en la escuela secundaria número 13 de la región de Kirov. Se conformó un grupo (n=21) de estudiantes de 4to grado para realizar un experimento pedagógico. Se trata de niños y niñas de 10 a 11 años con un grado leve de miopía (hasta 3 dioptrías), miopía de primer grado. El nivel de desarrollo de las habilidades de coordinación se determinó mediante una carrera de lanzadera de 3x10 metros, un salto de longitud desde un lugar con los lados derecho e izquierdo, Equilibrio en 1 pierna y coordinación dinámica de movimientos. Resultados: Una vez finalizado el experimento pedagógico, el desempeño de los niños del grupo experimental mejoró en todos los indicadores. En la prueba de ejecución de lanzadera, los indicadores aumentaron de 9,36±0,16 a 8,72±0,09 ($p < 0,05$), un aumento del 6,8%. El salto de longitud con el lado derecho aumentó un 10,4% ($p < 0,05$), y con el lado izquierdo un 7,3% ($p < 0,05$). En la prueba de equilibrio en una pierna, los indicadores aumentaron un 13,3% ($p<0,05$), y en la prueba de coordinación dinámica, los indicadores mejoraron de 8,83±0,89 a 10,05±0,16 ($p < 0,05$), el aumento de los indicadores fue del 13,8%. Conclusión: Los resultados obtenidos nos permiten concluir que nuestro método propuesto de utilizar ejercicios generales de desarrollo con objetos como medio para desarrollar habilidades de coordinación en niños de 9 a 10 años diagnosticados con miopía es efectivo, lo que se logra mediante el uso regular de ejercicios en las lecciones de educación física, así como estabilizando el curso de la miopía durante la jornada escolar.
Palabras clave: Salud escolar, Educación física, Miopía, Discapacidad visual, Habilidades de coordinación.

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Introduction

Myopia is an anomaly of clinical refraction in which rays coming to the eye from distant objects come into focus not on the retina, but in front of it, resulting in a fuzzy image (Baird et al., 2020). It has been established that the prevalence in the general population is 25-30%, usually develops in childhood or adolescence (Sankaridurg et al., 2021). A person diagnosed with myopia sees well what is close and cannot recognize distant objects (Baird et al., 2020; Sankaridurg et al., 2021).

The most common types of myopia include the following (Bullimore et al., 2021; Haarman et al., 2020):

1. Innate. The vast majority of children (according to various sources – up to 80%) are born with hypermetropia (good vision in the distance, poor near), which is due to the short anteroposterior axis of the eyeball of a newborn (16-18 mm). In the future, as both the child and the eyeball grow, hypermetropia gradually decreases, and in some children it turns into myopia.

2. Stationary (vision remains stable; no deterioration occurs).

Progressive (vision deteriorates over time, very often myopia progresses in childhood and adolescence due to the growth of the child).

3. Night (occurs when there is a lack of lighting). Caused by excessive pupil dilation in the dark. It is more common in young people.

4. Professional (occurs due to frequent prolonged visual strain when examining objects at close range).

5. School (occurs in students due to prolonged visual strain at close range, is a subspecies of professional myopia).

6. False (occurs with an increase in the tone of the ciliary muscle – a spasm of accommodation – and disappears with its normalization).

7. Complicated (with myopia, the eyeball may elongate, which leads to stretching of the inner membranes of the eye, impaired nutrition of its tissues and negatively affects the retina). The progression of myopia can lead to

dystrophic changes in the fundus, retinal tears and detachment. Therefore, people suffering from myopia are recommended to undergo an eye examination at least once a year by an ophthalmologist in order to prevent retinal detachment that threatens blindness (Grzybowski et al., 2020; Morgan et al., 2021).

Causes of myopia (Brennan et al., 2021; Jonas et al., 2021):

1. The genetic factor. This is especially evident in large groups of the population.

2. Adverse environmental conditions, especially when working at close range for a long time. This is a professional and school myopia, which is especially easy to form when the development of the body is not complete.

3. Primary weakness of accommodation, leading to compensatory stretching of the eyeball.

4. Unbalanced tension of accommodation and convergence, causing a spasm of accommodation and the development of false and then true myopia.

5. The weak structure of the outer dense protein membrane of the eye, in the anterior part, passing into the cornea, which cannot interfere with the active growth of the eye, since it is noted that people with large eyes suffer from myopia.

6. Poor performance of the ocular muscle, which is responsible for correcting the lens at different distances, depending on the refraction of light rays, and as a result, severe fatigue of this muscle.

The progression of myopia can be slow, and will end at the end of the growth of the body. Non-progressive myopia refers to a refractive error. Clinically, it is usually manifested by a decrease in distant vision, it is well corrected and does not require treatment (MN et al., 2020; Savinova et al., 2022). It is very difficult to recognize myopia. If it is present, a person begins to frown or squint when trying to see something in the distance, also with myopia, a person tends to bring the text close enough to the eyes - all this is an excuse to go to an eye doctor. When working at a very close distance, pain often occurs in the temple and forehead, as well as in the eyes (Verkicharla et al., 2020; Wang et al., 2021; Castañeda-Babarro et al., 2022).

The first signs of myopia can appear at the age of 7 to 12 years, in women myopia progresses to 20 years, and in men up to 22 years. As a rule, vision can either stabilize or deteriorate. Genetically determined myopia begins to manifest itself much earlier in girls than in boys (Tricard et al., 2021; Han et al., 2022).

There are three degrees of myopia:

up to 3.0 diopters – weak;

up to 6.0 diopters – average;

over 6 diopters - high;

Mild myopia is a defect in visual function in which the refractive system of the eye focuses the image directly in front of the retina, but not on it itself, as it happens in people with healthy eyesight.

The patient sees objects well near him, but viewing several distant objects becomes a difficult task, because a blurred fuzzy image appears on the retina. Optics (contact lenses and glasses) with a negative value are used to correct vision. Currently, myopia is a fairly common disease (Verkicharla et al., 2020; Morgan et al., 2021; Han et al., 2022).

According to statistics, every 5th student of a secondary educational institution suffers from mild myopia (up to 3.0 diopters), and by the student years this figure can reach 40% (Haarman et al., 2020; Jonas et al., 2021).

Myopia is one of the most common diseases, which manifests itself as: decreased visual acuity in the distance, blurred vision, difficulties in shifting the gaze from near objects to distant ones and back, the apparent change in the color of objects, double vision of visible objects, goosebumps and darkening of the eyes, excessive light sensitivity, decreased visual performance, diagnosis of myopia (Morgan et al., 2021; Sankaridurg et al., 2021; Tricard et al., 2021; Wang et al., 2021).

To stabilize myopia, there are many different means and methods of physical education. The analysis and generalization of literary sources has shown that the most effective means of developing coordination abilities in children aged 9-10 years with a diagnosis of myopia are physical exercises of various directions, eye gymnastics, outdoor games (Qu et al., 2020; Yin et al., 2021).

In order to develop coordination abilities in children diagnosed with myopia, it is advisable to use means of general physical training according to adaptive rules that will promote the development of coordination abilities and stabilize the course of impaired eye functions in conditions of educational classes in secondary schools (Modrzejewska et al., 2022; Yin et al., 2022).

Having familiarized with the types of myopia and the causes of its occurrence, it was revealed that myopia appears more often in middle school age due to increasing mental and physical exertion. Such children lag behind their peers in most indicators of mental and physical development (Karthikeyan et al., 2022; Harrington et al., 2023).

The aim of the study to increase the level of coordination abilities in children aged 9-10 years with a diagnosis of myopia.

Methods

Study participants:

To conduct a pedagogical experiment, a group (n=21) was formed from 4th grade students with a mild degree of myopia (up to 3 diopters) – myopia of the first degree. Boys and girls aged 10-11. The study involved 13 boys and 8 girls. The diagnosis of myopia in most children was made upon admission to school, when a doctor gives a medical opinion on the health of each student at the beginning of the school year. Most of the students diagnosed with myopia were wearing glasses.

The research procedure

The study was conducted in the period from September

2022 to June 2023 at secondary school number 13 in the Kirov region. Physical education classes are held 3 times a week for 40 minutes each lesson.

The experimental group was engaged in accordance with the state program of the Ministry of Education of the Russian Federation for grades 1-4 of secondary school, but with the use of special complexes aimed at developing coordination abilities and stabilizing the course of myopia. In working with visually impaired children, whose indicators of coordination abilities are reduced, exercises with a certain rhythm, clarity, smoothness of movements were used in the preparatory part of the lesson, exercises for the development and improvement of the basics of running, walking, jumping techniques were used. In determining the content and selection of organizational forms for conducting physical education lessons with visually impaired students, a selection of general developmental exercises with subjects, preparatory and summing exercises, as well as exercises for the development of coordination abilities was carried out. Classes with students with visual impairments were held in parallel with the rest of the class in a group form. The children participating in the experiment performed a special complex for the development of coordination abilities, the exercises were accompanied by gymnastics for the eyes, which included turns, circular movements of the eyeball in various directions, exercises for the eyelids. All exercises were performed under the commands: look up, down, circular movements, etc. The second group of students, who did not participate in the experiment, worked under the supervision of the duty officer and worked according to the plan prepared by the teacher.

The structure of each lesson consisted of a preparatory, main and final part. In the preparatory part of the lesson (15 minutes), general developmental exercises with subjects were used. They included exercises that required a lot of attention from the students. The exercises were arranged in order of increasing load, since the gradual increase in the coordination complexity of the task contributes to their better assimilation. The main part of the lessons was aimed at completing the main program material and was 20 minutes long.

In the final part (5 minutes), slow walking and breathing recovery exercises were used.

The following sports equipment was used in physical education classes: tennis balls, volleyballs, hoops, jump ropes, gymnastic sticks.

The following methodological techniques were used in the organization of classes: changing places of study, an individual form of conducting classes, monitoring the work performed, repeating the studied exercises and techniques aimed at developing the coordination abilities of children 9-10 years old with visual impairment. The following exercises were used to develop coordination abilities:

- General developmental exercises with a big ball,
- General developmental exercises with a small ball,
- General developmental exercises with a gymnastic stick.
- General developmental exercises with hoops.

The following exercises were used to stabilize the course of myopia:

- Maintaining visual control over the subject when rotating and tilting the head,
- Blinking of the eyes with different frequency,
- Intentionally keeping the eyes closed by holding them with your fingers,
- Shifting the gaze from a close to a distant object,
- Self-massage.

The second part of the experiment was the use of eye exercises during the school day. In children, visual functions are malleable to impact and can be restored by special eye exercises. Such gymnastics for the eyes has no contraindications, its performance should not tire the eyes. The most important thing is to train them regularly and gradually so that it becomes a habit and has a clear organization of classes). These exercises can be performed during a physical education minute, physical education pauses in class or at recess, sitting or standing. Eye exercises can also be performed to music, which will increase not only the mood, but also the interest of students in these exercises. The exercise complexes consisted of 3-5 exercises and lasted no more than 2-3 minutes. The complexes were conducted by class teachers 3 times a week in the last 2 lessons.

For example, while sitting on a chair, perform the following exercises:

1. Close your eyes tightly for 3-5 seconds, then open your eyes for 3-5 seconds (6-8 times).

2. Close the eyelids, massage them with circular movements of the fingers (1 minute).

3. Blink quickly (1 minute).

4. Look straight in front of you for 2-3 seconds, place the finger of your right hand along the middle line of the face at a distance of 25-30 cm from the eyes. Move your gaze to the end of your finger and look at it for 2-5 seconds, lower your hand (10 times).

Pedagogical testing included the following tests (Moseichuk et al., 2020; Rosa Guillamón et al., 2020; Zerf et al., 2021):

1. Shuttle run of 3x10 meters. The time is fixed in seconds.

2. Long jump from a place with the right and left sides. The best of 2 attempts is counted. The result is in centimeters.

3. Balance on 1 leg. The result is the sum of the balance on the right and left legs in seconds.

4. Dynamic coordination of movements. Without the help of hands, you need to sit on the floor and stand up again. The number of ascents in 30 seconds is taken into account.

The rest of the children were engaged in accordance with the usual physical education program at school. It is a block type. This is a section of athletics, gymnastics, martial arts, outdoor and sports games, ski training.

Statistical analysis

The Microsoft Excel program was used to process the results of the study. The reliability of the study results was determined by the Student's t – criterion, and the reliability was determined at the level of $p<0.05$. The Student's t-test is a method of statistical hypothesis testing (statistical criteria) based on the Student's distribution. It is used when checking the equality of the average values in two samples.

Results

Before the start of the study and after the end of the pedagogical experiment, all students who participated in the study took control tests (Table 1).

Table 1.
Average indicators of children aged 9-10 years from the beginning to the end of the experiment (n=21)

Tests	Before (M±m)	After (M±m)	t	p	%
Shuttle running	9.36±0.16	8.72±0.09	t=3.55	p< 0.05	6.8%
Right side jump	87.64±1.02	96.78±2.51	t=3.38	p< 0.05	10.4%
Left side jump	81.64±1.94	87.57±1.94	t=2.16	p<0.05	7.3%
Balance on one leg	36.5±4.46	41.36±9.34	t= 3.07	p< 0.05	13.3%
Dynamic coordination	8.83±0.89	10.05±0.16	t=2.57	p<0.05	13.8%

Table 1 shows that after the end of the pedagogical experiment, the indicators of children from the experimental group improved in all indicators. In the shuttle run test, the indicators became higher from 9.36±0.16 to 8.72±0.09 ($p<0.05$), an increase of 6.8%. The long jump with the right side increased by 10.4% ($p<0.05$), and with the left side by 7.3% ($p<0.05$). In the balance on one leg test, the indicators became 13.3% higher ($p<0.05$), and in the dynamic coordination test, the indicators improved from 8.83±0.89 to 10.05±0.16 ($p<0.05$), the increase in indicators was 13.8%. The increase in the indicators of schoolchildren with myopia from the beginning to the end of the study on all tests is shown in Figure 1.

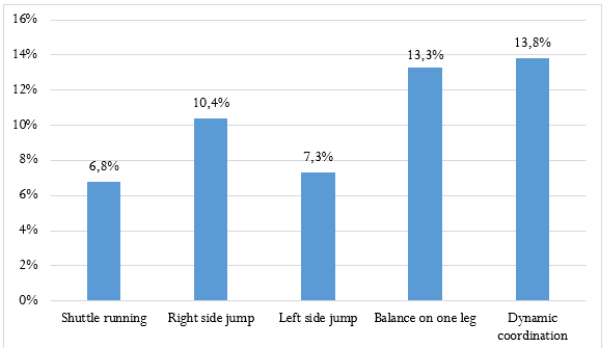

Figure 1. The increase in the indicators of schoolchildren with myopia from the beginning to the end of the study

Discussion

Currently, in Russia and in other countries of the world, an increase in the number of children with various developmental disabilities is characteristic. Every year, the number of children at risk for vision is growing, that is, children who may have vision problems if even minor adverse factors appear. One of the risk factors is a lack of movement in the life of a modern person, which affects the development of physical abilities and the state of the visual apparatus (Bullimore et al., 2021; Jonas et al., 2021; Wang et al., 2021; Matos et al., 2022).

Through vision, there is constant and active human interaction with the environment. Due to vision, they distinguish many objects, correctly determine their location in space, perceive a rich range of color shades. Vision has taken on an additional burden that was not programmed during evolution. The weakening of vision deprives a person of completeness of ideas about the world around him, complicates the processes of his cognition and perception. Impaired functions of the visual analyzer represent a barrier for children with visual impairment in the process of cognition of the surrounding world, which does not allow them to develop fully and harmoniously (Baird et al., 2020; Haarman et al., 2020; Savinova et al., 2022; Lourenço et al., 2023).

Currently, the tendency of visual impairment in the form of myopia continues in schoolchildren. The increasing mental and physical loads of schoolchildren have negative consequences that affect the deterioration of vision, and an important role in this is played by increasing requirements for the implementation of the school curriculum. Children diagnosed with myopia are inferior to schoolchildren who do not have it. (Grzybowski et al., 2020; Brennan et al., 2021; Morgan et al., 2021; Tricard et al., 2021; Westphal-Nardo et al., 2024).

The analysis and generalization of literary sources has shown that the most effective means of developing correctional abilities in children aged 9-10 years with a diagnosis of myopia are physical exercises of various directions, eye gymnastics, outdoor games (Yin et al., 2021; Modrzejewska et al., 2022; Yin et al., 2022; Harrington et al., 2023). Thus, there is a need to stabilize the course of myopia in children aged 9-10 years, along with an increase in their level of development of coordination abilities.

The scientific novelty of the study lies in the fact that for the first time, a methodology has been developed for the development of coordination abilities for children aged 9-10 years with a diagnosis of myopia based on educational standards. The effectiveness of an experimental technique for the development of coordination abilities in children aged 9-10 years with a diagnosis of myopia has been determined, which can be used by teachers of secondary schools in physical education lessons and during the school day.

The results of the pedagogical experiment show the positive impact of the experimental technique for the development of coordination abilities of children with myopia. This is confirmed by previous studies (Qu et al., 2020; Mujica Johnson & Jiménez Sánchez, 2021; Karthikeyan et al., 2022; Modrzejewska et al., 2022; Mercê et al., 2023). The proposed method made it possible to effectively and reliably improve the results on all coordination tests of schoolchildren aged 10-11 years. Of course, in the future, a wider

range of tasks can be used to develop different physical qualities and abilities of both healthy schoolchildren and children with various diseases, including myopia.

It is known that physical culture has a positive effect not only on the development of physical qualities, but also on mental processes (GG, 2022; Sarroeira et al., 2022; Polevoy, 2023). Along with myopia, a number of other urgent problems should be noted, such as obesity of schoolchildren (Rashid & Haque, 2022) and strabismus, as one of the problems of visual deviation (Belyaeva et al., 2021; Savinova et al., 2022; Doskarayev et al., 2023).

Limitation – It should be noted that the sample size is not representative of the population and, in turn, cannot be generalized to other visually impaired children in our region.

Conclusion

The results obtained allow us to conclude that our proposed method of using general developmental exercises with objects as a means of developing coordination abilities in children 9-10 years old diagnosed with myopia is potentially effective, which is achieved through regular use of exercises in physical education lessons, as well as by stabilizing the course of myopia during the school day. Perhaps retesting and agreeing on similar approaches in other regions may provide an opportunity to better understand whether your proposed methods are relevant for this particular population group.

The research materials can be used by specialists in physical education in secondary schools, as well as students of the specialization "Adaptive physical culture" in the process of preparing for professionally oriented practice.

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Conflict of interest

None. The authors declare no conflict of interest

Author contributions

Author Contribution: Study design; Data collection; Statistical analysis; Manuscript Preparation; Funds Collection – Georgiy Polevoy.

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