Original Article

ACTA

Blood pressure of children and teenagers from a public school in Fortaleza–Ceará*

Pressão arterial de crianças e adolescentes de uma escola pública de Fortaleza - Ceará

Presión arterial de niños y adolescentes de una escuela pública de Fortaleza-Ceará

Thelma Leite de Araujo[1], Marcos Venícios de Oliveira Lopes[2], Rafaella Pessoa Moreira[3], Tahissa Frota Cavalcante[4], Nirla Gomes Guedes[4], Viviane Martins da Silva[5]

ABSTRACT

Objective: To analyze the evolution of systolic blood pressure (SAP), diastolic blood pressure (DAP) and anthropometric measurement values of children and teenagers who presented altered arterial pressure on a first evaluation. **Methods:** Follow-up study, performed from October / 2004 to December / 2005, at a public school in Fortaleza. One hundred fifty-one subjects between six and seventeen years old were accompanied and evaluated for a period of one year. **Results:** It was observed that the SAP and DAP of children and teenagers decreased along the evaluations. The variables age, education, weight, height, body mass index, waist perimeter, hip perimeter, arm and subscapular skin fold circumference were correlated positive and significantly with SAP and DAP values. There was a difference in median among the variables: Gender, kinship degree for arterial hypertension, passive smoker with SAP and DAP. **Conclusion:** It was observed that the SAP and DAP of children and adolescents decreased along the evaluations.

Keywords: Blood pressure; Child health; Adolescent health; School health

RESUMO

Objetivo: O objetivo do estudo foi analisar a evolução dos valores da pressão arterial sistólica (PAS), da pressão arterial diastólica (PAD) e das medidas antropométricas de crianças e adolescentes que apresentaram alteração da pressão arterial em uma primeira avaliação. **Métodos:** Estudo longitudinal, realizado nos meses de outubro de 2004 a dezembro de 2005, em uma escola pública de Fortaleza, Ceará. Cento e cinqüenta e um indivíduos com idades entre seis e dezessete anos foram avaliados e acompanhados por um período de um ano. **Resultados:** As variáveis idade, escolaridade, peso, altura, índice de massa corporal, perímetro da cintura, perímetro do quadril, circunferência do braço e prega subescapular estiveram correlacionadas positiva e significativamente com os valores da PAS e da PAD. Houve diferença de mediana entre as variáveis: sexo, grau de parentesco para hipertensão arterial, fumante passivo com a PAS e com a PAD. **Conclusão:** Observou-se que a PAS e a PAD das crianças e dos adolescentes diminuíram ao longo das avaliações.

Descritores: Pressão arterial; Saúde da criança; Saúde do adolescente; Saúde escolar

RESUMEN

Objetivo: En este estudio se tuvo como objetivo analizar la evolución de los valores de la presión arterial sistólica (PAS), de la presión arterial diastólica (PAD) y de las medidas antropométricas de niños y adolescentes que presentaron alteración de la presión arterial en una primera evaluación. **Métodos:** Se trata de un estudio longitudinal, realizado en los meses de octubre del 2004 a diciembre del 2005, en una escuela pública de Fortaleza, Ceará. Ciento cincuenta y un individuos con edades entre seis y diecisiete años fueron evaluados y acompañados por el período de un año. **Resultados:** Las variables edad, escolaridad, peso, altura, índice de masa corporal, perímetro de la cintura, perímetro de la cadera, circunferencia del brazo y pliegue subescapular estuvieron correlacionadas positiva y significativamente con los valores de la PAS y de la PAD. Hubo diferencia de mediana entre las variables: sexo, grado de parentesco para hipertensión arterial, fumador pasivo con la PAS y con la PAD. **Conclusión:** Se observó que la PAS y la PAD de los niños y adolescentes disminuyeron a lo largo de las evaluaciones.

Descriptores: Presión arterial; Salud del niño; Salud del adolescente; Salud escolar

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[1] *PhD., Adjunct Professor of the Nursing Department at Federal University of Ceará - UFC – Fortaleza (CE), Brazil; CNPq Researcher.*
[2] *PhD., Adjunct Professor of the Nursing Department at Federal University of Ceará - UFC – Fortaleza (CE), Brazil; CNPq Researcher.*
[3] *Student of the Nursing Graduate Program at Federal University of Ceará - UFC – Fortaleza (CE), Brazil; Holder of a CNPq Scholarship.*
[4] *Student of the Nursing Graduate Program at Federal University of Ceará - UFC – Fortaleza (CE), Brazil; Holder of a CNPq Scholarship.*
[5] *Student of the Nursing Graduate Program at Federal University of Ceará - UFC – Fortaleza (CE), Brazil.*

Corresponding Author: **Rafaella Pessoa Moreira**
Al. dos Cravos, 202 - Quadra 37 - Cidade 200 - Fortaleza - CE
Cep: 60190-340. E-mail: rafaellapessoa@hotmail.com

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INTRODUCTION

Although hypertension is more frequently present in adults and elderly, its prevalence in childhood and adolescence may range from 2% to 13% in different parts of the world[1]. Recommendations suggest that, before a child is diagnosed with hypertension, the measurement must be repeated in a total of three consecutive tests. As a result, incidence levels are frequently considered lower than they actually are[2].

The interest in blood pressure evaluation in children and teenagers has evolved since the 60's and the first recommendations about routine blood pressure measurement in these age levels appeared in the 1970's. Previously, only very severe blood pressure changes were identified in children or teenagers, and secondary causes prevailed, especially renal causes. However, it was noticed that mild blood pressure changes could be seen in these groups and that, most of the times, they did not show a secondary cause[3].

Different longitudinal studies have shown that the development of hypertension in the adult phase may have started in an earlier life period. According to Cunningham[2], evidence suggests that hypertension starts in childhood or even during intra-uterine life and that children who persistently experience increased blood pressure levels have an increased risk of becoming hypertensive adults.

Blood pressure changes found in children and teenagers do not necessarily mean that these subjects have hypertension, but suggest a tendency towards the development of the disease[4]. This fact highlights the need for specialized clinical evaluation and regular follow-up of the group displaying blood pressure changes. In Brazil, studies of this nature are still insufficient.

Many factors are considered determinant for increased blood pressure in children and adults: increased initial values, age, sex, salt intake, obesity, use of alcohol, smoking, sedentariness, genetic factors and genetic-environmental interaction[5]. Each of these factors may have an important role in the essential etiology of hypertension. Educational interventions and clinical follow-up throughout childhood and adolescence could be more effective for hypertension prevention that those performed with adults, guaranteeing the identification of risk indicators in younger populations.

Children with blood pressure above the 90 percentile have a 2.4 times higher risk of becoming hypertensive adults. The identification of risk indicators, such as family history of high systemic blood pressure and increased Body Mass Index, provides an opportunity for the early implementation of preventive actions, aimed at decreasing morbidity and mortality among adults[6].

In view of the presence of blood pressure changes in children and teenagers and the lack of Brazilian studies, this research aims to evaluate the evolution of systolic blood pressure, diastolic blood pressure and anthropometric measurement values in children and teenagers with initial blood pressure value changes.

METHODS

The study was performed in a public Elementary and High School, located in the city of Fortaleza - Ceará, with data collected from October 2004 to December 2005. An open cohort of 154 subjects was followed for a 1-year period, when six evaluations were performed at intervals of up to two months. The subjects' screening met the following inclusion criteria: age between 6 and 17 years old at the first evaluation, to be enrolled in the state *locus* school, to show increased blood pressure levels, percentile equal to or higher than 90, in a causal measure, to agree with participation in at least another five blood pressure evaluations. The children and teenagers, as well as their parents / guardians agreed with the study, after being duly informed, and signed the informed consent form, confirming their participation.

Data were collected by means of an individual interview, during which a form was completed, including socio-demographic data, personal and family history of hypertension, physical activity practice, use of tobacco and alcohol. After the interview, the students were subject to an anthropometric evaluation and blood pressure was checked. The interview was performed only on the first evaluation, while the anthropometric evaluation and blood pressure verification data were collected during the first evaluation and the five subsequent follow-ups.

The method used for blood pressure measurement was indirect, through the auscultation technique. Tycos sphygmomanometers with aneroid manometers, duly tested and calibrated, and Tycos double stethoscopes were used. Cuff sets with variable widths were used while trying to keep the recommended relation of width, corresponding to 40% of arm circumference, and its length to involve at least 80% of the arm.

After the blood pressure measurement procedure had been explained, in order to minimize anxiety and fear, it was ensured that students avoided the intake of alcohol, coffee, food or tobacco until 30 minutes before the measurement; emptied their bladder and did not perform any physical exercise for, at least, 60 minutes.

The blood pressure measurements were performed in a calm and silent environment, with the patient sitting, relaxed, with the back supported, feet on the ground, legs uncrossed and the right arm resting on a table at precordium height. The right arm was chosen for the repeated blood pressure measurements, due to consistence and comparison with the reference tables and due to the possibility of aorta coarctation, which may lead to false readings (low) in the left arm. The children and teenagers were kept at rest before and during the verification, when they were told to keep quiet.

Blood pressure was measured three times at 1-minute intervals and arithmetic means were calculated, resulting in the value considered for analysis. In case of a difference equal to or higher than 6 mmHg between the SBP and/or DBP values, a new blood pressure verification was performed, the mean of the three closest SBP and/or DBP was calculated and the most divergent value was abandoned, as proposed by the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents[8].

For the collection of anthropometric data, the following equipment was used: Plenna futura Digital anthropometric scales duly tested and calibrated for weight checking, supporting 150 kg and with a 100 g precision; anthropometric scales with a rod to evaluate height, supporting 2 m and with a 0.5 cm sensitivity; non-extendable measuring tape with 0.1 cm intervals and 100 cm extension to check the arm, waist and hip circumference and a Sanny adipometer to check the skin folds, with a 1 mm accuracy. The skin folds (tricipital and subscapular) were measured with the students standing and the arms pending naturally, performed three times to calculate the means.

Brachial circumference was measured with the non-extendable measuring tape at the mean point between the olecranon and the acromion. This measure was used for cuff selection. To check the waist perimeter, the subject should be standing with the abdomen relaxed and arms relaxed beside the body. The non-extendable measuring tape was placed horizontally on the mean point between the lower border of the last rib and the iliac crest. The reading was performed between an exhalation and an inhalation.

To measure the hip perimeter, the non-extendable measuring tape was placed horizontally around the hip, in the most prominent gluteus part. The waist and hip perimeters made the elaboration of the waist-hip ratio (WHR) possible, obtained by the quotient between the waist perimeter and the hip perimeter.

In the analysis of smoking and alcohol intake, those with the habit of smoking and/or passive smokers (smoking parents, siblings or friends) were considered smokers. Moreover, children and teenagers who had already consumed alcoholic beverages at least once were considered alcohol users.

The correlation between mean systolic blood pressure and diastolic blood pressure obtained during the six verifications and the variables of age and educational background was measured, and also with the mean anthropometric measures obtained on the six verifications. Additionally, the median difference of the systolic blood pressure and diastolic blood pressure values with the variables: sex, kinship with blood hypertension patients, practicing of sports, smoking and drinking was calculated. The students practicing physical activities less than three times a week and/or with activity time equal or lower than 20 minutes each time were considered as sedentary.

Spearman's correlation coefficient was used when the absence of linearity, homoscedasticity and/or normality was identified. Mann-Whitney's Test was used in the median differences analysis. For the analysis of repeated systolic and diastolic blood pressure measures, Mauchly's test was used to check the spheriticy principle. Pillai trace was used for the multivariate analysis of variance (MANOVA) of the repeated systolic and diastolic blood pressure measures, with the variables showing statistical significance. For the univariate analysis of the blood pressure measures, the Huynh-Feldt test was used for intra-subject comparison of the selected variables. The behavior of the blood pressure values was seen over time and significant variables were identified for the elaboration of a multivariate linear regression model. The partial square Eta (h^2) was calculated for the evaluation of the total variability ratio attributable to the time factor. The data was processed and analyzed through SPSS version 13.0. The significance level adopted was 5% ($p<0.05$).

Considering administrative and ethical aspects of scientific research, documents to request the research development were sent to the school and consent was obtained. Additionally, the study proposal was forwarded and approved by the Ethics Committee of the Complexo da Universidade Federal do Ceará - COMEPE, in compliance with Resolution n.º 196/96 regarding research involving human beings[9].

RESULTS

More than half of the subjects assessed were male (52.3%), with a mean age of 11.89 years (±3.11) and mean educational background of 6.23 years (±2.86). Of the total, 75 (49.7%) practiced sports. Only one subject smoked actively (0.7%), but 88 (58.3%) were passive smokers and 16 (10.6%) had already consumed alcoholic beverage.

The variables height, body mass index, waist-hip ratio, arm circumference and tricipital skin fold show little dispersion compared to the mean. The weight variables, hip perimeter and systolic blood pressure were the ones showing a higher data dispersion compared to the mean. All Table 1 variables showed an asymmetric distribution ($p<0.05$).

The SBP and DBP values showed a mild decrease within time and variability decrease (Figure 1). The variables age, educational background, weight, height, Body Mass Index, waist perimeter, hip perimeter, arm circumference and subscapular skin fold were positively and significantly correlated with SBP and DBP. On the other hand, the waist-hip ratio showed a negative and significant correlation with SBP, DBP, as well as the tricipital skin fold (Table 2).

A median difference of SBP and DBP was identified for sex, kinship, active and passive smoking. However, this was not seen between the use of alcohol and SBP, nor between the practice of sports and DBP ($p > 0.05$). The male students, those with a second-grade kinship with hypertension and passive smoking patients showed higher SBP and DBP values. The absence of appropriate sports practice led to higher values only in SBP.

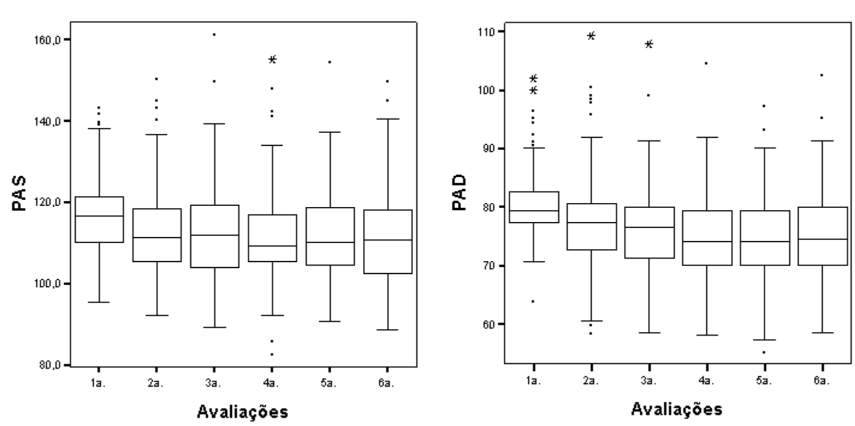
Table 1 - Distribution of anthropometric variables and systolic and diastolic blood pressure means in the evaluated children and teenagers. Fortaleza, 2006.

Variables	Mean (±SD)	Median	KS[1] (p-value)
Weight (kg)	42,09 (±14.37)	43,45	0,000
Height (m)	1,47 (±0.16)	1,5	0,000
Body Mass Index (kg/m²)	18,8 (±3.69)	18,2	0,000
Waist perimeter (cm)	66,37 (±10.46)	65	0,000
Hip perimeter (cm)	81,27 (±11.75)	83	0,000
Waist-hip ratio (WHR) (cm)	0,81 (±0.08)	0,81	0,000
Arm circumference (cm)	21,87 (±3.77)	22	0,000
Tricipital skin fold (mm)	11,72 (±4.83)	10,6	0,000
Subscapular skin fold (mm)	10,65 (±5.32)	9	0,000
Systolic blood pressure (mmHg)	112,47 (±10.88)	111,30	0,008
Diastolic blood pressure (mmHg)	76,28 (±7.87)	76,60	0,000

1 - KS: Kolmogorov - Smirnov Test

Table 2 - Correlation of the systolic blood pressure (SBP) and diastolic blood pressure (DBP) mean values obtained on six verifications with age and educational background indicators and the mean anthropometric measures obtained on six verifications. Fortaleza, 2006.

Variables	SBP		DBP	
	R	p-value	R	p-value
Age	0,441	0,000	0,384	0,000
Educational Background	0,410	0,000	0,361	0,000
Weight	0,418	0,000	0,380	0,000
Height	0,482	0,000	0,440	0,000
Body Mass Index	0,266	0,000	0,233	0,000
Waist perimeter	0,349	0,000	0,322	0,000
Hip perimeter	0,365	0,000	0,347	0,000
Waist-hip ratio	-1,47	0,000	-1,42	0,000
Arm circumference	0,317	0,000	0,275	0,000
Tricipital skin fold	-0,075	0,023	-0,033	0,325
Subscapular skin fold	0,131	0,000	0,141	0,000



Key [Legenda]: PAS = SBP PAD = DBP Avaliações = Evaluations

Figure 1 – Systolic and diastolic blood pressure values on the six evaluations performed. Fortaleza, 2006.

Table 3 - Analysis of the overall linear model for repeated Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) measures. Fortaleza, 2006

Multivariate Tests	**Pillai Trace**	**F**	**Sig.**	**Partial η²**
SBP	0,069	2,133	0,065	0,069
SBP * Arm Circumference	0,065	2,005	0,081	0,065
SBP * BMI	0,061	1,885	0,100	0,061
DBP	0,096	3,046	0,012	0,096
DBP * Waist Perimeter	0,104	3,319	0,007	0,104
DBP * Hip Perimeter	0,104	3,319	0,007	0,104
DBP * WHR	0,096	3,052	0,012	0,096
Intra-Subject Effect (Huynh-Feldt Test)		**F**	**Sig.**	**Partial η²**
SBP		1,904	0,095	0,013
SBP * Arm Circumference		1,660	0,146	0,011
SBP * BMI		1,601	0,161	0,011
DBP		3,773	0,004	0,025
DBP * Waist Perimeter		4,145	0,002	0,027
DBP * Hip Perimeter		4,116	0,002	0,027
DBP * WHR		3,770	0,004	0,025
Inter-Subject Effects Tests		**F**	**Sig.**	**Partial η²**
Intercept	SBP	512,743	0,000	0,776
Arm Circumference		20,708	0,000	0,123
BMI		8,397	0,004	0,054
Intercept	DBP	0,477	0,491	0,003
Waist Perimeter		4,846	0,029	0,032
Hip Perimeter		6,356	0,013	0,041
WHR		3,561	0,061	0,024

For further data analysis, a univariate and multivariate data analysis of the repeated measures of both SBP and DBP values was performed. In the multivariate analysis, the Pillai trace did not show influence of the variables under analysis on the repeated SBP values. Regarding the DBP results, the variables waist perimeter, hip perimeter and waist-hip ratio showed a significant correlation. However, Partial h^2 showed low influence of these variables, in separate, on the SBP and DBP values.

Even though significant coefficients are identified in the regression model for the repeated SBP measures, Partial h^2 showed a high influence of other variables outside the model (see intercept value in Table 3). On the other hand, for the DBP, only the waist and hip perimeters were significant, with low determination of their values for the repeated measures.

DISCUSSION

A higher number of male children and teenagers showing higher SBP and DBP values was identified in the study population when compared to the female children and teenagers. It is known that men show higher hypertension prevalence than women until the seventh decade of life, with higher prevalence in women from that age onwards[10]. Research carried out in Mexico[11] showed a prevalence only in the increase of systolic blood pressure for male patients.

The positive correlations identified in our study between the variables age, weight and height in children and teenagers with SBP and DBP values were also found in a number of other studies performed with young populations[2,12-14]. The relation between weight and blood pressure is considered one of the reasons why pressure increases with age[2]. However, other studies[12] show that weight and height in both genders have a linear relation to SBP and DBP, independent of age.

It was found in the study that, as the Body Mass Index, waist perimeter and hip perimeter increased, SBP and DBP values also increased. Most studies in young populations emphasize the role of physical development in the determination of pressure levels. Weight and Body Mass Index are the variables showing a stronger correlation with blood pressure in this age group[3,6,15].

Regarding waist circumference, the evidence that the central deposition of fat is an important marker of the risk for chronic diseases, including hypertension, has been constantly reported in different studies[16]. The ratio between waist and hip circumference measures (WHR), characterizing the central distribution of fat, has been used to identify the subjects at higher cardiovascular risk[15,17]. In a study performed with obese subjects[15], it was seen that the WHR increase was not associated with higher pressure levels. However, other studies[16] concluded that WHR is a complementary index to Body Mass Index in the evaluation of obesity and its metabolic changes and that the increased WHR is correlated to an adverse lipidic profile in hypertensive patients.

In recent years, a special interest in the study of the association between the skin folds and blood pressure in children and teenagers is emerging. Other studies[18,19] found a positive and significant correlation of blood pressure with the tricipital and subscapular skin folds. The same fact was seen, in this study, only for the subscapular skin fold. Regarding arm circumference, there was a positive and significant association in this study, in line with another study[20], proving that it points to a relation between circumference and blood pressure.

The subjects who did not practice sports showed a higher systolic blood pressure median than those who did. Additionally, as mentioned before, the subjects showing higher Body Mass Indexes had higher SBP and DBP values. Longitudinal studies have proven the consistent evidence of this variable's force, documenting the protective effects of physical activity for many chronic diseases, including coronary heart disease, non-insulin dependent diabetes, hypertension, osteoporosis and cervix cancer. On the other hand, low levels of physical ability are associated to higher cardiovascular mortality rates[2].

There are many interactions between obesity and physical activity. Researchers[21] appoint that children and teenagers tend to be obese when sedentary and that obesity itself contributes to make them even more sedentary. Physical activity decreases the risk of obesity, acting in the energy balance regulation, influencing body weight distribution, preserving or keeping the thin mass, besides contributing to weight loss and being effective, solely, to prevent blood hypertension[22]. In a meta-analysis study[23], it was found that aerobial physical exercise resulted in a blood pressure decrease of 3/3 mmHg in normotensive patients, 6/7 mmHg in adjacent hypertensive patients, and 10/8 mmHg in hypertensive patients.

The students classified as passive smokers showed SBP and DBP values higher than those of non-smoking students. Another research[11] found an increase in blood pressure of 8 to 66 mmHg among smokers. Passive exposure to tobacco was related to decreased plasma levels, HDL cholesterol, associated to a significant dose-dependant endothelial disorder.

The subjects who did not drink alcohol showed lower systolic blood pressure levels than those who did. There are controversies about a decrease in blood pressure values in people who drink alcohol moderately compared to those who do not. A case-control study checked a lower incidence of ischemic encephalic vascular accident in people drinking one to two drinks a day compared to those who do not[2,24]. On the other hand, intervention studies showed that decreasing alcohol intake results in lower systolic and diastolic pressures[2].

CONCLUSION

It was seen in the study that, throughout the follow-up, the children's and teenager's SBP and DBP values decreased. One of the factors that might have influenced a greater increase in blood pressure at first is the occurrence of white coat hypertension. This kind of hypertension is characterized by the presence of the healthcare professional resulting in a transitory blood pressure increase. Studies using casual blood pressure measures in children and teenagers showed that the prevalence of the abovementioned phenomenon ranges from 44% to 88%[25].

In spite of this decrease over time, 25 subjects maintained a blood pressure value equal or higher than the 90 percentile on all evaluations, and 26 showed values lower than the 90 percentile on a single evaluation.

In spite of the relatively short follow-up period, ranging from four months to one year, the children and teenagers keeping blood pressure levels equal or higher than the 90 percentile throughout the evaluations should be followed more closely, so the preventive measures may be started early in life, preventing or even delaying the onset of hypertension in adult life or at least the onset of its complications.

In conclusion, routine blood pressure monitoring is needed in children and teenagers, as well as the early identification of the risk indicators, such as overweight, obesity, sedentariness, positive hypertension history, use of tobacco and alcohol, in the prevention of future cardiovascular events.

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