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Elevated Blood Pressure in School Children and Adolescents – Prevalence and Associated Risk Factors

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A B S T R A C T

Elevated blood pressure (BP) in children and adolescents is determined on normative distribution of BP in healthy children. The aim of this study was to determine prevalence of high normal and elevated BP among school children and to assess associated risk factors. The study comprised 965 children (48.7% girls) in 8th grade of primary school. Data were obtained from questionnaire and anthropometric measurements. The prevalence of high normal BP was 28.5% in girls, 36.8% in boys, and elevated BP 7.9% in girls and 5.3% in boys. Overweight was present in 19.4% of girls and 9.3% boys with high normal, and 29.7% of girls and 30.8% boys with elevated BP. Hypertension in family history was the most common associated factor reported by boys and girls with high normal and elevated BP. Follow-up of children throughout school age makes possible taking of preventative measures and promotion of healthy life style.

Key words: *children, adolescent, blood pressure, risk factors, school health service*

Introduction

Hypertension is a progressive cardiovascular syndrome arising from complex and interrelated aetiology[1]. It is important worldwide public-health challenge, not only because of its high frequency, but also because it is only one of several proven major modifiable risk factors for cardiovascular disease[2]. Analysis indicates that more than a quarter of the world's adult population has hypertension and that this proportion will increase to 29% by 2025[3], and causes 6% of deaths each year that occur worldwide[4]. Recent study in Croatia has shown a prevalence of hypertension of 40.5% for men and 34.9% for women[5]. The prevalence of hypertension among school children and youth has been reported by ranges from 11.4% to 19.4% after first, 3.8% to 9.5% after second and from 2.2% to 4.5% after third screening[6,7]. Elevated blood pressure in children and adolescents is determined on the normative distribution of blood pressure (BP) in healthy children. Hypertension is defined as average systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) that is ≥95th percentile for gender, age and height on three separate occasions. SBP or DBP values that are ≥90th percentile but <95th percentile are designated as »high normal« and are considered to be an indication of heightened risk for developing hypertension. It is now recommended, that as with adults, children and adolescents with BP levels ≥120/80 mm Hg but <95th percentile should be considered pre-hypertensive[8,9]. Large scale epidemiology studies have shown that essential hypertension could be found among children and adolescents. Persistence (tracking) of BP trough childhood and from childhood into adulthood showed that adult BP is correlated with childhood BP, body size and change in ponderosity from childhood to adult life. An elevated BP, obesity and positive family history of hypertension in childhood are likely to help predict adult hypertension[10–14]. Studies of this type, not only help understand when and how adult hypertension occurs, but also have implications for early detection and prevention of the development of hypertension by appropriate dietary and life-style modifications starting in childhood[8]. Examinations of trends in SBP and DBP among children and adolescents (aged from 8 to 17 years) between 1988 and 2000 showed that SBP and DBP have increased. Except an increase in body mass index (BMI), for at least part of the increase in BP

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are responsible additional factors that still should be identified[15]. The pre-hypertension or high normal BP category is created to target children at risk for early identification and intervention. No outcome data exist to support the risk associated with pre-hypertension among adolescents as it is currently defined. Examination of the progression from pre-hypertension to hypertension are required regarding its time course and other associated abnormalities[8,16,17]. BP screening test in children and adolescents is necessary in order to allow early identification of children at risk and to start taking the necessary precautions to prevent and/or control the development of hypertension[18].

The aim of this study was to determine prevalence of high normal and elevated blood pressure among healthy school children and to assess personal medical history, family history and overweight as associated risks.

Materials and Methods

The present study included 965 school children (48.7% girls) in 8th grade of primary school. Data for this study was obtained from a previous study The School Health Survey 2003–2004 involving children from representative sample of 40 primary and 20 secondary schools. The Survey was conducted in children in 1st and 8th grade of primary and 3rd grade of secondary school. The methodology of The School Health Survey was described in the special paper[19] and in the latest issue of the journal[20,21]. In total, 3,101 individuals were selected to participate in The School Health Survey 2003–2004. Out of these selected individuals, response was obtained for 2,851 individuals which results in an overall response rate of 91.9%. Questionnaires were administered to all students in classroom and 30 minutes were given to fulfil. Children in 8th grade of primary and 3rd grade of secondary schools answered the questionnaires by themselves and questionnaires were collected immediately by team of examiners.

Questionnaire The School Health Survey 2003–2004 consisted of following group of questions about: family structure (education of parents, employment status, occupation, number of children in family, order of birth); socio economic, demographic characteristics of selected respondent (age, gender, place of birth, place where live); dietary habits (number of meals, breakfast, fat and caffeine intake, meat, fruit and vegetable consumption); physical activity (time spent and endurance); television and computer use (time spent) – only for 1st grade of primary school; alcohol (consumption, binge drinking); drug abuse (consumption) – only for 8th grade of primary and 3rd grade of secondary school; smoking (smoking habits); teeth hygiene; traffic safety (driving, using of seatbelt); physical conflicts (violence and bullying); self reported health problems (headaches, stomach or back pain and other diseases); family medical history (health problems of family members).

Anthropometric measurements (body height, body weight, blood pressure, heart rate) were taken approximately 5–7 minutes per one student, by trained team of examiners. Children were measured wearing light clothes and no shoes in calm, quite and comfortable setting. Body weight was measured on calibrated digital scale (*Seca 862*) and recorded to nearest 100 grams and body height was measured by a fixed wall-mounted stadiometer and recorded to nearest 0.1 centimetres. Blood pressure measurements were taken during one visit to the schools. BP was measured after the child rested 10 minutes in a comfortable sitting position. None of the children were agitated and none of them had pain. BP was measured twice by auscultation using a standard sphygmomanometer (Riester) with a time interval of at least 30 seconds between the two measurements, on the right upper arm, bent 90 degrees at the elbow, with appropriate cuffs size and recorded to nearest 2 millimetres. Phase I Korotkoff sound was used to indicate SPB and Phase V for DBP. Between two measures, the heart rate was measured in 30 seconds.

Girls were directly asked whether they started to menstruate, and if yes, the exact month and year were recorded.

Data for this study were obtained from completion of questionnaire and physical examination. For the purpose of this study, we analyzed answers from questionnaire about personal medical history (»Have you in the past three years visit a physician for difficulties with: heart and cardiovascular system or/ and thyroid gland?«) and family medical history: (»Illnesses in the family – father, mother, brothers, sisters, grandmothers and grandfathers: elevated blood pressure, heart diseases, diseases of thyroid gland, increased level of blood lipids, diabetes«). On the basis of the data obtained by measurements, BMI as weight/height^2 (kg/m^2) and average value of two BP measurements for SPB and DBP were calculated. In order to calculate the prevalence of high normal and elevated BP the mean value of two blood pressure measurements for SPB and DBP were used in analysis. Boys and girls with a BMI ≥90th percentile for sex and age were considered as being overweight. Overweight (BMI ≥90th percentile) and obese (BMI ≥95th percentile) categories were combined and described as overweight in this paper. The evaluation of BMI was performed according to Croatian BMI referent values for children aged 6.5–18.5 years[22]. Boys and girls with mean value of SBP and/or DBP ≥95th percentile for sex and age were considered to have elevated BP according to Croatian BP referent values for children aged 6.5–18.5 years[22]. Boys and girls were considered to have high normal BP if mean value of SBP and/or DBP was ≥120/80 mmHg[8,9] or if average value of SBP and/or DBP level was ≥90th percentile but <95th percentile for sex and age according to Croatian BP referent values for children aged 6.5–18.5 years[22]. Boys and girls were divided in three categories according to BP level: normal BP, high normal BP and elevated BP. Rates of normal, high normal and elevated BP were calculated. Rates of overweight, positive personal and family medical history were calculated for those categories.

Descriptive statistics was used to describe the distributions of variables and χ^2-test was used to test the dif-

TABLE 1
THE DISTRIBUTION OF CHILDREN ACCORDING TO BLOOD PRESSURE CATEGORIES

	Blood pressure categories			Total
	Normal BP	High-normal BP	Elevated BP	
	N (%)	N (%)	N (%)	N (%)
Girls	*299 (63.6)	*134 (28.5)	*37 (7.9)	470 (100.0)
Boys	*287 (58.0)	*182 (36.8)	*26 (5.3)	495 (100.0)
Total	586 (60.7)	316 (32.7)	63 (6.5)	965 (100.0)

*χ^2=8.816, p=0.0122, BP – blood pressure

ference between the groups according BP categories. Statistical significance was defined as $p<0.05$. The Statistica 9.0 was used for data analysis.

Results

The present study included 956 children in 8th grade of primary school, 470 girls (average age 14.66) and 495 boys (average age 14.73 years). The prevalence of high normal BP was 32.7%, 28.5% in girls and 36.8% in boys. The prevalence of elevated BP was 6.5%, 7.9% in girls and 5.3% in boys (Table 1). The prevalence of elevated SBP was 1.9%, 1.9 % in girls and 1.8% in boys. The prevalence of elevated DBP was 3.3%, 4.3% in girls and 2.4% in boys. Elevated SBP and DBP had 1.3% children, 1.7% of girls and 1.0% of boys. The prevalence rate of high normal BP was higher in boys and elevated BP in girls. The difference was statistically significant (p=0.0122). Average values of SBP, DBP and BMI have increased in boys and girls from group with normal, high normal to elevated BP. Average values of SBP and DBP in groups with normal, high normal and elevated BP were higher in boys than in girls. Average BMI was higher in girls, except boys with elevated BP (Table 2). Cardiovascular risk (CVR) factors associated to high normal and elevated BP were analyzed separately for boys and girls. In personal medical history, more boys and girls with high normal and elevated BP reported difficulties with heart and circulatory system than those with normal BP. Problems with thyroid gland were reported by 13.5% of girls with elevated BP and 1.5% of those with high normal and 2.3% with normal BP, with statistically significant difference ($p<0.001$). In boys, problem with thyroid gland was present in category of normal BP 0.7% and high normal 1.1% but not in group with elevated BP. The rate of overweight was higher in boys and girls with high normal and elevated BP than in those with normal BP. Of girls, 3.7 with normal, 19.4 high normal and 29.7% with elevated BP were considered to be overweight. Of boys, 2.4 with normal, 9.3 with high normal and 30.8% with elevated BP were overweight (Table 3). In family medical history, hypertension was reported by 44.5% girls with normal, 43.3% high normal and 51.4% with elevated BP. The prevalence in boys considering BP categories was 34.1, 35.2 and 42.3%, respectively. Heart disease was reported by 24.4% girls with normal, 20.9% high normal and 18.9% with elevated BP. The rates in boys were 20.6, 14.8 and 23.1%, respectively. Thyroid gland disease was more common in girls with normal 15.1% and elevated BP 21.6% than in group with high normal BP 6.7%. The difference was statistically significant (p=0.015). Increased level of blood lipids was present in 27.1% girls with normal. 21.6 with high normal and 32.4% with elevated BP. In boys, the rates were 14.3, 18.7 and 15.4% respectively. Diabetes was present in 22.7% girls with normal, 27.6% high normal and 18.9% with elevated BP. The rates in boys were 19.2, 21.4 and 23.1% (Table 4). Considering personal medical history, family history and overweight as associated CVR factors to high normal and elevated BP, without those associated risks were 41.2% boys and 24.6% girls with high normal BP and 26.9% of boys and 21.6% of girls with elevated BP (Table 5). Two or more additional CVR factors were more frequent in girls with high normal 17.9% and elevated BP 32.4% than in those with normal BP 6.0%, with statistically significant difference ($p<0.001$). In boys, the prevalence of two or more associated CVR factors were 4.2% in group with normal, 9.9% high normal and 19.2% with elevated BP, with statistically significant difference (p=0.0127) (Table 6). Considering prevalence rate of observed associated CVR factors, the most common CVR factor in boys and girls in all three BP categories was hypertension in family history.

TABLE 2
MEAN VALUE OF SYSTOLIC, DIASTOLIC BLOOD PRESSURE AND BODY MASS INDEX IN BOYS AND GIRLS ACCORDING TO BLOOD PRESSURE CATEGORIES

	Blood pressure categories					
	Normal BP		High-normal BP		Elevated BP	
	Girls $\overline{X}$±SD	Boys $\overline{X}$±SD	Girls $\overline{X}$±SD	Boys $\overline{X}$±SD	Girls $\overline{X}$±SD	Boys $\overline{X}$±SD
Systolic blood pressure (mmHg)	107.16±8.27	108.71±7.91	123.53±5.85	125.30±6.47	134.03±12.21	142.52±15.11
Diastolic blood pressure (mmHg)	62.92±7.72	63.71±7.53	74.71±6.80	73.76±8.73	83.97±7.38	89.10±11.94
Body mass index kg/m^2	19.91±2.64	19.52±2.72	21.63±4.20	21.30±3.86	22.87±4.48	23.19±4.34

$\overline{X}$ – Mean, SD – standard deviation, BP – blood pressure

TABLE 3
THE DISTRIBUTION OF CARDIOVASCULAR RISKS ACCORDING TO BLOOD PRESSURE CATEGORIES

Cardiovascular risks	Blood pressure categories					
	Normal BP		High-normal BP		Elevated BP	
	Girls (299)	Boys (287)	Girls (134)	Boys (182)	Girls (37)	Boys (26)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Personal medical history: heart and circulatory system diseases	9 (3.0)	10 (3.5)	5 (3.7)	7 (3.8)	2 (5.4)	1 (3.8)
Personal medical history: thyroid gland diseases	*7 (2.3)	2 (0.7)	*2 (1.5)	2 (1.1)	*5 (13.5)	0 (0.0)
Overweight	11 (3.7)	7 (2.4)	26 (19.4)	17 (9.3)	11 (29.7)	8 (30.8)

*χ^2=15.653, p=0,000, BP – blood pressure

TABLE 4
THE DISTRIBUTION OF CARDIOVASCULAR RISKS IN FAMILY HISTORY ACCORDING TO BLOOD PRESSURE CATEGORIES

Cardiovascular risks in family history	Blood pressure categories					
	Normal BP		High-normal BP		Elevated BP	
	Girls (299)	Boys (287)	Girls (134)	Boys (182)	Girls (37)	Boys (26)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Hypertension	133 (44.5)	98 (34.1)	58 (43.3)	64 (35.2)	19 (51.4)	11 (42.3)
Heart disease	73 (24.4)	59 (20.6)	28 (20.9)	27 (14.8)	7 (18.9)	6 (23.1)
Thyroid gland disease	*45 (15.1)	25 (8.7)	*9 (6.7)	1 (0.5)	*8 (21.6)	1 (3.8)
Increased level of blood lipids	81 (27.1)	41 (14.3)	29 (21.6)	34 (18.7)	12 (32.4)	4 (15.4)
Diabetes	68 (22.7)	55 (19.2)	37 (27.6)	39 (21.4)	7 (18.9)	6 (23.1)

*χ^2=8.387, p=0,015, BP – blood pressure

TABLE 5
PRESENCE OF ASSOCIATED CARDIOVASCULAR RISKS ACCORDING TO BLOOD PRESSURE CATEGORIES

Cardiovascular risks	Blood pressure categories					
	Normal BP		High-normal BP		Elevated BP	
	Girls (299)	Boys (287)	Girls (134)	Boys (182)	Girls (37)	Boys (26)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Without associated cardiovascular risks	74 (24.7)	122 (42.5)	33 (24.6)	75 (41.2)	8 (21.6)	7 (26.9)
Personal medical history or family medical history or overweight	207 (69.2)	153 (53.3)	77 (57.5)	89 (48.9)	17 (45.9)	14 (53.8)
Personal medical history and family medical history	10 (3.3)	6 (2.1)	4 (3.0)	2 (1.1)	3 (8.1)	1 (3.8)
Personal medical history and overweight	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Family medical history and overweight	8 (2.7)	6 (2.1)	19 (14.2)	16 (8.8)	7 (18.9)	4 (15.4)
Personal medical history and family medical history and overweight	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	2 (5.4)	0 (0.0)
Total	299 (100.0)	287 (100.0)	134 (100.0)	182 (100.0)	37 (100.0)	26 (100.0)

BP – blood pressure

TABLE 6
NUMBER OF ASSOCIATED CARDIOVASCULAR RISKS ACCORDING TO BLOOD PRESSURE CATEGORIES

Number of cardiovascular risks	Blood pressure categories					
	Normal BP		High-normal BP		Elevated BP	
	Girls (299)	Boys (287)	Girls (134)	Boys (182)	Girls (37)	Boys (26)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
0	*74 (24.7)	**122 (42.5)	*33 (24.6)	**75 (41.2)	*8 (21.6)	**7 (26.9)
1	*207 (69.2)	**153 (53.3)	*77 (57.5)	**89 (48.9)	*17 (45.9)	**14 (53.8)
≥2 or more	*18 (6.0)	**12 (4.2)	*24 (17.9)	**18 (9.9)	*12 (32.4)	**5 (19.2)
Total	299 (100.0)	287 (100.0)	134 (100.0)	182 (100.0)	37 (100.0)	26 (100.0)

*χ^2=30.906, p<0.001, **χ^2=12.720, p=0.0127, BP – blood pressure

In girls with normal BP, hypertension in family history was followed by increased level of blood lipids, heart disease, diabetes and thyroid gland disease. In girls with high normal BP, hypertension in family history was followed by diabetes, increased level of blood lipids, heart disease in family history and overweight. In girls with elevated BP, hypertension in family history was followed by increased level of blood lipids in family history, overweight, thyroid gland disease and diabetes in family history. In boys with normal BP, hypertension in family history was followed by heart disease, diabetes, increased level of blood lipids and thyroid gland disease in family history. In boys with high normal BP, hypertension in family history was followed by diabetes, increased level of blood lipids, heart disease in family history and overweight. In boys with elevated BP, hypertension in family history was followed by overweight, heart disease, increased level of blood lipids and thyroid gland disease in family history (Table 7).

Discussion and Conclusion

Epidemiological studies have demonstrated the importance of measuring BP during childhood and adolescence[10–14]. According to Task Force recommendation

TABLE 7
RANKS OF ASSOCIATED CARDIOVASCULAR RISKS ACCORDING TO BLOOD PRESSURE CATEGORIES IN BOYS AND GIRLS

Cardiovascular risks	Blood pressure categories											
	Normal BP				High-normal BP				Elevated BP			
	Girls (299)		Boys (287)		Girls (134)		Boys (182)		Girls (37)		Boys (26)	
	N (%)	Rank	N (%)	Rank	N (%)	Rank	N (%)	Rank	N (%)	Rank	N (%)	Rank
Hypertension in family history	134 (44.8)	I	98 (34.1)	I	58 (43.3)	I	64 (35.2)	I	19 (51.4)	I	11 (42.3)	I
Increased level of blood lipids in family history	81 (27.1)	II	41 (14.3)	IV	29 (21.6)	III	34 (18.7)	III	12 (32.4)	II	4 (15.4)	IV
Heart disease in family history	73 (24.4)	III	59 (20.6)	II	28 (20.9)	IV	27 (14.8)	IV	7 (18.9)	V	6 (23.1)	III
Diabetes in family history	68 (22.7)	IV	55 (19.2)	III	37 (27.6)	II	39 (21.4)	II	7 (18.9)	V	6 (23.1)	III
Thyroid gland disease in family history	45 (15.1)	V	25 (8.7)	V	29 (21.6)	III	11 (6.0)	VI	8 (21.6)	IV	1 (3.8)	V
Overweight	11 (3.7)	VI	7 (2.4)	VII	26 (19.4)	V	21 (11.5)	V	11 (29.7)	III	8 (30.8)	II
Heart and cardiovascular system disease	9 (3.0)	VII	10 (3.5)	VI	5 (3.7)	VI	7 (3.8)	VII	2 (5.4)	VII	1 (3.8)	V
Thyroid gland disease	7 (2.3)	VIII	2 (0.7)	VIII	2 (1.5)	VII	2 (1.1)	VIII	5 (13.5)	VI	0 (0.0)	VI

BP – blood pressure

multiple BP measurements (at least in three separate occasions) should be obtained before making a diagnosis of pre-hypertension or hypertension. The prevalence of high normal and elevated BP is higher after an initial set of measurements[8]. Some authors suggest that to be classified as having pre-hypertension it is only necessary to have a BP in pre-hypertensive range at one measurement[17]. According to results of study performed by Brady et al. among children aged 3 to 20 years, out of 39% of children with BP level above adult values (120/80 mmHg), 87% were not recognized as »at risk«. Obesity, family history of cardiovascular disease, or BPs significantly elevated above adult values was not sufficient for health care providers to recognize BP elevation in children[23]. Using the Croatian BP referent values according to age and sex to determine high normal and elevated BP in children of 8th grade of primary school, the prevalence of high normal and elevated BP after first screening in our study was 32.7% and 6.5%, respectively. The prevalence of high normal BP was higher in boys 36.8%, than in girls 28.5%, though the prevalence of elevated BP was higher among girls 7.9% than in boys 5.3%. The prevalence of elevated SBP 1.9% was higher than DBP 1.3%. The prevalence of elevated SBP, elevated DBP and both was higher in girls (1.9%, 4.3%, and 1.7% respectively) than in boys (1.8%, 2.4%, and 1.0% respectively). Among all children with elevated BP, the prevalence of elevated DBP 50.8% was higher than that of SBP 28.6%. Using the Croatian referent values to determine overweight, the prevalence of overweight (≥90th percentile) was 8.7%, in girls 10.2% and 7.3% in boys. The prevalence of overweight was higher among boys and girls in high normal and elevated BP category, than in those with normal BP. Studies conducted in different regions among children and adolescents demonstrated different prevalence rates of overweight, obesity, high normal and elevated BP. The divergent prevalence rates of high normal and elevated BP among children and adolescents in different age groups may result from influence of methodologies, protocols, number of measurements and criteria used to determine overweight, obesity high normal and elevated BP. Akgun et al. used national percentile curves according to age and sex to determine overweight, high normal and hypertensive BP values in 7–16 years old children, using mean value of six measurements. In their study, hypertension was more common in boys than in girls and among hypertensive children, the prevalence of systolic hypertension was higher than diastolic. The rate of obesity in girls with hypertension was 10.5%, in boys 13.2%. In 14 years old girls, the prevalence of systolic hypertension was 5.8% and diastolic 0.9%. In boys, the rates were 4.6% and 0.9%, respectively. Average value of SBP and DBP were higher in boys than in girls[24]. Adrogué et al. found prevalence of systolic hypertension 2.7% and diastolic 2.0% in children aged 10–15 years after the initial screening. There was no significant difference in prevalence of systolic hypertension between girls 2.8% and boys 2.7% but there were a significantly greater number of girls 2.7% than boys 1.3% with diastolic hypertension, as we found in our study[25]. McNiece et al. have found among adolescents aged from 11 to 17 years prevalence of high normal blood pressure after first screening 9.5%, which rose after 3 screenings to 15.7%, using the same criteria as we in our study for high normal BP (BP values equals or greater than 120/80 mmHg). Prevalence of hypertension after first screening was 11.7%. Overweight was independently associated only with hypertension. Considering children who met criteria for pre-hypertension and hypertension after first screening McNiece et al. emphasized that 20% of children after first screening could be considered to be »at risk« for them the lifestyle modifications and more frequent monitoring would be crucial[17]. Such approach would be required for 39.2% of children in our study. Costanzi et al. demonstrated prevalence rate of high normal BP among children aged 7 to 12 years of 5.4% and elevated BP of 8.4% after first screening. Overweight was 28.1% of participants and high BP was more frequent among those[26]. Stephen et al. indicated that familial influence could be detected in children and it is possible that factors responsible for essential hypertension are acquired in childhood[27]. Alpay et al. demonstrated, using ambulatory BP monitoring and Task Force criteria for hypertension, the presence and impact of parental hypertension in children aged 3–18 years. Children with a positive family history of hypertension had beside higher weight and BMI values, early changes in BP parameters, compared with children with normal BP. Those findings suggest that children with positive family history of hypertension are at increased risk for hypertension in later life and deserve closer evaluation and follow-up[28]. In our study, the prevalence of positive family history of hypertension was present in 51.4% of girls and 42.3% of boys with elevated BP and 43.35 of girls and 35.2% of boys with high normal BP. But also 44.5% of girls and 34.1% of boys with normal BP with positive family history of hypertension could be considered to be »at risk«. Malbora et al. have reported rate of 1.4% of children (average age 14.02±1.88) in a sample of 2776 children with at least one hypertensive relative revealed by questionnaire. The history of hypertension was the highest in grandmothers. The SBP and DBP levels of children with positive family history of hypertension measured by 24-hour ambulatory blood pressure monitoring (ABPM) were significantly higher than in those without family history of hypertension[29]. Munger et al. found higher mean of SBP at the first screening compared to children without such a history[30]. We found the similar results in our study in girls (114.78 *vs.* 113.30 mmHg) and in boys (117.14 vrs. 116.28 mmHg). The mean of DBP in our study were also higher among girls (68.57 vrs 67.47 mmHg) and boys (69.69 *vs.* 68.41 mmHg) with positive family history of hypertension. Salvadori et al. have found prevalence of pre-hypertension in cross sectional study in 7.6% and hypertension in 7.4% of children aged 4–17 years, after first screening. The difference in prevalence rate of overweight and obesity could be explained by use of different criteria as well as for hypertension. Overweight and obesity was present in 18.1% and 11.4% of children, respectively. The criteria used to determine pre-hypertension were those recommended by

Task Force. Only children aged ≥12 year for SBP and ≥16 years for DBP were considered pre-hypertensive if BP was ≥120/80 mmHg and it might explain the difference in pre-hypertension prevalence rate. Positive family history of hypertension was reported by 15.1% participants (in our study 39.7%). Data on family history was collected by face to face computer assisted interview and as we did it by questionnaire but such a difference in reported rate could not be explained by different methodology[31]. The questionnaire provides a reliable and valid method of collecting family history and can be used justifiably as a risk factor for life-style related diseases among children and youth[32]. Because of large association between obesity and elevated BP across age group and genders in this study independently of family history of hypertension authors suggest that substantial part of elevated BP in observed rural population could be explained by overweight and obesity[31]. The high prevalence of pre-hypertension and hypertension in our study could indicate the very high presence of CVR in population according to high rate of reported positive family history of hypertension. Mavrakanas et al. determined prevalence of elevated BP in rural Greek population of 4–10 years children 7.9% after firs screening. Obesity was associated with and increased risk of elevated BP (relative risk of 5.2 to 6.2) independently on criteria used. The criteria used to determine overweight and obesity were CDC growth charts, IOTF standards and national referent values. The prevalence of obesity varied from 13.6% to 31.7% for boys and from 14.4% to 35.1% for girls. The study was performed as a part of compulsory school health screening program. Those programs are approved and organize by Ministries of Health and Education and are exempt from additional ethics committee. Throughout regular systematic examinations could reveal actual CVRs and follow up the children considered to be »at risk«. Elevated BP was determined as BP ≥95th percentile using normative Greek charts according to age, gender and height. Authors' suggestion regarding explanation of high prevalence of obesity in rural areas is lack of health education and general perception in rural areas to be overweight is a sign of good health[33]. Similar general opinion seemed to present in Croatia, despite the prevalence rate of overweight and obesity is lower than presented in this study. Antal et al. reported prevalence of elevated BP among 6345 school children in Hungary aged 15 to 18 years, 14.1% in boys and 2.5% in girls after first recordings. The criteria of hypertension were SBP ≥135 and/or DBP ≥85 mmHg for age group 15 years and SBP ≥140 and/or DBP ≥90 mmHg for those aged >15 years. After three BP measurement in three separate occasions the prevalence rate among boys was 7.5% and in girls 1.1%. More hypertensive were found among the obese than non-obese subjects. Hypertensive children were referred to further examination or treated by school doctors. A portion of hypertensive students were not aware of pathological BP values and consequences[34]. Urrutia-Rojas et al have reported prevalence of 20.6% of hypertension (≥95th percentile) after first screening using oscillometric method, among school children aged 10–12 years. The factors associated with high BP in this study were obesity and ethnicity. Likelihood of having high BP was at least three times higher among overweight children (≥85th percentile). In this study, females showed higher risk of BP>95 percentile than males. The prevalence of systolic hypertension was 16% and diastolic 2%[35]. Dinç et al. reported prevalence rate of pre-hypertension 14%, hypertension of 3.5% (after first screening) which might have been attributed to low prevalence of overweight and obesity. The school based survey was conducted among 1346 adolescents aged 15–18 years; Task Force criteria for BP and CDC for overweight/obesity were used. Family history of hypertension was reported by 22% of participants. Systolic hypertension was found in 2.5% and diastolic in 1.8%. The prevalence of pre-hypertension/hypertension was the highest among children aged 15 years old 25.5% with higher prevalence in females. These results are the similar to our findings and might indicate that in this age group of 14–15 years old adolescents the level of CVR is high, especially pre-hypertension. In this study as pre-hypertensive were considered just those children with SBP and/or DBP ≥90th percentile[36]. Čavlek et al. have found among children in 8th of primary school prevalence of elevated BP after first screening 4.4% (in girls 2.7% and in boys 6.1%) using the criteria SBP and/or DBP ≥140/90 mmHg. Average values of SBP, DBP and BMI were higher in group of children with elevated BP. Elevated SBP was found in 0.7% girls and 3.9% boys, elevated DBP was found in 0.7% girls and was not found in boys. Elevated SBP and DBP were found in 1.3% girls and 2.2% boys. Positive family history of CVR was found in 29.6%, positive personal history on CVR was found in 37% and overweight was present in 29.6% children. Considering the number of CVR factors in all participants (2350 in 5th and 8th grade of primary school and 1st grade of secondary school), elevated BP without associated risks was present in 9% of participants and 60.4% of participants had 2 or more CVR factors. As in our study, this study presented high CVR among children in Croatia[37]. Rumboldt et al. have found among subgroup of children, considered as at risk, whose parents have suffered a heart attack in their late thirties and early forties that relative weight, BP and plasma cholesterol were significantly higher. Elevated BP (>124/84 mmHg) was found in 40% of those children. In 36% of children the most prevalent risk factors were overweight and elevated BP[38]. Positive personal and family history on thyroid gland disease and it influence was not discussed in recent BP screening studies. Our results suggest that it might have influence in girls with elevated BP, but not in those with high normal. However, results of our study indicates high rate of CVR in population of children aged 14–15 years and support the idea that is a age of 12 to 14 a possible critical temporal window for short term monitoring of BP and possibly to its maintenance up to the adult life[39]. Some of the limitations of our study are that BP measurement was performed during only one visit to school, since it may overestimate the prevalence of high normal and elevated BP. The second limitation could be the method of categorisation of family members as hyperten-

sive according to information obtained by questionnaire. Blood pressures of parents and other relatives were not measured and medical records were not used for validation of data from family and personal medical history. As Brady et al. emphasized, to prevent the long-term complications of unrecognized or untreated hypertension, it is important for health care providers, especially pediatricians and school medicine specialists to recognize children with elevated BP as early as possible. Once elevated BP is recognized, confirmation, evaluation, and treatment can commence. Enhanced provider education is needed to ensure that providers are practicing in the context of current guidelines and to improve ability to detect elevated BP in children who may seem to be at low risk[23]. The results of our study indicates inconsistency of findings considering classification of children in BP categories: normal, high-normal and elevated BP. Observation of associated common CVR factors indicates that presence of associated CVR factors such as personal medical history and family history of CVR is more frequent in children with elevated BP in comparison with those with normal BP. This trend was not observed in our study in children with high normal BP. But, as it was previously emphasized, the progression from pre-hypertension to hypertension requires further examination and follow up of children at risk group, those who met criteria for adult elevated BP (greater than or equal to 120/80 mmHg) in order to prevent development of cardiovascular disease in the future. School medicine in Croatia could detect children in risk for CVR and develop the data base of common CVR throughout regular program of specific preventive measures. The associated factors such as overweight, family history of hypertension and personal history of thyroid gland (in females) observed in this study can be used as independent markers of having elevated BP. Population of school aged children may be followed--up throughout school age, resulting in implementation of databases with the purpose of revealing the CVR thus making it possible to take useful measures, trying to prevent diseases and promote healthy life style.

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UČESTALOST I PRIDRUŽENI ČIMBENICI RIZIKA ZA POVIŠENI ARTERIJSKI TLAK U ŠKOLSKE DJECE I MLADIH

S A Ž E T A K

Povišeni arterijski tlak u djece i mladih određuje se na temelju normalne distribucije izmjerenog arterijskog tlaka u zdrave djece. Cilj ovog istraživanja bio je utvrditi učestalost visokog normalnog i povišenog arterijskog tlaka u zdrave školske djece, obzirom na prisutnost ostalih kardiovaskularnih rizika. Istraživanje je provedeno među 965 (48,7% djevojčica) učenika 8. razreda osnovnih škola. Podaci za potrebe ovog rada prikupljeni su pomoću upitnika i antropometrijskim mjerenjima. Učestalost visokog normalnog iznosila je u djevojčica 28,5%, u dječaka 36,8%, dok je učestalost povišenog arterijskog tlaka iznosila u djevojčica 7,9% i 5,3% u dječaka. Prekomjernu tjelesnu težinu imalo je 19,4% djevojčica i 9,3% dječaka s visokim normalnim i 29,7% djevojčica i 30,8% dječaka s povišenim arterijskim tlakom. Najčešći pridruženi kardiovaskularni rizik bila je hipertenzija u obiteljskoj anamnezi. Otkrivanje i praćenje čimbenika kardiovaskularnih rizika moguće je u školskoj dobi kroz aktivnosti školske medicine, s ciljem poduzimanja preventivnih mjera i promicanja zdravog načina života.