Indicators of the functional state of adolescents with visual impairment

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Abstract

This article examines the functional state and physical performance indicators of adolescents aged 12–15 with visual impairment. The study assessed the functional capabilities and strength indicators of the respiratory, cardiovascular, and vestibular systems using vital lung capacity (VLC), heart rate (HR), the Ruffier–Dickson index, the Yarotsky test, and hand dynamometry. The results revealed that in adolescents with visual impairment, the functional capabilities of the cardiorespiratory system, physical performance, and certain coordination indicators are insufficiently developed. According to the Ruffier–Dickson index, satisfactory results were recorded in 12-year-old girls, while the indicators for the remaining groups were rated as below average. The slow recovery process after physical exertion and the results of the Yarotsky test indicate the need to improve the functional preparedness of this cohort through an individualized approach. The findings substantiate the importance of considering the functional state when organizing adaptive sports and physical education classes for adolescents with visual impairment.

Keywords: adolescents with visual impairments, functional state, functional readiness, adaptive sports, respiratory system, vital lung capacity, heart rate, Ruffier-Dickson index, Yarotsky test, vestibular analyzer, physical work capacity, dynamometry.

Introduction

Currently, special attention is being paid to the development of adaptive sports and the involvement of young people with visual impairments in sports activities. In training such athletes, along with general physical preparation, an in-depth study of the body's functional capabilities and the determination of the level of adaptation to athletic loads are among the most important tasks.

The active participation of adolescents with visual impairments in sports training serves to develop their physical qualities: speed, agility, strength, endurance, flexibility, and coordination abilities. However, if an athlete's functional capabilities are not sufficiently considered when standardizing training loads, a decrease in training effectiveness or overexertion of the body may occur.

From this perspective, assessing the functional state of adolescents with visual impairments during sports training, determining the relationship between key functional indicators and age and physical fitness levels, and studying the characteristics of adaptation to physical loads are of significant scientific and practical importance.

The findings of this study can serve as a scientific basis for individually planning training loads for adolescent athletes with visual impairments, pedagogical monitoring of their functional state, enhancing the physical training process, and increasing the effectiveness of sports training.

Therefore, studying the functional state indicators of adolescents with visual impairments under sports training conditions, identifying their capacity for adaptation to physical exertion, and developing methods to improve their functional fitness establish the relevance of this research topic.

Literature Review. Children with visual impairments exhibit a range of motor disorders and varying levels of physical development, physical fitness, and functional preparedness. Therefore, it is not always possible to use uniform teaching tools and methods when educating these children [3, 4, 5, 7]. Evseev S.P., Kurdybalo S.F., Marzeeva O.F., and Solodkov A.S. [4] provide an integrated definition of the physical condition of adolescents with visual impairments—encompassing physical development, physical fitness, and functional preparedness—and assess its conformity to the demands of professional and daily life activities. The issue of standardizing physical exertion in sessions with children experiencing visual deprivation remains a relevant concern. The most optimal form of training for correcting physical condition primarily consists of health-improving physical education sessions that utilize a differentiated approach, in line with recommendations [1, 2, 7, 8].

Objective of the Study: To determine the functional status indicators of adolescents with visual impairments.

Methods

The functional state of adolescents with visual impairments was evaluated. The study was conducted at a specialized boarding school for blind and visually impaired children in the Hamza district of Tashkent. The study participants were adolescents aged 12–15 years, totaling 86 individuals, of whom 46 were girls and 40 were boys. This age range was not chosen randomly, as boys and girls enter puberty at different ages, and the growth rate of overall body dimensions differs during the same age period. To assess the functional state of visually impaired adolescents, a series of functional tests were used: Lung Capacity (LC), Heart Rate (HR), the Ruffier-Dickson index, the Yarotsky test, and hand dynamometry to determine strength qualities.

Results and discussion

Table 1 presents the age-related indicators of Vital Capacity of the Lungs (VCL). In 12-year-old girls, the VCL value is 1.95 liters, and at 15 years of age, it reaches 2.08 liters. Concurrently, the annual increase in VCL is 0.2 –0.5 cm. These are very low growth rates. It should be noted that in this age range, the respiratory system in girls is practically undeveloped. Normally, this age interval is characterized by a developmental peak in indicators such as an increase in chest circumference and an increase in VCL to 2.4–2.8 liters (from Table 1). According to scientific data, for this age group (12-13), the MVC indicator determined by the results of the load test is 2.60 ± 0.26 l/min. Heart rate (HR) indicators also show the presence of stress on the cardiovascular system, as the pulse in the examined children is slightly above the norm. The age-dependent response to physical exertion increases from 116 beats per minute in 12-year-old girls to 120.7 in 15-year-olds. In boys of this age range, the HR increased from 121 to 130.1 beats per minute. Five minutes after recovery, a return to the resting HR values was not observed in any age group, neither among girls nor among boys. All of this indicates low functional capabilities related to cardiorespiratory system indicators. The Ruffier -Dickson index values are also characterized as below average. In visually impaired adolescents, significant differences were found in hand strength indicators for girls and boys. The hand strength indicators in boys are significantly higher than in girls. The Yarotsky test determines the sensitivity threshold of the vestibular analyzer (Tables 1, 1a).

Table 1. A comparative analysis of the functional state of adolescent visually impaired girls and boys

Age (Group)	Number of adolescents – total number – 128 visually impaired students	Vital capacity of the lungs (liters)	Ruffier-Dickson Index (20 squats)			V.I. Yarotsky test (seconds)		Dynamometry: Hand grip strength		
			HR at rest (bpm)	HR load under exertion (bpm)	HR during recovery (bpm)	R-D index	Assessment	Right hand		Left hand
1. Girls – 12 years (n = 16)	16	1.95	85	116	88.3	8.1	Average	32.300	11.5	10.6
2. Boys – 12 years (n = 16)	16	1.94	88	121	91	10.0	Below average	2700	13.1	10.4
1. Girls – 13 years (n = 16)	16	2.0	85.8	125.2	92.2	10.3	Below average	21.900	10.8	11.2
2. Boys – 13 years (n = 16)	16	2.16	90	127	94	11.1	Below average	2800	15.5	15.8
1. Girls – 14 years (n = 16)	16	2.02	90.8	135.4	99.4	12.5	Below average	24.200	10.5	9.8
2. Boys – 14 years (n = 16)	16	2.04	92.6	129.3	96.6	11.8	Below average	38.200	21.4	21.0
1G – 15 years (n = 16)	16	2.08	89.7	120.7	97.5	10.8	Below average	25.300	13.7	12.5
2B – 15 years (n = 16)	16	2.88	91.8	130.1	95.0	11.7	Below average	3600	23.15	22.3

The test is performed from a standing start position with eyes closed, during which the subject begins to perform rapid head rotation movements.

In healthy adults, the time for maintaining balance is 28 seconds. For girls, the balance time gradually increases from 20 seconds at age 12 to 25 seconds at age 15, which can be assessed as satisfactory for this age group.

For boys, the vestibular apparatus sensitivity threshold increases from 27 seconds at age 12 to 36-38 seconds at age 15, indicating a positive shift in the development of coordin tion abilities. (Table 1a presents data for female

and male students separately).

The Ruffier-Dickson test was used, taking into account the condition of the contingent being tested for physical performance. It is considered the most convenient method for working with children and adolescents, as it assesses their adaptive and functional state/ physical performance and the activity of the cardiovascular system.

In our study, only the indicators obtained in 12-year-old girls were assessed as satisfactory, while the indicators in the remaining groups of adolescent girls and boys were found to be “below average”.

A comparison of the obtained data with scientific literature reveals the age and sex-specific characteristics of the functional state of the cardiorespiratory system in visually impaired adolescents versus their healthy peers. This reflects the biological laws of growth and development during this age period.

The obtained results are consistent with a number of authors who have identified the characteristics of respiratory system parameters in adolescents [3, 4, 6, 7].

Analysis of the data shows that the absolute values of vital lung capacity (VLC) are higher in boys. The lower limit of VLC varies from 1,500 to 2,500 ml in boys and from 1,800 to 2,600 ml in girls; that is, no significant differences were identified. The lowest indicators were observed in boys at age 15 and in girls at age 17. The upper limits vary significantly depending on sex, with a difference of 800–3,700 ml (21.05–97.36%). In boys aged 14 to 17, it increased by 2,900 ml (38.67%), and in girls by 800 ml (21.05%). At the same time, the increase in the upper limits in male adolescents occurred annually, whereas in females, it was noted only at age 15, with a subsequent stabilization of the indicators in the range of 4,400–4,600 ml.

The largest difference between the average VLC values for girls and boys was identified at age 16, and the smallest difference at age 14. An analysis of the relative lung capacity values in adolescents of both sexes showed that the smallest range of values was recorded at 14 years of age: 35–85 ml/kg for boys and 40–80 ml/kg for girls.

The largest range was observed at 15 years of age for boys (40–120 ml/kg), and at 15 and 17 years of age for girls (35–80 ml/kg). As can be seen, the lower limit of the value range varies between 35–40 ml/kg in both boys and girls. The upper limit was higher in boys, increasing by 35 ml/kg by the fourth year of the study. In girls, the age-related difference did not exceed 5 ml/kg. In general, it can be said that the relative VLC indicator is higher in boys than in girls. This is expected, as this value is dependent on body mass [2, 3, 9].

Conclusion

Most indicators of the respiratory system's functional state were within the age-appropriate norm. However, in adolescents with visual impairments, the respiratory system values can be assessed as below average and at the lower limits of normal parameters, whereas modern healthy adolescents show a trend toward an increase in the functional capabilities of the respiratory system.

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