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Risk factors associated with arterial hypertension in adolescents

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Abstract

Objective: To investigate the risk factors associated with essential arterial hypertension in adolescents.

Methods: A case-control, outpatients-based study of adolescents, aged 11 to 19 years, all treated at the Center for Studies into Adolescent Health (Núcleo de Estudos da Saúde do Adolescente) at Universidade Estadual do Rio de Janeiro. Nutritional status was assessed by means of body mass index. Data were also obtained on waist circumference, height, family history of arterial hypertension, birth weight and pubertal development. The analysis was performed using unconditional logistic regression.

Results: The study investigated 91 cases and 182 controls. Body mass index was associated with hypertension. Height had a positive association with hypertension only among the girls. There was no evidence of an association between pubertal development or birth weight with arterial hypertension in adolescence. In contrast, family history, particularly when both parents had hypertension, exhibited a robust association, both among the boys (OR = 13.32; 95%CI 2.25-78.94), and the girls (OR = 11.35; 95%CI 1.42-90.21).

Conclusions: In our study, overweight, obesity and family history of hypertension (father and mother with hypertension) were the principal risk factors for arterial hypertension in adolescents.

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Introduction

Essential systemic arterial hypertension is a multifactor disease, in which several different mechanisms are involved, leading to an increase in cardiac output and peripheral vascular resistance.[1] In Brazil, some studies have indicated prevalence rates of 22 to 44% among adults.[2] Although it predominantly affects that age group, its prevalence among Brazilian children and adolescents is not negligible. Observations of adolescents in Rio Grande do Sul revealed that 6.6% had diastolic blood pressure and 12.9% systolic pressure above the 95th percentile.[3] In São Paulo, a prevalence of 2.7% was observed among children and adolescents.[4]

Obesity is the principal risk factor for arterial hypertension. Reducing body mass index (BMI) results in significant reductions in blood pressure levels,[5] and this is one of the pillars of non-pharmacological management of the disease.[6] The prevalence of obesity and overweight has been increasing over the years among adolescents in many parts of the world. Cole et al.[7] studied 18-year-old adolescents in Brazil and found prevalence rates of obesity for males and females of 4.7 and 15.2%, respectively. The distribution of body fat and its relationship with cardiovascular disease, including hypertension, has been the investigated by many researchers.[8,9] Waist circumference measurements are currently considered one of the best parameters for studying

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the association between obesity and cardiovascular diseases, being directly related to the accumulation of intravisceral fatty tissue and causing greater damage to health.[10]

In recent years, intrauterine malnutrition and its association with degenerative pathologies, such as hypertension, coronary disease and others, have been the focus of study.[11,12] Familial aggregation and hypertension have also been investigated. A combination of family lifestyle, incorrect dietary habits and inactivity results in hypertension, together with overweight-obesity, being present in individuals who are genetically predisposed.[13] It is accepted that hypertension is determined by changes to biological systems, originating from combinations of genes, each one contributing an effect in the direction of increased blood pressure levels.[14] The fundamental importance of identifying these genes lies in the fact that, if children and adolescents who are predisposed can be diagnosed while still in a pre-hypertensive state, more effective preventative measures can be employed.

The objective of this study was to investigate the relationship between arterial hypertension and a history of hypertension among parents, socioeconomic status and nutritional status in addition to two aspects related to pubertal development and birth weight, in a sample of adolescents with high blood pressure treated at the Center for Studies into Adolescent Health (Núcleo de Estudos da Saúde do Adolescente) at the Universidade Estadual do Rio de Janeiro (NESA-UERJ).

Methods

This was a case-control, outpatients-based study of adolescents treated at the, NESA-UERJ.[15] The study population comprised adolescents of both sexes, aged 11 to 19 years, born and resident in the metropolitan region of Rio de Janeiro. When calculating the sample, we assumed prevalence rate of 8.3% of low birth weight and arterial hypertension in adolescence,[3] an odds ratio of 3.0, an alpha error of 5%, beta error of 20% and a case/controls ratio of 1:2. With these parameters, the sample size calculated was 91 cases and 182 controls. The cases were recruited from the NESA Program for Prevention and Care of Cardiovascular and Metabolic Diseases of Adolescence and met the following criteria: adolescents referred by the public or private healthcare systems having presented with elevated arterial blood pressure and being classified as suffering from essential arterial hypertension. Sufferers of other chronic pathologies, including any type of mental disease, were excluded from the study. The controls were recruited from adolescents treated at the dentistry and internal medicine clinics at NESA, as long as they did not have arterial hypertension or any other chronic disease, and were selected to be paired with the cases for sex and by the following age groups: 11 to 13 years, 14 to 15 years and 16 to 19 years. Three of the adolescents in the control group were identified as suffering from essential hypertension and, since they met the criteria, were included in the case group. Data collection was carried out between August 2002 and December 2003.

Determination of arterial hypertension was according to the criteria proposed by the Report of the Second Task Force on Blood Pressure Control in Children.[16]

The BMI of each adolescent was calculated and expressed in kg/m^2. We used the cutoff points for overweight and obesity proposed by the International Obesity Task Force.[7]

Waist circumference was defined as the smallest circumference measured between the costal margin and the upper iliac crest. The average of three consecutive measurements was considered.

We used the classification system proposed by Tanner to assess the adolescents' development of sexual characteristics.[17] Information was collected on parents' educational level, monthly income at the multiple of the minimum monthly wage and the number of residents per home were collected as variables indicative of socio-economic status.[18] Information on family income per capita, fathers' and mothers' education, and mothers or fathers with history of essential arterial hypertension was provided by the adolescents' mothers. Information on birth weight was obtained from mothers. Where possible, we compared the mothers' reports with the official data from maternity units, using the Intraclass Correlation Coefficient (ICC). Analysis of variance was used to assess the difference between means of continuous variables. The chi-square test was used to analyze categorical variables. Risk estimates were made by calculating odds ratios, with 95% confidence intervals, by means of unconditional logistic regression of the following variables: fathers' education, mothers' education, income per capita, BMI, waist circumference, height, birth weight and family history of arterial hypertension, considering elevated arterial blood pressure (systolic or systolic and diastolic) as the dependent variable. Multivariate models were developed with the intention of verifying the behavior of overweight, obesity (as categorical variables) and height (in different quartiles by sex), nor and adjusted by each other with relation to hypertension, to verify the relationship between hypertension and waist circumference, both raw and adjusted by BMI and to verify the relationship between nutritional status, height and family history of hypertension, adjusted by each other and by per capita income, separately for boys and girls. The software packages Epi-Info version 6.02[19] and Stata 7[20] were used for input and analysis of data, respectively. The study was approved by the Ethics and Research Committee at the Hospital Universitário Pedro Ernesto Pedro Ernesto - UERJ.

Results

We studied 91 cases, 100% of which had systolic arterial hypertension and 88% of diastolic hypertension in association, and 182 controls. Thirty-seven (40.6%) of the cases were girls. Twenty-six adolescents were aged between 11 and 13 years, 21 from 14 to 15 years and 44 were more than 16 years old, with 74.7% of cases and 68.3% of controls already having completed pubertal development. Mean systolic and diastolic pressure measurements for the cases were 149.03 and 91.85 mmHg, respectively, while for the controls these measurements were 108.43 mmHg and 71.81 mmHg, respectively (p = 0.000). Data on birth weight was obtained for 72 (80%) hypertensive adolescents and 151 (83%) controls. Mean birth weights for cases and controls were 3,322 and 3,163 g, respectively. Birth weight below 2,500 g was observed in eight (8.8%) cases and 16 (8.8%) controls. It was possible to compare the weight reported by mothers with official maternity unit data in 22 adolescents, resulting in an ICC of 0.89 (95%CI 0.81-0.97). In Table 1 we can observe simple and relative frequencies of the relating to socioeconomic status, parents' educational level and risk of hypertension.

No cases of malnourishment were found among the hypertensive adolescents. In contrast, 50.5% of the adolescents with high blood pressure were obese, while just 3.4% of the controls exhibited the same characteristic. We observed increased waist circumference and height among the cases, while the inverse was true of the controls. Being overweight was associated with hypertension (OR = 4.80; 95%CI 2.16-10.70), and obesity exhibit an even stronger relationship (OR = 38.16; 95%CI 14.54-104.56). Waist circumference had a robust association with arterial hypertension (p = 0.000), as did tall stature (p = 0.000). In contrast, pubertal development did not demonstrate a statistically significant association with arterial hypertension (OR = 1.27; 95%CI 0.67-2.40). We did not detect an association between low birth weight and arterial hypertension in adolescence in our study (OR = 1.05; 95%CI 0.39-2.79). It was not possible to obtain information on family history of hypertension for 25 adolescents' parents (9.1%); six cases and 19 controls. Nevertheless, we observed that the number of hypertensive adolescents whose parents were also hypertensive was greater than those who did not have two parents with high blood pressure,

Table 1 - Distribution of cases and controls by family income per capita, father's education, mother's education and odds ratio for elevated arterial blood pressure

Factors (socioeconomic status)	Cases		Controls		OR	95%CI
	n	%	n	%		
Family income per capita (multiples of min. wage)*						
< 1	46	50.5	129	70.8	1.00	
≥ 1	38	41.7	41	22.5	0.38	0.21-0.70
Father's education†						
Primary education (complete/incomplete)	45	49.5	105	57.7	1.00	
Secondary (complete/incomplete) or higher education	33	36.3	43	23.6	0.56	0.30-1.03
Mother's education‡						
Primary education (complete/incomplete)	51	56.0	105	57.7	1.00	
Secondary (complete/incomplete) or higher education	36	39.5	68	37.3	0.92	0.53-1.6

OR = odds ratio; 95%CI = 95% confidence interval; chi-square test
* Unknown in seven cases and 12 controls.
† Unknown in 13 cases and 34 controls.
‡ Unknown in four cases and nine controls.

when compared with the controls. In the same manner, the percentage of hypertensive adolescents with normotensive parents was much lower than where both or at least one of the parents was hypertensive, when compared with the controls. We therefore observed a positive association between hypertension in adolescence and having both mother and father with high blood pressure (OR = 8.6; 95%CI 3.51-20.59) and having just one hypertensive parent (OR = 2.17; 95%CI 1.18-3.99) (Table 2).

Age at menarche demonstrated an inverse association with arterial hypertension (OR = 0.70; 95%CI 0.49-0.99). However, it lost this association when adjusted for BMI (OR = 1.07; 95%CI 0.68-1.67).

Table 2 - Distribution of cases and controls by nutritional status, waist circumference, birth weight and pubertal development and raw odds ratios for elevated arterial blood pressure

	Cases		Controls			
Data	**n**	**%**	**n**	**%**	**OR**	**95%CI**
Nutritional status						
Malnourished/well-nourished	26	28.5	151	77.4	1.00	
Overweight	19	20.8	23	12.6	4.8	2.16-10.70
Obesity	46	50.5	7	3.8	38.16	14.54-104.56
Waist circumference (cm)						
1st quartile	5	5.4	64	35.1	1.00	
2nd quartile	13	14.3	53	29.1	3.50	1.08-9.70
3rd quartile	20	21.9	50	27.4	5.20	1.82-14.81
4th quartile	53	58.2	15	8.2	45.90	15.67-134.60
Height (m)						
1st quartile	8	8.8	51	28.0	1.00	
2nd quartile	26	28.5	53	29.1	3.20	1.29-7.54
3rd quartile	21	23.0	42	23.0	3.18	1.28-7.92
4th quartile	36	39.5	36	19.8	6.37	2.65-15.32
Birth weight						
≥ 2,500 g	64	70.3	135	74.2	1.00	
< 2,500 g	8	8.8	16	8.8	1.05	0.39-2.79
Pubertal development						
Incomplete	23	25.3	38	20.9	1.00	
Complete	68	74.7	143	78.6	1.27	0.67-2.40
Family history of hypertension*						
Neither parent hypertensive	23	25.3	86	47.2	1.00	
One hypertensive parent	39	42.9	67	36.8	2.17	1.18-3.99
Both parents hypertensive	23	25.3	10	5.5	8.60	3.50-20.59

OR = odds ratio; 95%CI = 95% confidence interval.
Chi-square test.
* Unknown in six cases and in 19 controls.

Table 3 illustrates the behavior of nutritional status and height (quartiles for each sex) adjusted for each other, with boys and girls separate. We can observe that the measures of association of overweight and obesity remain practically unaltered. The association between height and hypertension in boys has been lost, but the same has not occurred with the girls. They continue to have an association between tall stature and hypertension.

For both the boys and the girls, the association between waist circumference and hypertension is lost when adjusted for BMI. We observed an OR of 1.01; 95%CI 0.91-1.12 for boys and OR = 1.09; 95%CI 0.98-1.21 for girls.

Aiming to understand the behavior of the variables that had hitherto proven themselves associated with hypertension, a multivariate model was constructed, in which the variables were adjusted for each other and by per capita income. Overweight and obesity remain associated with hypertension, both for the girls and for the boys. We observed that the behavior of girls' height remained the same, with an association with greater height, in the third quartile for height and the last quartile. Family history is strongly associated in both sexes when the father and mother are hypertensive, with OR = 13.32; 95%CI 2.25-78.94 and OR = 11.35; 95%CI 1.42-90.21, for boys and girls respectively (Table 4).

Discussion

In this study we attempted to elucidate the behavior of certain risk factors and their relationship with essential arterial hypertension in adolescents, considering the study population as representative of the general population. Sorof et al.[21] evaluated the behavior of the arterial blood pressure of adolescents aged 10 to 19 years selected at schools and referred to health services and adolescents presenting at primary health care services and concluded that mean ages were similar, as were mean systolic and diastolic pressures for the two populations. Nevertheless, they detected higher BMI among the boys refers to health services. This study

Table 3 - Univariate and multivariate analysis of arterial hypertension and nutritional status and height, by sex

	Boys		Girls	
Factors	**Raw OR (95%CI)**	**Adjusted OR (95%CI)***	**Raw OR (95%CI)**	**Adjusted OR (95%CI)***
Nutritional status				
Well-nourished/ malnourished	1.00	1.00	1.00	1.00
Overweight	4.46 (1.72-11.57)	4.25 (1.57-11.48)	5.92 (1.81-19.38)	5.04 (1.37-18.53)
Obesity	36.96 (11.36-120.09)	43.29 (12.02-155.48)	44.44 (10.94-180.45)	51.13 (10.89-239.77)
Height				
1st quartile	1.00	1.00	1.00	1.00
2nd quartile	0.60 (0.18-1.95)	0.37 (0.08-1.67)	2.10 (0.44-9.94)	2.66 (0.35-19.89)
3rd quartile	2.68 (1.12-6.42)	2.47 (0.84-7.25)	6.58 (1.63-25.53)	6.65 (1.11-38.78)
4th quartile	2.58 (0.99-6.72)	2.16 (0.65-7.15)	10 (2.41-41.37)	13.69 (2.41-41.37)

* Adjusted by the variables in the table.
OR = odds ratio; 95%CI = 95% confidence interval.

Table 4 - Multivariate analysis of arterial hypertension with nutritional status, height and family history of arterial hypertension, by sex

	Boys		Girls	
Factors selected	**OR***	**95%CI**	**OR***	**95%CI**
Nutritional status				
Well-nourished/ malnourished	1.00		1.00	
Overweight	3.58	1.15-11.09	6.22	1.26-30.68
Obesity	33.11	7.75-141.41	61.78	8.42- 453.24
Height				
1st quartile	1.00		1.00	
2nd quartile	0.64	0.10-3.99	2.46	0.25-23.75
3rd quartile	1.16	0.24-5.55	9.72	1.17-80.79
4th quartile	2.31	0.54-9.82	9.44	1.02-78.20
Family history of hypertension*				
Neither parent hypertensive	1.00			
One hypertensive parent	1.04	0.36-2.98	2.16	0.43-10.34
Both parents hypertensive	13.32	2.25-78.94	11.35	1.42-90.21

OR = odds ratio; 95%CI = 95% confidence interval.
* Adjusted by the variables in the table and for per capita income.

encourages us to believe that a possible bias in selecting our cases may have been minimized.

In relation to the controls, arterial blood pressure was only measured only once, which could be a factor in classification error, since blood pressure varies over time and we cannot know if it would have exhibited a higher value if measured at a different time. We consider this fact a limitation to our study.

We observed hypertension in three controls, suggesting that cases and controls probably came from the same population base, and possibly exposed to the same risk factors.

Complete pubertal development did not behave as a factor associated with hypertension in our study. On the other hand, age at menarche was lower among cases; although this fact appears to be more directly related to obesity.

We observed a large number of cases who were also overweight and, primarily, obese. In this group, 71.4% exhibited overweight or obesity, in contrast with the controls, were just 16.4% exhibited this characteristics. These variables were strongly associated with arterial hypertension in our study.

Height behaves differently depending on sex. Among the boys, the association initially observed among the tallest was no longer observed when adjusted for nutritional status. Among the girls, in contrast, taller stature was associated with hypertension, in contrast with what was observed for the shorter girls, even after adjustment. Gidding et al.,[22] in 1995, reported that height was positively associated with elevated blood pressure levels in children and adolescents. Sichieri et al.,[23] analyzed 2,802 adults in the city of Rio de Janeiro and observed that the prevalence of arterial hypertension was greater for the first and last quartiles of height among. Our study indicated a positive test association with tallest stature only among female adolescents.

There is a vast literature on the inverse association between low birth weight and/or low birth weight for gestational age and blood pressure levels in adolescents. Nevertheless, we were not able to confirm this information. This association has been based observed in cohort studies, which, in the majority, assess the relationship between

systolic and diastolic pressures with birth weight, without first concerning themselves with a diagnosis of arterial hypertension.[3] The absence of information on parental history of hypertension constitutes a limitation to our study. Missing information was observed in both groups, particularly the controls. Nevertheless, with the data available, we confirmed that the risk of hypertension is great when both parents are hypertensive and less so when just one parent exhibits that characteristic. When adjusting for overweight and obesity, considered the primary risk factors for hypertension by the literature, we observed that the association remains stable when both parents were hypertensive, in contrast with what happened when just one parent was hypertensive.

We could attribute this fact to genetic and/or environmental factors. A study carried out in Brazil,[24] evaluating 43 adolescents, concluded that children of hypertensive parents exhibited increased systolic and diastolic pressures, and also an unfavorable lipid profile. A study undertaken with adults in Canada found significant evidence of familial aggregation of hypertension. According to the authors, genetics explained that fact; however, the elevated prevalence rates of hypertension among partners indicate that there is a strong environmental component.[25,26]

The finding of mother and father simultaneously with a history of hypertension was strongly associated with hypertension in adolescents, constituting an independent risk factor and suggesting the importance of genetic and environmental factors that are involved in the genesis of hypertension during this phase of life. This study has contributed to knowledge on the behavior of essential arterial hypertension in Brazilian adolescents, emphasizing the importance of preventive aspects of the disease with reference to the acquisition of healthy lifestyle habits, notably linked to obesity and/or those whose parents are hypertensive.

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