



Overweight and obesity associated with high blood pressure: a cross-sectional study in Brazilian students*

Sobrepeso e obesidade associados à pressão arterial elevada: um estudo seccional em escolares brasileiros

Sobrepeso y obesidad asociados a la presión arterial alta: un estudio seccional en escolares brasileños

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ABSTRACT

Objective: To verify the association among overweight, obesity and high blood pressure in Brazilian students aged between 6 and 10 years old. **Method:** Cross-sectional study carried out in the city of Macaé, RJ, in which body mass, height and blood pressure were collected. The body mass index was calculated using the Anthro Plus software and classified according to SISVAN. High systolic/diastolic blood pressure when ≥ 90 th percentile by age, gender and height/age percentile (7th Brazilian Guideline on Hypertension). Logistic regression with a 95% confidence interval, using SPSS software were done. **Results:** A total of 911 children were evaluated and, after stratification by nutritional status, the underweight were excluded. Among the remaining 888 children, the prevalence of overweight was 17.7% and obesity 16.2%. The prevalence of high blood pressure was 34%, with no statistical difference between gender ($p=0.57$). Overweight was significantly associated with high blood pressure in the 8-9 year old group (OR 1.99; $p=0.004$), while obesity was associated in both groups (6-7 year old OR 2.50; $p=0.004$ and 8-9 year old OR 4.21 $p=0.001$). **Conclusion:** The results showed that overweight and obesity significantly increased the chance of high blood pressure among children aged 6 to 10 years old.

DESCRIPTORS

Child; Overweight; Obesity; Arterial Pressure; Primary Prevention; Child Health.

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INTRODUCTION

Child overweight and obesity combined has increased significantly over the past 4 decades. In 2016, approximately 340 million children and adolescents aged between 5 and 19 years old were classified as overweight or obese, emphasizing this global pandemic⁽¹⁻²⁾. The World Health Organization (WHO) is categorical when stating that, during childhood, overweight and/or obesity are diseases that can interfere with quality of life⁽²⁾, which are related to the early occurrence of cardiovascular risk factors (CRF). For example, in the short term, elevated blood pressure levels, dyslipidemia, hyperglycemia can occur⁽³⁾ and, in the long term, ventricular hypertrophy and thickening of the intimal layer of the coronary arteries⁽⁴⁾. When CRF are present in childhood, they tend to last in adolescence and adulthood, being associated with cardiovascular diseases, stroke and, consequently, premature death⁽⁵⁾.

Associated with the obesity pandemic, the theme of high blood pressure during childhood has been gaining evidence for some years⁽⁶⁾. Previously, there was only secondary hypertension or underlying to some disorder, however, it is already known that changes in blood pressure levels in children can also represent the onset of essential hypertension observed in adults⁽⁵⁾.

High blood pressure (HBP) in children occurs when the systolic and/or diastolic blood pressure levels are above the 90th percentile for age, gender and height/age percentile, including the cutoff points for borderline HBP and systemic hypertension (SH). It is noteworthy that borderline HBP often precedes SH⁽⁷⁾.

In the International Childhood Cardiovascular Cohort Consortium study⁽⁸⁾, when compiling prospective data from four large longitudinal studies initiated in children, Bogalusa Heart Study⁽⁹⁾, Muscatine Study⁽¹⁰⁾, Young Finns Study⁽¹¹⁾ and CDAH⁽¹²⁾, authors observed that both individuals who had persistently HBP during childhood and individuals with normal BP, but with HBP in adulthood, had a higher risk of increased intima-media thickness of the carotid compared to individuals with normal BP from child to adulthood.

Despite the increase in studies on this topic, Brazil still does not have populational data of national scope reporting the prevalence of borderline HBP and SH in the pediatric population. A review study on the prevalence of hypertension in Brazilian students found a prevalence of HBP ranging between 2.3% and 40.6% in different regions of the country⁽⁶⁾. More recently, a study carried out with children aged between 7 and 10 years old in public schools in Espírito Santo state found a 25% prevalence of HBP values⁽¹³⁾, demonstrating that Brazilian studies carried out exclusively with school-age children and with the intention of screening for changes in blood pressure are still occasional and infrequent.

Considering the current scenario of childhood obesity and its consequences on high blood pressure, this study aimed to verify the association between overweight, obesity

and high blood pressure in Brazilian students aged between 6 and 10 years old.

METHOD

STUDY DESIGN

Cross-sectional study.

SCENARIO

The study was carried out between March 2013 and November 2014, in municipal public elementary schools in the urban area of the city of Macaé, Rio de Janeiro state. The city had a total of nine administrative sectors, and a school belonging to each sector was listed in a non-probabilistic manner. The total student list had 1779 children. Of these, 224 were outside the investigated age group, one had dwarfism and two were cited repeatedly, totaling 1552 eligible children.

The sample size calculation was performed by selecting a simple random sample (SRS), which was based on the prevalence of 15% HBP for children and adolescents⁽⁷⁾. 95% reliability was considered for the Confidence Interval (CI), maximum error between the HBP estimate not exceeding 1.5%, as well as the population size (1552 students). The formula used refers to an SRS for infinite populations. Subsequently, the result found was corrected, considering the size of the population of children distributed among the nine schools participating in the study and within the age range of six to 10 years old. Thus, the final sample size was 911 school children.

DATA COLLECTION

Demographic data (age, gender), systolic and diastolic BP and anthropometric data (body mass, height) were collected by two trained members of the Integrated Laboratory for Research and Innovation in Sport Sciences (*Lapice*) team – UFRJ - Campus Macaé.

BLOOD PRESSURE

The children remained seated and reclined in the chair, with their legs uncrossed, at rest for 5 minutes, and did not practice physical exercise before the measurement. Systolic and diastolic BP was obtained in duplicate with a 2-minute interval between measurements. The digital equipment OMRON HEM-705 CP® (G-Tech International Republican of Korea) was used and the cuff was adjusted to the size of the arm perimeter. Systolic and/or diastolic arterial normotension was classified when the mean BP value was <90th percentile, and HBP when this value was ≥ 90th percentile according to age, gender and height/age percentile, as recommended by the 7th Brazilian Guideline on Hypertension⁽⁷⁾.

ANTHROPOMETRY

Body mass and height were measured in duplicate. One used a Tanita® portable platform scale (Illinois, USA) with

a capacity of 150 kg and a variation of 50g, and a Altura Exata® stadiometer (Minas Gerais, Brazil) with a variation of 0.1 cm. The children were wearing light clothes, without shoes and without ornaments on their heads. From the average value of body mass and height measurements and with the help of the Anthro Plus software, BMI-for-age (BMI/A) was calculated, whose values were transformed into z-score and categorized into underweight (Z -score < -2), eutrophy ($> z$ -score -2 and $< z$ -score +1), overweight ($> z$ -score +1 and $< z$ -score +2) and obesity ($\geq z$ -score +2), according to the Food and Nutritional Surveillance System (In Portuguese: *SISVAN*)⁽¹⁴⁾.

DATA ANALYSIS

The normality of the sample was analyzed by the Kolmogorov-Smirnov test. Means and standard deviations of continuous variables and frequencies of categorical variables (gender, nutritional status, BP) were calculated. Analysis of variance (ANOVA) was used for BP means and the chi-square test for the frequency of HBP according to nutritional status. The age variable was stratified to avoid mistaken inference, with students grouped into 6-7 and 8-9 years old. Logistic regression adjusted for gender was used to verify the association between the exposure variable (overweight/obesity) and the outcome (HBP). The results were expressed in Odds Ratio (OR) and 95% confidence interval. In all analyzes, a value of $p < 0.05$ was adopted for statistical significance. The Statistical Program for the Social Sciences, version 21.0 (SPSS, Chicago, IL) was used.

ETHICAL ASPECTS

This study was approved by the Research Ethics Committee of the Veiga de Almeida University, protocol 876333, 2013. All procedures performed in studies involving human participants were in accordance with the ethical standards of the National Research Ethics Commission, according to the Resolution 466/2012 of the National Health Council. All those responsible for the children consented to participate in the study. The study was authorized by the Municipal Education Secretariat of the city of Macaé, Rio de Janeiro, and by the direction of each participating school.

RESULTS

A total of 911 children with an average age of 7.7 years old were evaluated, with 39.52% ($n=351$) aged between 6-7 years old and 60.47% ($n=537$) between 8-9 years old, 51.7% ($n=459$) were female and the others were male. No significant difference was found according to gender for the analyzed variables, as shown in Table 1.

Underweight was prevalent in 2.5% ($n=23$) of the initial sample, and these students were excluded from subsequent analyzes, which totaled 888 children. Among these, the total prevalence of overweight and obesity together was 34% ($n=302$), with 17.7% ($n=157$) overweight and 16.2% ($n=144$) obesity. Anthropometric and blood pressure variables differed significantly when nutritional status was considered (Table 1).

Table 1 – Characterization of the total sample of students aged 6 to 10 years old, according to gender and classification of the z-score of the body mass index – Macaé, RJ, Brazil, 2013/2014.

| | Total (n = 911) Mean ± SD | Boys (n = 439) Mean ± SD | Girls (n = 472) Mean ± SD | p-value | Eutrophy (n = 587) | Overweight (n = 157) | Obesity (n = 144) | p-value |
|--------------------------|---------------------------------|--------------------------------|---------------------------------|---------|-----------------------|-------------------------|----------------------|---------|
| Age | 7.74 ± 1.03 | 7.75 ± 1.0 | 7.74 ± 1.0 | 0.15 | 7.73 ± 1.0 | 7.76±1.0 | 7.75±1.0 | 0.89 |
| Weight (kg) | 29.7 ± 8.2 | 30.1 ± 8.3 | 29.4 ± 7.9 | 0.39 | 26.1±4.2 | 33.0±5.7 | 42.48±8.4 | <0.001 |
| Height (cm) | 129.7 ± 8.5 | 130.1 ± 8.6 | 129.4 ± 8.5 | 0.81 | 128.2±7.8 | 131.0±9.0 | 134.6±8.7 | <0.001 |
| BMI (kg/m ²) | 17.4 ± 3.2 | 17.5 ± 3.2 | 17.3 ± 3.2 | 0.57 | 15.7±1.17 | 19.0±1.2 | 23.3±2.8 | <0.001 |
| SBP (mmHg) | 107.0 ± 9.1 | 107.5 ± 9.5 | 106.5 ± 8.8 | 0.07 | 105.1±8.4 | 110.1±8.5 | 112.4±9.6 | <0.001 |
| DBP (mmHg) | 67.5 ± 7.5 | 67.6 ± 7.4 | 67.4 ± 7.6 | 0.64 | 66.16±7.3 | 69.32±6.7 | 72.0±7.4 | <0.001 |

Student t-test for gender; ANOVA for nutritional status; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure.

Note: ($n=911$).

When grouped by age, students in the 6-7-year-old group had a prevalence of 17.9% ($n=63$) for overweight and 15.7% ($n=55$) for obesity (Table 2). The prevalence was 17.5% ($n=94$) for overweight and 16.6% ($n=89$) for obesity in the 8-9-year-old group.

Changes in systolic and/or diastolic blood pressure were prevalent in 34% ($n=302$) of the sample, with no statistically significant difference between genders (boys 35% and girls 33.1%; $p=0.57$). In groups 6-7 and 8-9 years old, the prevalence of high systolic and/or diastolic BP was 29.1%

($n=102$) and 37.2% ($n=200$), respectively. These data are not shown in Table 2.

For both age groups, there was a significant difference among nutritional status, the prevalence of normotension and HBP. A higher prevalence of eutrophic children with normotension was also observed. In contrast, the prevalence of children with obesity and HBP was 43.6% ($n=24$) in the group 6-7 years old and 62.9% ($n=56$) in the group 8-9 years old, as shown in Table 2. Figure 1 shows the distribution of the mean systolic and diastolic BP values according to gender and BMI classification.

Table 2 – Prevalence of normotension and high blood pressure in students aged between 6-7 and 8-9 years old – Macaé, RJ, Brazil, 2013/2014.

| Blood pressure | 6-7 years old | | | | 8-9 years old | | | |
|---|--------------------------------|---------------------------------|------------------------------|---------|--------------------------------|---------------------------------|------------------------------|---------|
| | Nutritional status | | | p-value | Nutritional status | | | p-value |
| | Eutrophy (n = 233) % (n) | Overweight (n = 63) % (n) | Obesity (n = 55) % (n) | | Eutrophy (n = 354) % (n) | Overweight (n = 94) % (n) | Obesity (n = 89) % (n) | |
| Normotension ($< 90^{\text{th}}$ percentile) | 76.4 (178) | 63.5 (40) | 56.4 (31) | 0.005 | 71.2 (252) | 55.3 (52) | 37.1 (33) | 0.001 |
| High BP ($\geq 90^{\text{th}}$ percentile) | 23.6 (55) | 36.5 (23) | 43.6 (24) | | 28.8 (102) | 44.7 (42) | 62.9 (56) | |

Chi-square test for nutritional status, $p < 0.05$.

Note: (n=888).

In general, overweight was positively associated with HBP. Overweight was significantly associated with HBP only in the 8-9 year old group, while obesity was associated with high BP in both groups (6-7 years old OR 2.50;

$p=0.004$ and 8-9 years old OR 4.21 $p=0.001$), when compared to eutrophic, as shown in Table 3. The association remained significant after adjusting for gender.

Table 3 – Adjusted and unadjusted binary logistic regression by gender for an association between BMI/age and high blood pressure in students aged between 6-7 and 8-9 years old – Macaé, RJ, Brazil, 2013/2014.

| BMI by age | 6-7 YEARS OLD | | 8-9 YEARS OLD | |
|------------|---------------------------------|---------------------------------|-----------------------------------|-----------------------------------|
| | OR (95%CI) not adjusted | OR (95%CI) adjusted | OR (95%CI) not adjusted | OR (95%CI) adjusted |
| Eutrophy | - | - | - | - |
| Overweight | 1.86 (1.02 – 3.37) [#] | 1.85 (1.02 – 3.37) [#] | 1.99 (1.25 – 3.18) ^{**} | 1.99 (1.25 – 3.18) ^{**} |
| Obesity | 2.50 (1.35 – 4.62) [*] | 2.50 (1.35 – 4.62) [*] | 4.19 (2.57 – 6.82) ^{***} | 4.21 (2.58 – 6.87) ^{***} |

BMI = body mass index; OR = odds ratios; CI = confidence interval; * $P=0.003$

** $P=0.004$; *** $P=0.001$; # $P=0.41$.

Note: (n=888).

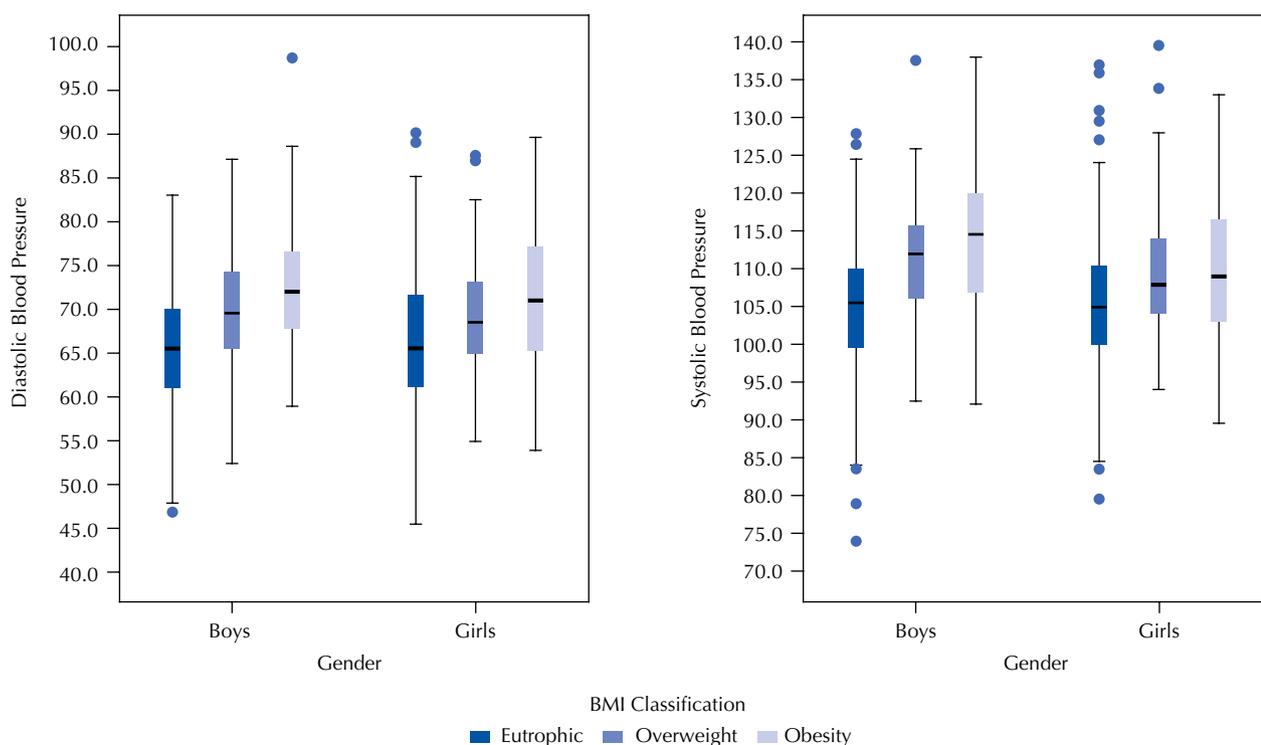


Figure 1 – Distribution of systolic and diastolic blood pressure mean value according to gender and classification of body mass index.

DISCUSSION

This cross-sectional study demonstrated an association between overweight and HBP in the investigated sample. The obesity increased the chance of HBP among children aged 6-7 years old twice. In children aged 8-9 years old, overweight doubled the chance of HBP, while obesity quadrupled that chance. The results found here are important in the context of screening for cardiovascular risk in the child population in primary care, due to the obesity epidemic and its associated comorbidities, including changes in blood pressure levels such as SH.

In the last four decades, national surveys have highlighted the change in the nutritional profile of Brazilian children over the age of five, demonstrating a reduction in malnutrition and an increased incidence of overweight⁽¹⁵⁾. In our study, about one third of the children assessed had this condition, not differing from the Brazilian national reference, the Family Budget Survey (POF, 2008/2009)⁽¹⁶⁾. It also interfaces with several more recent national and international studies, and overweight was found in a similar proportion in the children investigated in different regions of Brazil⁽¹⁷⁾. In the USA, one third of the children had overweight or obesity⁽¹⁸⁾. In addition, overweight was prevalent in 41.8% of Mexican children, 22% of Indian children, 19.3% of Argentine children⁽¹⁹⁾ and 38.3% of Spanish children⁽²⁰⁾.

Childhood overweight and obesity are complex diseases and are related to behavioral, socioeconomic and demographic variables^(2,5,21). Environmental factors are usually the main determinants of children's nutritional status, contributing to the increase in body mass. Changes in eating habits, such as excessive intake of ultra-processed foods rich in sugars, sodium and saturated fats, along with physically inactive behavior, can favor a significant increase in the percentage of children overweight⁽²²⁾. Overweight or obese children usually have higher levels of systolic and diastolic blood pressure, in addition to higher prevalence of dyslipidemia and insulin resistance⁽¹⁷⁾, favoring the risk of developing cardiovascular disease (CVD)⁽³⁾. In this study, the prevalence of HBP was 34%, not differing by gender. As observed in a study conducted with adolescents aged between 11 and 16 years old⁽²³⁾, the present results showed that both systolic and diastolic BP increased significantly among overweight and obese students, in both age groups (6-7 and 8-9 years old). In a study conducted with children and adolescents in China, aged between 7 and 18 years old, high prevalence of HBP was also found among those who had overweight and obesity, of 19% and 23.2%, respectively⁽²⁴⁾. Although this study had lower prevalence than those observed in the present research, the proportion is also high. The comparability of results is limited due to the lower frequency of studies conducted exclusively with children aged between 6 and 10 years old. A systematic review of BP among Brazilian students showed a great divergence in the prevalence of HBP among the studies, according to the applied methods (number of visits, number of measures per visit, time of rest) and region of the

country, which could explain the great variability between the present findings and other studies on the same topic⁽⁶⁾.

Hypertension related to overweight can be observed in children from 8 years old onwards (overweight boys and girls OR 3.3 and OR 3.5, respectively; boys and girls with obesity OR 10.7 and OR 13, 5, respectively)⁽²⁵⁾. In this study, obesity was associated with HBP in both age groups. Obese children aged 6-7 years old are 150% more likely to have HBP when compared to normal weight children (OR 2.5 $p=0.003$), with the percentage increasing to more than 300% in the 8-9 year old group (OR 4.21 $p=0.001$). In a national study carried out with students aged between 6 to 11 years old in the state of Paraná, an even greater chance was found there for obese children (OR 5.4 95% CI: 4.23-6.89)⁽²⁶⁾.

HBP in childhood can predict metabolic and structural changes at an early age, as demonstrated in the classic longitudinal studies initiated in children - Bogalusa Heart Study⁽⁹⁾, Muscatine Study⁽¹⁰⁾, Young Finns Study⁽¹¹⁾ and CDAH⁽¹²⁾. Likewise, there is evidence that children with high BP have a sustained risk of becoming hypertensive adults due to the permanent damage that can affect target organs^(5,9-12). According to the American Academy of Pediatrics⁽²⁷⁾, adopting the strategy of primary prevention of SH is essential to reduce the risk of cardiovascular disease in youth. An essential component of this strategy is the screening of BP in children. The 7th Brazilian Guideline on Hypertension recommends annual BP measurement from 3 years old onwards, and in case of HBP, it must be confirmed with repeated measurements⁽⁷⁾. Thus, the performance of pediatric nursing professionals in primary care is very important, especially when considering childhood as a phase of potentials and vulnerability to diseases and conditions⁽²⁸⁾.

It is important to emphasize that all children should be screened for changes in blood pressure levels, as HBP does not seem to be an uncommon condition, even in children with appropriate weight. In this study, one found a prevalence of 23.6% of HBP in eutrophic children aged 6-7 years old and 28.8% in those aged 8-9 years old. Another Brazilian study identified 18.5% of eutrophic students, between 7 and 17 years old, with HBP, suggesting that this may also be influenced by other variables besides weight⁽²⁹⁾. Factors such as ethnicity, low birth weight, inflammation, lifestyle and inappropriate eating habits are mentioned as influencing the genesis of SH^(2,6,22). However, some of them, such as eating habits and a healthy lifestyle, seem to be determinant for changes in BP during the transition from childhood to adulthood⁽²⁾. Recently, the Ministry of Health provided the document entitled "Cardioprotective Food: Guidance Manual for Primary Health Care Professionals", which aims to subsidize primary care health professionals in order to promote health and improve Brazilian food and nutritional security, contributing to the reduction of the development of cardiovascular diseases⁽³⁰⁾.

The results presented in this study are relevant, but the limitations inherent in sectional studies must be considered, among them the lesser strength in establishing a causal

relationship among overweight, obesity and HBP, in addition to the absence of other variables that could have an association with blood pressure. It is also noteworthy that the BP measurement performed in just one meeting does not constitute a diagnosis. Thus, children identified with HBP were instructed to seek the primary health center located in the region closest to their house.

CONCLUSION

The results showed that overweight and obesity increased the chance of HBP among children aged 6 to 10 years old.

In addition, regardless of weight, high blood pressure levels were also observed in eutrophic children. Thus, one signals the need for greater attention about the cardiovascular health of the pediatric population since HBP in childhood can be related to SH in adulthood. It is also emphasized the need for prevention and intervention programs to be efficiently applied in the school environment, considering that it facilitates the greater reach of the child population. One suggests that further investigations be carried out including other variables related to tension changes and which were not addressed here.

RESUMO

Objetivo: Verificar associação entre sobrepeso, obesidade e pressão arterial elevada em escolares brasileiros com idade entre 6 e 10 anos incompletos. **Método:** Estudo seccional realizado no município de Macaé, RJ, em que foi coletado massa corporal, estatura e pressão arterial. O índice de massa corporal foi calculado pelo software Anthro Plus e classificado conforme SISVAN. Pressão arterial sistólica/diastólica elevada quando \geq percentil 90 por idade, sexo e percentil da estatura/idade (7ª Diretriz Brasileira de Hipertensão). A análise foi por regressão logística com intervalo de confiança 95%, software SPSS. **Resultados:** Foram avaliadas 911 crianças e, após estratificação por estado nutricional, as com magreza foram excluídas. Entre as 888 crianças restantes, a prevalência de sobrepeso foi 17,7% e obesidade 16,2%. A prevalência de pressão arterial elevada foi 34%, não diferindo entre sexo ($p=0,57$). Sobrepeso foi significativamente associado à pressão elevada no grupo de 8-9 anos (OR 1,99; $p=0,004$), enquanto a obesidade associou-se em ambos os grupos (6-7 anos OR 2,50; $p=0,004$ e 8-9 anos OR 4,21 $p=0,001$). **Conclusão:** Os resultados demonstraram que sobrepeso e obesidade aumentaram expressivamente a chance de pressão arterial elevada entre crianças de 6 a 10 anos incompletos.

DESCRITORES

Criança; Sobrepeso; Obesidade; Pressão Arterial; Prevenção Primária; Saúde da Criança.

RESUMEN

Objetivo: Comprobar la asociación entre sobrepeso, obesidad y presión arterial alta en escolares brasileños con edad comprendida entre 6 y 10 años incompletos. **Método:** Se trata de un estudio seccional realizado en el municipio de Macaé, Río de Janeiro, en el que se recogió masa corporal, estatura y presión arterial. El índice de masa corporal se calculó con el software Anthro Plus y se clasificó conforme SISVAN. Se estima como presión arterial sistólica/diastólica alta \geq 90 percentil por edad, sexo y percentil de estatura/ edad (7ª Directiva Brasileña de Hipertensión). El análisis se realizó por regresión logística con intervalo de confianza del 95% mediante el software SPSS. **Resultados:** Se evaluó un total de 911 niños y, tras la estratificación por estado nutricional, se excluyeron los delgados. Entre los 888 niños restantes, la prevalencia del sobrepeso era del 17,7% y la obesidad, del 16,2%. La prevalencia de la hipertensión arterial fue del 34%, sin diferencia entre géneros ($p=0,57$). El sobrepeso estaba asociado significativamente a la hipertensión arterial en el grupo de 8-9 años (OR 1,99; $p=0,004$), y la obesidad, a ambos grupos (6-7 años OR 2,50; $p=0,004$ y 8-9 años OR 4,21 $p=0,001$). **Conclusión:** Los resultados demuestran que el sobrepeso y la obesidad de niños entre 6 y 10 años incompletos aumentan expresivamente la posibilidad de padecer hipertensión.

DESCRIPTORES

Niño; Sobrepeso; Obesidad; Presión Arterial; Prevención Primaria; Salud del Niño.

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