Original Article

Assessment of Overweight/Obesity and Elevation of Blood Pressure in Schools in Rural and Urban Area in the Backlands of Bahia

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Abstract

Background: **Childhood and adolescent obesity has been increasing, particularly in countries with greater social vulnerability. Given this context, assessing schoolchildren from Bahia's backlands — a region known for its low-income population — is essential.**

Objective: **To assess the frequency of overweight and obesity and their association with high blood pressure (BP) in children from urban and rural areas in four municipalities in the backlands of Bahia.**

Methods: **This study is part of a project evaluating the impact of a school meal intervention on the health of children and adolescents in Bahia's backlands. A subset of children aged five to ten from public schools in both rural and urban areas of four cities in Bahia's backlands was selected through random and proportional sampling. The participants had their weight, height, waist circumference and BP measured using standardized protocols. The Body Mass Index (BMI) was expressed as a z-score to determine nutritional status. The Student's t-test and Chi-square tests were used, with 5% statistical significance.**

Results: **The sample consisted of 461 students, 264 (57.3%) from urban areas and 238 (51.6%) males. The prevalence of overweight was 27.9%, and that of increased waist circumference was 7.4%. High BP or hypertension had a prevalence of 8%. A significant difference (p = 0.049) was observed between rural and urban areas in relation to the increased waist circumference.**

Conclusion: **The research revealed a high frequency of overweight, increased waist circumference and systemic BP in students, mainly those from urban areas.**

Keywords: **Child; Hypertension; Obesity.**

Introduction

The nutritional status of children and adolescents is a determining factor in their weight-height growth and intellectual development. Childhood obesity is now a major global public health concern. Once limited to developed countries, its prevalence has been rising in low-income nations since the 1990s. In 2016, the World Health Organization (WHO) estimated that there were 340 million children and adolescents (aged 5-19 years) who were obese or overweight in the world. The WHO recognizes obesity as a global epidemic and the most significant nutritional disorder.[1,2]

The ERICA study (Cardiovascular Risk in Adolescents), conducted in 2016 with Brazilian children and adolescents, reported a prevalence of overweight and obesity at 17.1% and 8.4%, respectively. It also identified associated comorbidities, including hypercholesterolemia (20.1%), metabolic syndrome (2.6%), and systemic arterial hypertension (9.6%), conditions linked to an increased risk of cardiovascular disease.[3-5]

This scenario underscores the importance of adopting healthy lifestyle habits during childhood and adolescence. Reducing the intake of calorie-dense foods such as fried items, ultra-processed products, and animal-based foods while increasing the consumption of plant-based options and engaging in physical activity is crucial for preventing cardiovascular and other chronic non-communicable diseases in adulthood.

In this sense, this study aims to assess the prevalence of overweight, obesity, and high blood pressure (BP) among children in Bahia's backlands and to determine whether these conditions differ between rural and urban areas.

Methodology

Study Design

This is a cross-sectional study that is part of the project entitled *"Avaliação de um projeto de intervenção na merenda escolar sobre a saúde de crianças e adolescentes no sertão da Bahia"*

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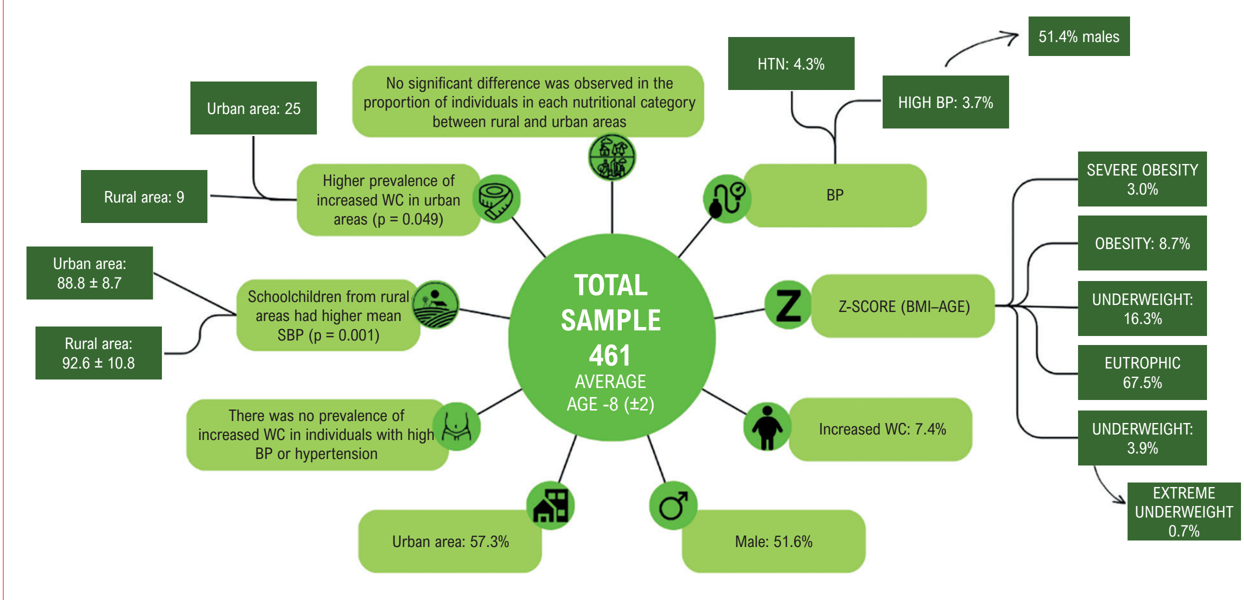
Central Illustration: Assessment of Overweight/Obesity and Elevation of Blood Pressure in Schools in Rural and Urban Area in the Backlands of Bahia



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BP: blood pressure; BMI: Body Mass Index; SBP: systolic blood pressure; HTN: Hypertension.

("Evaluation of an intervention project in school meals on the health of children and adolescents in the backlands of Bahia").

Sample Selection

The sample of the main project was randomly selected and proportional to the number of students enrolled in each school. Considering the number of 35,000 students in the cities under study and the frequency of obesity/overweight around 20%, a sample calculation was performed using the Z statistic with the aid of the "Win Pepi" electronic calculator. For a 95% confidence interval, a sample size of 1,500 participants was established for anthropometric assessment. The schools were randomized, respecting an equal proportion of students from rural and urban areas. All randomly selected students (n = 1,500) were evaluated in clinical and anthropometric aspects by the team involved in the study for two years.

Inclusion Criteria

For this study, children aged five to ten years regularly enrolled in public schools in rural and urban areas of four of Bahia's backland cities (Serrinha, Biritinga, Barrocas, and Teofilândia) were included, having no previous diagnosis of diseases that could interfere with their nutritional status, such as diabetes mellitus, celiac disease, thyroid dysfunction, or others.

Exclusion Criteria

Participants unwilling to or unable to perform any of the conducts were excluded, according to the Free and Informed Consent Form (TCLE) and Assent Form (TALE).

After applying the eligibility criteria, 461 children were included.

Procedures

Weight was measured using a scale regularly calibrated by a technical service accredited by the National Institute of Metrology, Standardization and Industrial Quality (INMETRO). The students were positioned upright, in the center of the scale, with their body weight distributed equally on both feet, barefoot and wearing uniforms. A portable, microelectronic scale, Welmy brand, model W 200 M, with a 136 kg capacity and a 100 g weight variation, was used to measure weight in kg. This instrument was calibrated by a competent company at each weighing cycle.

Height was measured using an Altura Exata stadiometer with a 10 cm graduation and a maximum capacity of 2.13 m. Students stood upright with feet together and barefoot.

Waist circumference was measured using an inelastic measuring tape with the students standing upright. Measurements followed the horizontal plane, with the tape positioned midway between the lower edge of the last rib and the iliac crest on the right side, avoiding the umbilical scar as a reference point. These measurements were taken at the end of normal expiration, in duplicate.

To compare the distribution of waist circumference percentiles, a literature review of population-based studies in a similar age group was conducted. Due to the lack of Brazilian reference values for such measurements in the pediatric age group, the North American standard described by Fernandez in 2004 (Figure 1) was employed. Values above the 90th percentile were considered increased for both sexes.[6]

The anthropometric indices measured were classified according to Z-score analysis based on the WHO child growth curves to determine their nutritional status.[7] Data were analyzed using the WHO Anthro software (version 3.2.2).

The Body Mass Index (BMI) was calculated using the Quetelet formula (weight in kg/height2 in meters). Children were classified into five categories according to BMI: extreme underweight (Z-score < -3), underweight (Z-score < -2), normal weight (Z-score between -2 and 1), overweight (Z-score between 1 and 2), or obese (Z-score > 2). For the analysis, individuals with extreme underweight, underweight or normal weight were grouped into a group called "underweight/normal weight." Likewise, individuals classified as overweight, obese or severely obese were grouped into a group called "excess weight."

Systemic BP was recorded three times at one-minute intervals using the oscillometric method (ONROM device). Cuff sizes varied and were selected based on the midpoint diameter between the scapular acromion and the elbow epicondyle, with the shoulder in a neutral position and the elbow flexed at 90°. The first measurement was disregarded and the average of the last two measurements was computed. Measurements were compared with the graphs of the 2017 American Academy of Pediatrics guidelines and classified as normal (< 90th percentile), high (between the 90th and 95th percentiles up to a maximum of 120/80 mmHg), stage 1 hypertension (greater than or equal to the 95th percentile up to a maximum of 12 mmHg above the 95th percentile or BP between 130/80 mmHg and 139/89 mmHg, whichever is lower) or stage 2 hypertension (greater than or equal to the 95th percentile + 12 mmHg or greater than or equal to 140/90 mmHg, whichever is lower) in children and adolescents up to 13 years of age.[8]

Statistical Analysis

The Statistical Package for Social Sciences (SPSS) software, version 25.0 for Windows, was used to prepare the database and perform descriptive and analytical analysis. The variable's normality was verified using descriptive statistics, and the analytical statistics were verified using the Kolmogorov-Smirnov test. The results are presented in tables, graphs and/or figures. Categorical variables are expressed in absolute values and percentages – n (%); all continuous variables present normal distribution and are expressed as mean and standard deviation (± SD).

Categorical variables were compared using Pearson's Chi-Square Test and, when the expected frequency was less than five, using Fisher's Exact Test. The means of BMI, WC, systolic blood pressure (SBP), and diastolic blood pressure (DBP) in rural and urban areas were compared using the Student's t-test for independent samples. All variables were normally distributed. The significance level adopted was 5%.

	Percentile for boys					Percentile for girls				
	10th	25th	50th	75th	90th	10th	25th	50th	75th	90th
Intercept	39.7	41.3	43.0	43.6	44.0	40.7	41.7	43.2	44.7	46.1
Slope	1.7	1.9	2.0	2.6	3.4	1.6	1.7	2.0	2.4	3.1
Age (y)										
2	43.2	45.0	47.1	48.8	50.8	43.8	45.0	47.1	49.5	52.2
3	44.9	46.9	49.1	51.3	54.2	45.4	46.7	49.1	51.9	55.3
4	46.6	48.7	51.1	53.9	57.6	46.9	48.4	51.1	54.3	58.3
5	48.4	50.6	53.2	56.4	61.0	48.5	50.1	53.0	56.7	61.4
6	50.1	52.4	55.2	59.0	64.4	50.1	51.8	55.0	59.1	64.4
7	51.8	54.3	57.2	61.5	67.8	51.6	53.5	56.9	61.5	67.5
8	53.5	56.1	59.3	64.1	71.2	53.2	55.2	58.9	63.9	70.5
9	55.3	58.0	61.3	66.6	74.6	54.8	56.9	60.8	66.3	73.6
10	57.0	59.8	63.3	69.2	78.0	56.3	58.6	62.8	68.7	76.6
11	58.7	61.7	65.4	71.7	81.4	57.9	60.3	64.8	71.1	79.7
12	60.5	63.5	67.4	74.3	84.8	59.5	62.0	66.7	73.5	82.7
13	62.2	65.4	69.5	76.8	88.2	61.0	63.7	68.7	75.9	85.8
14	63.9	67.2	71.5	79.4	91.6	62.6	65.4	70.6	78.3	88.8
15	65.6	69.1	73.5	81.9	95.0	64.2	67.1	72.6	80.7	91.9
16	67.4	70.9	75.6	84.5	98.4	65.7	68.8	74.6	83.1	94.9
17	69.1	72.8	77.6	87.0	101.8	67.3	70.5	76.5	85.5	98.0
18	70.8	74.6	79.6	89.6	105.2	68.9	72.2	78.5	87.9	101.0

Figure 1 – *Percentile value for all children and adolescents, according to sex. Source: Waist circumference percentiles in nationally representative samples of African-American, European-American, and Mexican-American Children and Adolescents.*[6]

Ethical aspects

The study complies with the guidelines and standards of Resolution No. 466/12, which regulates research involving human beings, and was approved by the Ethics and Research Committee of the Bahiana Foundation for the Development of Sciences (CAAE: 91282318.3.0000.5544). All participants signed the Free and Informed TALE, and their guardians signed the TCLE.

Results

The sample consisted of 461 schoolchildren, 264 (57.3%) from urban areas and 238 (51.6%) of whom were male. The mean age was 8 years (± 2), as can be seen in the Central Illustration. The mean and SD of BMI, mean SBP and mean DBP of the 461 schoolchildren are shown in Table 1.

The mean age of the schoolchildren from rural areas (7.8 ± 1.58) was not different from the average for students in urban areas (7.7 ± 1.5) (p = 0.47).

Figure 2 and Table 1 show the data on nutritional classification based on the Z-score (BMI – Age), with 311 (67.5%) students classified as normal weight, 75 (16.3%) as overweight, 40 (8.7%) as obese, 18 (3.9%) as underweight, 14 (3.0%) as severely obese and 3 (0.7%) students classified with extreme underweight. This distribution is also shown in the Central Illustration.

Among the individuals belonging to the underweight/normal weight group, 174 (52.4%) were male, while among those overweight or obese, 65 (50.4%) were female. Of the 461 students, 34 (7.4%) had increased WC, 24 (70.6%) of whom were male. Regarding the prevalence of systemic arterial hypertension, 17 (3.7%) students had high BP, 20 (4.3%) were hypertensive, and among the group of individuals with high BP/Hypertension, 19 (51.4%) were male, as can be seen in the Central Illustration.

Data from the nutritional classification based on the Z-Score (BMI–Age) comparative between the rural and urban areas are shown in Table 2. The results reveal that, among the individuals from the rural area, those belonging to the extreme underweight, underweight and normal weight groups prevail (75.1%). In the urban area, in turn, 69.7% are classified as extremely thin, thin and eutrophic and 30.3% are classified as overweight and obese. No significant difference was observed in the proportion of individuals in each nutritional category between the areas (p = 0.21). Regarding the increased waist circumference, there was a higher prevalence of schoolchildren with increased waist circumference in urban areas compared to rural areas: 25 (9.5%) vs. 9 (4.6%) (p = 0.049) (Table 2 and Central Illustration).

Table 3 represents data on systemic BP according to the area. Among individuals from rural areas, 178 (90.4%) were normotensive, while in urban areas, 246 (93.2%) of the schoolchildren were normotensive. No significant difference was observed in the proportion of individuals with increased BP or hypertension in rural and urban areas.

Schoolchildren from rural areas had a higher mean SBP (92.6 ± 10.8) than those from urban areas (88.8 ± 8.7), (p = 0.001), with no difference for DBP (60.5 ± 6.9 vs. 60.36 ± 8.39), (p = 0.79), which is shown in the Center Figure.

The prevalence of overweight or obesity was not higher in individuals with high BP or hypertension, as shown in Table 4. In the group with high BP or hypertension, 27 (73%) were extremely underweight, underweight, or eutrophic, while 10 (27%) were overweight or obese. On the other hand, among normotensive individuals, 305 (71.9%) were classified as extremely thin, thin, or eutrophic, and 119 (28.1%) were overweight or obese. Likewise, the prevalence of increased waist circumference was not higher in individuals with high BP or hypertension and vice versa, as shown in Table 4.

Among individuals with high BP or hypertension, 33 (89.2%) had normal waist circumference, while 4 (10.8%) had increased waist circumference. Among normotensive individuals, 394 (92.9%) had normal waist circumference, and 30 (7.1%) had

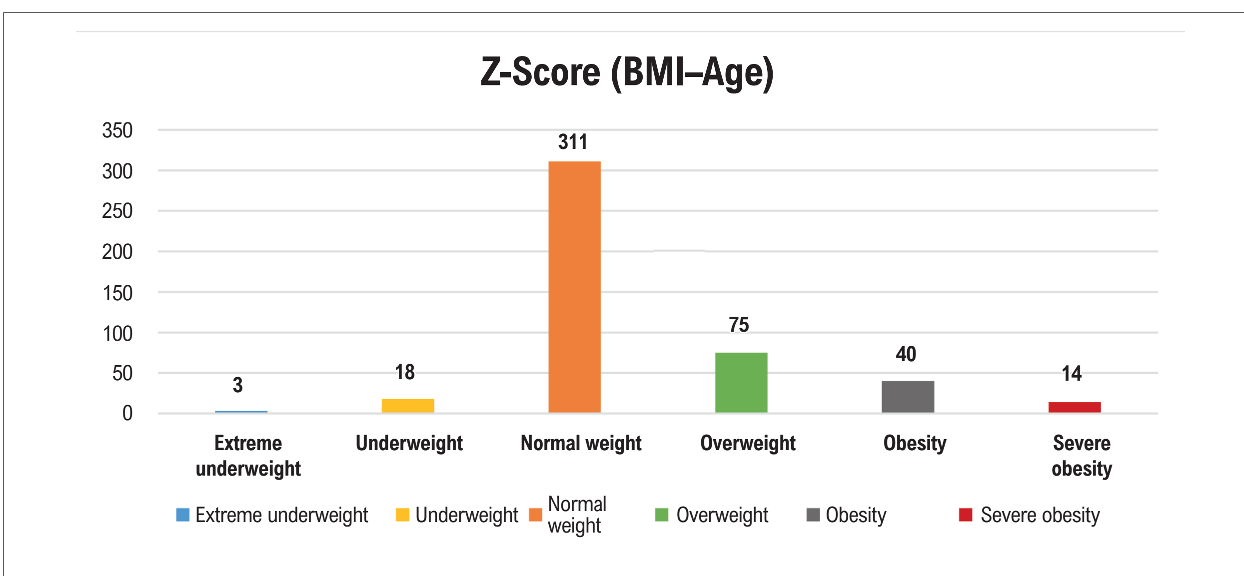

Figure 2 – *BMI Z-Score. BMI: body mass index*

Table 1: Clinical and sociodemographic data of 461 schoolchildren from the backlands of Bahia, 2019.

Variables	n = 461
	Mean ± SD
Age (years)	8 ± 2
BMI (Kg/m²)	16.8 ± 3.1
Mean SBP (mmHg)	90.4 ± 9.9
Mean DBP (mmHg)	60.5 ± 7.6
	n (%)
Urban Area	264 (57.3)
Male	238 (51.6)
Z-Score (BMI–Age)	
Extreme underweight (< -3)	3 (0.7)
Underweight (-3 a < -2)	18 (3.9)
Normal weight (-2 a ≤ +1)	311 (67.5)
Overweight (> +1 a ≤ +2)	75 (16.3)
Obesity (> +2 a ≤ +3)	40 (8.6)
Seve obesity (> +3)	14 (3.0)
Waist Circumference	
Normal	427 (92.6)
Increased	34 (7.4)
BP	
Normotensive	424 (92)
Increased BP/Hypertension	37 (8)

Source: author. Figure 2: Representation of the Nutritional Index percentage based on the Z-Score (BMI–Age) of 461 schoolchildren from the backlands of Bahia, 2019. SBP: systolic blood pressure; DBP: diastolic blood pressure; BP: blood pressure; BMI: body mass index.

increased waist circumference, with no significant difference between the groups.

Discussion

The literature shows a growing trend in the prevalence of overweight and obesity in school-age children, with childhood obesity being a key risk factor for adult obesity, premature death, and cardiovascular changes in adulthood. In this context, anthropometric measurements such as BMI and waist circumference, along with BP, are crucial tools for assessing the health of children and adolescents.

The prevalence of overweight in this study was 27.9% and that of increased waist circumference was 7.4%. Similar results were found by Ribas and Silva, 2012 (22.2%) in schoolchildren in the same age group (6-19 years) in the city of Belém do Pará (Brazil).[9] In the study by Bloch et al. (2016), a prevalence of 25.5% of excess weight was found in adolescents.[3] On the other hand, Oliveira et al.[10] found a 67% prevalence of excess weight (overweight/obesity) and 65.3% of increased waist circumference in children and adolescents aged 4 to 18 years in the city of Feira de Santana (BA).

Together, these data emphasize the importance of early detection of excess weight and central obesity in children and suggest that waist circumference can be a valuable tool in assessing cardiovascular risk in both children and adolescents. Its measurement should be included in routine pediatric exams. The significance of early assessment of central obesity is further supported by the fact that, in adults, waist circumference is considered the most accurate anthropometric indicator of cardiovascular risk.[11]

The diagnosis of systemic arterial hypertension in children and adolescents is still often delayed, mainly due to the lack of routine BP measurement in pediatric physical exams. In this study, a prevalence of 8% of individuals with high BP or hypertension was found. From a public health perspective, the estimated prevalence of systemic arterial hypertension in the pediatric population has rarely been summarized at a global level. A meta-analysis[12] of children and adolescents aged 19 years or younger revealed a 4% prevalence of hypertension (95% Confidence Interval, CI) and 9.67% (95% CI) of pre-hypertension, with no significant differences between sexes, rural and urban areas, or high- and low-income countries, as found in this study. However, the same meta-analysis showed a higher prevalence of systemic arterial hypertension in overweight (4.99%, 95% CI) and obese (15.27%, 95% CI) children and adolescents compared to those with normal BMI (1.9%, 95% CI), which was not observed in this study. A possible explanation for this discrepancy is that the prevalence of systemic arterial hypertension in children and adolescents increases with the onset and progression of puberty (associated with hormonal changes),[12] and this study focused on children up to 10 years old, most of whom were prepubertal. The higher prevalence of systemic arterial hypertension observed in overweight schoolchildren in the mentioned meta-analysis can be explained by the older age of the individuals rather than solely by their high BMI.

No significant difference was found in the proportion of lean/eutrophic and overweight individuals between rural and urban areas. However, most of the overweight individuals lived in urban areas. Likewise, since waist circumference reflects abdominal and visceral fat, a higher frequency of increased waist circumference was also observed in urban areas.

There is insufficient data in the literature to corroborate a higher prevalence of overweight and obesity in the child and adolescent population in urban or rural areas since multiple factors are involved in the genesis of a higher BMI, such as the socioeconomic development of the region in question, the population's level of education, the quality of nutrition, the physical activity profile practiced, in addition to genetic determinants.[13,14]

Studies analyzing American children and adolescents found a higher prevalence of overweight and obesity in rural areas compared to urban areas. This was attributed to greater access to nutritional education, as well as more frequent prenatal care and pediatric medical follow-up in urban areas.[13,15] Conversely, studies conducted in low- and middle-income countries — such as Brazil — found a higher prevalence of

Table 2 – Data from the nutritional classification based on the Z-score (BMI – Age) and waist circumference according to the area of 461 schoolchildren from the backlands of Bahia, 2019.

Variables	Rural Area	Urban Area	p
Under/Normal weight (n = 332)	148 (75.1%)	184 (69.7%)	0.21*
Overweight/Obesity (n = 129)	49 (24.9%)	80 (30.3%)	
	n = 197 (100%)	n = 264 (100%)	
Normal Waist Circumference (n = 427)	188 (95.4%)	239 (90.5%)	0.049*
Increased Waist Circumference (n = 34)	9 (4.6%)	25 (9.5%)	
	n = 197 (100%)	n = 264 (100%)	

Pearson's Chi-square test. Source: author.

Table 3 – Systemic BP data according to the area of 461 schoolchildren from the backlands of Bahia, 2019.

Variables	Normotensive (n = 424)	Increased BP / Hypertension (n = 37)	Total (n = 461)	p
Rural	178 (90.4%)	19 (9.6%)	197 (100%)	0.301*
Urban	246 (93.2%)	18 (6.8%)	264 (100%)	

Pearson's Chi-square test. Source: authors. BP: blood pressure.

Table 4 – Data from the nutritional classification based on the Z-score (BMI–Age) and waist circumference according to the systemic BP of 461 schoolchildren from the backlands of Bahia, 2019.

Variables	Normotensive	Increased BP / Hypertension	p
Under/Normal Weight (n = 332)	305 (71.9%)	27 (73%)	0.324*
Overweight/Obesity(n = 129)	119 (28.1%)	10 (27%)	
	n = 424 (100%)	n = 37 (100%)	
Normal Waist Circumference (n = 427)	394 (92.9%)	33 (89.2%)	0.506**
Increased Waist Circumference (n = 34)	30 (7.1%)	4 (10.8%)	
	n = 424 (100%)	n = 37 (100%)	

** Pearson's Chi-square test. ** Fisher's exact test. Source: authors. BP: blood pressure.*

overweight and obesity in urban areas compared to rural areas. The authors attributed this to the higher socioeconomic status in urban areas, which facilitates access to industrialized and processed foods, in contrast to the reliance on family farming products in rural areas. This finding can also be explained by the supposed lower prevalence of sedentary lifestyles in rural areas. As a low-income country, children in rural areas often travel long distances to attend school and participate in other activities, unlike their urban counterparts, who have better access to transportation options.[16] Moreover, there is less access to education in developing countries, which justifies a lower level of awareness regarding the importance of a healthy diet and physical exercise. In contrast, in developed countries such as the United States, even individuals in rural areas tend to have higher socioeconomic status, which makes it easier to access ultra-processed products and transportation.

Despite its originality and importance, it is crucial to note that this study did not include an analysis of student physical activity, which significantly impacts individuals' weight, waist circumference, and systemic BP. This study also did not discuss specific aspects of the dietary records of the students included in it.

Despite the limitations, it is worth emphasizing once again that this is an innovative study since it includes individuals in an extremely young age range (five to ten years old) living not only in urban areas but also in rural areas of the semiarid region of the Northeast. This area has been little evaluated in studies. The aim here is to support the adoption of measures that improve the living and health conditions of this population group, promoting greater life expectancy.

Further studies comparing the prevalence of overweight and obesity in pediatric populations from high-income countries and low- and middle-income countries and assessing differences between rural and urban areas are greatly needed.

Conclusion

In this study, which included children aged five to ten years from four municipalities in the backlands of Bahia, Brazil, a considerable prevalence of overweight, increased waist circumference, and elevated systemic arterial pressure was observed, particularly in the urban population. These data demonstrate the relevance of overweight and systemic arterial hypertension as early cardiovascular risk factors in pediatric populations.

Author Contributions

Conception and design of the research: Lopes A, Gomes AN, Lago R, Ladeia AMT; acquisition of data: Lopes A, Gomes AN, Lago R, Menezes CA; analysis and interpretation of the data: Lopes A, Valois ALV, Lisboa HLA, Lago R, Menezes CA, Ladeia AMT; statistical analysis: Lopes A, Ladeia AMT; obtaining financing: Ladeia AMT; writing of the manuscript: Lopes A, Valois ALV, Lisboa HLA, Ladeia AMT; critical revision of the manuscript for intellectual content: Lopes A, Valois ALV, Lisboa HLA, Gomes AN, Lago R, Menezes CA, Ladeia AMT.

Potential Conflict of Interest

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

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Study Association

This article is part of the thesis of completion of the Medicine course submitted by Andressa Cedraz Lopes, from Escola Bahiana de Medicina e Saúde Pública .

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Fundação Bahiana para Desenvolvimento das Ciências under the protocol number 91282318.3.0000.5544. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

References

1. Stenberg K, Axelson H, Sheehan P, Anderson I, Gülmezoglu AM, Temmerman M, et al. Advancing Social and Economic Development by Investing in Women's and Children's Health: A New Global Investment Framework. Lancet. 2014;383(9925):1333-54. doi: 10.1016/S0140-6736(13)62231-X.
2. World Health Organization. Report of the Commission on Ending Childhood Obesity. Geneva: WHO; 2017.
3. Bloch KV, Klein CH, Szklo M, Kuschnir MCC, Abreu GA, Barufaldi LA, et al. ERICA: Prevalences of Hypertension and Obesity in Brazilian Adolescents. Rev Saúde Pública. 2016;50(Suppl 1):9s. doi:10.1590/S01518-8787.2016050006685.
4. Kuschnir MCC, Bloch KV, Szklo M, Klein CH, Barufaldi LA, Abreu GA, et al. ERICA: Prevalence of Metabolic Syndrome in Brazilian Adolescents. Rev Saúde Pública. 2016;50(Suppl 1):11s. doi:10.1590/S01518-8787.2016050006701.
5. Faria-Neto JR, Bento VFR, Baena CP, Olandoski M, Gonçalves LGO, Abreu GA, et al. ERICA: Prevalence of Dyslipidemia in Brazilian Adolescentes. Rev Saúde Pública. 2016;50(Suppl 1):10s. doi:10.1590/S01518-8787.2016050006723.
6. Fernández JR, Redden DT, Pietrobelli A, Allison DB. Waist Circumference Percentiles in Nationally Representative Samples of African-American, European-American, and Mexican-American Children and Adolescents. J Pediatr. 2004;145(4):439-44. doi: 10.1016/j.jpeds.2004.06.044.
7. Onis M, Lobstein T. Defining Obesity Risk Status in the General Childhood Population: Which Cut-Offs Should We Use? Int J Pediatr Obes. 2010;5(6):458-60. doi: 10.3109/17477161003615583.
8. Flynn JT, Kaelber DC, Baker-Smith CM, Blowey D, Carroll AE, Daniels SR, et al. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. Pediatrics. 2017;140(3):e20171904. doi: 10.1542/peds.2017-1904.
9. Ribas SA, Silva LCS. Anthropometric Indices: Predictors of Dyslipidemia in Children and Adolescents from North of Brazil. Nutr Hosp. 2012;27(4):1228-35. doi: 10.3305/nh.2012.27.4.5798.
10. Oliveira AC, Oliveira AM, Adan LF, Oliveira NF, Silva AM, Ladeia AM. C-Reactive Protein and Metabolic Syndrome in Youth: A Strong Relationship? Obesity. 2008;16(5):1094-8. doi: 10.1038/oby.2008.43.
11. Haffner SM. Relationship of Metabolic Risk Factors and Development of Cardiovascular Disease and Diabetes. Obesity. 2006;14(Suppl 3):121-7. doi: 10.1038/oby.2006.291.
12. Song P, Zhang Y, Yu J, Zha M, Zhu Y, Rahimi K, et al. Global Prevalence of Hypertension in Children: A Systematic Review and Meta-analysis. JAMA Pediatr. 2019;173(12):1154-63. doi: 10.1001/jamapediatrics.2019.3310.
13. Ogden CL, Fryar CD, Hales CM, Carroll MD, Aoki Y, Freedman DS. Differences in Obesity Prevalence by Demographics and Urbanization in US Children and Adolescents, 2013-2016. JAMA. 2018;319(23):2410-8. doi: 10.1001/jama.2018.5158.
14. Pirgon Ö, Aslan N. The Role of Urbanization in Childhood Obesity. J Clin Res Pediatr Endocrinol. 2015;7(3):163-7. doi: 10.4274/jcrpe.1984.
15. Contreras DA, Martoccio TL, Brophy-Herb HE, Horodynski M, Peterson KE, Miller AL, et al. Rural-Urban Differences in Body Mass Index and Obesity-Related Behaviors Among Low-Income Preschoolers. J Public Health. 2021;43(4):e637-e644. doi: 10.1093/pubmed/fdaa162.
16. Neuman M, Kawachi I, Gortmaker S, Subramanian SV. Urban-Rural Differences in BMI in Low- and Middle-Income Countries: The Role of Socioeconomic Status. Am J Clin Nutr. 2013;97(2):428-36. doi: 10.3945/ajcn.112.045997.