MAEDICA – a Journal of Clinical Medicine
2013; 8(1): 5-10

MÆDICA - a Journal of Clinical Medicine

ORIGINAL PAPERS

Hypertension in Romanian Children and Adolescents: A Cross-Sectional Survey

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ABSTRACT

Aim: *Knowledge of the existence of a prolonged action of cardiovascular risk factors since childhood is extremely important in a country with one of the highest cardiovascular mortality in Europe. The purpose of this survey was to study the prevalence of arterial hypertension (AH) and cardiovascular risk factors in Romanian paediatric population.*

Methods: *Children and adolescents (2407 males, 2459 females), aged 3 to 17 years from Bucharest and Ilfov County were admitted in a cross–sectional survey. Body weight, height, and blood pressure (BP) were measured and the percentiles for height, BP and body mass index were established. An interviewer-administered questionnaire about some presumed risk factors was used.*

Results: *The prevalence of AH in our population was 7.4%. In Bucharest AH prevalence was 8% and in rural areas 6.8% (P=0.69). AH prevalence was higher both in overweight (12.4%) and obese (24.4%) groups comparing with normal weight (5.8%), (P<0.0001). In the underweight group, AH prevalence was 3.8%. We found statistically significant the association between male gender and SH (P=0.032). While SH increases with age (P=0.015), diastolic DH decreases with age (P=0.0003). We found no correlation between AH in children and adolescents and consumption of caffeinated beverages, family history of cardiovascular disease, smoking, low birth weight, sleep disorders and abnormal sleep duration, absence of extra-school sport activity.*

Conclusion: *The high AH prevalence together with overweight or obesity represent cardiovascular risk factors, identified within our population.*

Keywords: hypertension, children, high normal blood pressure, overweight, cardiovascular risk factors

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Article received on the 13th of December 2012. Article accepted on the 20th of March 2013.

INTRODUCTION

Romania has one of the highest national prevalence rates of arterial hypertension (AH) in the European Union (1). The etiology of AH is multifactorial, but whether the external factors act earlier in life is less known. An early onset of AH in children and adolescents was demonstrated in many reports, but what is worrying is the increasing prevalence in children, often associated with overweight and obesity (2), responsible for an early progression to end-organ damage (left ventricular hypertrophy, increased arterial intima-media thickness, chronic kidney disease) (3).

Previous Romanian reports, written 30 years ago, showed a prevalence of AH in children around 3%, equal or smaller than prevalence in other countries. A number of various methods of measurement were used and the groups were restrained to limited ranges of ages (4). The present AH prevalence in children and adolescents in Romania and the relation with other cardiovascular risk factors are unknown.

We therefore conducted a cross-sectional survey on pediatric population aged 3-17 years, to determine AH prevalence. We evaluated a paediatric population from the Bucharest area and Ilfov County surrounding villages. ❑

MATERIALS AND METHODS

Study Population

5290 children and adolescents were initially recruited for this study between 2006 and 2008. 424 were excluded for either of the following reasons: they were absent at the second or third measurement, they were older than 18, they or their parents did not give their consent. We selected 3 kindergartens, 5 schools and 1 high school in Bucharest and 8 kindergartens, 6 schools and 1 high school in Ilfov County. There were 2187 participants from Bucharest (urban area) and 2679 from Ilfov County (rural area) who made up the entire population attending school or kindergarten at the moment of the study. In the end we analyzed data from 4866 subjects. 2459 were females (50.5%) and 2407 males (49.5%).

Data Collection

Weight, height, blood pressure (BP) measurements were taken. BP was measured at different hours, never the same for the same subject. Consent was obtained before measurements. We calculated the body mass index (BMI). We reported the values obtained for height, BMI, BP to those from tables recommended by the American Academy of Pediatrics (AAP)5 and the Centers for Disease Control and Prevention (CDC) (http://www.cdc.gov/growthcharts). An interviewer-administered questionnaire about family history of heart disease, consumption of caffeinated soft drinks, smoking, absence of extra-school sport activity, and sleeping hours and disorders was used for both parents and children.

A mobile digital scale (SECA, Hamburg, Germany; accuracy 100 g) was used to measure weight, with children dressed in light clothing. Height accuracy was 5 mm. BP measurements were made using a validated oscillometric BP monitor for the first measurement (Omron 705IT) and a mercury BP monitor (Riester) for the second and the third measurement, both with adapted cuffs, taken at one week interval; method accepted by the AAP.5 We strictly followed the recommendations of the Fourth Report on the Diagnosis, Evaluation and Treatment of High Blood Pressure in Children and Adolescents of the National High Blood Pressure Education Program (NHBPEP) (5).

Systolic blood pressure (SBP) was defined as the first Korotkoff sound, and diastolic blood pressure (DBP) as the fifth Korotkoff sound (the disappearance of Korotkoff sounds). A trained physician wearing casual clothes performed the measurements, after at least 5 minutes of patients resting, in a sitting position. They were performed in the patient's right arms supported at heart level. Appropriately sized cuffs were used (bladder width at least 40% of arm circumference, length 80-100% of arm circumference).

The study was approved by the Ethics Committee of the "Carol Davila" University.

Definitions

Arterial hypertension in children is defined as systolic and/or diastolic blood pressure exceeding the 95th percentile for age, gender and height after at least three measurements (5). High normal BP represents the average SBP or DBP levels that are ≥90th percentile and <95th

percentile (5). BP measurements were included in a computerized database and values of BP over 95th percentile identified based on US normative blood pressure tables (5). The second and third measurement followed at one week interval between themselves. If all three measurements exceeded the 95th percentile of BP for age, gender and height, the subjects were considered hypertensive.

BMI percentiles pointed to underweight, overweight and obesity. BMI less than 5th percentile identified underweight; between 85th and 95th percentiles, BMI was an indicator of overweight, while obesity was defined as BMI over 95th percentile according to CDC normative tables (6,7).

Statistical Analysis

Mean and standard deviation were calculated for height, BMI, SBP and DBP according to gender. We described types of hypertension (systolic, diastolic and systo-diastolic) for each weight class.

The proportions of hypertensive children were compared between sexes and weight classes by chi-squared test.

P values were calculated for each type of AH in various weight classes.

We used linear regression of age-related height, BMI, BP.

All-data analysis was performed in R V1.21.1 (R Foundation for Statistical Computing, 2010) on an Ubuntu V11.04 personal computer.

$P < 0.05$ was considered statistically significant. ❑

RESULTS

Characteristics of the study population regarding height, BMI, SBP and DBP for each 3 to 17 age group are presented in Table 1 for females and in Table 2 for males, respectively.

Age (years)	Subjects (n)	%	Height (cm)		BMI		SBP (mmHg)		DBP (mmHg)	
			Mean	SD	Mean	SD	Mean	SD	Mean	Sd
3	35	1.4	99.7	5.9	14.4	1.8	92.1	11.1	60.6	9.1
4	85	3.5	106.0	6.4	14.3	2.7	94.7	10.0	61.0	9.5
5	95	3.9	115.7	5.6	14.4	1.9	101.1	11.6	63.4	8.3
6	150	6.1	120.5	5.3	14.8	2.5	102.7	11.6	62.8	9.8
7	179	7.3	126.1	6.5	15.5	2.4	102.1	13.0	63.9	10.9
8	201	8.2	131.9	6.7	15.9	2.9	104.3	12.4	64.5	11.1
9	190	7.7	137.7	7.2	16.8	3.3	106.1	14.5	65.4	11.9
10	202	8.2	142.7	8.0	17.3	3.4	107.8	15.3	65.7	11.5
11	152	6.2	148.3	7.9	18.3	3.6	111.9	13.1	69.0	10.7
12	175	7.1	153.7	8.0	19.2	3.4	116.4	13.3	70.5	10.2
13	154	6.3	157.9	7.3	20.1	3.1	118.3	14.2	72.1	10.2
14	182	7.4	161.8	6.5	20.4	3.6	116.3	11.6	71.6	8.9
15	209	8.5	163.5	6.3	19.9	2.8	114.1	12.0	69.6	10.0
16	229	9.3	164.3	6.2	20.0	2.6	113.0	12.2	67.9	9.8
17	221	9.0	164.5	6.4	20.0	3.0	113.0	14.2	67.4	11.1
Total	2459	100.0	145.2	19.4	17.9	3.7	109.3	14.4	67.0	10.9

TABLE 1. Description of the cohort according to height, BMI, SBP and DBP in females.

Age (years)	Subjects (n)	%	Height (cm)		BMI		SBP (mmHg)		DBP (mmHg)	
			Mean	SD	Mean	SD	Mean	SD	Mean	Sd
3	31	1.3	101.6	5.9	15.2	1.6	95.7	13.2	59.6	7.3
4	63	2.6	108.3	5.8	15.0	2.0	95.9	10.2	58.6	8.5
5	116	4.8	116.0	5.7	15.0	2.4	100.5	11.1	62.2	10.9
6	150	6.2	121.6	5.9	15.1	2.3	101.6	11.5	61.3	9.1
7	207	8.6	127.3	6.5	15.6	2.6	104.8	12.6	64.9	11.4
8	194	8.1	132.9	7.8	16.4	2.9	105.0	11.8	63.0	10.9
9	203	8.4	138.2	7.5	16.7	3.2	107.2	12.1	64.2	10.3
10	216	9.0	142.8	6.7	17.2	3.4	108.4	12.1	66.5	11.1
11	188	7.8	146.3	7.0	18.0	3.3	109.8	12.9	68.8	10.7
12	180	7.5	153.0	8.2	19.2	3.8	113.7	12.5	69.5	10.1
13	176	7.3	159.7	8.9	19.1	3.2	118.2	14.4	70.6	11.5
14	189	7.9	166.9	9.6	19.8	3.4	121.3	12.9	69.8	10.4
15	186	7.7	173.5	8.5	20.0	3.1	120.7	13.5	68.5	11.2
16	163	6.8	176.5	7.1	20.7	3.2	123.5	14.1	67.7	10.9
17	145	6.0	177.2	7.1	20.9	3.4	122.5	14.4	67.5	9.8
Total	2407	100.0	147.1	21.9	17.9	3.7	111.5	15.1	66.3	11.0

TABLE 2. Description of the cohort according to height, BMI, SBP and DBP in males.

Height, BMI, SBP and DBP tend to increase with age in both genders.

AH prevalence was 7.4%, found in 358 children and adolescents (7.3% in female gender and 7.4% in male gender, P=0.001). 4.1% had systolic hypertension (SH), 0.3% had diastolic hypertension (DH) and 3.0% had systo-diastolic hypertension (SDH) (Table 3). In Bucharest AH prevalence was 8% and in rural areas 6.8% (P=0.69). AH prevalence was higher in overweight and obese groups: 12.4% and 24.4%, respectively, compared with 5.8% normal-weight (P<0.0001, OR 2.32, 95%CI =1.69, 3.13, and P<0.0001, OR 5.27, 95%CI =3.90, 7.07, respectively). In the underweight group, AH prevalence was 3.8%. We found statistically significant the difference between AH prevalence in normal-weight and underweight groups (P<0.0001, OR 1.56, 95% CI = 1.04, 2.42). SDH was prevalent in underweight, while SH was the most frequent in normal weight, overweight and obese groups.

High normal BP prevalence was 16.7%, found in 813 children and adolescents (Table 3).

69.3% of children and adolescents were in the normal weight range. Overweight and obesity prevalences were 10.1%, and 6.4%, respectively. Underweight was present in 14.2%. Obesity prevalence in the AH group was 21.2%.

We found statistically significant the association between male gender and SH (P=0.032). While SH increases with age (P=0.015), diastolic DH decreases with age (P=0.0003).

We found no correlation between AH in children and adolescents and the other presumed risk factors: heart disease family history (P=0.26), smoking (P=0.16), low birth weight (P=0.79), sleep disorders (P=0.089) and abnormal sleep duration (P=0.82), absence of extra-school sport activity (P=0.64). AH prevalence in these subgroups of presumed risk factors are listed in Table 4.

Although many reports associated soft drink consumption with overweight/obesity, we found no significant relation between caffeinated soft drink consumption and overweight/obesity (P=0.36) or arterial hypertension (P=0.96). Daily caffeinated soft drink consumption was present in 10.4% of all children and adolescents. 9.3% of these obese children (n=311) and adolescents were daily consumers of caffeinated soft drinks. ❑

DISCUSSIONS

The present study explored the prevalence of hypertension and other cardiovascular risk factors in children and adolescents living in the Bucharest area. We found AH prevalence of 7.4%, higher than previously reported. Hypertension was more prevalent in males and associated with obesity and overweight. High normal BP prevalence was 16.9%. Overweight and obesity prevalence in children and adolescents were 10.1%, and 6.4% respectively,

		High	Normal BP	SH		DH		SDH		AH	
		n	%	n	%	n	%	n	%	n	%
Total	4866	813	16.7	200	4.1	13	0.3	145	3.0	358	7.4
UW	691	80	11.6	9	1.3	2	0.3	15	2.2	26	3.8
NW	3374	554	16.4	116	3.4	2	0.1	77	2.3	195	5.8
OW	490	112	22.8	32	6.5	3	0.6	26	5.3	61	12.4
O	311	67	21.5	43	13.8	6	1.9	27	8.7	76	24.4

TABLE 3. Percentages of different types of hypertension in weight categories.

BP, blood pressure; SH, systolic hypertension; DH, diastolic hypertension; SDH, systo-diastolic hypertension; AH, arterial hypertension; UW, underweight; NW, normal weight; OW, overweight; O, obese.

Presumed risk factor	Total number of children (n)	AH children (n)	%
Overweight	490	61	12.4
Obesity	311	76	24.4
Underweight	691	26	3.8
Family history of heart disease	484	46	9.5
Smoking	164	12	7.3
Low birth weight	20	2	0.1
Caffeinated soft drinks	507	49	9.7
Sleep disorders	131	8	6.1
Abnormal sleep duration	163	11	6.7
Physical inactivity	431	48	11.1

TABLE 4. Prevalence of presumed risk factors.

which are around the median of reported values from other countries (8). These results complement recent data about AH prevalence in adults in Romania (1) and show the importance of AH screening in children.

Our study has several strong points relevant for AH assessment in children. Firstly, this is the largest study on 3-17 age range published in Romania, a Central-Eastern European country with one of the highest prevalences of cardiovascular diseases in the European Union. Secondly, measurements were taken with validated instruments by a physician wearing casual clothes, in order to obtain a minimization of the "white-coat" effect. Thirdly, there were three blood pressure measurements in order to obtain a lower blood pressure prevalence. High blood pressure prevalence is widely known to decrease at the second, and more so at the third measurement. Fourthly, this is one of few studies to look into the relation between hypertension and caffeinated soft drink consumption. However, our study does not carry enough statistical strength, given that only about 20% of respondents provided an answer to the caffeinated soft drink consumption question. There are data in the literature claiming a relation of increased soft drink intake to overweight/obesity (9,10).

Our study also has limitations. Firstly, it is a monocentric study (Bucharest area) and biases could interfere, should we extrapolate results to the whole Romanian paediatric population. However, this study observes urban-to-rural population proportions at country level and includes all social, economic and ethnic groups living in these areas. Secondly, equipment used was different between the first and the second and third BP measurements (oscillometric vs. mercury). However, we abided by the NHBPEP5 recommendation regarding BP evaluation which specifies that in case of over 90th percentile BP obtained with oscillometric devices, measurements must be repeated by auscultation (3,5), and acted accordingly. Thirdly, there is the unavoidable subjective nature of this or any questionnaire to take into account, as well as the fact that not all questions benefited from answers. Partial data were consequently collected using the questionnaire. Fourthly, there is the usual diminished value of heart disease family history in younger children (with younger parents). Fifthly, we used American reference data for European children, and are aware of adjusted percentiles for SBP and DBP in Northern-Western European being 6/3 mmHg higher than in American children (11). But data from a neighbour country, Serbia, presented the same or equal percentiles for children aged 7 to 14, just like American data (12). European references published after the moment we took measurements proved the same as American references (3,5).

We found a high AH prevalence, although there are significant differences between studies regarding the number of participants, age groups, the number of measurements per individual or overall number of visits, the method used, or BMI group composition. In our group, 69.3% of the participants were in the normal weight range, whereas in another study the majority was underweight (13). 7.4% AH prevalence in children and adolescents in our study was higher compared with other European countries: Switzerland (2.2%) (14), Iceland (3.1%) (15), Poland (3.3%) (16), Italy (4.2%) (17), but also compared with countries outside Europe like the US (3.2-3.6%) (18), Brazil (3.5%) (19), Egypt (4%) (20), Mexico (4.7%) (21), and India (5.2%) (13). Higher AH prevalence in children and adolescents were found only in a few countries, like Iran (7.7%) (22), China (11.1%) (23), Tunisia (11.2%) (24), Portugal (12.8%) (25), and Greece (13.3%) (26). In Japan, AH prevalence was reported together with high normal blood pressure at 10.8-15.9% (27).

We found a strong correlation of AH with obesity and overweight, which confirms the importance of the weight issue in AH management. 24.4% AH was identified in the obese group, compared with 30% or 51% reported in other studies (2,5). Obesity and overweight were 3.3, and 1.7, respectively, more frequent in hypertensive children and adolescents, compared with the whole group. Our study also confirms high AH prevalence in males.

AH prevalence in urban areas was higher compared with rural areas although the proportion of overweight and obese children and adolescents was higher in rural areas.

We found no significant relation between AH prevalence and caffeinated soft drink consumption, low birth weight, smoking, abnormal sleep duration or sleep disorders. The literature features a strong correlation between soft drink consumption and overweight/obesity both in pre-adult and in adult ages. The daily consumption of caffeinated soft drink in our group was 11.7%, in the same range as in other

European country (Latvia, 10-16%), but less than in the US (56%) or Canada (36%) (9,28). Heart disease family history was not significantly associated with AH in children and adolescence in our study, but there are limitations of the study regarding the parents' age.

The most important finding brought by this study is the confirmation of the increasing AH prevalence in children and adolescents in our geographical area, this being, for the moment, one of the highest AH prevalences in children and adolescents in Europe. AH prevalence in children and adolescents in Bucharest area is more than double, compared with the one 30 years ago (4). The increasing AH trend in children and adolescents in Bucharest area is likely to be associated with the high overweight and obesity prevalence in this age group. ❑

Conflict of interest: none declared.

Financial support: none declared.

Acknowledgements: The authors express their gratitude to the children and their parents for their agreement and participation in the study and also thank the headmasters, teachers and all the other people who support us in performing this study. We thank Alexandru Corlan, MD, PhD, for the statistical analysis carried out.

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