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Changes in body composition of children aged of 9 to 12 years with excess body weight under the influence of eight-week workout

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Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
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abstract

Background: The increasing problem of overweight and obesity in children is the reason for taking further actions leading to mass reduction, because, in contrast to adults, the consequences of this pathology in young people are still not well known. The intervention actions that can lead to reduction in mass are not easy to find in literature, and their long-term effects are unknown. The aim of this research was to define the changes in body composition of children with excess body mass after eight-week high intensity workout.

Material and methods: The study was conducted on 47 children aged 9–12 years who were overweight or obese, including 25 girls and 22 boys.

Results: The following results were obtained: the percentage body fat decreased by 2.11% with great reduction in the visceral fat area of 7.86 cm², the decrease in fat mass by 1.44 kg, BMI decrease by 0.95 kg/m², the reduction of percentile in OLAF grids by 2.42 points. All of these results were statistically significant.

Conclusions: The results of this study allow stating that: 1) the participants tolerated high intensity physical workout at the level of 70–90% maximal heart rate (HR max) during 2 months of training, 2) systematic physical exercises caused positive changes in the body composition, 3) gender varied the scope of changes in some indicators.

Key words: children, obesity, physical exercise, body composition.

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INTRODUCTION

Nowadays obesity and overweight are a global problem that concerns not only adults but also applies to children and youth. The United States of America is a country that reports the largest percentage of such cases in the world, where about 30% of children aged 13–15 years are struggling with excess of body mass. At the forefront in Europe are such countries as: Greece, Portugal, Slovenia, Italy, where obesity in children is found in about 18–21% of the population. Close behind there is also Spain and Poland, where 17% of children are overweight or obese. According to the same report, in the last decade the number of children aged 11–15 years who are overweight has increased twice in our country. It has been the fastest growth among all countries in which the research was conducted [1].

Report of the Polish Institute of Nutrition and Food from October 2013 shows that in the last years of primary school 28% of boys and 22% of girls have a higher than normal body mass [2]. As the main causes of overweight and obesity, mainly poor nutrition and lack of sufficient physical activity are suggested. Overweight in children supports the development of metabolic syndrome and later affects the quality of adult life [3].

Reduction in excess body mass initiated by limiting the calories can be just as effective as exercise or even more. But we should not forget that regular exercise leads to many other benefits which could not be achieved as a result of calorie restriction (for example, maintenance of muscle mass, improving cardiovascular fitness and energy metabolism etc.) [4,5]. Effects of physical training mainly depend on a number of factors, such as intensity, volume and the type of physical exercise [6, 7].

The aim of this study was to determine the scope and magnitude of changes in body composition of children aged 9 to 12 years with overweight or obesity under the influence of eight-week high intensity workout.

MATERIAL AND METHODS

The study was carried out on a group of 47 children, including 25 girls and 22 boys at the age of 9–12 years, who were characterized by excess body mass. The criteria for overweight and obesity were adopted by the OLAF* scale, in accordance with principles commonly used by other researchers. Overweight was qualified from 85 to 94 percentile while obesity above 95 percentile [8]. In the examined group, 17 of the children were overweight and 30 obese (Table 1).

Table 1. General characteristics of the experimental group

Gender	Number of subjects (n)	Age (years)		Body height (cm)		Body mass (kg)	
		M	SD	M	SD	M	SD
Girls	25	10.4	0.9	145.8	8.7	52.5	10.5
Boys	22	10.4	0.9	147.2	8.2	52.9	10.0

* OLAF – Polish project under the Honorary Patronage of the Ministry of National Education, aimed at developing norms of arterial pressure in the form of centile grids (centiles: 1-5-10-25-50-75-90-95-99) for gender, age and body height (centiles of body height: 5-10-25-50-75-90-95) for children and young people aged 7-18, representative of the Polish population and development of a standard in the form of centile grids (centiles: 3-5-10-15-25-50-75-85-90-95-97) for the same group [http://olaf.czd.pl/].

The measurement of body composition was made before and after the training program at the Laboratory of Physical Effort located at Gdansk University of Physical Education and Sport. In accordance with the planned procedure, the study was carried out in the morning. The children were fasting and dressed in sports attire (shirt, shorts). We performed the study using the "InBody 720" analyzer. We assessed the following parameters: body mass – BM, skeletal muscle mass - SMM, body fat mass – BFM, percentage of body fat relative to body weight, visceral fat area, body mass index – BMI, the index of OLAF.

An eight-week training program took place in between the tests. Activities were performed by the repetitive method twice a week for 60 minutes. In order to achieve and maintain high intensity (70–90% HR max) during the exercise, we used the station form which provides children with work variability, attractiveness of the exercises and rest breaks. In order to make the activities more attractive to children, we allowed parents to participate and watch their children. This method was used because it is considered to be very effective in reducing body fat [9, 10, 11]. During the exercises, the cardiovascular reactions in children, in the form of the heart rate (HR), were monitored by sporttester Polar.

The results were processed using STATISTICA 10 by calculating the mean, standard deviation and the significance of differences between the means. We tested the similarity of the groups by using the chi-square test, the significance of differences using Student's t-test. The level of significance of the individual tests was set at $p \leq 0.05$.

RESULTS

The comparison of studies of children's body composition before and after the eight-week training program reveals changes. There were statistically significant differences in the mean values of the basic indicators (except skeletal muscle mass) in the whole experimental group (Table 2).

Table 2. Mean values of selected indicators obtained before and after the training program $p \leq 0.05$

Indicators	Measurement I		Measurement II		Change	*p*
	M	SD	M	SD		
Body Mass (kg)	52.69	10.12	51.69	10.02	-1.00	0.001*
Skeletal Muscle Mass (kg)	18.01	3.95	18.22	3.95	0.21	0.259
Body Fat Mass (kg)	18.91	5.18	17.47	4.95	-1.44	0.001*
Percent Body Fat (%)	35.67	5.52	33.57	5.90	-2.11	0.001*
Visceral Fat Area (cm^2)	88.27	29.16	80.41	25.52	-7.86	0.001*
BMI (kg/m^2)	24.35	2.57	23.40	2.54	-0.95	0.001*
OLAF Index (centile)	94.27	4.09	91.85	5.79	-2.42	0.001*

*BMI – body mass index; * – statistical significance at the level of $p \leq 0.05$.*

Body mass of children participating in the project was reduced by an average of 1.00 kg. There was a significant decrease in fat mass of 1.44 kg and a simultaneous increase in muscle mass of 0.21 kg. The percentage of body fat decreased slightly more than two percent (2.11%). There was great reduction of the visceral fat area (by about 7.86 cm2). We also noted a change in the body mass index (BMI decrease of 0.95) and a reduction of percentile in OLAF grids of 2.42 points. These changes were statistically significant (Table 2).

Analysis of the results according to gender showed differences in the size of changes in each indicator. In boys, body fat mass decreased by 1.55 kg, and in girls by 1.35 kg. At the same time their body weight was reduced to a lesser extent than in girls, respectively boys to 0.90 kg, girls to 1.08 kg. It was caused by the difference in the growth of muscle mass – in boys a change of 0.41 kg, and in girls indicator remained virtually as before exercise (increase by 0.04 kg) (Fig. 1).

A content of fat in the abdominal cavity is very important for the proper functioning of internal organs. Changes in the visceral fat area (VFA) under the influence of training are presented in Figure 2. During the first test, the VFA average of girls was 90.7 cm^2, and after the program, 80.9 cm^2 (a decrease of 9.8 cm^2). In boys, the average VFA at the beginning was 85.5 cm^2, and after the program, 79.9 cm^2 (a decrease of 5.6 cm^2) (Fig. 2).

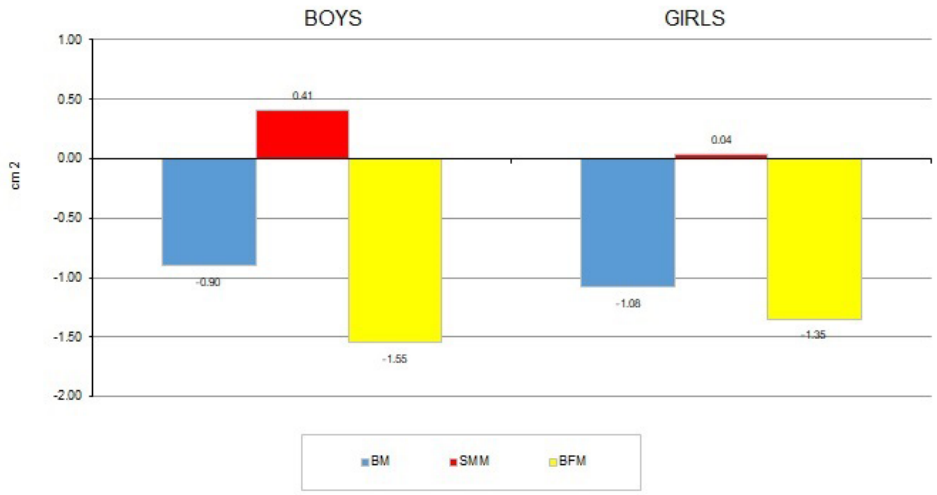

Fig. 1. Changes in body mass (BM), skeletal muscle mass (SMM) and fat mass (BFM) in girls and boys after applying the eight-week training program

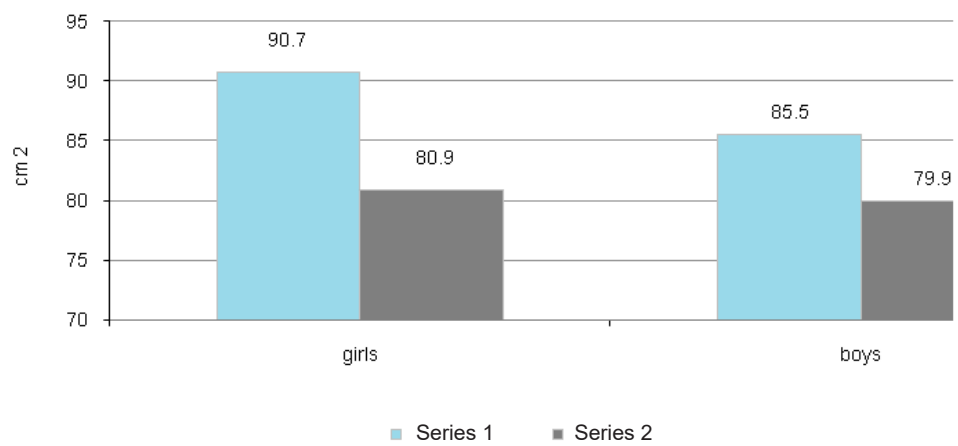

Fig. 2. The evolution of the Visceral Fat Area (VFA) in girls and boys before (VFA before) and after the eight-week training program (VFA after)

In order to obtain the information about changes in body composition caused by the workout of overweight girls in comparison to obese girls, additional analyses were conducted (Table 3). It showed that the greatest reduction occurred in the visceral fat surface in obese girls 10.94 cm^2, while in overweight girls it was 6.50 cm^2. These changes were statistically significant in all indicators except skeletal muscle mass, where despite the favorable change, the results were not statistically significant.

Table 3. Mean values of selected indicators of girls with overweight or obesity, under the influence of the eight-week training program ($p \leq 0.05$)

Indicators	OVERWEIGHT (n = 6)				OBESE (n = 19)			
	I	II	change	*p*	I	II	change	*p*
Body Mass (kg)	43.17	41.82	-1.35	0.018*	55.49	54.50	-0.99	0.007*
Skeletal Muscle Mass (kg)	15.58	15.63	0.05	0.825	18.69	18.73	0.03	0.943
Body Fat Mass (kg)	13.58	12.13	-1.45	0.005*	20.65	19.33	-1.32	0.038*
Visceral Fat Area (cm^2)	59.32	52.82	-6.50	0.026*	100.65	89.71	-10.94	0.000*
BMI (kg/m^2)	21.72	20.65	-1.07	0.007*	25.34	24.40	-0.94	0.000*
OLAF Index (centile)	90.33	86.00	-4.33	0.004*	96.84	95.21	-1.63	0.003*

*BMI – body mass index; * – statistical significance at the level of $p \leq 0.05$.*

A similar analysis was carried out among boys who were overweight and obese. Similarly to girls, the largest range of changes occurred in the visceral surface of adipose tissue: in obese boys the reduction was 6.18 cm^2, and in overweight boys 5.51 cm^2. This change did not reach statistical significance, as well as weight loss in overweight boys by 0.76 kg (Table 4).

Table 4. Mean values of selected indicators of boys with overweight or obesity, under the influence of the eight-week training program ($p \leq 0.05$)

Indicators	OVERWEIGHT (n = 12)				OBESE (n = 10)			
	I	II	change	*p*	I	II	change	*p*
Body Mass (kg)	47.70	46.94	-0.76	0.109	59.05	57.97	-1.08	0.037*
Skeletal Muscle Mass (kg)	16.91	17.38	0.48	0.028*	19.48	19.82	0.34	0.024*
Body Fat Mass (kg)	15.58	14.16	-1.43	0.004*	22.80	21.11	-1.69	0.008*
Visceral Fat Area (cm^2)	72.01	66.50	-5.51	0.050*	102.1	95.95	-6.18	0.058
BMI (kg/m^2)	22.30	21.47	-0.83	0.002*	26.50	25.46	-1.04	0.000*
OLAF Index (centile)	90.17	86.33	-3.83	0.001*	96.70	95.60	-1.10	0.007*

*BMI – body mass index; * – statistical significance at the level of $p \leq 0.05$.*

DISCUSSION

Intervention programs for children with body weight excess are of great practical importance because, as statistics show, 60% of those young people will maintain overweight status after reaching maturity [12, 13]. Even one week of increased physical activity in children aged 9-11 could cause beneficial changes in body composition (lower BMI value, lower percentage of adipose tissue and less muscle mass deficiency), although statistically insignificant [14]. Studies show that 60-minute medium and high intensity physical workout, taken twice a week, after eight weeks causes beneficial changes in body composition (such as decrease in fat mass on average 1.44 kg and the percentage of 2.11%). Previous reports usually concerned physical exercise conducted for a longer

period of time or with higher frequency. Differences in the achieved results after training are mainly due to the nature and type of work and the applied methods and measurement tools. In a study by Sawczyn et al. [15], changes in body composition in overweight women between 40 and 50 using two types of aerobic and strength loads, after 8 weeks of aerobic training. the reduction in fat mass was about 1%, which is a lower value than in the children in this study (2.11%).

McGuigan et al. [16] in their paper from 2009 obtained similar results using an 8-week program with resistance training conducted three times a week in a group of 48 children (26 girls and 22 boys, mean age 9.7 years) with overweight or obesity. They noted a slightly greater decrease in the percentage of adipose tissue by 2.6% ($p = 0.003$) vs 2.11 % ($p = 0.001$) and increased free fat body mass by 5.3 % ($p = 0.07$). However, they did not find any significant changes in body mass or the BMI. A greater increase in free fat body mass can be explained by the different character of resistance training conducted by McGuigan, compared to the station circuit used in this work as well as the higher frequency of classes per week (3 times vs. twice a week).

It is worth mentioning that a reduction in fat mass was at similar levels in groups of overweight and obese children of both sexes (from 1.32 kg to 1.69 kg), but the loss of visceral fat was higher in girls than in boys. Ross R. et al. [17] observed a greater reduction in visceral fat than in subcutaneous fat in women under the influence of physical exercise combined with a low calorie diet. However, Ovens in his paper [18] examined loss of visceral fat mass by 2.2% ($p < 0.01$) in obese children aged 7–11 under the influence of four months, more than in the current work, daily training.

In this study, gender also differentiated results in the increase of muscle mass tissue. While in the group of overweight and obese girls the increase was about 0.03 kg and 0.05 kg, respectively, in overweight boys the muscle tissue growth was on average 0.48 kg, and 0.34 kg in the obese ones. Also Hubal et al. in their paper [19] noticed twice less muscle mass gain in women compared to men after 12 weeks of training of elbow flexors strength. That study included 585 people aged 24 of both gender. In the present paper, the training program was not focused on developing strength, so the exercises could be too weak to stimulate the growth of muscle mass in girls. Nevertheless, even a short eight-week training program conducted twice a week using the method applied in the experiment may play an important role in improving the body composition indexes in children with excess weight. An attractive form of classes is the motivation to effectively implement the assumed loads, and the initiated visible changes encourage children to make the effort. Further long-term studies are necessary to explain the effectiveness of the exercises also for other indicators.

CONCLUSIONS

The results of this study allow formulating the following observations:

1. The effectiveness of peripheral health training, determined by changes in body composition, is at a similar level in overweight and obese children.

2. Gender significantly differentiated the children's body response to the training program in terms of two indicators: an increase in muscle mass and a reduction of body fat in the abdomen.

3. High intensity physical workout at the level of 70–90% HR max (maximum heart rate) twice a week can be an effective tool in solving the problem of excess body weight in children.

4. This kind of training should systemically enter schools as obligatory for people at risk and constitute a basis for a health program

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