

Pro-health education in the fight against obesity and its complications among school-age children – 6-month program of cooperation with a child and parents

Edukacja prozdrowotna w walce z otyłością i jej powikłaniami u dzieci w wieku szkolnym – 6-miesięczny program współpracy z dzieckiem i rodzicami

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Summary

Introduction: The dynamic development of society affects the health of the population. We often address civilization-related diseases increasingly affecting younger people. The lack of both a balanced diet and physical activity leads to hypertension and obesity. These diseases have a number of serious consequences. The purpose of the study was to demonstrate the influence of an educational program on the arterial pressure and body weight status of children between 10 and 12 years of age.

Material and methods: The study (education program) involved 60 primary school pupils in grades 4–6, including 40 boys and 20 girls whose BMI and arterial blood pressure values deviated, higher from the standard norms. Anthropometric measurements were made, i.e., height, body weight, blood pressure and blood biochemical tests. Then, the pupils were taken care of by a dietician and a coach.

Results: The problem is the small number of fruits and vegetables in the children's diet, which is far below the recommended standards. In the group under study, nearly 12% of the children had elevated TSH levels. Physical activity of the participants was low and was mostly limited to compulsory physical education classes. According to the surveys carried out the girls were physically active much less frequently than the boys.

Conclusions: The increase in the BMI index results in increased systolic pressure in children. An increase in TSH increases the value of diastolic pressure among 10- to 12-year-olds. Children eat not enough fruits and vegetables per week compared to the established standards. The implementation of an educational program in nutrition and physical activity affects the reduction of BMI among children with excess body weight.

Keywords: obesity, pro-health education, children, BMI

Introduction

Since the beginning of the 21st century, there has been a high incidence civilization diseases: overweight and obesity, hypertension, atherosclerosis and diabetes. The problem is all the more serious because it is affecting younger and younger people. Overweight or obesity, as well as hypertension, are increasingly being diagnosed among children and adolescents. A high content of simple sugars and animal fats in the diet results not only in weight gain but also in significant changes within the body,

which are evidenced by increased values of blood biochemical tests. High cholesterol levels are not indifferent to the proper functioning of the body, and the number of people suffering from insulin resistance is also increasing [1].

Prevention is an important element in the fight against overweight and obesity. It is vital that children are taught proper eating habits and active leisure activities from an early age. Periodic measurements should be conducted among children covered by a prevention program. The best way is to measure body mass, height, body fat level, and blood pressure and calculate indicators such as BMI. The measurement results should then be interpreted using current and standardized growth charts. It may also

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be helpful to perform blood biochemical tests and compare them to the results previously obtained [2, 3].

The purpose of the study was to demonstrate the influence of an educational program on the arterial pressure and body weight status of children between 10 and 12 years of age.

Methods

The study was being conducted from 2014 to 2017. The study covered 1286 children from grades 4–6 of 10 randomly selected primary schools in southern Poland. Body weight and height, as well as systolic and diastolic blood pressure, were measured and interpreted using standardized growth charts. A group of children was then selected, whose BMI and arterial blood pressure values deviated, higher from the standard norms. Participation in the program was proposed to all of children, whose results and tests were not within the norm, but only 60 parents expressed interest in the proposal. Permission for the study to be conducted was obtained from the Bioethics Committee at the Medical Chamber in Tarnów (No. 2/0177).

To ensure that the selected children, 20 girls and 40 boys, could be examined further, their parents' and the primary school directors' approvals were obtained. The consent of the Bioethical Committee of the local Medical Chamber was also obtained. In addition, a blood biochemical test was performed, from which TSH, glucose and total cholesterol levels were selected. The tests were conducted by a specialist certified laboratory at St. Luke's Province Hospital in Tarnów. In order to find out about eating habits and participation in sports activities, a survey questionnaire was used.

Before the study commenced, the children and their parents were informed about the duration and course of the study. Conditions of privacy were observed during the measurements. Before mass and body measurements were taken, the students were informed about the need to remove their shoes and outerwear.

The body height of the children under examination was measured with a Martin anthropometer. Before the measurement, the children were instructed to take the appropriate body position: upright, arms lowered along the body, feet joined, and eyes looking forward. The measurement was made to an accuracy of 0.1 cm.

Tanita electronic weighing scales were used to measure body weight. To ensure a correct reading of the measurements, the children were asked to take an upright position and remain motionless for a few seconds.

All parameters were interpreted with the use of the growth charts for children and adolescents aged 3–18, developed by researchers from the OLAF nationwide research project coordinated by the Children's Memorial Health Institute [4, 5]. Based on the measurements collected, the BMI index was calculated in compliance with the standards. On the basis of body height and weight measurements, the BMI index was calculated accord-

ing to the formula, whereas the BMI border values responsible for determining nutritional status were centile values specified by WHO as the following: <10 percentiles as underweight, the range between 10 and 85 percentiles as normal body weight, ≥ 85 percentiles as overweight and ≥ 95 percentiles as obesity [6].

During blood pressure measurement, the children remained seated, the width of the cuff was being adjusted to the circumference of the arm of the child under examination.

Before peripheral blood was collected for biochemical studies, the parents were informed about the necessity of having the children fast for at least 6 hours and giving them 2 glasses of non-carbonated mineral water to drink an hour before the examination.

An educational program was prepared for the children, which included advice from a paediatrician-diabetologist and a diabetes educator nurse. A proper diet was established, and physical exercises were proposed: swimming at the swimming pool of the university conducting the study once a week, as well as an aerobics class, also once a week, conducted by employees of the Department of Physical Education of the university.

The parents and children followed the instructions given by the specialists. Aerobic and swimming pool classes were used to list children's attendance. Parents and children kept diaries in which they recorded the types of meals they ate. After 6 months of the follow-up, anthropometric measurements and blood pressure measurements were taken in accordance with the applicable rules.

Statistical analysis was performed with the use of Statistica v10 program. Contingency tables and basic descriptive statistics (mean, median, standard deviation, and quartile range) were used to describe the collected data. Because the nominal variables were not characteristic of a normal distribution (Shapiro-Wilk test), the significance of intergroup differences was assessed by Mann-Whitney U test. Cross-group differences in qualitative variables were estimated by Fisher's exact test. The relations between variables were tested using Spearman's rank correlations. The materiality level $\alpha = 0.05$ was adopted.

Results

Eating habits

Nearly all of the 60 examined participants (92.7%) ate four meals a day. The others ate 3 meals. The first breakfast was eaten by 55 out of the 60 respondents (91.7%) each day—all the girls surveyed and 35 out of the 40 boys surveyed (87.5%).

Second-breakfast eating habits significantly differentiated the students under examination (Fisher's exact test, $p < 0.001$). A total of 90% of the girls and 50% of the boys would bring a second breakfast from home to school. A total of 10% of the girls and 7.5% of the boys declared buying snacks in the school store. The remaining boys (42.5%) did not eat the second breakfast at all. The girls would most often have sandwiches or buns for the sec-

and breakfast, whereas the boys would eat sandwiches or fruit.

All the students under evaluation consumed fluids during their stay at school. Regardless of their sex, they more often chose water (91.7%) than sweet drinks (8.3%). However, the boys reportedly drank more fluids than the girls (Fisher's exact test, $p=0.02$). The participants also differed in the time of eating lunch. The girls had dinner earlier (usually at 3 p.m.) than the boys (4 p.m.). Approximately of the girls and $\frac{3}{4}$ of the boys would eat dinner at home, 10% of the children of both sexes would have dinner at school and 12.5% of the boys and 25% of the girls would eat two dinners (at school and at home).

Supper was always consumed by 85% of the respondents. The remaining students ate supper only occasionally. In this respect, the girls and the boys did not differ. The most popular supper time was 7 p.m. for both sexes, although the girls would go to sleep earlier (9 p.m.) than the boys (10 p.m., Fisher's exact test, $p<0.001$).

Three-quarters of the girls and boys surveyed declared that they liked fruit and ate it every day. Vegetables were more likely to be eaten by the girls (Fisher's exact test, $p = 0.002$). On the other hand, vegetables were eaten by 90% of the girls and 65% of the boys daily, vegetables were consumed by 10% of the girls and 2.5% of the boys 3 times a week, and 32.5% of the boys consumed vegetables only once a week.

The question "Does what you eat affect your health?" received an affirmative answer from 87.5% of the boys and from only 25% of the girls (Fisher's exact test, $p < 0.001$).

Physical activity

According to the surveys carried out, the girls were physically active much less frequently than the boys (Fisher's exact test, $p = 0.01$). A total of 35% of the boys and 15% of the girls did sports four times a week; 27.5% of the boys and 15% of the girls,

3 times a week; 12.5% of the boys and 50% of the girls, twice a week; 10% of the boys and 20% of the girls, once a week. Last but not least, 7.5% of the boys did not do any sports at all.

Initial results of physical examination

In the first study, the boys' BMI was slightly higher than that of the girls (Table 1). Based on Cole et al.'s BMI norms for children and adolescents (2000), overweight was diagnosed in 7 (35%) of the 20 girls and in 20 (50%) of the 40 boys. Obesity was reported in 13 (65%) girls and in 20 (50%) boys.

The level of systolic pressure was similar in both sexes, and its typical values ranged between 110 mmHg and 125 mmHg (first and third quartile, respectively). Additionally, diastolic blood pressure did not differ significantly among the pupils under examination. The values for the first and third quartiles show that typical results ranged between 70 mmHg and 80 mmHg. The mean values of systolic and diastolic blood pressure for the 27 overweight children were 113.25 ± 10.35 mmHg and 72.07 ± 5.08 mmHg, respectively, whereas in the 33 obese children, they were 116.9 ± 13.95 mmHg and 74.15 ± 6.62 mmHg, respectively. However, the differences were not statistically significant (Mann-Whitney U test, $p > 0.05$).

Significantly higher total cholesterol levels and greater TSH levels activity were recorded among the girls. The glucose levels were similar in both groups. The values of these indices did not differ significantly in overweight and obese children (Mann-Whitney U test, $p > 0.05$). Comparison of the results with generally accepted standards showed that 40 (66.4%) of the participants had normal cholesterol levels, while 20 participants (33.3%) had abnormal, borderline values. TSH levels activity was normal in 53 participants (88.33%), while it was elevated in 7 people (11.67%). All the children under examination had normal glucose levels.

Table 1.

BMI values, arterial blood pressure, and blood test results at the commencement of the educational program
(Mann-Whitney U test)

Variable	Group	Mean	Median	Quartile range	Standard deviation	p
BMI [kg/m ²]	Girls	25.83	26.44	6.00	3.15	0.71
	Boys	26.75	25.44	3.89	3.30	
Systolic pressure [mmHg]	Girls	114.1	112.5	25.00	11.64	0.58
	Boys	115.93	110.00	15.00	13.01	
Diastolic pressure [mmHg]	Girls	72.6	70.0	5.00	5.69	0.83
	Boys	73.53	70.00	10.00	6.23	
Total cholesterol [mmol/l]	Girls	5.04	5.16	1.05	0.68	0.02*
	Boys	4.62	4.61	1.22	0.63	
TSH [μ U/ml]	Girls	2.31	2.57	0.76	0.70	0.003*
	Boys	3.11	3.08	1.14	0.99	
Glucose [mmol/l]	Girls	4.34	4.32	0.33	0.30	0.19
	Boys	4.43	4.41	0.40	0.27	

*statistically significant differences

Results obtained after completion of the educational program

Upon completion of the 6-month educational program, the BMI was still slightly higher among boys (Table 2). Compared to the first measurement, BMI decreased by 0.80 kg/m² in boys and by 0.91 kg/m² in girls. The differences were statistically significant (Mann-Whitney U test, $p < 0.01$). All of the children still had excess body mass, but the number of obese children decreased by 6 boys and by 4 girls.

The level of systolic and diastolic blood pressure did not change significantly during the 6 months of the program (Sign test, $p > 0.05$) and still did not differ between the boys and the girls or between the overweight and obese children.

Correlations between variables

The analysis of the correlations between variables showed a significant positive moderate correlation between BMI and systolic blood pressure. Children with higher BMI were prone to higher blood pressure. A similar correlation was recorded between diastolic blood pressure and TSH. Higher diastolic blood pressure was associated with a greater activity of this enzyme. A significant, albeit very weak, negative dependence occurred between systolic blood pressure and total cholesterol level.

Discussion

In the contemporary world, the problem of overweight and obesity is very serious because it affects a large percentage of the population. This problem also arises among children and has very serious consequences that have an impact on their lives. Being overweight and obese involves not only a lack of acceptance from the peer group but also a number of comorbidities, whose symptoms intensify with a passage of time. However, it should be borne in mind that timely action can eliminate the problem of overweight and obesity and their effects [7].

The purpose of the study was to demonstrate the effect of an educational program on the arterial pressure and body weight

Table 3.

Correlations between variables under examination after 6 months of the program (Spearman's rank order correlations)

Correlated variables	R	p
BMI & systolic pressure	0.27	0.04*
BMI & diastolic pressure	0.20	0.13
BMI & total cholesterol	-0.01	0.94
BMI & TSH	-0.03	0.84
BMI & glucose	-0.11	0.41
Systolic pressure & total cholesterol	-0.56	<0.01*
Systolic pressure & TSH	-0.04	0.73
Systolic pressure & glucose	0.20	0.10
Diastolic pressure & total cholesterol	-0.15	0.23
Diastolic pressure & TSH	0.27	0.03*
Diastolic pressure & glucose	0.14	0.28

* statistically significant difference

status of children between 10 and 12 years of age.

The results of the study show that children eat far too few fruits and vegetables per week. According to generally accepted standards, the daily intake of fruit and vegetables should be approximately 4–5 portions a day. Among the children surveyed, nearly 75% ate vegetables and fruit only once a day, while the remainder of the group ate them only once or several times a week. Ewa Sosnowska-Bieliczy Joanna Władniak reported a very similar result, according to which 20% of school-age children ate fruits and vegetables less than once a day [8]. In 2014, in the state of Wisconsin, USA, Santiago-Torres et al. conducted a study to determine the eating habits of children of Spanish origin. They found that 85% of school-age children ate vegetables and fruits only twice a week [9]. Too little supply of vegetables and fruits can result in an insufficient amount of vitamins, with serious consequences. Attention should also be paid to the fibre contained in vegetables and fruit and its importance

Table 2.

BMI and blood pressure after completion of the educational programme (Mann-Whitney U test)

Variable	Group	Mean	Median	Quartile range	Standard deviation	p
BMI [kg/m ²]	Girls	24.93	25.17	3.46	2.68	0.53
	Boys	25.95	24.78	3.05	3.10	
Systolic pressure [mmHg]	Girls	115.60	115.00	5.00	9.14	0.95
	Boys	116.60	115.00	15.00	10.43	
Diastolic pressure [mmHg]	Girls	72.60	70.00	5.00	5.21	0.20
	Boys	74.65	75.00	10.00	5.41	

to the digestive tract. Dietary fibre improves digestion and the absorption of food and accelerates the feeling of satiety, thereby reducing the risk of excessive weight gain [10].

The analysis of our own study demonstrated a relationship between TSH levels in the blood of the children under examination and their diastolic blood pressure. The higher the TSH level, the higher the diastolic blood pressure. Similar observations were made by Lee et al., who reported higher systolic blood pressure among adolescents aged 12–19 with elevated TSH levels [11]. The relationship between the thyroid hormone level and the value of the arterial pressure, confirmed in both studies, is of great clinical significance. It seems that the presence of excess weight and increased blood pressure among children and adolescents should be the basis for the diagnosis of thyroid diseases.

The present study revealed that more than 33% of the children examined had borderline levels of total cholesterol in their blood. In 2012, Wyka et al. examined children aged between 13 and 15 years. As a result of the biochemical analysis, 7.8% of the girls and 4.8% of the boys were found to have elevated total cholesterol [12]. These percentages are lower than those found in the present study, but it should be remembered that only children with excess weight were subject to detailed examination. The results of both studies indicate the need for screening and rapid action to reduce cholesterol levels, which can hinder the development of serious cardiovascular diseases.

During the assessment of their eating habits, the children were asked about the effects of a healthy diet on their health. Most of them knew that a proper diet improves their health. However, it can be noted that the girls were less convinced of the truthfulness of this statement. This observation is not confirmed by other researchers who, while also indicating children's knowledge of the principles of healthy diet, found that the girls they had examined had a better understanding of the principles of healthy eating and followed them [13].

The children who participated in the study were also participants in the trademark educational course and were taken under the care of a dietitian and a coach. Six months after the commencement of the program, body mass, height and blood pressure were measured again. The results show that under the influence of the implemented educational program, the examined children's BMI decreased. A similar program involving 6-year-old children and their parents was conducted by Nyberg et al. in Sweden. Although the parents participated in a special training, which led to an increase in the children's consumption of vegetables, no impact of physical activity and dietary changes on the incidence of overweight and obesity was found [14]. However, the studies confirmed how important it is to educate parents on healthy eating. Both our own and the cited studies have shown that raising parents' awareness of proper eating habits has helped to implement a healthy diet for their children. Studies show that positive attitudes of parents and good co-operation with a dietitian and a coach have a positive impact on children's

motivation. Sobol-Goldberg et al. [15] show an important role of parents in achieving the positive effects of the educational program.

The study conducted by Ling et al. [16] confirmed the positive importance of health education. Education had a positive impact on the level of physical activity and the way children ate. Similarly, the beneficial effects of childhood obesity prevention programs, especially in the case of programs targeting children aged six to twelve, were presented by Waters and WP. [17]. They noted the importance of educational support not only for children but also for teachers, other school staff and parents. The opposite results of the obesity prevention program were presented by De Henauw et al., who indicated the lack of effectiveness of a two-year program in reducing the incidence of overweight and obesity and in reducing adipose tissue in children [18].

The main difficulty in studies conducted among 10- to 12-year-olds is in convincing their parents of the need to conduct biochemical tests and in the systematic participation in education and classes. Another limitation of the study is the small size of the study group and the lack of repeated biochemical examinations.

Conclusions

1. The increase in the BMI index results in increased systolic pressure in children.
2. An increase in TSH increases the value of diastolic pressure in 10- to 12-year-olds.
3. Children eat not enough fruits and vegetables per week compared to the established standards.
4. The implementation of an educational program in nutrition and physical activity affects the significant reduction of BMI among children with excess body weight.

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Streszczenie

Wstęp: Dynamiczny rozwój społeczeństwa wpływa na zdrowie ludności. Często odnosi się go do chorób cywilizacyjnych dotyczących coraz młodszych ludzi. Brak zarówno zbilansowanej diety, jak i aktywności fizycznej prowadzi do nadciśnienia i otyłości. Choroby te mają wiele poważnych konsekwencji. Celem pracy było wykazanie wpływu programu edukacyjnego na ciśnienie tętnicze i masę ciała dzieci w wieku od 10 do 12 lat.

Material i metody: Badania przeprowadzono w latach 2014–2017. W programie edukacyjnym wzięło udział 60 uczniów szkół podstawowych w klasach 4–6, w tym 40 chłopców i 20 dziewcząt, u których wartości BMI i tętniczego ciśnienia krwi były wyższe od standardowych norm. Wykonano pomiary antropometryczne, tj. wysokość i masę ciała, ciśnienie krwi i testy biochemiczne krwi. Następnie uczniowie rozpoczęli współpracę z dietetykiem i trenerem.

Wyniki: Problemem jest niewielka liczba owoców i warzyw w diecie dzieci, która jest znacznie poniżej zalecanych standardów. W badanej grupie prawie 12% dzieci miało podwyższony poziom TSH. Jak wynika z przeprowadzonych ankiet, dziewczęta są znacznie mniej aktywne fizycznie w porównaniu do chłopców.

Wnioski: Wzrost wskaźnika BMI powoduje wzrost ciśnienia skurczowego u dzieci. Wzrost TSH zwiększa wartość ciśnienia rozkurczowego u 10- do 12-latków. Dzieci jedzą zbyt mało owoców i warzyw tygodniowo w porównaniu do ustalonych standardów. Realizacja programu edukacyjnego dotyczącego odżywiania i aktywności fizycznej wpływa na obniżenie BMI u dzieci z nadmierną masą ciała.

Słowa kluczowe: otyłość, edukacja prozdrowotna, dzieci, BMI