

Physical activity training program for obese children

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ABSTRACT

This study aimed to evaluate the physical development of obese children after participating in a physical exercise program at school. The pedagogical experiment involved 188 obese school students (aged 8-10). For 4 months, obese children studied together with children of the basic medical group and performed physical exercises that were feasible for them (stage 1). After the next control measurement, these schoolchildren did physical education for 4 months according to a specially developed program for obese children (stage 2). After stage 1 of physical education classes, obese children grew by 2.8 cm (+2.1%), their weight increased by 1.9 kg (+3.9%), their body mass index improved from 28.6 ± 3.1 to 28.1 ± 3.5 (-1.8%), and vital capacity of the lungs increased by 0.05 l (+4.5%). The difference between the obtained and initial data was not significant ($p > 0.05$), which may indicate the low efficiency of the standard physical education program for obese children. After stage 2, as a result of the experimental program, on average schoolchildren grew by 4.3 cm (+3.1%), and their weight decreased from 51.2 ± 7.9 kg to 47.9 ± 7.7 kg (-6.9%), body mass index improved by 13.8% ($p < 0.05$), and vital capacity of the lungs increased by 16.2% ($p < 0.05$). The results obtained can be used when organizing the process of adaptive physical education for overweight primary school children in general education schools in extracurricular activities or in the system of additional education.

KEYWORDS

Hypodynamia; Hypertension; Physical Education; Physical Exercises; Gymnastics

1. INTRODUCTION

Today, regardless of the level of development of the country, obesity has affected the entire world to a greater or lesser extent. According to WHO experts, in the world there will be more than 300 million people who have the diagnosis of obesity by 2025. The most important medical, social, demographic, and state problem should be considered the prevention and treatment of obesity. It is also alarming that this type of pathology is becoming "rejuvenated".

Obesity is a disease characterized by excessive fat deposition in the subcutaneous tissue and organs, caused by metabolic disorders and accompanied by changes in the functional state of various organs and systems, which leads to weight gain. Obesity is an extremely common disease at the global level (Al-Taïar et al., 2021; Aragón-Martín et al., 2022).

Obesity occurs when caloric intake exceeds energy expenditure. Several processes play an important role in the development of obesity: genetic factors, dietary factors, abnormalities in energy expenditure, and increased accumulation of ingested calories (Carrasco-Marín et al., 2022; Argenio et al., 2024).

Separately, it should be noted that the most important factor leading to the development of obesity is low physical activity, when even the normal amount of food consumed is excessive. This happens because the calories that enter the body with food are not burned during physical activities, but are converted into fat (Gerber et al., 2022; Idamokoro et al., 2023).

For example, Gerber et al. (2022) note that in recent decades, the level of overweight among children has increased in many African countries. The authors studied the relationship between a sedentary lifestyle, moderate to intense physical activity, and body composition in South African elementary school students. As a result, the prevalence of overweight and obesity was 77.1% of children who did not engage in intense physical activity for ≥ 60 minutes/day (Gerber et al., 2022).

Idamokoro et al. (2023) point out that childhood obesity has become a growing global epidemic that has negative health consequences. The authors determined the immediate and sustained impact of a 9-week exercise program on the body composition of 7-8-year-olds. The 9-week exercise program was performed twice a week for 30 minutes during school hours with an emphasis on improving BMI. The intervention positively changed the waist circumference. The subscapular skin fold and BMI showed statistically and practically significant sustained changes as a result of the intervention, although gender influenced these effects (Idamokoro et al., 2023).

Childhood obesity is one of the most pressing problems of modern healthcare. Almost all over the world, the number of children who have excess body weight is steadily increasing, this is due to a decrease in physical activities at home and at work (children often sit at a computer, TV or phone), as well as the evolution of the food industry, which has led to unbalanced excess nutrition. Products rich in carbohydrates and fats (fast food and snacks) are a source of unnaturally increased fat formation in the body. Most children who are overweight skip such an important meal as breakfast, which is why they increase the amount of food they eat in the evening (Lahyani et al., 2024; Jin et al., 2025).

Obesity may result in development of cardiovascular diseases (atherosclerosis, coronary heart disease, and hypertension) of the pulmonary system, and also complicates the course of such diseases as cholelithiasis, diabetes mellitus, arthrosis and arthritis, functional disorders of the central nervous system and intestines (Lehmann et al., 2020; Latorre-Román et al., 2022).

It is noted that the mortality rate is 60% higher in obese patients than in people who have normal body weight (Norov et al., 2023; Moliterno et al., 2024).

Classification of obesity (Oliveira et al., 2023; Spiga et al., 2024): I. Primary obesity. Alimentary-constitutional. a) constitutional-hereditary; b) accompanied by an eating disorder (night eating syndrome, increased food consumption during stress); c) mixed obesity. II. Secondary obesity. a) resulted from genetic defects; b) cerebral obesity (brain tumors or inflammatory diseases); c) endocrine obesity; d) obesity due to mental illness or taking neuroleptics.

The most common form of obesity in childhood and adolescence is obesity not associated with endocrine system dysfunction (83.7% of cases). Schoolchildren most often have cases of obesity of the 1st and 2nd degree. The main causes of excess body weight are a sedentary lifestyle and poor nutrition (Ramírez-Rivera et al., 2021; Rossi et al., 2023).

Even a small weight gain can become a serious burden for the child's body. Metabolic disorders lead to problems in almost all body systems. Excess weight overloads the musculoskeletal system and leads to poor posture, curvature of the spine, flat feet and hallux valgus. Obese children may lag behind their peers in development. Physical development suffers first of all. Such children are not distinguished by endurance and quickly get tired under any load. Children may have complexes about their appearance, psychological discomfort arises, which in the future can lead to serious psychological problems (Wang et al., 2022; Vilardell-Dávila et al., 2023).

The key meaning of physical education is prevention and maintenance of health and a harmoniously developed personality. This is achieved only when the adequacy of physical activities and the functional capabilities of the child's body are taken into account. In order to exclude such negative effects on the body, all schoolchildren are divided into groups by health level for the implementation of the physical education program: basic, preparatory and special (Liu et al., 2023; Roccliffe et al., 2023).

The widest range of children and adolescents can be classified as persons with deviations in health. This includes dysfunction of the cardiovascular, respiratory, musculoskeletal and other systems, and organs of hearing and vision, and conditions caused by metabolic disorders. This category includes children who have alimentary obesity (Zhang et al., 2021; Yue et al., 2022).

It is necessary to take into account individual indicators of the functional state of children and their level of physical fitness. Physical education classes for children of a special medical group should be implemented according to specially developed programs that provide for the selection, intensity and volume of physical activities in accordance with the functional capabilities of the body (Chen et al., 2023; Benavente-Marín et al., 2024).

The optimal motor regime of overweight primary school children is ensured by the main forms of physical education, which include: physical education classes, physical education and health work in the daily routine, extracurricular and extracurricular forms of physical exercises.

The main task of adaptive physical education is the development of the functional adaptability of the main systems of the body (nervous, circulatory, respiratory, and digestive) to impaired metabolism (Crotti et al., 2022; Ge et al., 2025).

Among the various types of physical exercises, gymnastic exercises are the most widely used; they are successfully used in the treatment of obese patients of different ages. They are quite diverse, can create minimal, medium and high physical activities, allowing alternating the participation of different muscle groups (Lee et al., 2023; Slimi et al., 2025).

In case of excess body weight, it is recommended to use mainly aerobic and long-term physical activities. It is also suggested to use morning hygienic gymnastics, therapeutic gymnastics, exercises on exercise machines, terrain cure, dosed walking, special physical exercises in the pool, swimming in open water, running, hiking, rowing, cycling, skiing, skating, outdoor and sports games (von Hippel & Frisvold, 2023; Tanveer et al., 2024).

To date, modern literature does not fully present data on the organization of adaptive physical education classes for children who have metabolic disorders using specially developed educational programs, taking into account the individual characteristics of the physical condition of the body. Thus, the scientific problem is formulated, which consists in evaluating the physical activity training program on weight control in obese children at school.

2. METHODS

2.1. Participants

The study was conducted at comprehensive school No. 1,326 in Moscow (Russia). A total of 672 students aged 8-10 study in elementary grades (grades 2-4). Out of them 188 schoolchildren who are overweight took part in the study. Exclusion criteria:

1. Children who did not engage in physical education systematically, that is, they had a lot of missed classes (more than 20 classes).
2. Children who engaged in additional physical activity that could affect the initial, intermediate or final statistical data.
3. Children or their parents who refused to participate in the pedagogical experiment.

All procedures complied with the ethical standards of the Helsinki Declaration of 1964 and were approved by the local university ethics committee. Informed consent was obtained from all parents of the students who participated in the study. Students could withdraw from the experiment at any time.

2.2. Procedure

The study was conducted in several stages:

1. At the beginning of the school year, on September 3, 2023, all schoolchildren underwent control weighing, their height was measured. The Quetelet index was calculated and it was found that 188 schoolchildren are obese. The vital capacity of the lungs was additionally measured in these children.
2. From September 3 to December 29, 2023, all children were engaged in regular physical education 3 times a week for 40 minutes, and children who were overweight performed feasible physical exercises in the basic group, as it is usually the case in comprehensive schools.
3. At the end of the first half of the year, on December 29, the height, weight, and vital capacity of the overweight children were measured again. This determined the effectiveness of physical education classes for obese children in the basic group with children who had no health problems.

4. From the beginning of the second half of the year, from January 3 to April 29, 2024, obese children studied according to an experimental program aimed at reducing the body mass index of obese schoolchildren.

5. At the end of the second half of the year, on April 29, the height, weight, and vital capacity of the children participating in the study were measured again. This determined the effectiveness of physical education classes for obese children according to the experimental program.

Thus, obese children studied for 4 months together with healthy schoolchildren, but the adaptive physical education instructor was different.

2.3. Exercises Implemented

The following exercises were selected for the experimental program: dosed walking, running, combined developing and breathing exercises with and without objects, parterre gymnastics, and active games with elements of running.

The intensity of the exercises was individual. However, the pulse rate varied between 60-70% of the individual maximum.

If the student's maximum heart rate during exercise is 180 beats per minute, then he should perform an adaptive physical training program with a pulse rate of about 150-160 beats per minute. The sequence of exercises corresponded to the laws of physical culture. All classes begin with a build-up, followed by dosed running for 5-7 minutes, followed by general development exercises for 10 minutes, exercises from parterre gymnastics (15-18 minutes), breathing exercises (5-7 minutes), outdoor games (7-8 minutes), then summing up the lesson. The physical education teacher supervised the performance of physical exercises and the condition of the students, as well as a wristwatch that displays the student's current pulse.

An important condition for effective weight loss was adherence to rational nutrition. Recommendations on proper nutrition were given at the parent-teacher meeting. Monitoring the children's nutrition during the study was assigned to their parents. A part of the thematic plan of classes according to the experimental program is presented in Table 1.

Table 1. A part of the thematic plan of classes according to the experimental program

№	Material of the experimental program	Class number					
		2	3	4	5	6	5
1	Dosed walking, running	7		7		7	
2	Combined developing exercises	10	10	10	10	10	10
3	Parterre gymnastics	18	18	18	18	18	18
4	Breathing exercises	5	5	5	5	5	5
5	Active games with elements of running		7		7		7
Class time in minutes		40	40	40	40	40	40

Walking and running corresponded to the individual capabilities of each student, each schoolchild worked at the pace that was suited him/her.

Combined developing exercises included a set of physical exercises with and without objects, various leg and arm swings, and those performed on a gymnastic mat.

Sets of exercises of parterre gymnastics on the floor were used for a dynamic mode of the musculoskeletal system, warming up the muscles. The use of sets of parterre gymnastics allows to overcome monotony and creates a favorable emotional and psychological environment in the classroom. Parterre gymnastics allow each student to master freedom of movement and psychologically relax.

Breathing exercises were used according to Strelnikova's method.

Active games with running elements were given to increase the motivation of the students to attend the following physical education classes. All exercises helped to strengthen certain muscle groups of the neck, arms, legs, back, abdomen; aimed at improving blood circulation and contributed to the development of coordination and posture.

The design and implementation of classes with overweight primary school children were based on the following pedagogical principles: awareness and activity, systematicity and consistency, clarity, accessibility and individualization.

2.4. Measurements

Body length (height) was measured using a standard medical stadiometer (Figure 1). The result was measured in centimeters.



Figure 1. Medical stadiometer

Body mass (weight) was measured using standard medical scales (Figure 2). The result was measured in kilograms.



Figure 2. Medical scales

The body mass index (BMI) was determined using the formula: $\text{weight (kg)} / \text{height}^2 \text{ (m)} =$ conventional units. The result of the BMI according to Quetelet allows assessing the correspondence between a person's body weight and height (Table 2).

Table 2. Quetelet's body mass index

Body mass index	Characteristic
Less than 18.5	Underweight
18.5-24.9	Norm
25-25.9	Excess body weight
30-34.9	Class 1 obesity
35.0-39.9	Class 2 obesity
More than 40	Class 3 obesity

Vital capacity of the lungs (VC) was determined using a spirometer (Figure 3). The result was measured in liters.



Figure 3. Spirometer

2.5. Statistical Analyses

Statistical analyses were performed using IBM SPSS Statistics (Version 26.0; IBM Corp., Armonk, NY, USA). Data are presented as mean $\pm$ standard deviation (SD). Changes in physical development indicators (height, weight, body mass index [BMI], and vital capacity [VC]) before and after each intervention period were analyzed using paired-samples *t*-tests. Percentage changes were calculated to assess the magnitude of improvement. Statistical significance was set at $p < 0.05$.

3. RESULTS

As a result of applying the experimental program of using parterre gymnastics, combined developing and breathing exercises, as well as active games with elements of running in order to improve the physical fitness of children of primary school age who have excess body weight, the following data were obtained. Table 3 presents the indicators of physical development of children of primary school age who have excess body weight at the stage from September 3 to December 29.

Table 3. Changes in physical development indicators of obese children using a standard school physical education program

Measurements	September 3	December 29	Growth %	<i>p</i> value
Height (cm)	132.1 $\pm$ 13.2	134.9 $\pm$ 11.6	+2.1%	$p > 0.05$
Weight (kg)	49.3 $\pm$ 8.6	51.2 $\pm$ 7.9	+3.9%	$p > 0.05$
BMI (c.u.)	28.6 $\pm$ 3.1	28.1 $\pm$ 3.5	-1.8%	$p > 0.05$
VC (l)	1.12 $\pm$ 0.1	1.17 $\pm$ 0.1	+4.5%	$p > 0.05$

Table 3 shows that over 4 months of physical education classes in the basic group, obese children grew by 2.8 cm (+2.1%), gained 1.9 kg (+3.9%), average BMI values slightly improved from 28.6 $\pm$ 3.1 to 28.1 $\pm$ 3.5 (-1.8%), and VC values increased by only 0.05 l (+4.5%). Although all

values showed a positive increase, the difference was not significant ($p>0.05$). This may indicate low efficiency of the regular physical education program for obese children. Table 4 shows the physical development values of the same schoolchildren after the implementation of the special physical education program for obese children from January 3 to April 29.

Table 4. Changes in physical development indicators of obese children after the implementation of an experimental physical education program for obese children

Measurements	December 29	April 29	Growth %	p value
Height (cm)	134.9±11.6	139.2±11.4	+3.1%	$p>0.05$
Weight (kg)	51.2±7.9	47.9±7.7	-6.9%	$p>0.05$
BMI (c.u.)	28.1±3.5	24.7±3.6	-13.8%	$p<0.05$
VC (l)	1.17±0.1	1.36±0.2	+16.2%	$p<0.05$

Table 4 shows that after completing the experimental physical education program for obese children, the schoolchildren grew by an average of 4.3 cm (+3.1%), and their weight was reduced from 51.2±7.9 kg to 47.9±7.7 kg (-6.9%). BMI improved by 13.8% ($p<0.05$), and VC increased by 16.2% ($p<0.05$). These results indicate the effectiveness of the special physical education program for overweight children. The results of the study of both experimental stages are presented in Figure 4.

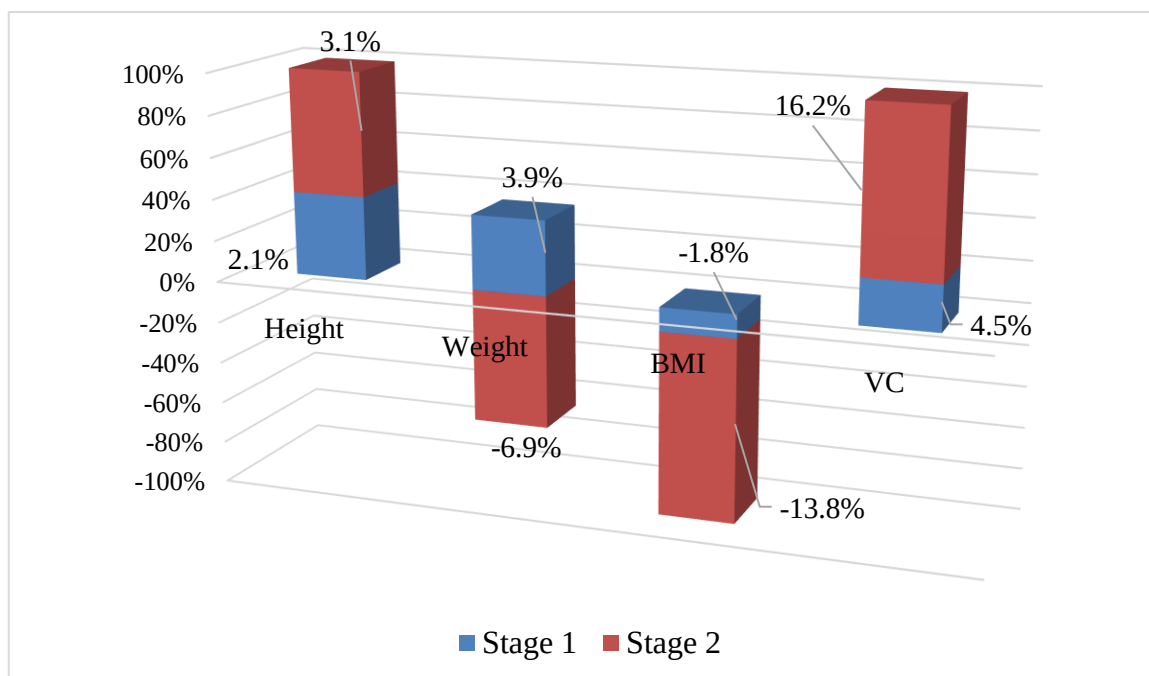


Figure 4. Physical development of schoolchildren during the study period

Figure 4 shows that during the period of the experimental program for obese children, all indicators improved significantly. This allows us to state the significant effectiveness of using such a program for overweight children in physical education classes.

4. DISCUSSION

The analysis of literary sources has shown that alimentary obesity is increasingly observed in children of primary school age. Excess weight in a child can lead to the early development of such diseases that are not typical for childhood, such as hypertension, diabetes mellitus. The main causes of the diseases are hereditary-constitutional factors, physical and mental injuries, low mobility, unbalanced excess nutrition, stress (Al-Taiar et al., 2021; Carrasco-Marín et al., 2022; Idamokoro et al., 2023).

The number of children in primary school prone to obesity increases by 1% annually. This is due to both hereditary factors (0.3%) and physical inactivity and hypokinesia. A child prone to obesity should be under the close supervision of doctors, physical education teachers. If measures are not taken in time, pathological changes in the cardiovascular system and the musculoskeletal system of the child, characteristic of developing obesity, may occur (Latorre-Román et al., 2022; Norov et al., 2023; Spiga et al., 2024).

Most modern children do not get significant physical activity, and therefore there is an imbalance between high energy intake with food and reduced energy expenditure, which in turn leads to fat deposition in the body. In addition, poor nutrition and physical inactivity lead to a slowdown in metabolic processes (Ramírez-Rivera et al., 2021; Rossi et al., 2023; Vilardell-Dávila et al., 2023).

Scientific research in the field of childhood obesity provides some abstract recommendations for correcting existing or emerging health problems associated with excess body weight, and lists the means and methods that should be used in physical education classes. (Crotti et al., 2022; Lee et al., 2023; Tanveer et al., 2024). However, as practice has shown, such recommendations need to be systematic, a specific program that will be necessary for study at school and will improve the physical condition of children. Therefore, a special program for correcting the physical development of primary school children who have excess body weight was developed.

As a rule, in regular physical education classes at school, obese children cannot complete most of the tasks that are determined by the program and the teacher for each class, so such children often spend a significant part of the lesson either trying to do an exercise that is beyond their strength, or remain sitting on the bench.

The use of a complex of parterre gymnastics, combined developing and breathing exercises, as well as active games with running elements in adaptive physical education classes allows each child to master freedom of movement and become psychologically relaxed. All the proposed exercises are aimed at improving physical development indicators, as well as reducing body weight.

As a result of the experimental program, the physical development indicators of overweight primary school children significantly improved. It should be noted that before the study, the children's BMI averaged 28.6 ± 3.1 conventional units, which corresponds to excess body weight (25-29.9), close to class 1 obesity according to the Quetelet index. After stage 1, BMI improved by only 1.8% and amounted to 28.1 ± 3.5 conventional units, which also corresponds to excess body weight. These results indicate the low efficiency of using the standard physical education program for obese children. However, after stage 2 of the study, BMI improved by 13.8% and averaged 24.7 ± 3.6 conventional units, which corresponds to the range of normal physical development of schoolchildren (18.5-24.9). At the same time, it was possible to reduce the children's weight by an average of 6.9%, and VC improved by 16.2% ($p < 0.05$). The increase in indicators at stage 2 of the pedagogical experiment allows us to conclude that the proposed program for correcting the physical development of overweight primary school children is effective.

Thus, despite the positive increase in all the studied indicators over the 4 months of using the experimental program, the indicators of obese schoolchildren significantly and significantly improved in only 2 of the 4 indicators. Perhaps this is due to the fact that the duration of the exercises or the intensity of the impact was insufficient. It may be the frequency of exposure or the duration of the pedagogical experiment was short. However, this is a reason to conduct additional research in this direction. At the same time, attention should be paid to monitoring the nutrition of schoolchildren.

The scientific novelty of the study lies in the fact that for the first time exercises of adaptive physical education aimed at correcting the physical development of primary school children who have excess body weight were selected.

The theoretical significance of the study is to supplement and expand knowledge in the field of physical education of primary school children who have excess body weight.

The practical significance of the developed program for correcting the physical development of primary school children who have excess body weight is that the results obtained can be used when organizing the process of adaptive physical education of primary school children who have

excess body weight in the conditions of comprehensive schools in extracurricular activities, in health camps, in the system of additional education.

5. CONCLUSIONS

If the physical development correction program for overweight primary school children is applied at physical education classes for obese schoolchildren, their physical development indicators will improve significantly. The physical development correction program for obese children should include walking and running, combined development exercises, parterre gymnastics, breathing exercises according to Strelnikova's method, and active games with running elements. It is also necessary to maintain a balanced diet for effective weight loss. Physical exercises should be performed at least 3 times a week according to the physical activity in the presented experimental program. Physical exercises should be based on the pedagogical principles of awareness and activity, systematicity and consistency, clarity, accessibility, and individualization.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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