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Original Article

Effect of athletic activity on chosen indicators of physical development and obesity parameters in 6 to 7 year old children

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Abstract:
This contribution presents the results of physical development and body composition parameters which are suggestive of obesity in younger school age children. The aim of this research is to test the effect of aerobic activity in reducing risk-bearing obesity factors. Fifty-five younger school age children took part in this research. The experimental group consisted of 24 subjects (17 boys and 7 girls) aged 6.62 ± 0.31 years. The control group consisted of 31 subjects (22 boys and 9 girls) aged 6.78 ± 0.3 years. The IAAF Kids' Athletics Programme was the experimental stimulus. The experiment lasted for 6 months, during which the experimental group subjects completed 38 one-hour training sessions twice a week. In the experimental group a decrease of BMI (0.07 $kg.m^{-2}$; 0.28%), fat percentage ($p < 0.05$, small effect), fat mass (0.10 kg; 2.48%) and visceral fat (0.04; 2.94%) was measured. The natural increase of body weight was nearly the same in the experimental and control group. However, a decrease in the parameters suggestive of obesity was recorded in the experimental group (the fat mass, visceral fat, hip to waist ratio). Research results show that participation in a physical programme oriented towards universal development in athletic training had a positive effect on the parameters suggestive of obesity in 6 to 7-year-old children.
Key words*:* younger school age, body composition, obesity, prevention, athletic preparation

Introduction

Obesity has become the main public health issue. This is rather upsetting in the child population (Dehghan, Akhtar-Danesh, & Merchant, 2005; WHO, 2016). It is estimated that in 2015, there were more than 42 million overweight children up to 5 years old (WHO, 2016). Furthermore, the chance of being overweight in adulthood is twice as great for children who are overweight during childhood (Singh et al., 2008).

Exercise or an increase of aerobic activity is essential in obesity prevention because they increase energy expenditure and create the optimal ratio between energy intake and energy expenditure (Epstein, & Goldfield, 1999; Dao et al., 2005).

Based on the analysis of children's physical fitness it is obvious that children with low level of aerobic activity are being diagnosed with cardiovascular diseases in adulthood. Therefore, it is very important to focus on athletic activity during childhood.

Regular aerobic activity performed from the younger school age positively affects body weight but not only that, it also considerably affects healthy body development and it decreases the risk of overweight and obesity (Bielik et al., 2017).

Physical education of primary school-aged children must be oriented to health strengthening, physical development, obesity prevention, functional abilities and improvement of vital motor skills (Andrieieva et al, 2017, Butenko et al, 2017).

Children who take part in sport as early as in preschool, experience an increase of their physical capacity and the development of their social skills (Chatrath, 2002). This research focuses on the children who have just begun their compulsory primary school education. It studies the effect of athletic activity within the framework of child athletics on obesity parameters.

Material & methods

Participants

Fifty-five younger school age children took part in this research (pupils of Ďumbierska Elementary School in Banská Bystrica). The experimental group consisted of children who voluntarily participated in athletic training in the aforementioned school in the Athletic Club of Matej Bel University Sport Club in Banská Bystrica. There were 24 subjects aged 6.62 ± 0.31 years in the experimental group (17 boys and 7 girls). At the

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beginning of our research we recorded the average body height of 122.69 ± 5.12 cm, average body weight of 23.65 ± 3.58 kg and average BMI 15.65 ± 1.62 kg.m^{-2} in the somatic parameters.

The control group consisted of 31 subjects (22 boys and 9 girls) aged 6.78 ± 0.3 years. Control subjects were of the same age and they were pupils at the same school (Ďumbierska Elementary School in Banská Bystrica) as experimental subjects but they did not participate in athletic training. At the beginning of our research we recorded the average body height of 124.27 ± 4.03 cm, average body weight of 24.87 ± 4.27 kg and average BMI of 16.03 ± 1.92 kg.m^{-2} in the somatic parameters.

Procedure

In body development parameters there were no statistically significant differences measured between boys and girls. In the group of boys, we recorded higher average values in every parameter. The only exception was in the parameter of body fat.

The IAAF Kids' Athletics Programme was the experimental stimulus (Gozzoli et al., 2002). The experiment lasted for 6 months (October – March) and the research subjects completed 38 training sessions. Training took place every Tuesday and Thursday from 3:30 PM to 4:30 PM in Ďumbierska Primary School gym in Banská Bystrica. Athletic activity consisted of various exercises. It consisted of cardio games (63.37%), athletic exercises (18.44%) and gymnastics (18.18%). Motor games – the time spend doing cardio games and exercises developing physical capacity was measured. Gymnastics – the time spend doing gymnastic exercises and stretching exercises was measured. Athletics – the time spend doing running exercises, sprint starts, relay race exercises, jumping exercises, throwing and hurling exercises was measured.

The athletic equipment suitable for children of the given age category was used. The training consisted of 70 – 80% of general exercises and 20 – 30% of specific exercises. This combination is recommended for example by Myer et al. (2013) for the given age category at the beginning of athletic preparation. (Fig. 1).

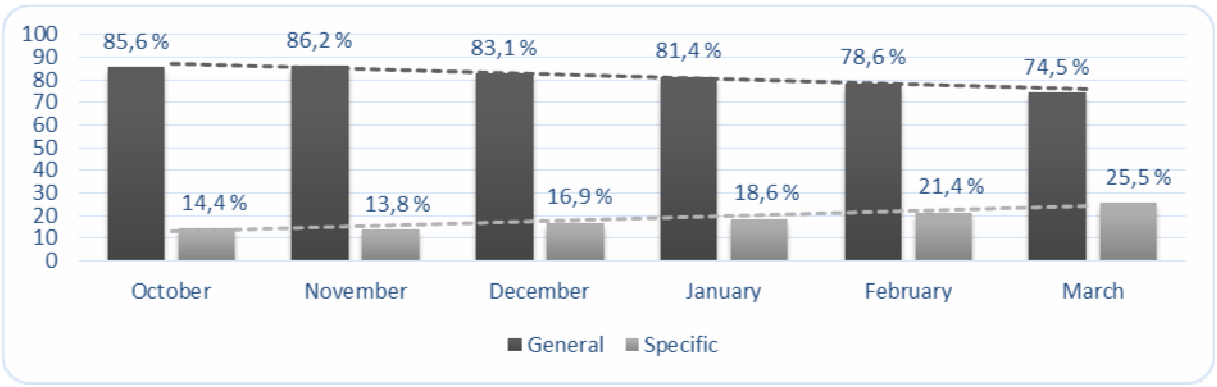

Fig. 1 Ratio of the general and specific preparatory training during the experimental period

There was the same amount of organised after-school aerobic activity in the experimental and the control group, with the exception of the athletic club.

InBody 120 (Biospace Co., Ltd.; Seoul, Korea) was used to analyse the body composition parameters. With the help of the direct segmental multi-frequency bioelectrical impedance analysis, body composition parameters were measured. InBody is frequently used because of its ability to analyse various body composition parameters and because of its clinical reliability. With the use of 8-point tactile electrode and the most accurate DSM-BIA technology, the InBody 120 was able to diagnose the body in cylinders. DSM-BIA technology views the body as 5 cylinders (left arm, right arm, left leg, right leg and the trunk). InBody provides independent measurements for each cylinder to provide accurate measurements for the entire body. Measurements were recorded with the help of data management Lookin'Body120 software version 1.2.2.7. Based on the impedance analysis and further corrections, the body fat percentage (PBF), the body fat mass (FM), the visceral fat level (VFL) and waist to hip ratio (WHR) were analysed (Kyle et al., 2004).

The general somatic indicators were also taken into consideration: Body Height, Body Weight and BMI.

Statistical analysis

Using the mathematical and statistical indicators, the standard deviation and the median and arithmetic average were calculated. Normality of data was determined by the Shapiro-Wilk test. Statistically significant differences between the entry test and final test were calculated with a t-test and the Wilcoxon signed-rank test. The t-test and the Mann–Whitney U test were used across the data. Statistical significance was calculated at the significance level of $p < 0.05$ a $p < 0.01$. Cohen's d coefficient and effect size r coefficient was used to calculate the strength of a phenomenon (Cohen, 1988).

The research has been approved by the Matej Bel University Ethics Committee.

Results

In the experimental and control group the body development parameters were analysed (table 1, table 2). In the comparison of body development parameter entries between subjects there were no statistically significant differences ($p > 0.05$). They were homogenous and it was possible to use the aforementioned statistical methods.

Table 1. Body Development Parameters of the Experimental Group

	PRETEST S-W test	x	**POSTTEST** S-W test	x	t-test between pairs and Wilcoxon test	**Effect size**
BH [cm]	0.47	122.69 ± 5.12	0.49	125.64 ±5.57	t = -13.445, p < 0.01	d = 2.74 large
BW [kg]	0.01	23.15 (21.2-25.1)	0.002	23.85 (22.3-26.4)	T = 0, Z = -4.199, n = 24, p < 0.01	r = 0.61 large
BMI [kg.m^{-2}]	0.04	15.2 (14.8-16.9)	0.01	15.13 (14.6-16.3)	T = 134.5, Z = -0.443, n = 24, p > 0.05	r = 0.06
PBF [%]	0.008	17.15 (12.8-19.4)	0.005	15.85 (12.7-16.8)	T = 55, Z = -2.525, n = 24, p < 0.05	r = 0.36 medium
BW [kg]	0.0001	3.55 (2.8-4.5)	0.0007	3.45 (2.9-4.5)	T = 91, Z = -0.851, n = 24, p > 0.05	r = 0.025
VFL [i]	0.000	1.0 (1.0-2.0)	0.000	1.0 (1.0-1.25)	T = 76.5, Z = -0.764, n = 24, p > 0.05	r = 0.023
WHR [i]	0.012	0.71 (0.69-0.72)	0.005	0.72 (0.7-0.72)	T = 87, Z = -0.672, n = 24, p > 0.05	r = 0.012

Note: BH – body height, BW – body weight, BMI – body mass index, PBF – body fat percentage, FM – body fat mass, VFL – visceral fat level, WHR – waist to hip ratio, S-W test – Shapiro-Wilk test

In the experimental group an increase of body height of 2.95 cm was recorded (2.4%). An increase of body weight of 0.7 kg (4.58%) was recorded as well. In the aforementioned parameters the statistical significance was recorded ($p < 0.01$). The BMI decreased by 0.07 kg.m^{-2} (0.28 %).

During the entry test the body fat percentage (PBF) was 17.15% (12.8-19.4). During the final test this value decreased by 1.3 (7.65%), so the final body fat percentage was 15.85% (12.7-16.8). In the body fat percentage value, the statistical significance ($p < 0.05$) was recorded, as well as substantive significance with a small strength of a phenomenon ($r = 0.36$). The body fat mass (FM) value was 3.55 kg (2.8-4.5) during the entry test. During the final test a decrease of 0.10 kg (2.48%) was recorded, so the final value was 3.45 kg (2.9-4.5). In the body fat mass parameter neither statistical ($p > 0.05$) nor substantive significance was recorded.

During the entry test the average value of visceral fat level (VFL) was 1.0 (1.0-2.0). During the final test the average value of visceral fat level was 1.0 (1.0-1.25). In the visceral fat level neither statistical ($p > 0.05$) nor substantive significance was recorded.

The average value of waist to hip ratio parameter (WHR) was 0.71 (0.69-0.72) during the entry test. The final value increased by 0.01, so it was 0.72 (0.7-0.72).

Table 2. Body Development Parameters of the Control Group

	PRETEST S-W test	x	**POSTTEST** S-W test	x	t-test between pairs and Wilcoxon test	**Effect size**
BH [cm]	0.209	124.27 ± 4.03	0.158	126.47 ±4.33	t = -13.259, p < 0.01	d = 2.38 large
BW [kg]	0.0005	23.6 (22.3-26.3)	0.003	25.9 (23.3-28.1)	T = 0, Z = -4.199, n = 31, p < 0.05	r = 0.61 large
BMI [kg.m^{-2}]	0.026	16.06 (14.9-16.8)	0.021	16.46 (15.2-17.1)	T = 64, Z = -3.606, n = 31, p < 0.01	r = 0.46 medium
PBF [%]	0.005	16.5 (14.3-20.7)	0.035	16.9 (13.5-21.3)	T = 201, Z = -0.046, n = 31, p > 0.05	r = 0.010
BW [kg]	0.000	4.0 (3.3-5.0)	0.0002	4.5 (3.1-5.9)	T = 109.5, Z = -2.129, n = 31, p < 0.05	r = 0.087
VFL [i]	0.000	1.0 (1.0-2.0)	0.000	1.4 (1.1-2.0)	T = 3.5, Z = -2.03, n = 31, p < 0.05	r = 0.104 small
WHR [i]	0.009	0.71 (0.70-0.72)	0.000	0.73 (0.71-0.75)	T = 0, Z = -4.457, n = 31, p < 0.01	r = 0.098

Note: BH – body height, BW – body weight, BMI – body mass index, PBF – body fat percentage, FM – body fat mass, VFL – visceral fat level, WHR – waist to hip ratio, S-W test – Shapiro-Wilk test

In the control group an increase of body height of 2.06 cm was recorded (1.66%). An increase in body weight of 2.3 kg (8.95%) was recorded as well. Furthermore, BMI increased by 0.4 kg.m^{-2} (3.52%). In the aforementioned parameters the statistical significance was recorded ($p < 0.01$).

During the entry test the body fat percentage (PBF) of 16.5% (14.3-20.7) was recorded. During the final test an increase of 0.4 (1.72%) was recorded, so the final body fat percentage was 16.9 (13.5-21.3). In the body fat percentage neither statistical ($p > 0.05$) nor substantive significance was recorded.

During the entry test the body fat mass value (FM) was 4.0 kg (3.3-5.0). During the final test an increase of body fat mass by 0.5 kg (10.01 %) was recorded, so the final value of body fat mass was 4.5 kg (3.1-5.9). In body fat mass a statistical significance ($p < 0.05$) was recorded.

For the visceral fat level (VFL) the average value was 1.0 (1.0-2.0) during the entry test. During the final test, the increase of 0.4 (16.67 %) was recorded, so the average value was 1.4 (1.1-2.0).

For the visceral fat level a statistical significance ($p < 0.05$) as well as substantive significance with a small strength of a phenomenon was recorded ($r = 0.104$).

The average value of the waist to hip ratio parameter was 0.71 (0.70-0.72) during the entry test. During the final test an increase of the average waist to hip ratio value by 0.02 (2.96 %) was recorded, so the final value was 0.73 (0.71-0.75). In the hip to waist ratio a statistical significance ($p < 0.01$) was recorded.

Between the body weight of the experimental and control group, statistically and substantive significance differences of the strength of a phenomenon were recorded ($t = -2.592$, $p < 0.05$, $d = 0.35$ – small strength of a phenomenon).

Between BMI values there were statistically as well as substantive significance differences in the strength of a phenomenon ($t = -3.699$, $p < 0.01$, $d = 0.50$ – medium strength of a phenomenon).

In the body fat percentage, statistical and substantive significance differences of a strength of a phenomenon between experimental and control group were recorded ($t = -2.048$, $p < 0.05$, $d = 0.28$ – small strength of a phenomenon).

In the body fat mass, statistical and substantive significance differences of the strength of a phenomenon were recorded between groups ($t = -2.457$, $p < 0.05$, $d = 0.31$ – small strength of a phenomenon).

For the visceral fat level, statistical and substantive significance differences of the strength of a phenomenon were not recorded between groups ($t = -0.739$, $p > 0.05$, $d = 0.10$).

In the hip to waist ratio a statistically significant difference of the strength of a phenomenon between groups was recorded ($t = -1.856$, $p < 0.05$, $d = 0.18$).

Discussion

BMI increases with age (Poortmans et al., 2005; PHASR, 2011; Simmonds et al., 2015). This research proves that regular aerobic activity in the age of 6 can slow down the increase of BMI and even make it stop temporarily.

Between ages of 5 to 11, the increase of the parameters of body composition (fat free mass - FFM, fat mass - FM, body fat percentage PBF) is constant for both sexes (Xiong et al., 2012).

The study by Lazaar et al. (2007) focused on the effects of intervention aerobic activity on child obesity prevention. The study results showed that 6 to 10-year-old obese children who had taken part in the research had positive changes in their BMI recorded compared to children who had not taken part in athletic activity. The maintenance of fat free mass provides an effective way to increase the daily energy expenditure and therefore decrease fat mass. In the case of this research, a significant change in values was not recorded. The maintenance of an optimal level was achieved though which functions as obesity and overweight prevention.

Junger, Palanská, and Čech (2014) were interested in the comparison of the level of physical activity of 5 to 7-year-old children from the Prešov region in comparison to their body composition parameters. The average body height was 116.1 cm, the average body weight was 23.5 kg and the average BMI was 15.75 $kg.m^{-2}$. There was an average of 8.2 kg of skeletal muscles, 18.2% of body fat, 3.37 kg of proteins and 1.19 kg of minerals. The hip to waist ratio was 0.74-0.75 and the level of basal metabolic rate was 728.1 kcal in girls and 758.6 kcal in boys. No substantive significance differences between sexes was recorded. The only difference was in the parameters of nutritional values (the amount of minerals and proteins). The results of this research are higher in the parameters of body development in 6 to 7 year old children. Our research group had lower values of the parameters suggestive of obesity risk (body fat mass - FM, waist to hip ratio - WHR).

Vasiljević et al. (2015) state worrisome data showing the older the infant population is, the more often they meet with a question of overweight, especially among boys. In boys at the age of 6-7 years, the average BMI was 17.6 $kg.m^{-2}$. In girls at the age of 6-7, the average BMI was 16.55 $kg.m^{-2}$.

Twenty individuals were studied for the effect of aerobic activity on the body composition of 11 to 12-year-old children. They recorded a minimal BMI decrease, which, as they described, was the result of the children's body development. During the research which lasted for 12 weeks (3 times 15 minutes of aerobic activity weekly) they recorded a significant fat mass (FM) decrease. BMI changes in the experimental group are similar and in the fat mass parameter are less significant (Sánchez et al., 2017).

The study Carrel et al. (2005) documents the effect of optimal aerobic activity on the improvement of physical capacity. Furthermore, it demonstrated the positive change of the body composition parameters which are suggestive of overweight and obesity. In children aged 12 ± 0.5 years who took part in fitness oriented exercises for 9 months, a significant fat mass decrease and increase of cardiovascular capabilities were recorded when compared to the general public.

It is recommended that Slovak children and young people spend at least 90 minutes doing some physical activity of medium intensity or 60 minutes doing some physical activity of medium to strong intensity daily. The aerobic activity should be done in school during physical education lessons and in sport clubs during children's free time (Bielik et al., 2017).

Both groups did almost the same amount of after-school physical activities with the exception of athletic club. Children from the experimental group undertook a greater amount of after-school physical activities which could have resulted in the decrease of obesity parameters. From the gender point of view, there were the same percentage of boys and girls in the research.

The research concentrated on the comprehensive development of sport abilities. Subjects of the experimental group were present at 85.96 % of the training sessions. The amount of comprehensive aerobic activity could contribute to a decrease in children's obesity.

Conclusions

Research results show the change in the level of parameters suggestive of obesity in children (6–7 years old), who took part in an athletics club. With the help of the IAAF Kids' Athletics Programme, positive changes in the average value of every obesity parameter were recorded in the experimental group.

In the experimental group the BMI decrease, body fat mass (FM) decrease and the decrease of visceral fat level (VFL) was recorded. A statistically significant ($p < 0.05$) decrease of body fat percentage (PBF) was recorded. The strength of a phenomenon was small. The waist to hip ratio (WHR) did not change.

In the control group a statistically significant ($p < 0.01$) increase of BMI was recorded. A statistically significant ($p < 0.05$) increase of fat mass (FM) and visceral fat level (VFL) was recorded. Waist to hip ratio (WHR) statistically ($p < 0.01$) increased.

Although body weight (BW) increased because of natural development in both groups, in the experimental and in the control group, in the experimental group a decrease of obesity parameters (FM, VFL, WHR) was recorded. The research proved that 6 months of athletic activity (two 60 minutes' training sessions weekly) can positively influence body development and body composition parameters suggestive of obesity. The results showed that regular aerobic activity has a positive effect on the factors which influence obesity in 6 to 7 year old children. It is assumed that regular long-lasting aerobic activity can significantly decrease the parameters which affect obesity in younger school age children.

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