

Prevalence of excessive body weight and high blood pressure in children and adolescents in the city of Łódź

Lidia Ostrowska-Nawarycz, Tadeusz Nawarycz

Department of Human Physiology and Biophysics, Chair of Experimental and Clinical Physiology, Medical University, Łódź, Poland

Abstract

Background: Overweight and elevated blood pressure in children and adolescents are two independent risk factors of basic importance for early prevention of cardiovascular and metabolic diseases.

Aim: To evaluate the prevalence of overweight and elevated blood pressure in children and adolescents aged 7-18 years from the city of Łódź.

Methods: A total of 25,309 children and adolescents (12,669 girls and 12,640 boys) aged 7-19 years from 111 schools in the city of Łódź were examined. Basic anthropometric measurements (body mass and height) as well as three independent blood pressure measurements using the auscultatory method were performed. The prevalence of overweight and obesity were evaluated based on BMI analysis and using international criteria (IOTF). The prevalence of prehypertension state and hypertension was evaluated using the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents.

Results: The mean prevalence of overweight (without obesity) was 15.1% (13.2% for girls and 17% for boys) and obesity was found in 3.7% of children (2.9% of girls and 4.4% of boys). Prevalence of the prehypertensive state and hypertension was 11.1% and 4.9%, respectively. In the younger groups of children aged 7-13 years the prevalence of overweight as well as elevated blood pressure was significantly ($p < 0.001$) higher than in groups aged 14-19 years.

Conclusions: The results indicate that the prevalence of overweight as well as elevated blood pressure is significantly higher in younger groups of children. The observed relations may result from specific social determinants and improper nutritional habits. The results show that intensive preventive activities should also be directed towards younger groups of children.

Key words: overweight and obesity, children and adolescents, prevalence, hypertension

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Introduction

Excessive body weight (EBW), including overweight (OW) and obesity (OB), together with hypertension (HA), represent major civilisation threats of the twenty-first century. A number of epidemiological data confirm that excess fat tissue substantially influences blood pressure and the occurrence of cardiovascular and metabolic complications [1].

Increased blood pressure (BP) in early childhood together with frequently coexisting excessive body weight are considered the main factors initiating the

development of atherosclerosis and ischaemic heart disease in later life [2-4]. They may also lead to the development of conditions such as metabolic syndrome, dyslipidaemia, insulin resistance and type 2 diabetes mellitus. Degenerative arthritis is a very common complication involving mainly the spine, hip and knee joints and joints of the foot. Other complications include respiratory disorders, such as sleep apnoea or hypoventilation. Other very important issues associated with abnormal body weight are psychological disorders such as a lack of acceptance by

Address for correspondence:

Lidia Ostrowska-Nawarycz MD, Zakład Fizjologii Człowieka i Biofizyki, Uniwersytet Medyczny, pl. Hallera 1, 90-647 Łódź, tel.: +48 42 211 13 56, e-mail: tednawarycz@neostrada.pl, tednaw@achilles.wam.lodz.pl

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other children, low self-esteem and the inability to accept one's own appearance. Very frequent meals become the cure for emotional problems like fear or anger, or become a substitute for friendship, appreciation or love. Abdominal obesity, representing a special type of obesity, may lead to endocrine disorders.

In clinical practice, Body Mass Index (BMI) is used to assess the presence of overweight or obesity, and is calculated as a person's weight in kilograms divided by squared height in metres. For adults, a BMI of 18.5 to 24.9 kg/m² indicates optimal weight; values of 25.0-29.9 kg/m² indicate the person is overweight; and above 30 kg/m² suggests the person is obese [4].

In developmental age, both BMI and BP values continually change together with age and depend on the rate of individual growth [5]. The assessment of body weight and hypertension deemed excessive in developmental age is much more complex than in adults, and has been a subject of constant controversy [6]. The diversity of criteria used for defining overweight/obesity and hypertension in developmental age has resulted in significant discrepancies in epidemiological assessment of the prevalence of these conditions.

Currently, for the assessment of hypertension in developmental age, the guidelines included in the latest 4th Report of the Scientific Board of Hypertension Control in Children (National High Blood Pressure Education Program – NHBPEP – on Children and Adolescents) are used [7]. The interpretation of BP measurements in children and adolescents is based on BP centile charts (centile distribution) including age, gender and the child's height.

The assessment of overweight and obesity is currently more often based on criteria proposed by the International Working Group for Obesity (IOTF – International Obesity Task Force). These criteria are based on mean BMIs of children and adolescents aged 2-18 years from six countries including Brazil, Hong Kong, the UK, Holland, Singapore and the USA. The IOTF standards were issued driven by an urgent need to fight the epidemic of obesity (obesity pandemic) that threatens the health of both adults and children as well as adolescents. The unquestionable advantages of IOTF standards include the universal character of international comparative analysis of BMIs, and the fact that they provide a continuum of normal values in adolescents and adults. The cut-off values for 18-year-old subjects were agreed to be the same as for adults, i.e. 25 kg/m² for overweight and 30 kg/m² for obesity [6, 8]. It should be noted, however, that the IOTF criteria were created based on means coming from studies conducted in only two European countries.

Monitoring the prevalence of excessive body weight and hypertension among children and adolescents has been an objective of inquisitive studies conducted in some research centres in our country [9–12].

The aim of the study was to assess, based on international criteria, the prevalence of excessive body weight and elevated BP in the population of children aged 7-18 years in Łódź.

Methods

Presented herein are the results of the 'Early prevention of hypertension and overweight and obesity in children and adolescents in Łódź' study, conducted in the years 2005-2006 to assess the prevalence of abnormal body weight and hypertension in this population [13]. The programme was an open study addressed to all primary and higher level schools in Łódź. One hundred and eleven schools finally participated in the study, including 45 elementary schools, 34 secondary schools and 32 high schools from all 5 districts of Łódź (Śródmieście, Polesie, Widzew, Bałuty and Górna).

The study included 25,309 children and adolescents, 12,640 boys and 12,669 girls aged 7-18 years. The group, according to data obtained from the school authority office in Łódź, included 30% of the child population of Łódź and was representative for the whole population of youngsters.

The study was carried out during the school year of 2005/2006, from September 2005 to April 2006, and was conducted by educated school nurses. Attendants were trained by physicians, specialists in paediatrics for the methods of the survey, analysis of the most frequent errors and specificity of the study. All measurements were carried out before 12 a.m. in surgeries at schools. The approval of the Local Ethics Committee of the Medical University in Łódź was obtained for the study (RNN/280/05/KB).

The assessment of abnormal body weight

The assessment of height and weight was performed in all subjects using a weight scale integrated with a height measurement device. The measurements were done with accuracy of 0.5 cm for height and 0.1 kg for weight in the morning hours, as mentioned before.

Body Mass Index was then calculated for each person according to the formula:

$$\text{BMI} = \text{weight}/(\text{height})^2 \text{ [kg/m}^2\text{]}$$

The prevalence of overweight or obesity was assessed based on the BMI analysis and the IOTF international criteria [8], and for each gender was defined for each age-category (yearly intervals) as a mean prevalence in two age subgroups: 7-13 years and 14-18 years.

The assessment of elevated blood pressure

Blood pressure measurements in all children were taken in the morning hours using the auscultatory method and were repeated 3 times during a single visit, according to the procedures and guidelines of the 4th Report [7]. The mean value of the second and third measurement was used for the analysis. In individuals with increased BP, the measurements were repeated during three separate visits.

The methodology of the study was explained in detail to all participants. Appropriate size of the sphygmomanometer cuff was chosen individually, depending on the arm circumference. A smaller cuff (8 × 22 cm) was used if the arm circumference was smaller than 25 cm.

Three BP measurements were taken using the sphygmomanometer and the cuff wrapped around the right arm, after 10 minutes of rest in a sitting position, at 5-minute intervals. Diastolic BP was identified according to the 5th Korotkov phase (K5).

According to the criteria of the 4th Report, mean systolic (SBP) and diastolic (DBP) BP values were classified as follows:

- normal BP (normal values): when both SBP and DBP values were below the 90th centile (<c90),
- high normal BP (pre-hypertension) (PHA): when SBP and/or DBP values were between the 90th and 95th centile (c90-c95),
- hypertension: when SBP and/or DBP values were above the 95th centile (>c95).

To classify BP according to the recommendations of the 4th Report, apart from gender and age, the centile position of body height, based on the normal values determined for children in Łódź, was used [14].

Statistical analysis

Statistical analysis involved calculation of mean value ± standard deviation for each variable in each age group and gender. Prevalence of overweight/obesity and pre-hypertension/hypertension was defined separately for each age as well as for two age subgroups: 7-13 and 14-18 years. The statistical significance of the differences was assessed based on fraction analysis. A p value <0.05 was considered significant. Statistical analysis and graphs were performed using computer software Statistica v.6 and MS Excel.

Results

Characteristics of the study group of children and adolescents, including the number of examined individuals, mean values of height and weight, as well

as of BMI, are presented in Table I. In all age groups, males presented with higher mean body mass than females. Mean height of girls was higher than that of boys only in the group of 11 and 12 year-old subjects. Mean BMIs were also higher in boys (Table I), except for the group of 14 and 15 year-old females, who presented with higher mean BMI.

The prevalence of overweight and obesity among girls and boys in Łódź, in each age group, is presented in Figure 1. Among girls, overweight was present in 9-15% and obesity in 2.1-5.6% of individuals, depending on their age. Similarly, 12.5-23.6% of males were found to be overweight and 2-6.3% obese.

Table I. Mean values of weight, height and BMI in the studied population

Age [years]	Number	Weight [kg]	Hight [cm]	BMI [kg/m ²]
Males				
7	449	26.4±5.7	126.3±5.5	16.5±2.6
8	803	29.1±6.1	130.5±6.0	17.0±2.6
9	1070	33.3±7.4	136.6±6.3	17.7±2.9
10	1033	36.6±8.7	141.5±6.7	18.1±3.2
11	1081	41.1±9.9	147.3±7.1	18.8±3.5
12	1204	45.3±11.4	152.4±7.9	19.3±3.6
13	1474	50.9±12.1	159.9±8.9	19.7±3.5
14	1215	56.4±12.5	167.1±9.0	20.0±3.3
15	1333	61.4±12.1	172.7±8.1	20.5±3.2
16	1219	66.2±12.8	175.3±7.4	21.5±3.5
17	863	68.7±11.9	177.5±7.2	21.7±3.1
18	896	71.0±11.5	178.4±6.8	22.3±3.1
Females				
7	433	25.4±5.0	124.5±5.6	16.3±2.4
8	767	28.1±6.0	129.5±5.9	16.6±2.6
9	1000	31.3±6.7	135.1±6.5	17.0±2.7
10	956	35.3±7.8	141.1±7.1	17.6±2.9
11	1075	39.6±9.4	147.4±7.5	18.1±3.2
12	1172	45.1±9.6	153.7±7.3	19.0±3.2
13	1422	49.9±10.7	158.9±7.0	19.7±3.4
14	1185	53.6±9.8	162.0±6.2	20.4±3.3
15	1158	55.8±9.7	163.9±6.0	20.7±3.2
16	1402	57.2±9.4	165.1±6.2	21.0±3.1
17	985	58.5±10.1	165.6±6.0	21.3±3.3
18	1114	59.1±10.5	165.7±6.1	21.5±3.5

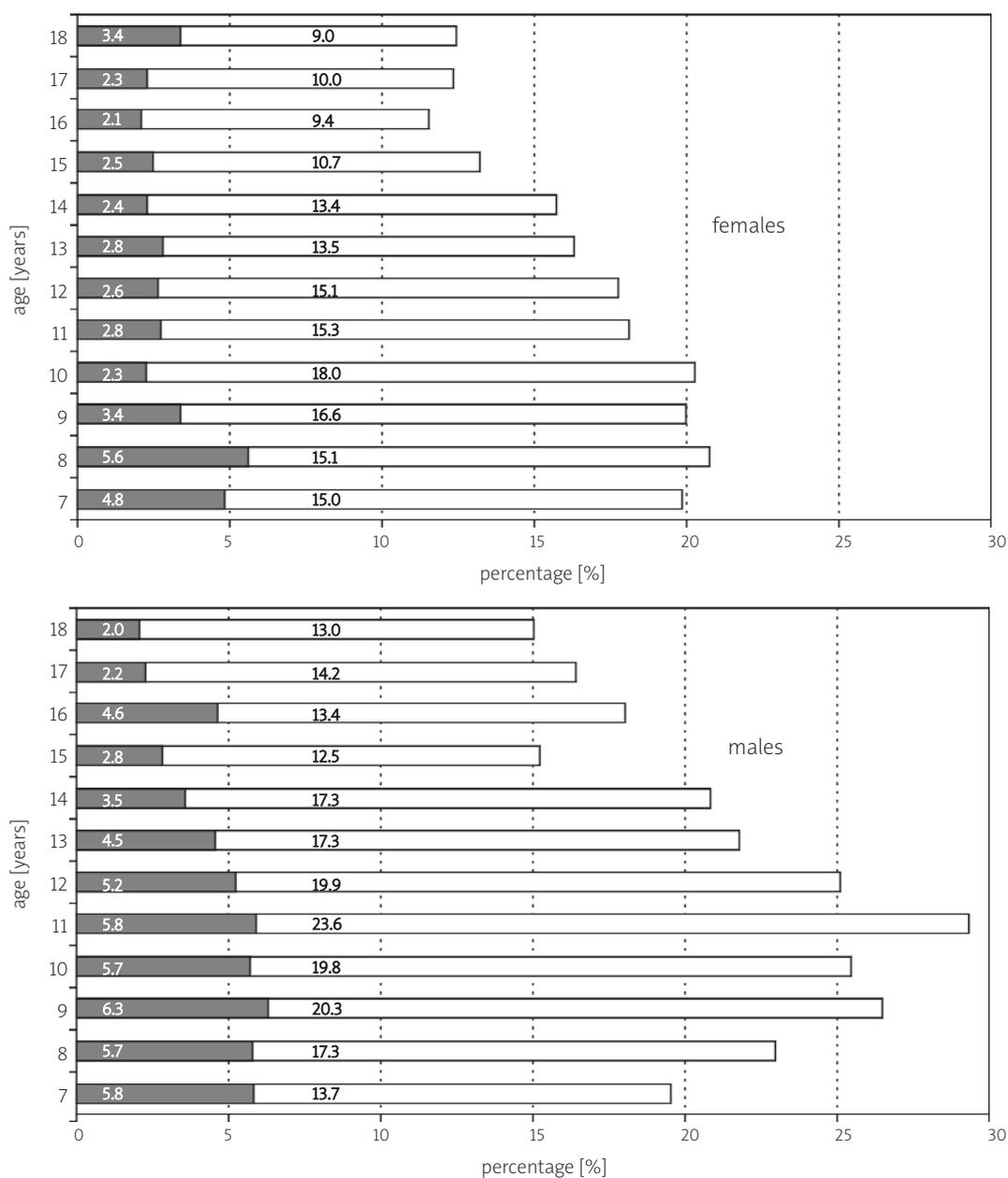


Figure 1. Prevalence of overweight (white bars) and obesity (grey bars) among girls and boys aged 7-18 years (according to IOTF criteria [8])

Table II. Mean prevalence of overweight and obesity among females and males in two age subgroups: 7-13 years and 14-18 years

Age [years]	Females		Males		Both genders	
	Overweight [%]	Obesity [%]	Overweight [%]	Obesity [%]	Overweight [%]	Obesity [%]
Subgroup A: 7-13 years	15.4	3.2	19.3***	5.5***	17.4	4.4
Subgroup B: 14-8 years	10.5	2.5	14.1***	3.1	12.3	2.8
All subjects 7-18 years	13.2	2.9	17.0***	4.4***	15.1	3.7
Statistical significance (A vs. B)	***	*	***	***	***	***

* $p < 0.05$; *** $p < 0.001$

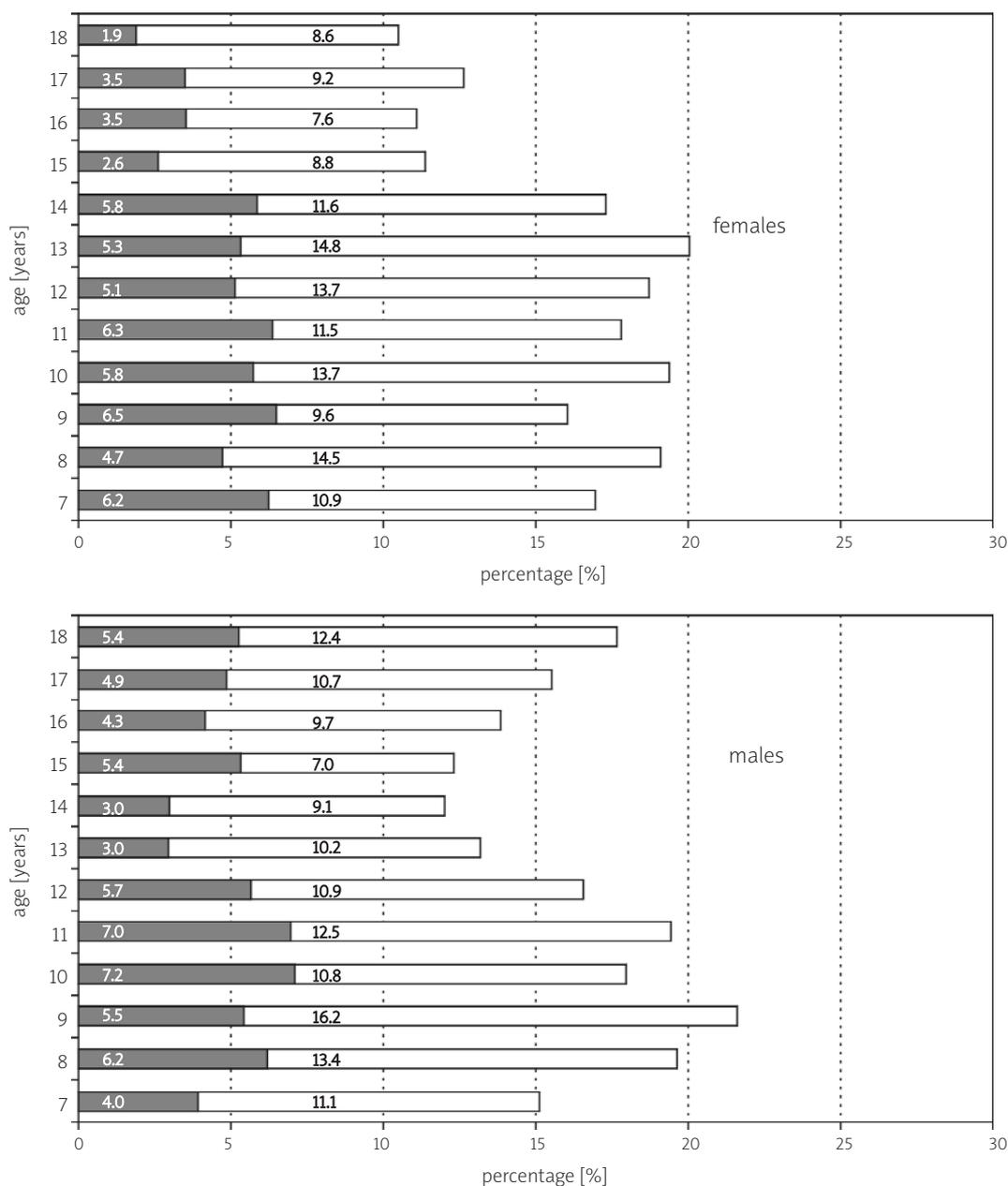


Figure 2. Prevalence of pre-hypertension (white bars) and hypertension (grey bars) among girls and boys aged 7-18 years (according to the criteria of the 4th Report [7])

The mean prevalence of overweight and obesity in all examined children (both girls and boys) aged 7-18 years was 15.1 and 3.7%, respectively; there were, however, significant differences between age-subgroups and between the group of boys and the group of girls (Table II). The prevalence of both overweight and obesity in all boys was considerably higher (17.0 and 4.4% respectively, $p < 0.001$) than in all examined girls (13.2 and 2.9%, respectively). Furthermore, in the subgroup of younger children

(7-13 years old, group A) the mean prevalence of overweight (17.4%) and obesity (4.4%) was significantly higher ($p < 0.001$) than in adolescents (14-18 years old, group B), being 12.3% and 2.8% respectively. A similar tendency was present in both genders (Table II).

The prevalence of pre-hypertension and hypertension in study groups, with respect to the age of subjects, is presented in Figure 2. In females, pre-hypertension was present in 7.6-14.8% and hypertension in 1.9-6.3% of

Table III. Mean prevalence of pre-hypertension (PHA) and hypertension (HA) among girls and boys, in two age-subgroups: 7-13 years and 14-18 years

Age [years]	Females		Males		Both genders	
	PHA [%]	HA [%]	PHA [%]	HA [%]	PHA [%]	HA [%]
Subgroup A: 7-13 years	12,9	5,7	12,1	5,5	12,5	5,6
Subgroup B: 14-8 years	9,1	3,5	9,5	4,5**	9,3	4,0
All subjects 7-18 years	11,2	4,6	10,9	5,1*	11,1	4,9
Statistical significance (A vs. B)	***	***	***	*	***	***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

subjects. In males pre-hypertension was found in 7-12.5% and hypertension in 3-7.2% of individuals.

The mean prevalence of pre-hypertension and hypertension in examined children and adolescents, aged 7-18 years, was 11.1% and 4.9%, respectively, and was similar in boys (10.9% for pre-hypertension and 5.1% for hypertension) and girls (11.2% for pre-hypertension and 4.6% for hypertension).

There were, however, significant differences between age-subgroups (Table III). In younger children (7-13-years-old, subgroup A) the mean prevalence of pre-hypertension and hypertension was considerably higher than that of adolescents (12.5 and 5.6 vs. 9.3 and 4%, respectively, $p < 0.001$). A similar tendency was seen in both genders (Table III).

Discussion

The results of epidemiological studies carried out in several countries suggest increasing numbers of children with abnormal body weight, decreased physical activity and coexisting hypertension [2, 15]. The clinical significance of abnormal body weight in children with pre-hypertension and hypertension results from the presence of coexisting metabolic disorders that increase the risk of cardiovascular complications [3]. More attention paid to the problem of hypertension in children is the result of multiple observations indicating the relation between the level of BP in childhood and adulthood, as well as observations on the inheritance of hypertension. The study conducted by Wyszyńska et al. indicated that during 4-year follow-up hypertension developed in 68% of children with pre-hypertension [3].

A strong causal relationship between obesity and hypertension, also in children and adolescents, has been indicated by many investigators [1, 7, 9, 13]. The mechanisms of such an association are very complex and have not been clarified so far. The role of insulin resistance, hyperinsulinaemia, sympathetic hyperactivity,

natriuretic dysfunction, as well as a role of adipose tissue metabolites, has been suggested [3, 16-20].

The largely inconsistent results of the assessment of abnormal body weight and hypertension prevalence are due to different criteria used for their evaluation.

In the assessment of abnormal body weight the IOTF criteria have been more widely used, also in Poland, and thus results are more internationally comparable [8]. The prevalence of abnormal body weight among Polish children aged 7-11 years is about 10-20%, similar to that in France, Switzerland, the Netherlands, Germany and Hungary [21]. An European high score, with the prevalence of abnormal body weight in children and adolescents reaching 30%, was established in populations of islanders and Mediterranean countries such as Malta, Spain, Portugal, Crete and Cyprus. Nevertheless, the increasing prevalence of abnormal body weight in children suggested in some reports may be the reason for growing concerns also in Poland [22, 23].

Our study of children and adolescents aged 7-18 years from Łódź, based on the IOTF criteria, revealed that abnormal body weight (both overweight and obesity) affected 18.8% of this population, with 15.1% of children being overweight and 3.7% obese. Males were significantly more often found to be overweight or obese than females. The prevalence of excessive body weight was also considerably different depending on the age of examined children. Both overweight and obesity occurred more often in the group of younger children.

Studies conducted in other research centres in Poland, using the IOTF criteria, have shown similar prevalence of excessive body weight in children to that in Łódź. Szponar et al. in a study on children aged 2-15 years, conducted in the year 2000, documented that overweight and obesity, diagnosed based on the IOTF criteria, were present in 16.9 and 4.5% of males and in 12 and 4.0% of females, respectively [12]. Chrzanowska et al. in a group of children aged 3-20 years representative for the population of Cracow

documented the prevalence of overweight reaching 11.5% and obesity 1.8% [9].

Furthermore, a study conducted in the years of 2005-2006 by a group of investigators representing the Institute of Food and Nutrition in a population of adolescents aged 11-15 years revealed the presence of overweight in 11.4% of males and in 11.4% of females, and obesity in 2.8 and 3.4% of boys and girls respectively [22]. In another study, Małecka-Tendera et al. demonstrated a relatively low prevalence of both overweight and obesity, similar to that in France, in a group of 7-9 year-old children [11].

The prevalence of hypertension in children in Poland, reported in many studies, varies depending on methodology and the number of examined subjects [3, 10, 24, 25]. Wyszynska found hypertension to be present in 1-1.5% of 15-16 year-old adolescents [3]. Krzyżaniak A. in her long-term studies of children in Poznań, reported the prevalence of hypertension in children at school age reaching 2-3%, with a clear trend to increase [10]. Kardas et al., in studies of 9-14 year-old children from Łódź, detected hypertension in 3.8% of boys and 2.9% of girls [25].

Our study demonstrated that pre-hypertension was present in 11.1% of boys and girls and hypertension in 4.9%, with similar rates of PHA and HA in both genders. Similarly to the observed prevalence of excessive body weight, both pre-hypertension and hypertension occurred more frequently in the group of younger children. This observation, alarming enough, seems to confirm a close relationship between obesity and hypertension, known from studies in adults [1, 17].

The health status of Łódź inhabitants, also children and adolescents, is still thought to be inferior in comparison with other Polish big city dwellers [1]. What should also be emphasised is that a very important developmental specificity of children in Łódź is poor socioeconomic status of families and the still very critical problem of prematurity [1, 14].

Furthermore, both BP and BMI centile distribution, different in the population of Łódź and in the guidelines of the 4th Report, as well as different BMI thresholds for OW diagnosis according to OITF, may be important. This concerns mostly younger children and may overestimate the prevalence of obesity and hypertension [13]. Similar observations have also been made by several other Polish investigators [12].

Despite many controversies regarding the criteria of obesity and hypertension in children at developmental age, the observations made in Łódź seem to confirm the necessity of more frequent epidemiological monitoring and more aggressive preventive actions directed particularly towards younger children.

It is children and adolescents who constitute the social group most flexible and most likely to benefit from appropriate changes of lifestyle. Blood pressure, weight and height assessment represent the basic, most easily performed and the cheapest means of early prevention, very often underrated.

Conclusions

The assessment of the prevalence of excessive body weight and elevated blood pressure in children and adolescents aged 7-18 years in Łódź leads to the following conclusions:

- 1) Overweight and obesity, detected based on the IOTF criteria, occur on average in 15.1 and 3.7% of children, respectively, and are more frequent in males than females.
- 2) Pre-hypertension (PHA) and hypertension (HA), diagnosed according to criteria of the 4th Report, occur on average in 11.1 and 4.9% of children and adolescents in Łódź. The prevalence is similar in males and females.
- 3) Both excessive body weight and elevated blood pressure occur more frequently in the group of younger children, aged 7-13 years. This finding likely confirms the need for regular epidemiological screening, particularly in younger children.

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Częstość występowania nadmiernej masy ciała oraz podwyższonego ciśnienia tętniczego u dzieci i młodzieży łódzkiej w wieku szkolnym

Lidia Ostrowska-Nawarycz, Tadeusz Nawarycz

Zakład Fizjologii Człowieka i Biofizyki, Katedra Fizjologii Doświadczalnej i Klinicznej, Uniwersytet Medyczny, Łódź

Streszczenie

Wstęp: Nadmierna masa ciała oraz podwyższone ciśnienie tętnicze u dzieci i młodzieży to dwa niezależne czynniki ryzyka o podstawowym znaczeniu dla wczesnej prewencji chorób układu krążenia. Wobec obserwowanej w wielu krajach epidemii otyłości w wieku rozwojowym, rzetelny monitoring tych dwóch patologii oraz śledzenie ich trendów nabiera coraz większego znaczenia. Znaczne rozbieżności w literaturze na temat częstości występowania zarówno otyłości, jak i nadciśnienia w wieku rozwojowym wynikają głównie z różnic metodycznych oraz stosowania odmiennych kryteriów interpretacyjnych.

Cel: Ocena częstości występowania nadmiernej masy ciała oraz podwyższonego ciśnienia tętniczego u dzieci i młodzieży łódzkiej w wieku 7–18 lat, wg międzynarodowych kryteriów.

Metodyka: Zaprezentowane wyniki stanowią fragment zrealizowanego w latach 2005–2006 programu „Wczesna profilaktyka nadciśnienia tętniczego oraz nadwagi i otyłości u dzieci i młodzieży w Łodzi”. Badaniami objęto 25 309 dzieci i młodzieży (12 669 dziewcząt oraz 12 640 chłopców) w wieku 7–18 lat – uczniów 111 szkół łódzkich. U wszystkich badanych wykonano pomiary wysokości i masy ciała oraz 3-krotne, niezależne pomiary ciśnienia tętniczego krwi metodą osłuchową. Badania dzieci były zapowiadane wcześniej, a przed samymi pomiarami, które wykonywane były w godzinach przedpołudniowych, objaśniano uczniom sposób ich wykonania. Indywidualnie dobierano szerokość mankietu pomiarowego w zależności od obwodu ramienia dziecka. Częstość występowania nadmiernej masy ciała w postaci nadwagi (NW) bądź otyłości (OT) oceniano na podstawie analizy wskaźnika BMI oraz kryteriów międzynarodowych (IOTF). Częstość występowania stanu przednadciśnieniowego (PNT) oraz nadciśnienia tętniczego (NT) oceniano na podstawie kryteriów zgodnych z IV Raportem (IVR) amerykańskiej grupy roboczej ds. NT u dzieci i młodzieży. Wyniki pomiarów analizowanych cech opracowano statystycznie, określając dla każdej grupy wiekowej oraz płci ich wartość średnią oraz odchylenie standardowe. Procentową częstość występowania NW/OT oraz PNT/NT określano zarówno w poszczególnych grupach wieku kalendarzowego, jak i w dwóch podgrupach wiekowych: 7–13 lat oraz 14–18 lat. Istotność statystyczną różnic oceniano przy użyciu analizy frakcji, przyjmując $p=0,05$ jako granicę istotności. Do obliczeń statystycznych oraz prezentacji graficznej wykorzystano pakiety Statistica v. 6 oraz MS Excel.

Wyniki: Częstość występowania NW u dzieci łódzkich w wieku 7–18 lat kształtuje się średnio na poziomie 15,1% (dziewczeta – 13,2%, chłopcy – 17,0%), zaś OT dotyczy średnio 3,7% dzieci, w tym 2,9% dziewcząt oraz 4,4% chłopców. Stany PNT oraz NT oceniane na podstawie IVR występują u dzieci i młodzieży łódzkiej średnio z częstością odpowiednio 11,1 i 4,9%. Częstość występowania zarówno NW/OT, jak i PNT/NT w grupach dzieci w wieku 7–13 lat była istotnie wyższa ($p < 0,001$) w stosunku do grupy młodzieży w wieku 14–18 lat.

Wnioski: Do niepokojących zjawisk obserwowanych wśród łódzkich dzieci należy zaliczyć istotnie większą częstość występowania zarówno nadmiernej masy ciała, jak i podwyższonego ciśnienia tętniczego w grupach dzieci młodszych (7–13 lat). Zaobserwowane relacje mogą wynikać ze specyfiki socjoekonomicznej Łodzi oraz procesów transformacji ustrojowej, a także z nieprawidłowych zachowań żywieniowych. Wyniki wskazują na konieczność intensywnych działań profilaktycznych ukierunkowanych również na młodsze grupy dzieci.

Słowa kluczowe: nadwaga i otyłość, dzieci i młodzież, częstość występowania, BMI

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Adres do korespondencji:

dr n. med. Lidia Ostrowska-Nawarycz, Zakład Fizjologii Człowieka i Biofizyki, Uniwersytet Medyczny, pl. Hallera 1, 90-647 Łódź, tel.: +48 42 211 13 56, e-mail: tednawarycz@neostrada.pl, tednaw@achilles.wam.lodz.pl

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