

Epidemiological aspects of obesity and systemic hypertension among school children of Western Ukraine

Epidemiologiczne aspekty otyłości i nadciśnienia u dzieci szkolnych w Zachodniej Ukrainie

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Abstract

Introduction. Systemic hypertension (SH) is a major long-term health condition and is the leading cause of premature death among adults throughout the world, including developed, developing, and lesser developed countries. In recent years there has been a progressive increase in SH among children and adolescents. Epidemiological studies demonstrated an overall increase in the prevalence of hypertension. SH is rarely recorded isolated and is often combined with obesity or the metabolic syndrome. **Aim of the study.** The aim of our research was to study the prevalence of overweight, obesity, and systemic hypertension in Ukrainian school children aged 10-16 years. **Material and methods.** 540 pupils of two secondary schools in the city of Ternopil, aged 10-16 years, were involved. Blood pressure was measured under standard conditions using the standard technique. To assess the physical development of each child, indicators of body weight, height, waist circumferences and body mass index were compared with percentile tables. **Results.** The study has demonstrated that the prevalence of overweight is 11.1% and obesity 4.8% among pupils of Ternopil. The elevated blood pressure was found in 50 % of overweight or obese pupils. SH was found in 13.3% of children (11.8% of girls and 15.1% of boys), where pre-hypertension ($p < 0,01$) and SH 1st ($p < 0,01$) stages were observed twice as often in boys than in girls, and normal BP was recorded less frequently ($p < 0,01$). **Conclusions.** The boys are three times more often obese than girls and 1.4 times more often overweight. The blood pressure is directly correlated with increased BMI, waist and hip circumference in the examined children. The abdominal obesity is a predictor of hypertension in adolescents. The result of the present study has demonstrated the real epidemiology of obesity and systemic hypertension in children and adolescents, and should motivate family doctors and paediatricians to prevent this pathology in Ukraine.

Key words

obesity, systemic hypertension, school children, epidemiology

Streszczenie

Wstęp. Pierwotne nadciśnienie tętnicze krwi (SH-systemic hypertension) jest główną, długoterminową przyczyną przedwczesnej śmiertelności wśród dorosłych na świecie, włączając kraje rozwinięte, rozwijające się i te mniej rozwinięte. W ostatnich latach zaobserwowano progresywny wzrost częstości SH u dzieci i młodzieży. Badania epidemiologiczne wykazały, że całkowity wzrost częstości nadciśnienia rzadko jest izolowany, a częściej współistnieje z otyłością i innymi zaburzeniami metabolicznymi. **Celem badania** była ocena częstości występowania nadwagi, otyłości i pierwotnego nadciśnienia tętniczego krwi wśród ukraińskich dzieci w wieku szkolnym. **Pacjenci i metody.** Do badania włączono 540 uczniów dwóch szkół w mieście Tarnopol w wieku 10–16 lat. Zmierzono ciśnienie tętnicze krwi z zastosowaniem standardowej techniki. Ocena rozwoju każdego dziecka objęła masę ciała, wzrost, obwód talii, wskaźnik masy ciała BMI oraz porównanie z siatkami centylowymi. **Wyniki.** W badaniu wykazano, że u 11,1% badanych uczniów Tarnopola występuje nadwaga, u 4,8% otyłość. Podwyższone ciśnienie tętnicze krwi stwierdzono u 50% dzieci z nadwagą lub otyłością. U 13,3% dzieci (11,8 dziewczynek i 15,1% chłopców) wykazano stan przednadciśnieniowy ($p < 0,01$), nadciśnienie tętnicze 1st ($p < 0,01$) występowało dwa razy częściej u chłopców niż u dziewczynek ($p < 0,01$). **Wnioski.** U chłopców w porównaniu z dziewczętami trzykrotnie częściej występuje otyłość, a 1,4 razy częściej nadwaga. Ciśnienie tętnicze krwi jest bezpośrednio związane ze wzrostem BMI, obwodem talii i bioder u badanych dzieci. Otyłość brzuszna jest predyktorem

nadciśnienia tętniczego u nastolatków. Wyniki obecnego badania wykazały realną epidemię otyłości i nadciśnienia tętniczego u dzieci i nastolatków. Powinno to zmotywować lekarzy rodzinnych i rodziny do próby zapobiegania i powstrzymania tej patologii na Ukrainie.

Słowa kluczowe

otyłość, nadciśnienie tętnicze krwi, dzieci, epidemiologia

Introduction

Systemic hypertension (SH) is a major long-term health condition and is the leading cause of premature death among adults througho ut the world, including developed, developing, and lesser developed countries [1]. The prevalence of SH in children appearst obein creasing, especially in view of the growing population of children with obesity [2]. However, the true incidence of hypertension in the pediatric population is not known. The variable methods used in the earlier blood pressure (BP) surveys limit the ability for us to define a longitudinal trend in children's BP over several decades. An analysis of the trends in childhood BP from two more recent studies by the National Health and Nutrition Examination Surveys (NHANES) group, which were sequential, national and cross-sectional, identified a significant in crease in both systolic and diastolic BPs. The BP increase is most striking among minority groups that also have the highest rates of childhood obesity [3]. Another analysis of the same two data cohorts demonstrated an overall increase in the prevalence of hypertension, from 2.7% in the 1988–1994 survey to 3.7% in the 1999–2002 survey [4]. Both analyses verified that the population increase in BP among children and adolescents was largely due to the increase in obesity. The investigators indicated that targeted screening of hypertension to children with either overweight/obesity or those with hypertensive parents helps to reduce the proportion of children to screen to 30% as well as helping to identify up to 65% of all those with hypertension [5]. There is evidence that the natural history of essential hypertension in adults begins during childhood, often manifests in children 14–15 years and persists throughout life. Among adolescents with pre-hypertension, 14% had developed hypertension 2 years later, which yielded an approximate incidence rate of 7% per year. A limitation of these data is that they were based on only a single blood pressure measurement for BP classification. Despite this limitation, the serial data indicate that those with high BP continue to have high BP. Among adolescents with high risk BP values, including those designated from a single measurement as having pre-hypertension and hypertension combined, 68% of boys and 43% of girls had developed pre-hypertension or hypertension 2 years later [6].

Traditionally SH in childhood was mostly attributed to secondary causes. This has already changed. However, in adolescents, primary hypertension prevails [7]. At the same time SH is rarely recorded isolated and is often combined with conditions such as obesity, insulin resistance/ hyperinsulinemia and dyslipidemia [2, 8–10]. As each of these states alone and their combination increase the risk of the cardiovascular disease, there is a need for early diagnosis of SH taking into

consideration its features in childhood or adolescence and detection of associated risk factors.

The aim of the study was to identify the prevalence of overweight, obesity and systemic hypertension among school children aged 10–16 years of Ternopilcity, Ukraine.

Methods

The study was a prospective cross sectional study conducted in two schools in the city of Ternopil, Ukraine. The schools were selected by using purposive sampling method keeping operational feasibility in view.

The study subjects were 540 children aged between 10 and 16 years, citizens of Ternopilcity that is a regional center with mildly developed industries in Western Ukraine. The following subjects were eliminated from the study, those who (1) had been advised bed rest for more than 15 days during the last 6 months, due to any sickness, [2] had any chronic systemic disease, (3) were absent during the time of conduction of the study due to any reason, (4) unwilling for study.

The average age of subjects was (13.5 ± 1.9) years. Among them 277 were boys and 263 girls (51.3% and 48.7%, respectively).

Blood pressure was measured under standard conditions by the standard technique (OMRON M2 Classic HEM-7117-E Digital Upper Arm Blood Pressure Monitor) in three single occasional ambulatory measurements with two weeks' interval interpreted using percentile tables according to height, age, and gender. Systemic hypertension in children has been defined as systolic BP and/or diastolic BP persistently at least 95th percentile for sex, age and height measured according to 2016 European Society of Hypertension guidelines [11]. Children with systolic BP and/or diastolic BP at least 90th, but less than 95th are classified as having high-normal BP (pre-hypertension). Hypertension was classified as 1st Stage (95th percentile to the 99th percentile and 5 mmHg) and 2nd Stage (>99th percentile plus 5 mmHg). If one of three measurements was within normal range, we have concluded about unstable SH.

Anthropometric measurements were obtained by trained staff members using calibrated instruments and standardized methods. Height and weight were measured by standard methods using a wall-mounted stadiometer and a digital personal scale OMRON HN-289, respectively. Waist circumferences (WC) were measured at midpoint between the last rib and the top of the iliac crest and evaluated by percentile charts for European-American children [12]. Hip circumference (HC) was measured at the maximum protuberance of the buttocks in a standing position.

To assess the physical development of each child, indicators of body weight, height, WC, and body mass index (BMI) were compared with percentile tables to age and gender according to the WHO Child Growth Standards and latest guidelines. Child or adolescent had been classified as overweight if the BMI was >85th percentile but <95th percentile for age and sex, and as obese if the BMI is >95th percentile [13]. Methods of variation statistics analysis such as Fisher's criterion, the level of significance (p) and correlation analysis have been carried out by StatSoft Statistics programme.

Results

The study has demonstrated 60 of overweight (11.1%) and 26 obese (4.8%) school children of Ternopil city (Figure 1). The boys are three times more often obese than girls and 1.4 times more often overweight. Underweight state is not correlated with gender (Figure 2).

Based on the initial examination, normal blood pressure was revealed in 404 (74.8%) children, pre-hypertension in 68 (14.4%), SH 1st Stage in 33 (6.1%) subjects, and SH 2nd Stage

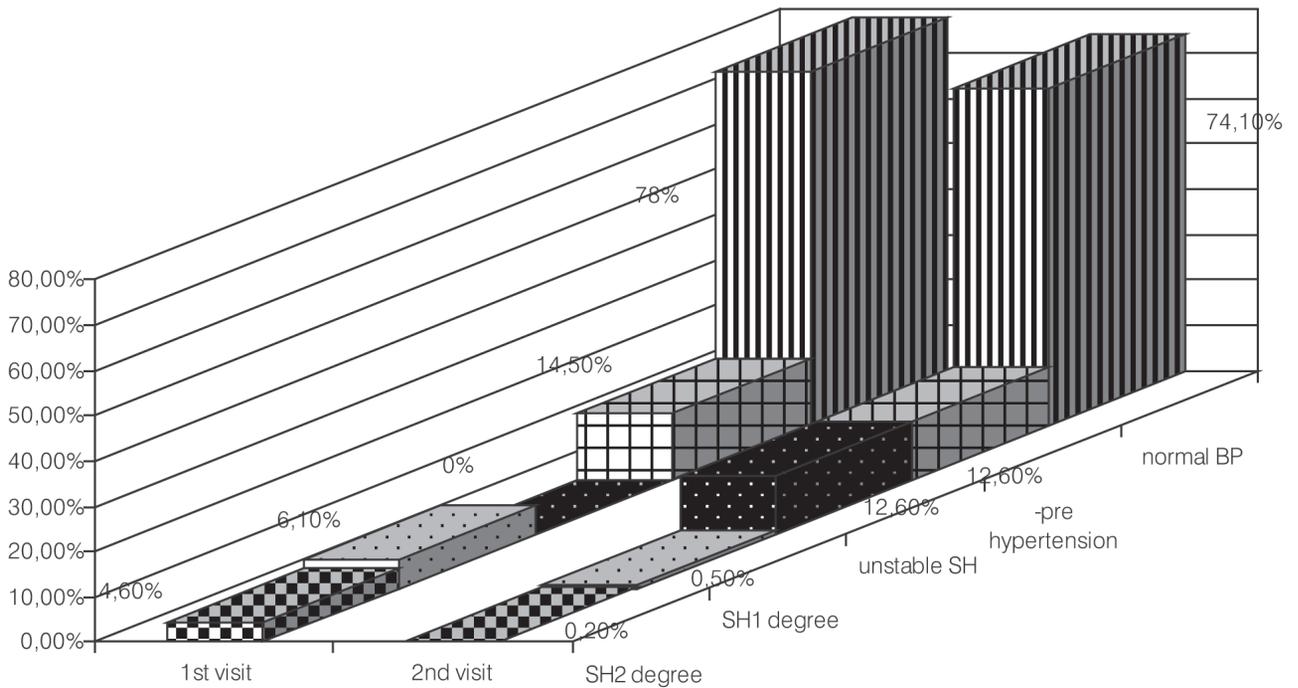


Fig. 1. Distribution of the surveyed children depending on the values of body weight

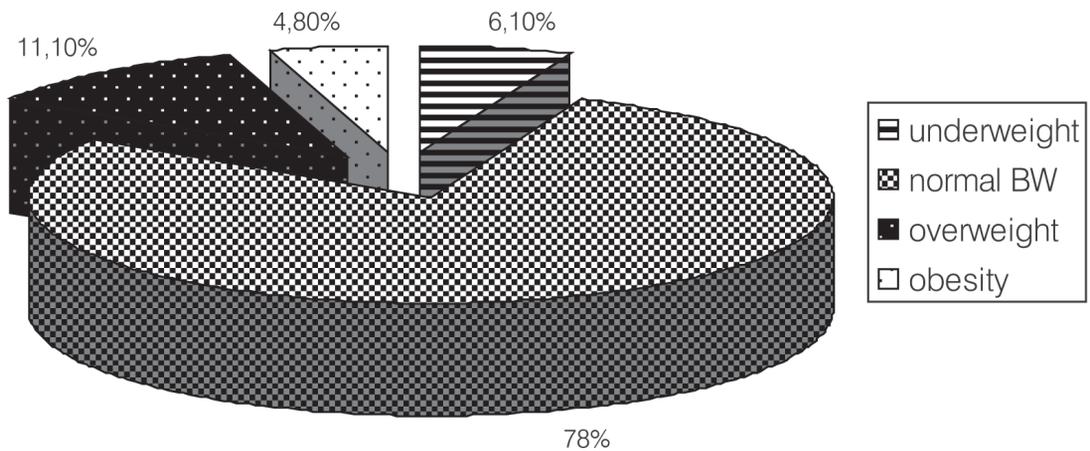


Fig. 2. Distribution of the surveyed children depending on the values of body weight and gender

in 25 (4.6%) children. Generally, in 10.7% of the patients SH of any stage have been registered. After three visits clinical situation changed: normal blood pressure was found in 400 (74.1%) children, pre-hypertension and unstable (labile) SH were reported equally in 68 (12.6%) subjects; 1st Stage SH in 3 (0.6%) and 2nd Stage SH in 1 (0.2%) children, respectively (Figure 3). We assume that higher figures during the first visit may be explained as a result of the anxiety of children and classified as “white coat” or “office” hypertension, which is common in those situations and was confirmed by other studies [9,10].

In general, SH was found in 13.3% of children (11.8% of girls and 15.1% of boys), where pre-hypertension ($p < 0,01$) and SH 1st Stage ($p < 0,01$) were observed twice as often in boys than in girls, and normal BP was recorded less frequently ($p < 0,01$) (Figure 4).

The dependence of BP on subject’s body weight was clearly confirmed. In particular, pre-hypertension was observed in one third of the children, regardless of gender, unstable SH was observed in 45% of obese boys, compared to only 16.7% of obese girls. The SH 1st and 2nd stages were registered only in boys and girls with obesity. In overweight or obese girls normal BP was registered much more often than in boys.

Abdominal obesity (one of the clinical criteria of the metabolic syndrome) was confirmed by the WC > 90 percentile in 4% of all surveyed boys and 1.9% of girls. Among overweight and obese children, the frequency was 19.3% and 18.5% respectively ($p > 0.05$), which have not had a statistically significant gender difference.

Correlation analysis between anthropometric indices and BP levels was conducted. There was a direct medium strength correlation between WC, HC, body weight and BMI and systolic BP in boys and girls and weak direct correlation between the level of diastolic BP and body weight and BMI only in boys (table).

Discussion

According to official statistics in Ukraine, the prevalence of obesity among adolescents has increased 2.5 times over the past ten years [14]. Hanna Senatorova and co-workers presented an examination of 582 school children in Kharkiv (Eastern Ukraine) which showed that the prevalence of overweight and obesity was about $(15.0 \pm 2.96) \%$ of the total population. Gender differences in the body composition are recorded reliably after 14 years [15]. According to The Children’s Memorial Health Institute in Poland, the prevalence of overweight and obesity among Polish school-aged children and adolescents in a population-based, random sample among adolescents aged 13–18 years was in the range of 14.6–19.4% and 10.3–13.0%, boys and girls, respectively [16]. The results of our research confirmed the same trends. However, Agnieszka Wasiluk et al., by the investigation of body proportions in school girls of Lublin region, Poland in twenty years period, have demonstrated statistical increase in percentage of overweight children (7–12 years old) and its significant decrease in the following years [17].

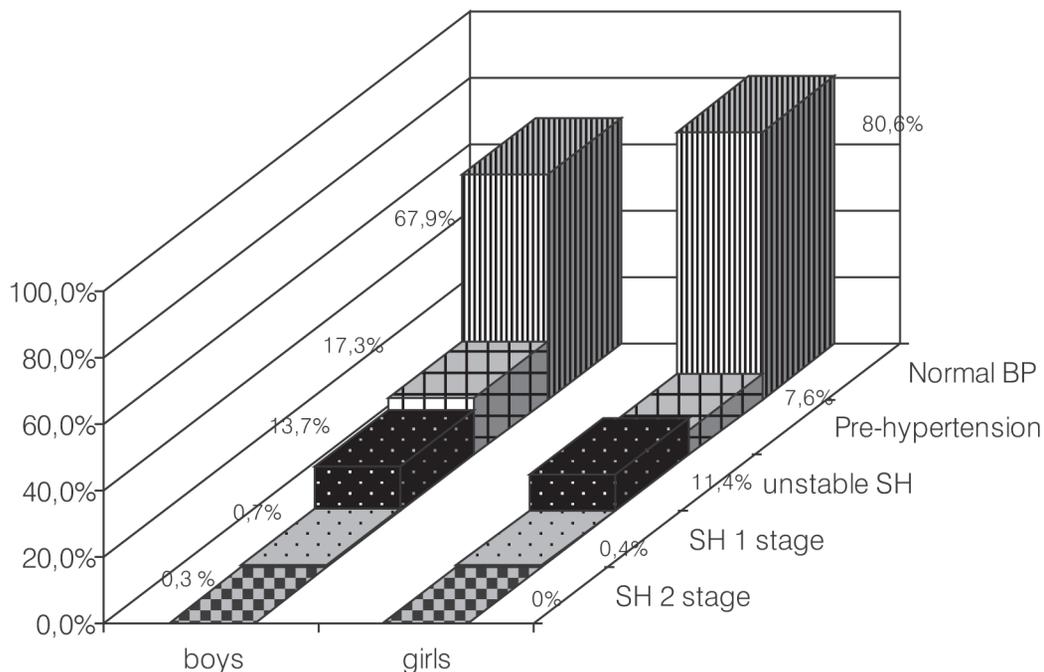


Fig. 3. Distribution of the surveyed children depending on the values of blood pressure

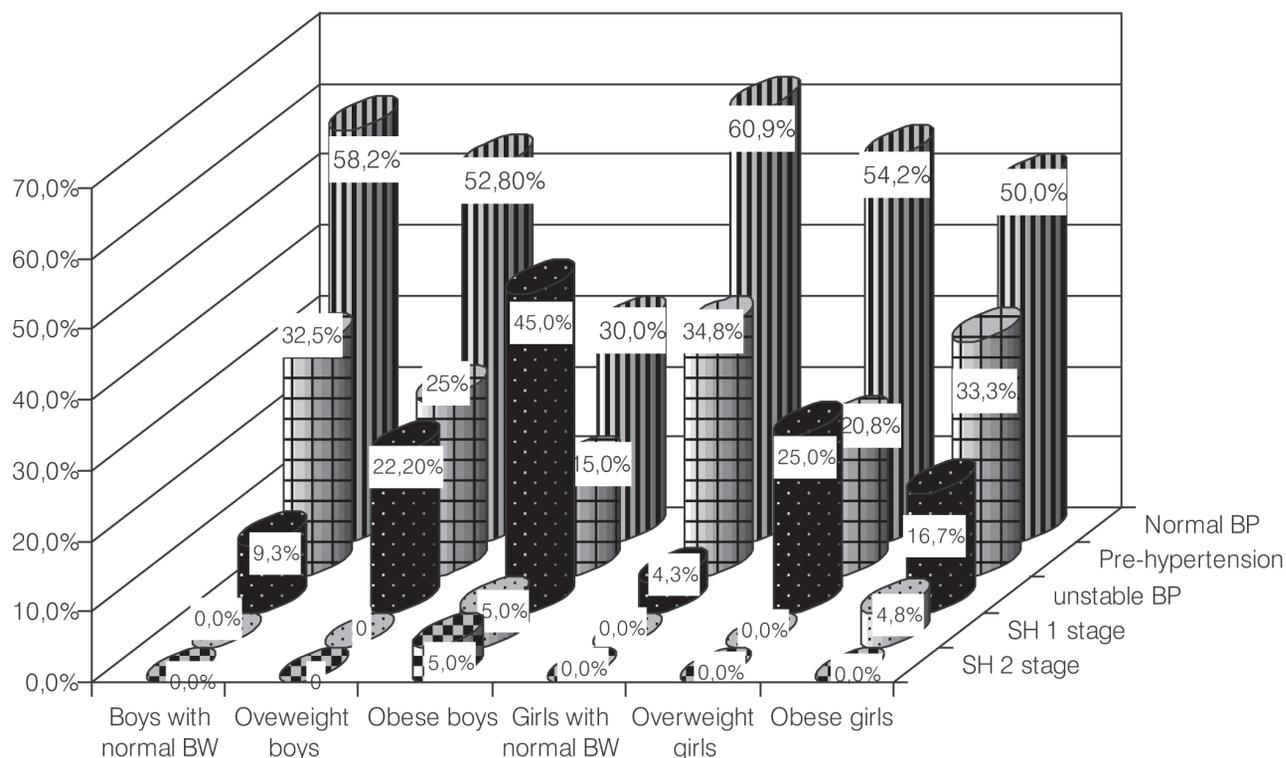


Fig. 4. Distribution of blood pressure values by gender in surveyed pupils

Table I. Results of the first phase of the study

Parameters		School 1			School 2			Total		
		Girls	Boys	Both	Girls	Boys	Both	Girls	Boys	Both
Body weight	Overweight	14	23	37	10	13	23	24	36	60
	Obesity	6	15	21	0	5	5	6	20	26
	Normal	125	129	254	91	76	167	216	205	421
	Underweight	10	16	26	7	0	7	17	16	33
Blood pressure	Prehypertension	15	34	49	8	21	29	23	55	78
	SH 1 Stage	2	11	13	11	9	20	13	20	33
	SH 2 Stage	2	2	4	10	11	21	12	13	25
	BP normal	136	136	272	79	53	132	215	189	404

Gender prevalence of SH in males in some periods of life and the correlation with body proportions were confirmed by other previous research [18]. Cook S. et al, by examination of 2430 respondents in USA aged 12 to 19 years, have concluded that the overall prevalence of the metabolic syndrome among adolescents was 4.2%; 6.1% of males and 2.1% of females were affected ($P=.01$), like in our research. The syndrome was present in 28.7% of obese adolescents compared with 6.8% of overweight and 0.1% of those with a BMI below the 85th percentile ($P<.001$) [19].

The present study has found significant rise in hypertension with obesity in both sex groups, elevated BP was found in 50% of children with overweight and obesity. This association was also demonstrated in prevalent studies all over the world [2,9,10]. Similar observations were also reported among adolescent population in the Czech Republic, Romania, and Portugal [20–22]. A study that evaluated targeted screening of hypertension in 5207 Swiss children (age 10–14 y) found a 2.2% overall prevalence of hypertension in this population, with 14% overweight/obese [23].

The Present study has also documented a positive association between high BP and BMI, waist and hip circumferences in children and adolescents. Anthropometric assessment has been widely used in scientific research to screen children and youth for cardiovascular risk, principally because of their low-cost, ease of administration and non-invasive nature.

The result of the examination of 6895 students (3442 boys and 3453 girls) aged 7–17 years in China presented that SBP and DBP were positively correlated with WC and BMI in both boys and girls. The strongest correlation observed for BP was with WC. Z-scores of BP and the prevalence of relatively high BP increased with WC percentiles, this trend being especially obvious in the upper percentiles of WC. The prevalence of relatively high BP increased from 9.21% (boys) and 11.76% (girls)

in the <5th WC percentile group to 58.99% (boys) and 40.34% (girls) in the \geq 95th WC percentile group, an increase of 5.4- and 2.4-times [24].

Freedman et al reported significant odds ratio in obese children for raised diastolic blood pressure (OR 2.4) and raised systolic blood pressure (OR 4.5). In the same study, Freedman and co-operatives also found that 58% of obese 5–10 y olds had at least one of five cardiovascular risk factors, and 25% had two or more [25].

The present study has some limitations: it did not assess the socioeconomic status, time spent on physical exercise, which activities were practiced, nor even the level of sedentary lifestyle. The lack of data on nutrition and family history should also be mentioned as limitations of this study. Therefore, it is suggested that further studies be conducted in order to establish a more accurate picture.

Conclusions

The study has demonstrated that the prevalence of overweight is 11.1% and obesity 4.8% among pupils of Ternopil. The elevated BP was found in 50% of overweight or obese pupils. SH was found in 13.3% of children (11.8% of girls and 15.1% of boys). Obese boys are more predisposed to pre-hypertension and SH 1st stage than girls. The blood pressure is directly correlated with increased BMI, waist and hip circumference in the examined children. The abdominal obesity is the predictor of hypertension in adolescents. The result of present study has demonstrated the real epidemiology of obesity and systemic hypertension in children and adolescents and should motivate family doctors and paediatricians to prevent this pathology in Ukraine.

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