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Article

Physical fitness of young pupils engaged in the health gymnastics

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Abstract: Numerous studies conducted in recent years indicate an unfavorable trend in children's health, which prompts the optimization of schoolchildren's physical activity outside of school hours. The purpose of the study is to determine the level of physical development and physical fitness of children of primary school age. Methods: analysis and generalization; sociological methods; pedagogical observation; methods of assessing the level of physical development and physical fitness; methods of mathematical statistics. The research was conducted on the basis of the sports complex of the Ivan Boberskij Lviv State University of Physical Culture. 33 children, 18 girls and 15 boys, participated in the study. Results: According to the survey data, 57.6% of children like recreational gymnastics classes, 45.5% attend classes for the purpose of improving their health. Harmonious physical development corresponds to 69.4% of children. 69.4% of children have a body mass index within the normal range, 21.1% are underweight and 9.4% are overweight. Adequate adaptation of the cardiovascular system to physical exertion according to the Ruffier test in 93.8% of children. The vital index was normal in 81.1% of the examined. 72.6% of children showed a sufficient level of hand flexor strength. The boys had slightly higher results in the 30 m run and the handstand. In the flexibility test, the girls' results were better ($p < 0.05$). No statistically significant difference was found in the 30 m run and the 4x9 m "shuttle" run ($p > 0.05$).

Keywords: health; harmonious; BMI; tests; motor activity

1. Introduction

Numerous studies conducted in recent years indicate an unfavorable trend in children's health. The search for optimal ways of engaging in systematic physical exercises stems from the foundations of the reconstruction of the national system of physical education, where the preservation and strengthening of children's health is given special importance. Ozudogru et al. [1] studied the effects of sport on physical fitness; this article shows the effects of sport on cognitive functioning.

The data of special studies by Al-Nemr and Reffat [2] showed that the growth of the static component during the day, correspondingly, the decrease in motor activity leads to the deterioration of the child's health. In order to preserve and strengthen the health of children of primary school age, the amount of daily physical activity should be 4.5–5.5 h, of which at least 1.5–2.0 h should be outdoors [3–5]. However, studies emphasize that most children do not reach the hygienic standard. Girls are less active than boys, and motor activity on weekends is lower than on weekdays [6,7].

The results of Andreeva's research [8] show that there is a decrease in the functional capabilities and regulatory mechanisms of the body in junior

schoolchildren, and no students with a high level of health were found. Predominance of a sedentary lifestyle while studying at school leads to diseases of the musculoskeletal system (impaired posture), which tends to worsen during the growth and development of the child [9]. Research by Ghanem emphasizes the importance of understanding school triggers (academic, behavioral, social, and environmental) that elementary school students face, which also have an impact on a child's academic performance and health [10].

The negative consequences of schooling—the increased sensitivity of the child's body to physical and psychological stress in combination with other stress factors, as well as a decrease in the amount of motor activity, are practically impossible to eliminate within the limits of physical education lessons alone [11]. According to many researchers, the problem of improving children's health and increasing daily physical activity can be solved precisely through extracurricular activities. Numerous scientific studies are devoted to the search for the most effective forms of such classes, in which various approaches are proposed: based on karate classes [12]; application of elements of choreographic orientation [13]; using yoga-aerobics [14]; means of health tourism. Other scientists, in order to increase motor activity, propose the complex use of forms of physical education, introducing the "concept of an active school", which integrates physical activity into all aspects of school life [15].

The peculiarity of extracurricular forms of physical education is the provision of meaningful leisure time, increasing the daily physical activity of children of primary school age. In their research, scientists emphasize the positive impact of motor activity on children's health.

According to Mykhno [11] and 51.4% according to Sergienko [13], 49.1% of children of primary school age do not have specially organized extracurricular motor activity. Most children spend their free time talking with friends, playing computer games, and reading [13,14]; 35.1% of junior schoolchildren prefer martial arts, followed by gymnastics at 16.5% [13]. According to other data, classes in dance clubs are popular among junior schoolchildren, and gymnastics is also in second place. Gymnastics is recommended as a basic movement activity in childhood and adulthood [16]. The above testifies to the importance and popularity of gymnastics classes.

Despite the wide range of presented works and their practical and theoretical significance, insufficient attention has been paid to the search for effective extracurricular forms for the purpose of preserving and strengthening health, increasing the daily physical activity of children of primary school age.

The purpose of the study is to determine the level of physical development and physical fitness of children of primary school age who are engaged in recreational gymnastics.

2. Materials and methods

Theoretical analysis and generalization; sociological survey methods (questionnaires); pedagogical observation; methods of assessing the level of physical

development and physical fitness; methods of mathematical statistics were applied. Body mass index (BMI) values have been determined using the formula as follows:

$$\text{BMI} = \frac{m}{h^2} \tag{1}$$

where m is body mass (kg), h is body height (m). Evaluation ranges of the BMI values were as follows: below 18.5–the underweight range, 18.5 to 24.9–the healthy weight range, 25 to 29.9–the overweight range, and 30 to 39.9–the obese range.

Vital index (VI) was calculated using the formula as follows:

$$VI = \frac{VLC}{m} \tag{2}$$

where *VLC* is vital lung capacity (ml/kg). With the help of a dry spirometer, we have seen 2–3 deep inhalations and breathe out, and then, having seen the maximum inhalation, we have seen the wave of the introduction. They carried out 2 tests, all the greatest demonstration.

Force index (FI) was determined with the formula as follows:

$$\text{FI} = \frac{F}{m}100\% \tag{3}$$

where F is the force of the stronger hand (kg).

Ruffier's index was determined using the formula as follows [17]:

$$RI = \frac{k(P_1 + P_2 + P_3) - 200}{10} \tag{4}$$

where k is a coefficient of the age correction; the pulse was measured for 15 s (P_1) in the sitting position, with a stretch of 45 s with the restraints of the 30th squat, with the hands forward. After the first 15 s (P_2) and 15 s (P_3) of the first sitting, the pulse was measured in the first 15 s (P_3) of the first period of restoration.

The research was conducted on the basis of the Ivan Boberskij Lviv State University of Physical Culture sports complex (gymnasium) with children of primary school age: 33 children, 18 girls and 15 boys participated in the study.

The methods of the research were as followed: analysis and generalization; sociological methods; pedagogical observation; methods of assessing the level of physical development and physical fitness; methods of mathematical statistics. Physical fitness was assessed by the level of development of physical qualities: speed (running 30 m, s); flexibility (bend of the trunk forward from a sitting position, cm); dexterity ("shuttle" run 4x9 m, s); strength abilities (hang on bent arms, grip from above).

Written informed consent was obtained from parents of each study participant. Ethics committee permission for the study was performed by Lviv State University of Physical Culture named after Ivan Boberskij (Lviv, Ukraine) just before the study.

3. Results

The results of the study indicate that all 100% of the interviewed parents and their children have a positive attitude to physical education and sports, believing that such activities contribute to the preservation and strengthening of health: 100% of

children like health gymnastics classes, as parents noted, their child attends classes to improve health. 57.6% of children are interested in attending such classes, 45.5% want to be healthy, 39.4%—to be strong, 21.2%—to be famous athletes, 18.2%—because friends do it, 15.2%—convinced by their parents, 12.1%—to be flexible and beautiful, 6.1%—have problems with excess weight.

Children prefer relays and competitions—42.4%, like to perform somersaults—30.3%; exercise "wheel"—27.3%; handstand—24.2%; "Twins" exercise—24.2%; horse jumping exercises—21.2%, "bridge" exercise—21.2%; "basket" exercise—18.2%, shoulder stand—15.2% and pull-up on the crossbar—12.1%. It was found out that only 54.5% of the surveyed children perform exercises in recreational gymnastics at home. According to the survey, 84.8% of children plan to continue attending gymnastics classes.

It turned out to be interesting that 45.5% of children additionally attend other sports clubs and sections, namely: 18.2% of children are engaged in swimming, 9.1% in dancing, 6.1% in parkour, and 3.0% each in kung fu, football, karate, and volleyball. More than half of children (57.6%) can ride a bicycle and jump rope (54.5%). Only 48.5% swim, 21.2% roller skate, 18.2% play badminton, and 15.2% skate, play football, and ride a scooter.

According to the results of the study, it was established that 69.4% of children correspond to harmonious physical development, among such children 66.6% are boys and 72.2% are girls. Disharmonious physical development was found in 11.7% of children, of which 6.7% were boys and 16.6% were girls. Accordingly, 18.9% of children, of which 26.6% are boys and 11.1% are girls, have severely disharmonious physical development, which may indicate certain health disorders (**Figure 1**).

When determining the body mass index (BMI), it was found that 69.4% of children (66.6% of boys and 72.2% of girls) are within the normal range, but 21.1% of children (20.0% of boys and 22.2% of girls) have insufficient body weight. Excess body weight is observed in 9.4% of children (13.3% of boys and 5.5% of girls).

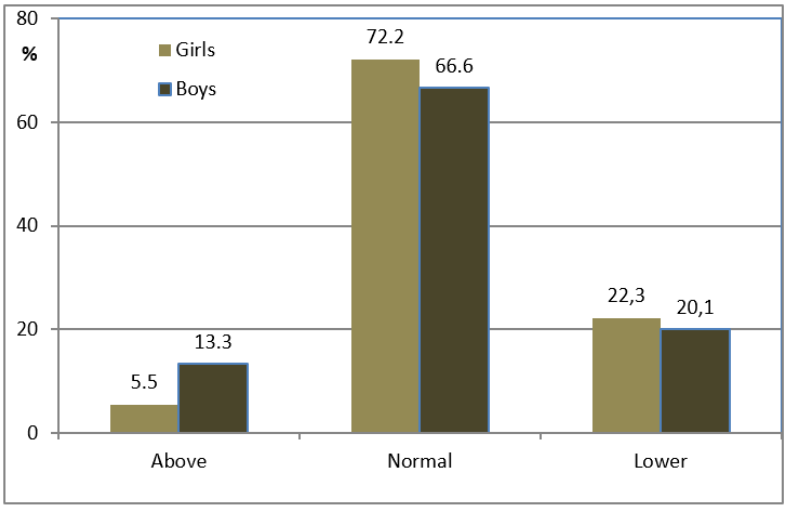

Figure 1. Correspondence of body mass and body height evaluation.

According to the Ruffier index, 9.4% of children (13.3% of boys and 5.5% of girls) have a high level of functional heart reserve (athletic heart). 57.2% of children

(53.3% of boys and 61.1% of girls) have an above-average level (very good heart). Average level (good heart) is characteristic of 27.2% of children (26.6% of boys and 27.7% of girls). 6.1% of children (6.6% of boys and 5.5% of girls) have a below-average level (heart failure of an average degree). No children with a low level (severe heart failure) were found.

Assessing the functional state of the respiratory system, it was found that 44.4% of children have average indicators of the vital capacity of the lungs (66.6% of boys and 22.2% of girls); 33.9% of children (6.6% of boys and 61.1% of girls) showed a level above the average. Only 2.8% of children confirmed a high level of the vital capacity of the lungs (5.5% of girls did not have such a level among boys). The indicator below the average is characteristic of 12.2% of children (13.3% of boys and 11.1% of girls); 6.7% of children (13.3% of boys) have a low level, no such level was found in girls.

Dynamometry data showed that only 6.0% of children (6.6% of boys and 5.5% of girls) had high FI scores; 24.2% of children (26.6% of boys and 22.2% of girls) have above average FI. The largest percentage of children, 42.4%, passed the test at the intermediate level (40.0% of boys and 44.4% of girls). Below average FI was shown by 15.1% of children (13.3% of boys and 16.6% of girls), and 12.1% of children (13.3% of boys and 11.1% of girls) showed a characteristically low FI. The **Table 1** presents the average statistical indicators of the vital capacity of the lungs and dynamometry (**Table 2**).

Table 1. Age correction coefficient in the index Equation (4).

Years old	**6**	**7**	**8**	**9**
k	2.7	2.9	3.1	3.2

Table 2. Statistics of tests.

Tests		**Boys (*n* = 15)**	**Girls (*n* = 18)**
		M* ± SD	
Vital capacity of the lungs, ml/kg		1546 ± 345	1183 ± 217
Dynamometry, kg	right	13.9 ± 3.2	11.9 ± 3.0
	left	13.2 ± 2.9	11.8 ± 3.0

Note: * M is arithmetic mean, SD is standard deviation.

It should be noted that the boys had somewhat higher results in the tests: running 30 m and standing on bent arms. In the test "tilting the torso forward from a sitting position", the results of the girls were better ($p < 0.05$). Height on bent arms was not a significant difference ($p = 0.09$). There is no statistically significant difference between boys and girls in the 30 m run and the 4x9 m "shuttle" run ($p > 0.05$) (**Tables 3** and **4**).

Table 3. Parameters of fitness (boys, n = 15).

Statistics	Tests			
	Run 30 m, s	**Forward bend of the trunk from a sitting position, cm**	**"Shuttle" run 4x9m, s**	**Hanging on bent arms, grip on top, s**
Max	7.2	12	17.3	20
Min	5.2	5.3	11.1	4
M	6.1	8.8	13.5	10.4
SD	0.6	2.0	1.9	4.3
W(S-W)*	0.975	0.967	0.936	0.961
p(W)	0.205	0.443	0.657	0.645
V%	9.2	22.5	14.3	41.6

Note: * W(S-W) is Shapiro–Wilks statistics.

Table 4. Parameters of fitness (girls, n = 18).

Statistics	Tests			
	Run 30 m, s	**Forward bend of the trunk from a sitting position, cm**	**"Shuttle" run 4x9 m, s**	**Hanging on bent arms, grip on top, s**
Max	7.1	17.1	17.2	15.0
Min	5.2	6.4	10.1	3.0
M	6.2	11.2	13.2	8.6
SD	0.6	2.8	2.0	3.1
W(S-W)	0.922	0.950	0.957	0.977
p(W)	0.285	0.834	0.359	0.224
V%	9.9	24.5	15.4	35.7

The data show that the groups were homogeneous according to the results of the 30 m run (V < 10%), while according to the results of the "shuttle" run (V = 10%–20%), the homogeneity of the contingent was average. A significant dispersion of indicators was observed when bending the body forward from a sitting position and hanging on bent arms (V > 20%).

4. Discussion

A significance of the problem studied in this paper is a lot of scientific publications on the themes of development of the physical fitness of young pupils engaged into healthy gymnastics.

The results of our research showed that the parents and children interviewed by us have a positive attitude to health gymnastics classes and plan to continue attending such classes in order to maintain and strengthen their health. Curiosity, the desire to be healthy, strong, beautiful, flexible, and also to be famous athletes motivates children to study. In the studies of other scientists, incentives to improve health and achieve high sports results also prevail [11,14]. It can be argued that parents and children consciously treat such classes, which improves the very process of learning motor actions and developing physical qualities.

Junior schoolchildren get special pleasure from performing exercises that raise their emotional state and improve their mood: relays, somersaults, handstand,

"wheel", "twins", "bridge", "basket" and others. Almost half of all children are engaged in swimming, dancing, parkour, kung fu, football, karate and volleyball in addition to gymnastics. According to the results of other scientific studies, swimming and sports games are popular among children of this age [11,13]. Most of the children have skills such as riding a bicycle, rollerblades, skates, scooters, and can also jump rope, swim, play football and badminton.

So, the results of the questionnaire testified to the presence of expressed preferences, interests, and positive attitude of younger schoolchildren towards recreational gymnastics and movement activities in general.

The formation of the child's growing body is caused by significant changes in physical development indicators, which reflects the morphological and functional capabilities of the child's body (cardiovascular, nervous, respiratory systems and musculoskeletal system). We found that a third of all children have disharmonious physical development, which may indicate certain health disorders. Such data are consistent with data obtained somewhat earlier by other studies [11,13,14].

Both underweight and overweight are associated with adverse health outcomes throughout life. This problem exists and is studied all over the world [15]. According to the results obtained by us, 21.1% of children are underweight and 9.4% are overweight, this is confirmed in other studies [11]. In order to prevent deviations in the state of health, such children need a medical examination and clarification of the causes. In the studies of other authors, the relationship between BMI and general motility was studied, where the value of motor activity was substantiated in order to prevent various deviations in the state of health and improve the quality of life [1].

The frequency of heart contractions in younger schoolchildren is higher than in older children, so the age of the child was taken into account when determining the Ruffier index [17]. The results obtained by us characterize the good state of adaptation of the cardiovascular system of children to physical exertion, because the total percentage of children whose functioning of the cardiovascular system belongs to the high, above average and average levels was 93.8%. The obtained indicators can be explained by the fact that children regularly engage in both health gymnastics and other types of physical activity, according to the information obtained from the questionnaire. Other studies confirm the positive influence of specially organized extracurricular physical activity on the functional state of children of primary school age [11,13].

The functional state of the respiratory system determines the vital capacity of the lungs and 18.9% of children have a characteristically low level. Evaluating FI based on dynamometry data revealed that a low level is characteristic of 27.2% of children. The average statistical indicators of VL and dynamometry are confirmed in other scientific studies [4,8].

Physical fitness is the result of a person's physical activity, because almost all systems of the body are involved in the process of performing physical exercises, which makes it possible to assess the functional state as a whole. In all tests, except for bending the trunk forward from a sitting position, boys had higher scores than girls. Our results coincide with previous studies by other scientists [11,18].

The highest increases in flexibility are observed from 7–8 to 14–15 years. However, in girls, mobility in the joints is about 10% higher, which is due to the

elasticity of the fascia of muscles and ligaments. The sensitive periods of muscle strength growth in boys and girls do not coincide, the strength of the muscles of the arms and trunk of boys in all age periods after 6 years is somewhat greater than that of girls [19–21]. Progressive natural development of speed and dexterity in both boys and girls is observed from 7–8 to 11–12 years. This age is characterized by the ability of the central nervous system, the intensive development of the motor analyzer, which leads to an improvement in the spatio-temporal characteristics of movement. During this age period, new motor skills and skills are easily formed and it is possible to successfully rebuild them [12,16].

Basterfield, et al. conducted an association between physical fitness, sports club participation and body mass index on health-related quality of life in primary school children from a socioeconomically deprived area of England [22]. Dong, et al. during a national cross-sectional survey in China carried out comprehensive physical fitness and high blood pressure in children and adolescents [23]. Capio, et al. examining the antecedent role of movement proficiency in child development with study protocol [24]. Raz-Silbiger et al. ascertained relationship between motor skills, participation in leisure activities and quality of life of children with Developmental Coordination Disorder: temporal aspects [25].

Redondo-Tebar carried out association between gross motor competence and health-related quality of life in (pre)schoolchildren: the mediating role of cardiorespiratory fitness [26]. Herrmann et al. reviled connection between social relationships and basic motor competencies in early childhood [27]. Bremer and Cairney taking into account fundamental movement skills and health-related outcomes presented a narrative review of longitudinal and intervention studies targeting typically developing children [28]. Landgraf et al. giving voice to the child perspective studied psychometrics and relative precision findings for the child health questionnaire self-report short form (CHQ-CF45) [29].

Langeland et al. during a prospective longitudinal study examined boys' and girls' health-related quality of life from the first to the third year of upper secondary school [30]. Masini et al. determined a health-related quality of life in a sample of primary school children using a cross-sectional analysis [22]. Shuqing et al. presented effects of fundamental movement skills on health-related quality of life in Chinese school-age children; they showed a mediating role of physical fitness level [23]. AL-Nemr and Reffat Studied relationship between body mass index, fundamental movement skills, and quality of life in primary school children [24].

Bendikova and Sagat studied active school and its role in promoting health of younger school-age children [25]. Andersen et al. discussed associations between health-related quality of life, cardiorespiratory fitness, muscle strength, physical activity and waist circumference in 10-year-old children [26]. Cattuzzo et al. prepared: a systematic review on motor competence and health related physical fitness in youth [27].

Individual assessment of the level of physical fitness of each child allows determining the means and methods of learning motor actions and the development of physical qualities, taking into account sensitive periods and age-sex characteristics of children.

5. Conclusion

Our study emphasizes the importance of using extracurricular forms of physical education, namely health gymnastics classes, in order to reduce the deficit of daily physical activity, which will positively affect the health of children. It was found that children enjoy attending such classes, they like to perform various gymnastic exercises. Most children are characterized by harmonious physical development, body mass index is within the norm, as well as sufficient adaptation of the cardiovascular system to physical exertion. The obtained results give grounds for asserting that physical qualities such as speed and dexterity of boys and girls develop equally in primary school age. At the same time, flexibility dominates in girls, and strength in boys.

Prospects for further research. The theoretical analysis of scientific and methodological literature, the "Physical Culture" program for secondary schools (grades 1–4) and the results of the data obtained during the research make it possible to develop a program of "Recreational Gymnastics" for children of primary school age. Age limitation of the program for young pupils should be inviolate during further study with teen-agers.

Author contributions: Conceptualization, IZ and OB; methodology, IZ; software, IZ; validation, IZ, OB and OM; formal analysis, IZ; investigation, IZ; resources, IZ; data curation, IZ; writing—original draft preparation, IZ; project administration, IZ. All authors have read and agreed to the published version of the manuscript.

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