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Source / Izvornik: **Collegium Antropologicum, 2013, 37, 761 - 764**

Journal article, Published version

Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

Permanent link / Trajna poveznica: <https://um.nsk.hr/um:nbn:hr:105:642007>

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Download date / Datum preuzimanja: **2024-06-13**



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# Hypertension, Overweight and Obesity in Adolescents: The CRO-KOP Study

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## ABSTRACT

*The objective of this study was to determine the prevalence of hypertension, overweight and obesity in Croatian adolescents. In this cross-sectional survey (the sub-study of the EH-UH study) 375 boys and 381 girls (mean age 15.9 ± 0.5 years) from four high schools in the city of Koprivnica were enrolled. Blood pressure, body height and body weight were measured according to the current ESH/ESC guidelines. Data on life style were obtained from questionnaire. Average blood pressure values were higher in boys than in girls (117/74 mmHg vs. 111/69 mmHg;  $p < 0.001$ ). Significantly higher blood pressure values were obtained in overweight children compared to those with normal weight (119/76 mmHg vs. 115/72 mmHg;  $p < 0.01$ ). Prevalence of hypertension was 8.5% in the whole group being significantly higher in boys than in girls (11.2% vs. 5.8%;  $p = 0.0007$ ). As expected, prevalence of hypertension was significantly higher in obese children than in those with normal weight (20.0% vs. 6.8%;  $p = 0.015$ ). A significant correlation was found between body mass index and blood pressure ( $p = 0.0001$ ). The overall prevalence of obesity was 3.54% (boys 2.2%; girls 4.9%). Our results confirmed positive relationship between overweight, obesity and hypertension starting from childhood pointing again the utmost importance of preventive measures beginning from early life.*

**Key words:** hypertension, overweight, obesity, adolescents, risk factors

## Introduction

In last several decades, prevalence of obesity and hypertension in adulthood has increased worldwide<sup>1</sup>. According to the nationwide survey, the EHUH study, every third Croatian adult has hypertension<sup>2</sup>. Number of reports on increased trend in children and adolescents is even more considering<sup>3,4</sup>. However, hypertension in children and adolescents is generally under diagnosed, even though reports underscore the importance of blood pressure control even at a younger ages<sup>5,6</sup>. Cross-sectional cohort study on 2365 healthy schoolchildren aged 8–16 years from Germany reported by Reich et al. showed significant increase of obesity among schoolchildren and tight relationship between overweight, obesity and hypertension<sup>7</sup>. This problem is of epidemic proportion as Sorof and colleagues reported in 2002<sup>8</sup>. It is obvious that lifestyle habits significantly influence blood pressure in childhood and adolescents<sup>10–12</sup>.

Results on prevalence of hypertension and obesity in Croatian adolescents are still lacking leaving those questions unanswered<sup>9</sup> so our aim was to analyze prevalence of hypertension, overweight and obesity in school-aged adolescents in the city of Koprivnica, North-West part of Croatia.

## Materials and Methods

This cross-sectional epidemiological survey was sub-study of the nationwide study »Epidemiology of Hypertension in Croatia, EH-UH study«<sup>2</sup>, and was conducted in the city of Koprivnica. In this study 756 high school adolescents from 4 schools (375 boys and 381 girls; 15 to 18 years old) were enrolled. Hypertension was defined as blood pressure values higher than 95<sup>th</sup> percentile for body height. High normal blood pressure was defined as

blood pressure values between 90<sup>th</sup> and 95<sup>th</sup> percentile for height<sup>3,13</sup>. Blood pressure was measured according to the recent guidelines<sup>1,3</sup> using a mercury sphygmomanometer and appropriate cuffs in the seated position (3 times at 5 minute intervals). Third recorded value was taken for further analysis. Body height and body mass were measured without shoes and in light clothes. The body height was measured by a fixed height meter (accuracy of 0.5 cm) and body mass by decimal scales (accuracy of 0.1 kg); body mass index (BMI) was defined as body weight mass (kg)/(height (m))<sup>2</sup>. Overweight and obesity were defined using »body mass index – for-age percentiles« as follows: overweight was defined as a BMI between 85<sup>th</sup> and 95<sup>th</sup> percentile for age and gender. Obesity was defined as a BMI of  $\geq 30$  kg/m<sup>2,14,15</sup>. Data were statistically processed on a PC using the Statistics for Windows program. Differences between the groups were determined using Student's t-test, ANOVA and  $\chi^2$  test. A p-value 0.05 was considered statistically significant.

## Results

Basic anthropometric and clinical data of enrolled subjects are presented in Table 1. Boys had higher blood pressure values than girls ( $p < 0.0001$ ). We failed to find difference in BMI between boys and girls ( $p = 0.53$ ). Data on prevalence of blood pressure categories in the whole group and separately in boys and girls are shown in Table 2. In the whole group the prevalence of hypertension was 8.5% being significantly higher in boys than in girls (11.3% vs. 5.7%, respectively;  $p = 0.0007$ ). Prevalence of high normal blood pressure values was also higher in boys than in girls. Overweight subjects had significantly higher blood pressure values than those with normal BMI (119/76 mmHg vs. 115/72 mmHg;  $p < 0.01$ ). Prevalence of obesity in the whole group was 3.54% (25/707) with slight predominance of obese girls (4.9% girls (17/345) vs. 2.2% boys (8/362). As shown in Table 3, prevalence of hypertension increases from 14% in subjects with normal BMI to 21% in overweight and obese chil-

**TABLE 1.**  
ANTHROPOMETRIC DATA AND BLOOD PRESSURE VALUES OF ADOLESCENTS

|                                 | Whole group<br>N=756 | Boys<br>N=375    | Girls<br>N=381   | p       |
|---------------------------------|----------------------|------------------|------------------|---------|
| Age (years)                     | 15.9 $\pm$ 0.5       | 15.9 $\pm$ 0.5   | 15.8 $\pm$ 0.5   | 0.67    |
| Body mass (kg)                  | 61.05 $\pm$ 12.2     | 64.9 $\pm$ 9.46  | 57.2 $\pm$ 13.49 | <0.0001 |
| Height (m)                      | 1.68 $\pm$ 0.08      | 1.73 $\pm$ 0.06  | 1.63 $\pm$ 0.07  | <0.0001 |
| BMI (kg/m <sup>2</sup> )        | 21.3 $\pm$ 3.5       | 21.4 $\pm$ 3.14  | 21.2 $\pm$ 3.94  | 0.53    |
| Systolic blood pressure (mmHg)  | 114.2 $\pm$ 17.9     | 117.5 $\pm$ 17.4 | 111.0 $\pm$ 17.8 | <0.0001 |
| Diastolic blood pressure (mmHg) | 72.1 $\pm$ 11.9      | 74.3 $\pm$ 11.4  | 69.8 $\pm$ 11.9  | <0.0001 |

\* p indicates boys vs. girls; Values are expressed as mean  $\pm$  standard deviation

**TABLE 2.**  
PREVALENCE OF BLOOD PRESSURE CATEGORIES IN ADOLESCENTS

| Blood pressure category    | Whole group | Boys       | Girls     | p      |
|----------------------------|-------------|------------|-----------|--------|
| Normotension               | 586 (83.1)  | 279 (78.8) | 307(87.5) | <0.01  |
| High normal blood pressure | 59 (8.4)    | 35 (9.9)   | 24 (6.8)  | <0.001 |
| Hypertension               | 60 (8.5)    | 40 (11.3)  | 20 (5.7)  | 0.0007 |

Data are presented as number and (%)

**TABLE 3.**  
PREVALENCE OF BLOOD PRESSURE CATEGORIES IN ADOLESCENTS ACCORDING TO BODY MASS INDEX

| Blood pressure category    | Underweight | Normal weight | Overweight | Obese     |
|----------------------------|-------------|---------------|------------|-----------|
| Normotension               | 405 (84.4)  | 51 (79.7)     | 12 (63.2)  | 14 (56.0) |
| High normal blood pressure | 42 (8.8)    | 4 (6.3)       | 3 (15.8)   | 6 (24.0)  |
| Hypertension               | 33 (6.8)    | 9 (14.0)      | 4 (21.0)   | 5 (20.0)  |

Data are presented as number and (%)

dren. Statistically significant correlation between BMI and systolic and diastolic blood pressure was observed ( $r=0.18$ ;  $p=0.0001$ ;  $r=0.20$ ;  $p=0.0001$ , respectively). Beside anthropometric data and blood pressure values, using anonymous questionnaire, data on smoking, physical activity and alcohol intake were collected. We found that 25.5% (84/329) of boys and 16.3% (49/301) of girls are smokers; 27.7% (91/328) boys and 10.5% (42/401) girls reported drinking alcohol (average weekly spirits 0.03 L, wine 0.2 L, beer 0.2 L). Active sport activity level (>3 times per week per 30 minutes) was reported by only 15.83% (38/240) of boys and 4.94% (8/162) of girls. Habitual (recreational) sport activity (<3 times per week) was reported by 72.08% (173/240) of boys and 40.74% (66/162) of girls. No physical activity at all was reported by 12.08% (29/240) boys and 54.32% (88/162) girls.

## Discussion

The objective of this study was to determine prevalence of hypertension, overweight and obesity in school-aged adolescents in the city of Koprivnica, Croatia. Our results on positive relationship between obesity and hypertension in this age group are in concordance with other reports. Recently Musil and colleagues<sup>16</sup> reported on that 7.9% girls and 5.3% boys from 8<sup>th</sup> grade of primary school have elevated blood pressure values. Čavlek and others<sup>17</sup> reported on high prevalence of hypertension (5.7%) in Croatian children from the first grade of comprehensive school. In Serbia, Vlajinac and others<sup>18</sup> found significant correlation of BMI and age with blood pressure values what is in line with our results. The prevalence of hypertension in adolescents varies between 1% and 10%<sup>3</sup> and vast majority of studies showed that prevalence is increasing in different regions<sup>10,12</sup>. Data from different national and international studies reported on relationship between obesity and hypertension<sup>7,12</sup>. Nur et al. reported that prevalence of hypertension was 4.4% in a cohort of 1041 students from Turkey. In agreement with our data, they also found a significant correlation between BMI and prevalence of hypertension<sup>20</sup>. Sharma et al. reported that prevalence of hypertension in a population of 1085 Indian children aged 11–17 years was 5.9%. Although prevalence of obesity in their group was only 0.4%<sup>21</sup> every fifth obese child was hypertensive what is concordance with our data. Mahyar et al.<sup>22</sup> from Iran reported results from a cross-sectional study on 840 primary school children aged 7–12 years. Prevalence of hypertension was 6.15% among boys and 3.4% in girls. The trend of higher hypertension prevalence in boys parallels our findings. Borges et al. reported on the similar prevalence of hypertension (8.7%) in Brazilian boys and girls aged 7–10 years<sup>23</sup>. Salvadori in the group of 675 Cana-

dian children and adolescents aged 4–17 years found significant relationship between overweight, obesity and hypertension underlying influence of poor lifestyle habits in youth<sup>24</sup>. Our results on high percentage of adolescents who are smokers and who drink alcohol are particularly alarming as well as is low prevalence of young people who are physically active.

In addition to habit of poor eating habits, physical inactivity dramatically contributes to increased prevalence of obesity and thus to high prevalence of hypertension. Our data on high prevalence of overweight (19%) and obesity (3.5%) in adolescents are congruent with reports from other author's worldwide<sup>25</sup> and 20% of obese subjects were hypertensive what is in agreement with results of McNiece et al.<sup>19</sup> Almost 15% of Americans between the ages of 6 and 19 are obese and this percentage is continuously rising. Analyzing data from different national surveys Din-Dzietham et al.<sup>25</sup> revealed that overall increase in the prevalence of hypertension in children and adolescents was mostly due to increase in prevalence of obesity. It is reported that high blood pressure values and BMI in childhood determine blood pressure values in adulthood<sup>4,17</sup>. This fact stresses the need for early screening and diagnosis of hypertension in youth. Falkner et al.<sup>26</sup> showed that almost 50% of adolescents with defined prehypertension developed hypertension within a follow up period of 2 years. In our group prevalence of prehypertension i.e. high normal blood pressure was higher in obese subjects than in those with normal BMI (20% vs. 6.3%;  $p<0.001$ ). Prevalence of hypertension in adolescents slightly varies from one area to another being influenced by race, nutrition, environmental factors and obesity<sup>27</sup>. Our results are in concordance with majority of reports worldwide. High prevalence of hypertension and its relationship to obesity points on importance of early detection and need to implement preventive measures and start education from early life. Physical inactivity, smoking and alcohol consumption in addition to high prevalence of obesity and overweight are indicators of poor life style and general ignorance. Public health authorities should be more and permanently active.

## Acknowledgement

Authors would like to dedicate this paper to Dr. Branko Heinrich one of principle investigators in this survey but who unfortunately suddenly died. His enthusiasm, knowledge and friendship were strong support. We will miss him in professional and private life.

Research was supported by the Research Grant of the Croatian Ministry of Science, Sport and Technology No 0108109 for the survey »Epidemiology of Hypertension in Croatia, the EHUH study«.

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## ARTERIJSKA HIPERTENZIJA, PREKOMJERNA TJELESNA TEŽINA I PRETILOST U KOPRIVNIČKIH ADOLESCENATA: CRO-KOP STUDIJA

### SAŽETAK

Cilj ove studije je odrediti prevalenciju arterijske hipertenzije, prekomjerne tjelesne težine i pretilosti u hrvatskih adolescenata. U ovu studiju, koja je dio nacionalne EH-UH studije, uključeno je 375 dječaka i 381 djevojčica (srednje dobi 15,9± 0,5 godina) iz četiri srednje škole grada Koprivnice. Arterijski tlak mjereno je sukladno recentnim preporukama, uzeti su podaci o tjelesnoj masi i visini te proveden iscrpan upitnik o životnim navikama. Rezultati ukazuju kako su srednje vrijednosti arterijskog tlaka više u dječaka no u djevojčica (117/74 mmHg vs. 111/69 mmHg; p<0,001). Ukupna prevalencija pretilosti je 3,54% (dječaci 2,2%; djevojčice 4,9%). Značajno više vrijednosti arterijskog tlaka imaju prekomjerno teški adolescenati u usporedbi s adolescentima uredne tjelesne težine (119/76 mmHg vs. 115/72 mmHg; p<0,01). Prevalencija arterijske hipertenzije je 8,5% u cjelokupnoj ispitivanoj populaciji, značajno viša u dječaka no u djevojčica (11,2% vs. 5,8%; p=0,0007). Prevalencija hipertenzije bila je viša u pretilih adolescentata (20,0% vs. 6,8%; p=0,015) u usporedbi s adolescentima normalne tjelesne težine. Prati se značajna korelacija između indeksa tjelesne mase i arterijskog tlaka (p=0,0001). Rezultati ove studije potvrđuju pozitivnu povezanost prekomjerne tjelesne težine, pretilosti i arterijske hipertenzije s početkom već od najranije životne dobi, pritom skrećući pozornost na važnost provođenja preventivnih mjera već od najranije životne dobi.