Overweight and Cardiovascular Risk among Young Adults Followed-up for 17 Years: The Rio de Janeiro Study, Brazil

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Abstract

Background: **The adoption of primary prevention measures among young people has a favorable impact on the context of cardiovascular diseases.**

Objectives: **To assess blood pressure (BP) and cardiovascular risk variables among young adults stratified according to the body mass index (BMI) behavior obtained along 17 years, since childhood/adolescence (C/A).**

Methods: **Three assessments were carried out in 115 individuals pertaining to the study cohort of Rio de Janeiro, Brazil. A1: 12.97 ± 1.48 years old; A2: 21.90 ± 1.71 years old; A3: 30.65 ± 2.00 years olds and divided into three groups according to BMI in the three assessments: Group N (always normal BMI; n=46), Group L (varying BMI; n=49) and Group O/O (always increased BMI; n=20). In A1, A2 and A3, BP and BMI were obtained. In A2 and A3, glucose (G) and lipidic profile were dosed. Also in A2, insulin (INS) was dosed and HOMA-IR was calculated. In A3, the measurement of waist circumference (WC), abdomen/hip relation (AHR) and body fat percentage (%BF) were added.**

Results: **1) Group O/O presented higher mean values of increased BP ($p<0.0001$) at the three assessments; 2) In A3, Group O/O showed higher mean values for WC, AHR and %BF and prevalence of increased WC and metabolic syndrome (MS) ($p<0.0001$); 3) higher mean values were observed for INS, HOMA-IR, LDL-c in A2, and G, cholesterol, LDL-c and triglycerides in A3 for Group O/O ($p<0.05$); 4) masculine sex and O/O at A1 determined higher risk for MS occurrence in adult age.**

Conclusion: **The presence of O/O since C/A was associated with higher BP values, anthropometric indexes and higher prevalence of MS in the young adult phase. (Arq Bras Cardiol 2010;94(2): 193-201)**

Key Words: **Blood pressure; body weights and measures; cardiovascular risk; adolescents.**

Introduction

Despite therapeutic advances, the cardiovascular disease, especially it presentation as coronary arterial disease (CAD), remains as the main death cause in the whole world[1].

Several epidemiological studies on adults have clearly pointed out the relation between cardiovascular risk factors (CVF) and the CAD development, and among the implicated risk factors, the most important ones are arterial hypertension (AH), dislipidemia, smoking, sedentarism and obesity, particularly central distribution obesity[1].

Similarly to adults, among young people, cardiovascular risk factors are also implicated in this determinism and have crucial importance if they tend to repeat and worsen along the years[2-6]. In this context, we highlight the Bogalusa study that, based on many cohorts, demonstrated that cardiovascular risk factors are present since the childhood/adolescence (C/A)[7] and have a relation to atherosclerotic lesions evidenced in studies of necropsy in young individuals[8-10].

Data on overweight/obesity (O/O) in Brazilian population reinforce its increased prevalence in early age groups, as it may vary from 18.8% to 26.3% in Brazilian cohorts comprising children and adolescents[11-13].

Body fat (BF) distribution is as important as O/O. The relation between central body fat and health risk is already established, and is more reliable than the obesity degree itself[14-18].

In this manner, the necessity of identifying these abnormalities since C/A with the purpose of identifying individuals with higher risk for cardiovascular diseases is clear[7].

Besides, the strong relation between obesity and the remaining cardiovascular risk factors is well establishes, and many authors suggest that obesity represents the common and favoring link in the aggregation of these risk factors. Vague[19], since 1956, included the central obesity as one of the elements that unleash what is known today as metabolic syndrome (MS).

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Manuscript received November 17,2008; revised manuscript received April 15, 2009; accepted May 15 2009.

Face to the exposed, the present study had the objective of assessing BP and cardiovascular risk factors variables in young individuals stratified according to their BMI behavior obtained along 17 years, since C/A.

Methods

The studied sample were from *Estudo do Rio de Janeiro* (ERJ), a research line on BP and other cardiovascular risk factors in young people and their families developed at Universidade do Estado do Rio de Janeiro (UERJ), Brazil, since 1983[2-6]. The study was performed in two stages: first, children from 6 to 9 years old were assessed (1983-1986) in two phases: school phase and home phase, with the objective of creating BP normality curves based on sex and age group. In the second phase, children and adolescents from 10 to 15 years old were assessed (1987-1999) in five phases: school phase (1987-1988), home phase (1989-1991), hospital phase (1992-1995), family phase (1996-1999)[2-5] and ambulatory phase (2004-2008)[6], with the objective of evaluating the behavior of cardiovascular risk factors variables and their relation with BP, since C/A as well as the presence of lesions in target-organs of AH in the young individuals and their families. The present study is part of the ambulatory phase of the 2nd stage of ERJ[6] (Figure 1).

In the present assessment, 115 young people of both sexes were included and denominated as target-students. Three assessments of the second stage of ERJ were considered: A1 (school phase: 10 to 15 years old / 1987-1988), A2 (family phase: 18 to 26 years old / 1996-1999) and A3 (ambulatory phase: 26 to 31 years old / 2004-2008) (Figure 1).

According to the BMI obtained from the three assessments along 17 years, three groups were created: Group N (always normal BMI; n=46), Group L (varying BMI; n=49) and Group O/O (always increased BMI; n=20) (Figure 2).

This research was approved by the Ethics Committee of University Hospital Pedro Ernesto (HUPE, acronym in Portuguese) and all the assessed individuals and/or their legal responsible adults signed the informed consent.

In the three assessments, the study protocol consisted of the employment of a questionary for the analysis of clinical, epidemiological, metabolic and sociocultural variables. The qualification of the individual according to low, medium or

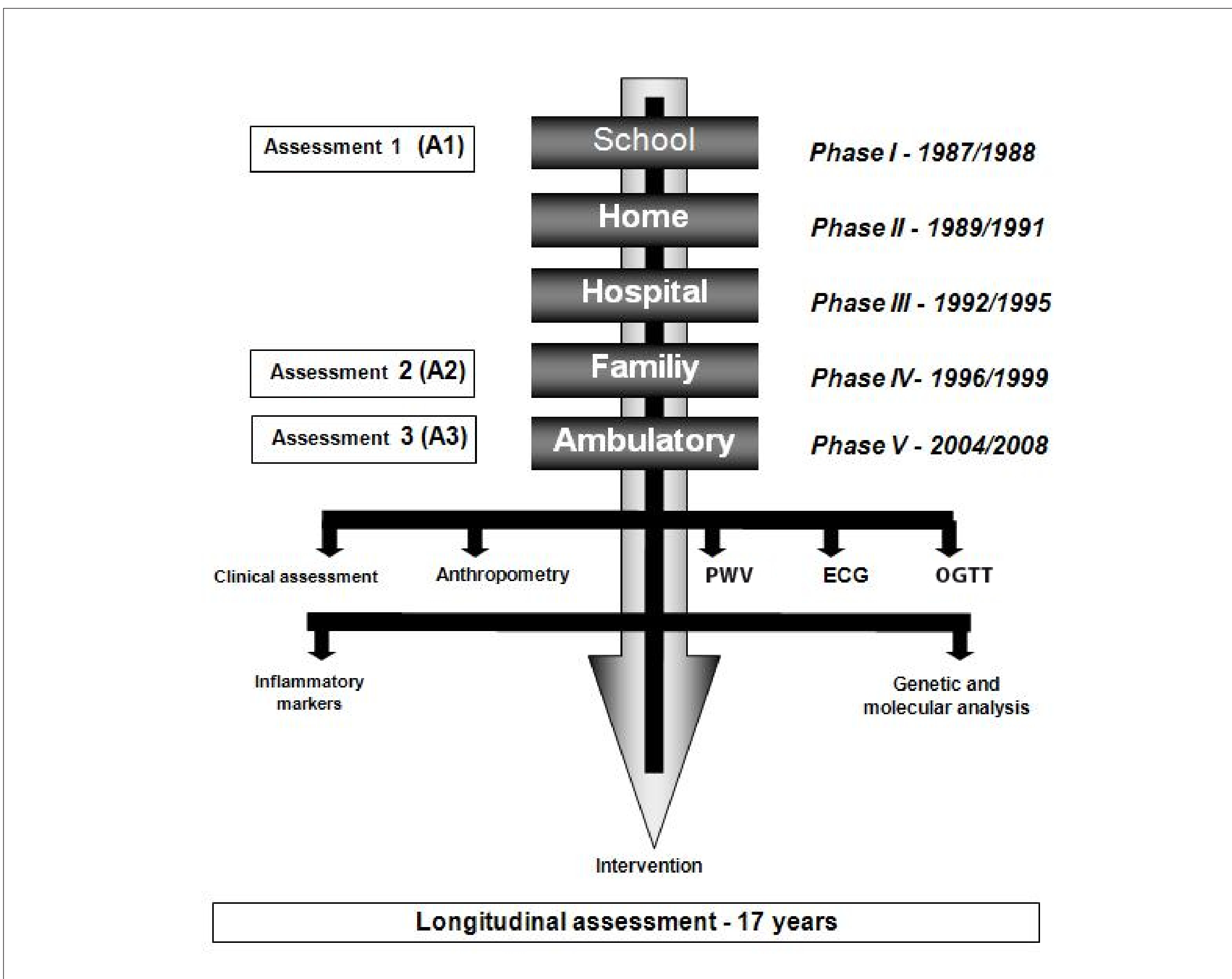

Figure 1 - Algorithm of Estudo Rio de Janeiro – Second stage; PWV - pulse wave velocity; ECG - electrocardiogram; OGTT - oral glucose tolerance test.

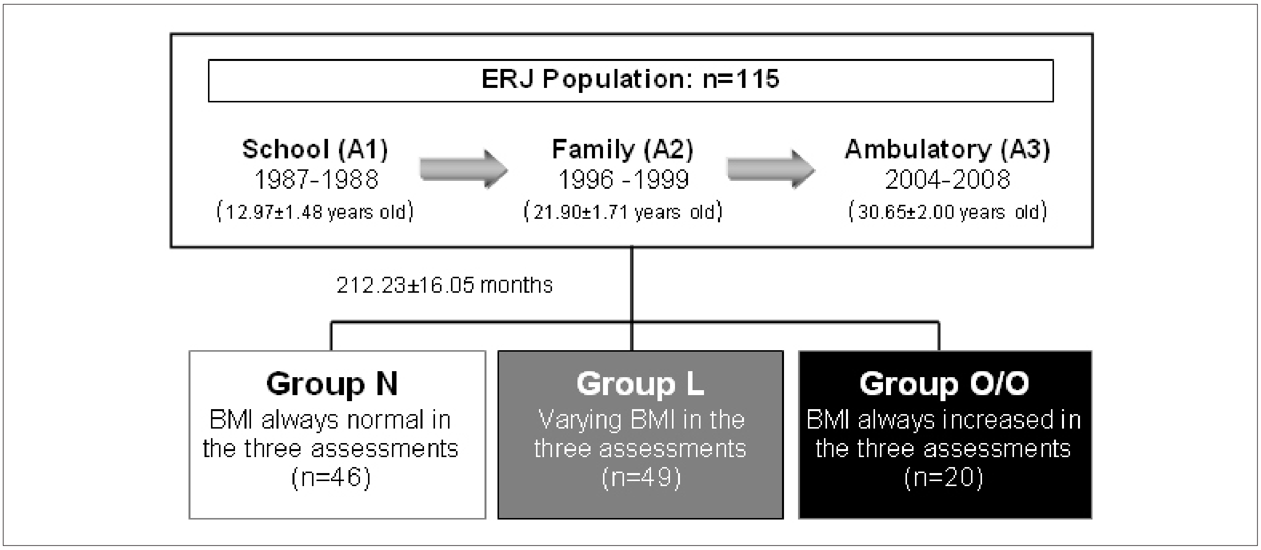

Figure 2 - - Description of the studied population.

high socioeconomic level (SEL) was carried out based on monthly gains of parents, their professions, place of residence and school localization, according to criteria established by Secretaria Estadual de Educação do Rio de Janeiro. Moreover, BP, weight (W) and height (H) were obtained, and BMI was calculated. At A2 and A3, after a 12-hour fast, glucose (G), cholesterol, HDL-c, triglycerides (TG) were dosed, and the LDL-c was calculated. Also at A2, insulin dosage and HOMA-IR calculus were performed. In A3, the measurement of waist circumference (WC), abdomen/hip relation (AHR) and the measurement of cutaneous fold (CF) with the calculation of body fat percentage (%BF) were added.

Increased BP at A1 was defined in A1 according to the values that corresponded to 95 Percentile obtained in ERJ when this population's curves for blood pressure were created. At A2 as much as at A3, the criteria established by Brazilian directives for arterial hypertension in vigour at the moment of the study were adopted. At A1, increased BP was considered when BP ≥ 95 Percentile for sex and age[20], and at A2 and A3 when BP≥140/90 mmHg[21].

BMI was obtained by means of the quotient: BMI = weight (kg) / height^2 (m) for the classification of the nutritional status, according to World Health Organization[22]. Values of BMI between 18.50 kg/m^2 and 24.99 kg/m^2 were considered normal; when BMI values were between 25 kg/m^2 and 29.99 kg/m^2 was considered overweight and when BMI≥30 kg/m^2 it was considered obesity[2,22].

WC measurement was obtained by means of an inextensible measuring stick at the mean point between iliac peak and the inferior border of the last rib[23]. Values were defined as increased when WC>102 cm for men and >88 cm for women[24].

For %BF calculation, body density was firstly determined (bD) according to Durnin and Womersley equation[25] by means of cutaneous fold measuring: tricipital cutaneous fold (TCF), bicipital cutaneous fold (BCF), subescapular cutaneous fold (SECF) and suprailiac cutaneous fold (SICF). Following, %BF was obtained according to Siri's equation[26].

The presence of MS was defined according to I Brazilian Directive for MS[24], once the cut point ≥100 mg/dL was adopted for fast glucose, as proposed by Grundy et al[27].

For the metabolic variables, glycemia <100 mg/dL, was considered a normal value, glycemia between 100 mg/dL and 126 mg/dL was considered glucose intolerance range, and glycemia ≥126 mg/dL was considered diabetes mellitus (DM)[28]. The normality values for lipidic profile followed the recommendations of the IV Brazilian Directive on Dislipidemia and Atherosclerosis Prevention[29].

The collected information was stored in one single database generated by Microsoft Access. Data were assessed by means of the statistical software SPSS for Windows, version 8.0, Copyright SPSS Inc. 1989-1997, and the following statistical tests were used: Variance analysis, Tukey's test, Kruskal-Wallis non-parametric test, multiple comparisons non-parametric test and chi-square test.

Results

A group of 115 individuals, 64 men (55.7%) and 51 women (44.3%), mean age 30.65 ± 2.00 years old (27 to 36 years old) was studied in a follow-up of 212.23 ± 16.05 months. The epidemiological characteristics are presented on Table 1.

For all the studied epidemiological variables (genre, skin color, socioeconomic level at A1 and follow-up period of the study), groups were similar (Table 1).

As the distribution of BP Percentiles were assessed at A1 by groups, we observed that, in Group O/O, 70% of the individuals presented BP Percentile ≥95, 20% had BP Percentile between 50 and 95, and 10% presented BP Percentile ≤50. These values for Group N were 19.6%, 32.6% and 47.8%, respectively. For Group L, the percentages were 44.9%, 16.3% and 38.8%, respectively (p<0.001).

In the current study phase (A3), 30.4% of the assessed young adults had increased BP and, in all assessments, we observed that Group O/O presented mean systolic blood

Table 1 - Epidemiological characteristics of the groups stratified by BMI behavior at the three assessment moments

Variables		Group N (n=46)	Group L (n=49)	Group O/O (n=20)	Statistical test	p-value
Genre						
M	n(%)	24 (52.2)	27 (55.1)	13 (65)	χ2=0.940	NS
F	n (%)	22 (47.8)	22 (44.9)	7 (35)		
Skin color						
B	n (%)	40 (87)	39 (79.6)	13 (65)		
P	n (%)	2 (4.3)	2 (4.1)	3 (15)	χ2=5.626	NS
Non-W Non-B	n (%)	4 (8.7)	8 (16.3)	4 (20)		
Age (years old) at A1		12.66±1.54	13.33±1.40	12.80±1.38	F=2.665	NS
SEL						
Low	n (%)	5 (10.9)	9 (18.4)	6 (30)		
Moderate	n (%)	15 (32.6)	15 (30.6)	6 (30)	χ2=3.766	NS
High	n (%)	26 (56.5)	25 (51)	8 (40)		
Follow-up period (months)		213.58±15.27	213.23±16.90	206.65±15.20	F=1.477	NS

Group N - group with BMI always normal at the three assessments; Group L - group with varying BMI in the three assessments; Group O/O - group with BMI always increased in the three assessments; M - male; F - female; W - white; B - Black; Non-W Non-B - non-white non-black color; SEL - socioeconomic level; F - variance analysis; χ2 - chi-square.

pressure (SBP) and diastolic blood pressure (DBP) values significantly higher at the three moments of assessment in comparison to Group N ($p<0.0001$) (Table 2).

In the analysis of anthropometric variables, we found the prevalence of 25.2% for O/O at A1, 30.4% at A2 and 53.9% at A3 in the general studied population. In comparisons between groups, we observed that Group O/O had higher mean values for WC, AHR and %BF in Group N at A3, all statistically significant (Table 3). Children and adolescents who maintained their weights in compliance with normality (Group N) presented and increase of 21 kg and 3.8 kg/m^2, respectively, for weight and BMI along the 17 years of follow-up, while among those whose BMI remained high (Group O/O), there was an increase of 38.7 kg for weight and 8.4 kg/m^2 for BMI along the 17-year follow-up.

Abdominal obesity assessed through increased waist circumference was present in 38.3% of the assessed individuals at the current phase of the study (A3). The prevalence of increased AHR was 47.8%, while for increased %BF the value was 50.9%.

The comparison of prevalence of increased WC reached a statistically significant difference between groups, with prevalence of 8.7% and 75% in Groups N and O/O ($p<0.0001$), respectively. There were no differences between groups for increased AHR or %BF prevalence (Table 3).

When the metabolic variables were assessed, higher mean values for insulin, HOMA-IR, LDL-c at A2 in Group O/O were observed, as well as glucose, cholesterol, LDL-c and triglycerides at A3 in the same group (O/O) in comparison to the other studied groups. For the remnant variables, there were no differences between groups, though Group O/O had always presented mean values higher than those observed in Groups L and N, as described in Table 4.

When variables were assessed in conjunct: presence or absence of increased BP and presence or absence of O/O among groups at the three moments of assessment, we observed a statistically significant difference in the comparison of the prevalence of such variables association between all groups ($p<0.0001$ for A1, A2 and A3). In all assessments (A1, A2 and A3), Group O/O contributed with higher prevalence of

Table 2 - Mean ± standard deviations of systolic and diastolic blood pressure of groups at A1, A2 and A3, with stratification according to BMI behavior in the three assessment moments

	Variables	Group N (n=46)	Group L (n=49)	Group O/O (n=20)	Statistical test	p-value	Comparison 2 to 2
A1	SBP (mmHg)	108.87 ± 12.83	115.67 ± 14.85	119.00 ± 14.76	F=4.613	0.012	N=L<O/O
	DBP (mmHg)	57.89 ± 12.48	64.37 ± 14.21	66.10 ± 12.30	F=3.966	0.022	N=L<O/O
A2	SBP (mmHg)	117.74 ± 9.97	127.08 ± 16.55	132.60 ± 14.22	H=15.536	<0.0001	N<L=O/O
	DBP (mmHg)	74.52 ± 8.02	81.02 ± 12.25	82.10 ± 12.49	F=5.561	0.005	N<L<O/O
A3	SBP (mmHg)	112.71 ± 12.81	124.54 ± 13.53	136.80 ± 18.93	F=20.841	<0.0001	N<L<O/O
	DBP (mmHg)	73.73 ± 10.57	82.46 ± 10.24	91.80 ± 17.40	F=16.912	<0.0001	N<L<O/O

Group N - group with BMI always normal at the three assessments; Group L - group with varying BMI in the three assessments; Group O/O - group with BMI always increased in the three assessments; SBP - systolic blood pressure; DBP - diastolic blood pressure; F - variance analysis; H - Kruskal-Wallis.

Table 3 - **Anthropometric variables of the groups stratified by BMI behavior at the three assessment moments**

	Variables	Group N (n=46)	Group L (n=49)	Group O/O (n=20)	Statistical test	p-value	Comparison 2 to 2
A1	BMI (kg/m²)	17.84 ± 1.77	20.40 ± 2.13	24.85 ± 2.99	H=63.712	<0.0001	N<L<O/O
A2	BMI (kg/m²)	20.74 ± 1.54	24.21 ± 2.07	29.07 ± 3.55	H=78.393	<0.0001	N<L<O/O
A3	BMI (kg/m²)	21.63 ± 2.26	27.36 ± 3.12	33.25 ± 5.94	H=75.281	<0.0001	N<L<O/O
	WC (cm)	80.03 ± 6.32	92.82 ± 8.03	108.14 ± 14.98	H=63.815	<0.0001	N<L<O/O
	AHR	0.86 ± 0.05	0.90 ± 0.08	0.94 ± 0.07	H=20.530	<0.0001	N=L<O/O
	%BF (%)	24.30 ± 4.14	29.81 ± 3.63	33.39 ± 3.74	F=45.403	<0.0001	N<L<O/O
	Increased AHR n (%)	16 (34.8)	26 (53.1)	13 (65)	χ2=5.61	NS	-
	Increased %BF n (%)	19 (41.3)	26 (53.1)	13 (65)	χ2=3.04	NS	-

Group N - group with BMI always normal at the three assessments; Group L - group with varying BMI in the three assessments; Group O/O - group with BMI always increased in the three assessments; BMI - body mass index; WC - waist circumference; AHR - abdomen/hip relation; %BF - percentage of body fat; kg, kilogram; m - meters; kg/m2, kilogram per square meter; cm - centimeters; % - percentage; F - variance analysis; H - Kruskal-Wallis; χ2- chi-square.

Table 4 - **Mean ± standard deviations of metabolic variables obtained at A2 and A3 from groups stratified according to BMI behavior in the three assessment moments**

Metabolic variables		Group N (n=46)	Group L (n=49)	Group O/O (n=20)	Statistical test	p-value	Comparison 2 to 2
Glucose	A2	92.05 ± 6.97	92.22 ± 9.97	96.42 ± 6.12	H=4.578	*NS*	-
(mg/dL)	A3	78.34 ± 10.78	84.33 ± 13.66	87.50 ± 11.05	F=4.606	0.012	N<L<O/O
Total cholesterol	A2	170.57 ± 29.15	177.93 ± 34.94	191.84 ± 35.97	F=2.791	*NS*	-
(mg/dL)	A3	175.33 ± 30.17	187.06 ± 41.46	202.60 ± 32.76	F=3.970	0.022	N<L<O/O
HDL-c	A2	49.91 ± 12.83	46.66 ± 13.87	41.42 ± 8.20	F=3.040	*NS*	-
(mg/dL)	A3	53.11 ± 12.95	49.22 ± 14.15	45.40 ±15.31	F=2.012	*NS*	-
LDL-c	A2	104.59 ± 23.04	113.72 ± 28.44	129.02 ± 29.64	F=4.275	0.005	N<L<O/O
(mg/dL)	A3	105.19 ± 25.92	115.35 ± 35.17	130.47 ± 25.76	F=4.275	0.017	N<L<O/O
Triglycerides	A2	80.34 ± 33.51	87.75 ± 43.64	107.00 ± 46.23	F=3.376	*NS*	-
(mg/dlL	A3	91.89 ± 55.11	107.23 ± 60.29	133.60 ± 56.73	F=3.376	0.038	N<L<O/O
Insulin (µUI/mL)	A2	10.54 ± 4.10	15.28 ± 8.40	19.79 ± 19.47	H=7.043	0.030	N<L<O/O
HOMA-IR	A2	2.42 ± 1.04	3.55 ± 2.04	4.74 ± 4.56	H=6.242	0.044	N<L<O/O

Group N - group with BMI always normal at the three assessments; Group L - group with varying BMI in the three assessments; Group O/O - group with BMI always increased in the three assessments; mg/dL - milligram per deciliter; µUI/mL - international microunits per milliliter; HOMA-IR - homeostasis model assessment for insulin resistance; F - variance analysis; H - Kruskal-Wallis.

the association of increased BP and presence of O/O, while in Group N the majority of the studied children and adolescents had normal BP and BMI. In this manner, the association of increased BP with presence of O/O was present in 70%, 35% and 70% of the individuals from Group O/O assessed at A1, A2 and A3, respectively, while in Group N the prevalence of assessed individuals that did not present association of increased BP and O/O presence was 80,4% at A1, 91,3% at A2 and 91,3% at A3 (Figure 3).

As the aggregation of cardiovascular risk factors was assessed, the prevalence of alterations in the components used for the classification of MS at the current study phase (A3) were described in Table 5: Increased SBP and/or DBP, increased WC, increased TG and glucose and low HDL-c. For all the assessed components, except for TG, the prevalence of these variables' alterations was higher in Group O/O in comparison to Groups L and N (p<0.05).

With regard to the presence of MS, 28.7% of the studied individuals fulfilled the criteria required for the diagnosis, and Group O/O presented a higher MS prevalence (60%) in relation to Group N (8.7%) and to Group L (34.7%) (p<0.0001).

The relative risk for the occurrence of metabolic syndrome in the young adult age group (A3) was assessed by means of logistic regression analysis. Genre, increased BP and the presence of O/O were considered as independent variables at A1. We observed that male genre and the presence of O/O in the school determined higher chances of MS occurrence in the current phase of the study (*Odds Ratio* 32.66; 95%CI: 6.47-164.89 and *Odds Ratio* 4.13; 95%CI: 1.13-15.10, respectively).

Discussion

Many studies[30-32] have clearly demonstrated that isolate or associated cardiovascular risk factors are already present in the pediatric phase and may contribute to the development of atherosclerosis[7-10].

In this context, the ERJ is a line of research on BP and cardiovascular risk factors and have followed-up young people during 17 years, accomplishing several assessments along this period. It is important to emphasize that this series' original design was characterized by the follow-up of individuals with distinct BP behaviors in school phase: with Percentile of BP≤50 and ≥95. Hence, in subsequent phases of the study, prevalence rates of BP higher than those observed in the general population of this age group are expected. As O/O is strongly related to BP in this age group, it is possible that the currently constituted groups do not reflect the characteristics of the general population, though it is a school population.

One of the first observational studies that showed relation between cardiovascular risk factors and CAD was the *Framingham* study. Among the various assessed risk factors, O/O always showed to be strongly related to CAD[33].

In the present study, at A1, a prevalence of 25.2% of O/O was observed, considering BMI≥ Percentile 85 for sex and age as cut point. It is important to emphasize that these values result from studies carried out in non-Brazilian populations, and it is possible that national curves for BMI could show different values, what would modify such finding.

At A3, O/O was observed in 53.9% of the studied individuals, and in the same population, an increased in the prevalence of overweight along the years was observed, which confirms other studies' results[11-13].

Another important finding was that Group O/O since childhood and adolescence presented higher mean values of BP and higher percentage of individuals with increased BP in all the assessments. As reinforcing this association between overweight and AH along the years, higher mean values for SBP and DBP were observed in the group who maintained abnormal BMI (Group O/O) in comparison to the group whose BMI values were always normal (Group N) along 17 years. The behavior of Group L (varying BMI) was notorious, for it presented an intermediate position with a tendency to proximity of Group O/O in the majority of assessments.

The important reduction in the prevalence of increased BP in Group O/O between the two first evaluations (A1 and A2) deserves to be mentioned. Factors possibly related to this finding would be: the employment of distinct criteria for the definition of high blood pressure at A1 and A2 (different age groups) and psychosocial factors typical of the passage of adolescence to adult age, even though such aspects have no been object of the present study. As the individual enters the adult age (between A2 and A3), the greater period of exposition to O/O may be considered as the main factor responsible for the high prevalence of increased BP observed

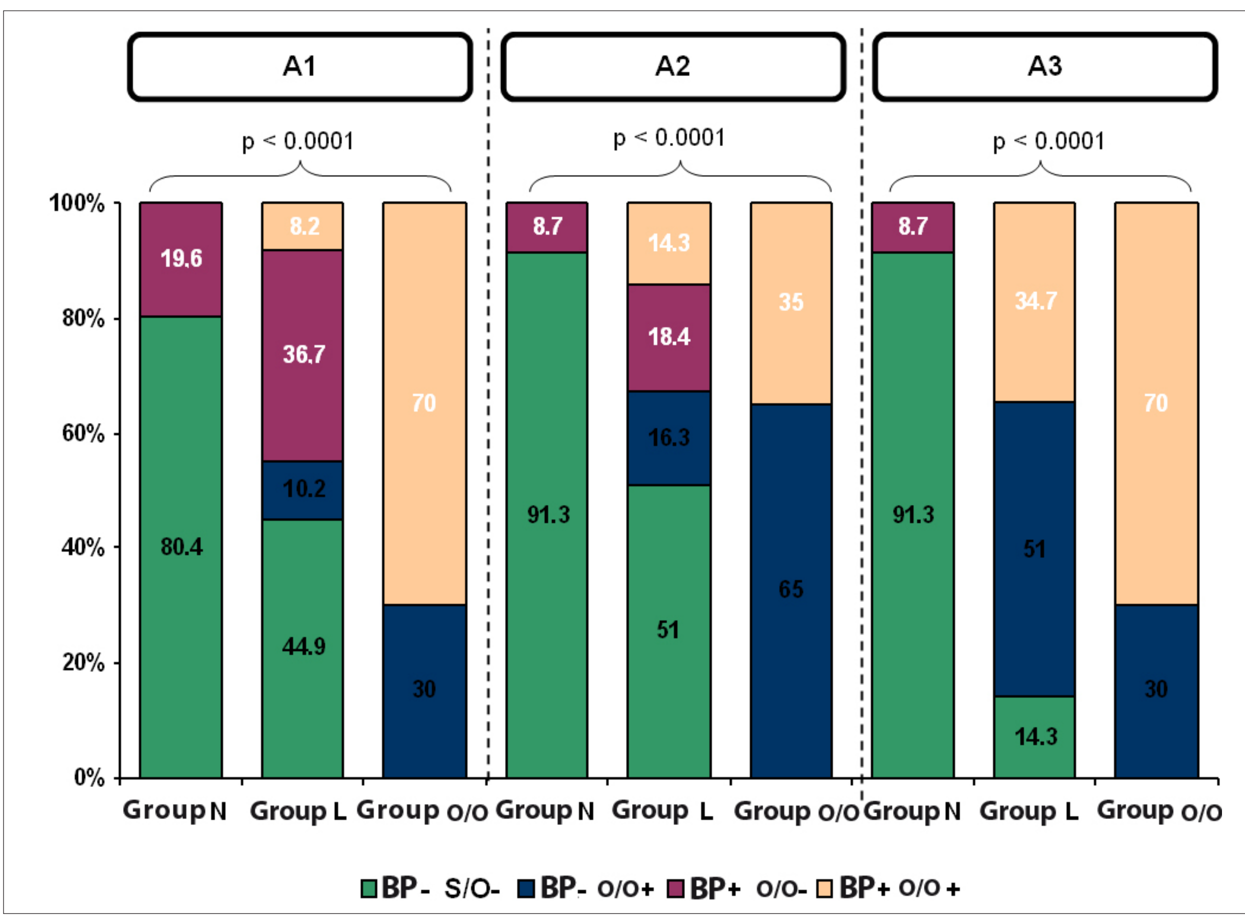

Figure 3 - - Prevalence of the four different models of association between presence/absence of increased BP and the presence/absence of O/O from groups N, L and O/O at A1, A2 and A3. A1 - school phase; A2 - family phase; A3 - ambulatory phase; Group N - group with BMI always normal at the three assessments; Group L - group with varying BMI in the three assessments; Group O/O - group with BMI always increased in the three assessments; BP- O/O - absence of increased BP and absence of overweight/obesity; BP- O/O+ - absence of increased BP with presence of overweight/obesity; BP+ O/O - presence of increased BP with absence of overweight/obesity; BP+ O/O+ - presence of increased BP with presence of overweight/obesity.

Table 5 - **Prevalence of alteration in components involved in MS classification of groups stratified according to BMI behavior at A3**

Variables			Group N (n=46)	Group L (n=49)	Group O/O (n=20)	Statistical test	p-value
A3	Increased WC	n (%)	4 (8,7)	25 (51)	15 (75)	χ^2=31,83	<0,0001
	Increased BP	n (%)	4 (8,7)	17 (34,7)	14 (70)	χ^2=25,475	<0,0001
	Increased TG	n (%)	5 (10,9)	9 (18,4)	6 (8,0)	χ^2=3,607	*NS*
	Increased glucose	n (%)	0	2 (10,2)	3 (15,0)	χ^2=6,237	0,044
	Low HDL-c	n (%)	13 (28,3)	26 (53,1)	13 (65)	χ^2=9,716	0,008

Group N - group with BMI always normal at the three assessments; Group L - group with varying BMI in the three assessments; Group O/O - group with BMI always increased in the three assessments; BMI - body mass index; WC - waist circumference; BP - blood pressure; TG - triglycerides; % - percentage; X2 - chi-square.

at A3. In this manner, the present study has contributed to reinforce that this group of people, higher mean values and prevalence of increased BP are associated with the presence of O/O.

Confirming these data, several series have recognized the relation between O/O and BP, mainly SBP and weight and BMI variables[2-6].

The relevance of the relation between overweight and increase in BP receives emphasis as we verify that child and adolescent obesity is implicated in the development of hypertension and obesity in adult life[34] and mortality among young adults[35].

Just as important as overweight is the pattern of body fat deposition, specially it central distribution and its relation to the risk for cardiovascular disease[16,17,36]. An important limitation of the anthropometric indexes most widely used in epidemiological studies (BMI, WC and AHR) is the fact that they do not reflect the same fat quantity due to specific characteristics of different populations, like ethnicity[36].

In the current study phase, we demonstrated that Group O/O presented higher mean values of WC, AHR and %BF, and 38.3% of the individuals had increased WC. With regard to AHR, a study carried out in Rio de Janeiro showed that this indicator presented higher capability predictive of HA and smaller correlation to BMI than WC[16]. In a study carried out in São Paulo, AHR and WC were similarly associated with AH[17].

Concerning metabolic variables, in the present study, we observed statistically significant differences between groups for the studied lipidic variables, except for HDL-c. Higher mean values for LDL-c, insulin and HOMA-IR were observed at A2 in Group O/O, as well as higher mean values for G, LDL-c, total cholesterol and triglycerides at A3 in the same group (O/O) in comparison to the other studied groups. Although the longitudinal behavior of these variables since C/A was not studied, the findings suggest that an association of the metabolic variables with the presence of O/O, which is in accordance to literature[37].

The concept of MS brought a new dimension for the understanding of cardiovascular disease in the last decades. Each component of the syndrome is associated with an individual increase of cardiovascular risk; however, when associated, this risk increases exponentially, also elevating the general and cardiovascular mortality rates in approximately 1.5 and 2.5 times, respectively[23].

The classic Bogalusa Study longitudinally assessed variables involved in the MS diagnosis in a cohort of 1,020 children/adolescents. The authors demonstrated that such variables coexisted for 16 years and that their degree of agglomeration in adult age (18-38 years old) was consistently higher than those observed in C/A (4-17 years old). There as an increase of 5.8 kg/m^2 in BMI, 7.5 mmHg in mean BP and 0.45 points in HOMA-IR, which indicates a worse metabolic profile as age raises[38].

In the Brazilian population, the prevalence of MS is not known yet, partially because of the absence of a consensus in its definition and in the cut points of its components[39]. In the present study, the prevalence of young adults with MS was 28.7%, and when we assessed MS in association with BMI behavior along 17 years, we observed that this prevalence is higher in Group O/O (8.7% in Group N, 35.7% in Group L and 60% in Group O/O), which demonstrates that the maintenance of overweight may contribute expressively to the occurrence of MS.

In accordance with these data, the present study demonstrated that male genre and the O/O in C/A constitute higher risks for the aggregation of cardiovascular risk factors, which is characterized as MS. A longitudinal study carried out with American children and adolescents demonstrated that abnormal values of BMI and WC in C/A determine increased risk for the development of MS in the adult age[40].

The main limitation of this study is the same experimented by many cohorts reported in literature and is related to the longitudinal character of the follow-up, which determines progressive losses of a portion of the original sample. However, it is emphasized that the population sample of ERJ is a non-hospital sample, of school origin and that has been followed-up for the last 17 years, considered as the Brazilian cohort of this age group with the longest follow-up period till nowadays.

In conclusion, the importance of cardiovascular risk assessment in young populations has been emphasized by many longitudinal studies and, in this context, the present study showed that overweight along the 17-year follow-up, since C/A, was associated with higher BP and anthropometric indexes values and also higher prevalence of MS in the adult age. Male sex and O/O in C/A (A1) increased the risk of MS occurrence in the adult age.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

There were no external funding sources for this study.

Study Association

This article is part of the thesis of master submitted by Flávia Lopes Fonseca, from Faculdade de Ciências Médicas - Universidade do Estado do Rio de Janeiro.

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