ORIGINAL ARTICLE

Body Profile Impact on Blood Pressure and Lipid Profile in Rural and Urban Schoolchildren of a Brazilian Semiarid Region in The State of Bahia

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Abstract

Background: The present study describes the prevalence of excess weight, obesity, and high blood pressure (BP) in children from a Brazilian semiarid region (Sertão) and its association with lipid profile and area of residence.

Objective: To describe the prevalence of excess weight, obesity, and high BP in children, as well as the association between these variables, lipid profile, and area of residence.

Methods: Thi work is a cross-sectional study conducted with schoolchildren, aged 6 to 10 years, from three municipalities in the countryside of Brazil. Weight, height, waist circumference (WC), and BP, together with the analysis of lipid markers, were assessed. Z-scores (BMI-Age) were used to determine the anthropometric classification. Total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides (TG) were meseared with eight hours of fasting. The Student´s t-test and the Mann-Whitney test were aplied. Perceptual maps were constructed through multiple correspondence analysis. A p-value<0.05 was considered statistically significant. The Institution's Ethics Committee approved this study (CAAE: 35038914.3.0000.5544).

Results: Among 138 schoolchildren in this study, 76 (55.07%) were female and 81 (58.7%) were from urban areas. Twenty-one children (15.2%) were overweight, and 44 (31.9%) had a family history of obesity. Children from rural areas showed higher levels of TC (p = 0.041) and systolic BP (p = 0.028). The correlation between excess weight and a family history of obesity (p = 0.029), TG (p = 0.003), TG/HDL ratio (p = 0.009), systolic BP (p = 0.000), and WC (p = 0.000) were observed. In the correspondence analysis, the eutrophic group presented expected values for lipid variables.

Conclusion: Overweight indicators are associated with cardiometabolic risk factors, reinforcing the need for early monitoring.

Keywords: Obesity; Dyslipidemias; Hypertension; Child.

Introduction

Obesity is a worldwide public health problem, also affecting the pediatric population.[1] For example, between 1989 and 2010, an 82% increase in obese individuals was observed in this population, calling attention to the association of childhood obesity with high blood pressure (BP),[2] similar to dyslipidemia and Type 2 Diabetes Mellitus.[3]

The Bogalusa study showed that risk factors during childhood could result in cardiovascular diseases in one'sadult life. Berenson et al. demonstrated that increases in body mass index (BMI), systolic BP, low-density lipoprotein (LDL), triglycerides (TG), and smoking are related to the extent of atherosclerotic lesions, determined after performing autopsies on 204 young people.[4]

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Central Illustration: Body Profile Impact on Blood Pressure and Lipid Profile in Rural and Urban Schoolchildren of a Brazilian Semiarid Region in The State of Bahia

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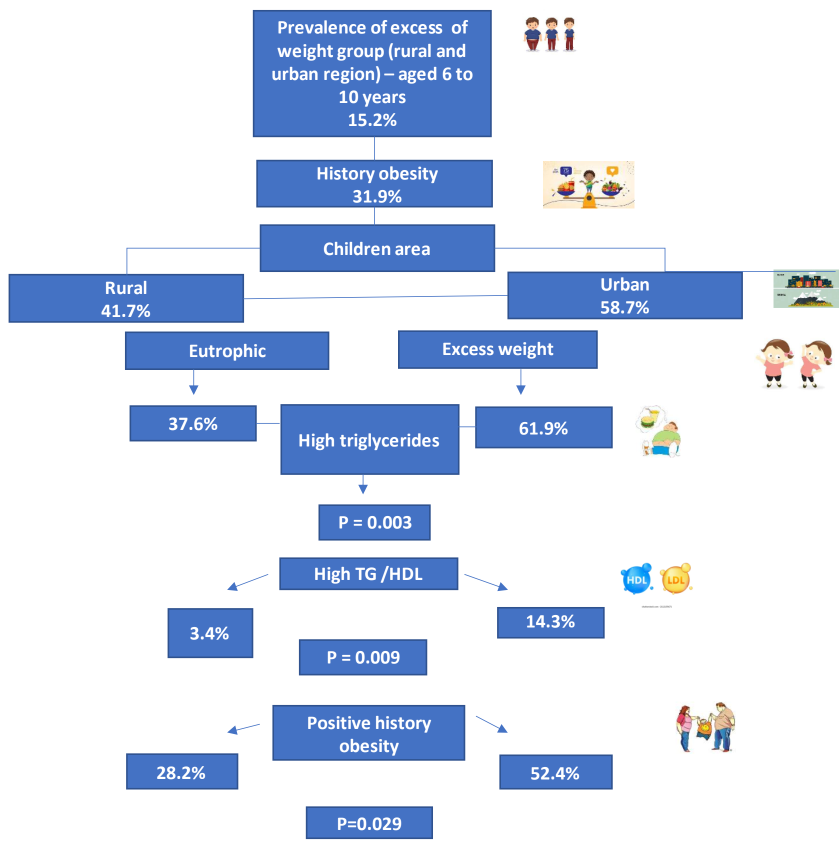

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TG: triglycerides; HDL: high-density lipoprotein

The European Childhood Obesity Surveillance Initiative (COSI) study, which is in its fourth round, through the prevalence of thinness, obesity, and severe obesity in 203,323 children, aged 6 to 9 years, living in different regions of Europe and Asia, including 36 participating countries, demonstrated that excess weight and obesity are more common among children of in the European Region, identified in 28.7% among boys and 26.5% among girls.[5] The ERICA (Studies of Cardiovascular Risks in Adolescents), conducted with Brazilian children and adolescents, described the prevalence of excess weight and obesity at 17.1% and 8.4%, respectively, as well as other disorders, such as hypercholesterolemia (20.1%), metabolic syndrome (2.6%), and high BP (9.6%).[6-10]

Thus, the present study aimed to evaluate the prevalence of excess weight (overweight/obesity) and its association with BP, lipid profile, and area of residence (rural vs. urban) in the pediatric population of a Brazilian semiarid region (Sertão).

Methods

Study and Sample Design

This cross-sectional study included children, aged 6 to 10 years, of both sexes, enrolled in the public network of three municipalities in the rural and urban areas of the sertão of the state of Bahia: Serrinha, Barrocas, and Teofilândia, with a minimum school attendance of 75% in March 2019, when the evaluation was conducted. In addition, children diagnosed with a pre-diagnosed chronic disease or who did not agree to sign the Free and Informed Consent Form (FICF) were excluded from the study.

Considering an estimated prevalence of 37% of overweight children, 138 children were needed to estimate the prevalence of overweight schoolchildren in the Serrinha region, with approximately 80% accuracy and a significance level of 5%.

Clinical and Laboratory Assessment

Anthropometric measurements evaluated: weight, height, waist circumference (WC), BMI, as well as systolic blood pressure (SBP) and diastolic blood pressure (DBP) measurements.

Weight measurements were performed using a portable microelectronic scale, Welmy® brand, model W 200 M, with a capacity for 136 kg and a weight variation of 100g, regularly calibrated by technical assistance accredited by the Brazilian National Institute of Metrology, Standardization and Industrial Quality (INMETRO). The child was positioned barefoot, orthostatically, in the center of the scale, with feet together and arms extended along the body. Height was verified using an Altura Exata® stadiometer, graduated every 10 centimeters, with a limit of 2.13 meters.

WC measurements were taken with an inelastic measuring tape on the imaginary line halfway between the lower border of the last rib and the right anterior superior iliac crest. Researchers applied the criteria of Santos et al. for the classification of average or altered circumference.[11]

Based on childhood growth curves, anthropometric indices were classified according to Z-score analyses using the WHO AntrhoPlus calculator (version 1.0.4) of the World Health Organization (WHO).

BP was measured using an automatic digital Omron® device with a cuff suitable for the child's arm. SBP and DBP were measured, disregarding the first measurement, using the average of the final two measurements.

To perform laboratory evaluations, the study collected 15 ml of blood from the cubital or radial vein of the children after fasting for at least eight hours to analyze the lipid profile.

The analyses of total cholesterol (TC), high-density lipoprotein (HDL) cholesterol, and TG were determined by automated enzymatic colorimetric methodology using Biosystems® brand analysis kits and the BS 200 model equipment from the same company. Low-density cholesterol (LDL) used calculations applying the Friedwald equation.

The TG/HDL ratio was calculated, with values equal to or greater than 2.73 defined as high, and the ratio was considered normal for lower levels.[12]

Statistical analysis

Data distribution described continuous variables as a mean, standard deviation (normal distribution); median and interquartile interval (non-normal distribution); and categorical variables as absolute and relative values (95% CI). A p-value < 0.05 was considered statistically significant. The *Statical Package For Social Sciences* (SPSS) software, version 14.0 for Windows was used for database creation.

To assess normality, the Kolmogorov-Smirnov Test with Lilliefors correction was used.

To compare the groups, the Student's t-test (unpaired), used for normal distribution, and the Mann-Whitney test were applied.

The Chi-square test was applied for comparative analysis to assess the association between the variables. When this was significant, the Bonferroni test identified the relationship between the categories of the analyzed variables.

The grouping was performed to determine the main groups of this study from the nutritional status variable, using the BMI as a key variable in the Z-score scale as a criterion.

In this study, after the chi-square test, multiple correspondence analyses were performed to establish the different profiles of groups of children based on the studied characteristics and previously defined categories. Perceptual maps were constructed.

Ethical Aspects

The present study complied with the guidelines and norms of Resolution nº 466/12 and was approved by the Ethics and Research Committee of the Fundação Bahiana para Desenvolvimento das Ciências (Bahian Foundation for Scientific Development) (CAAE: 35038914.3.0000.5544).

Results

The sample consisted of 138 schoolchildren, aged 6 to 10 years, 76 (55.07%) female, and 81 (58.7%) from the urban area.

None of the lipid, anthropometric, WC, SBP, and DBP variables showed differences in terms of sex.

As for region (rural or urban area), children from rural areas had higher levels of TC and SBP than did those living in urban areas, and higher than desirable TC values (≥ 170 mg/dl) among rural children. However, no differences were observed for the other clinical and laboratory variables (Table 1).

The frequency of children classified as eutrophic was 84.8% and excess weight, 15.2%, including overweight (8.7%), obesity (5.1%), and severe obesity (1.4%). No schoolchildren were classified as thin or excessively thin. The frequency of these groups was analyzed in rural and urban areas, defining the "excess weight" group as children who fit the overweight, obesity, and severe obesity groups. In the urban area, the frequency of the excess weight group was higher (17 children, 8 overweight, 7 with obesity, and 2 with severe obesity, corresponding to 12.31%) than in the rural area (04 children, 3 overweight, and 01 with obesity, corresponding to 2.89%) (p = 0.024).

No differences were observed between groups when considering the students with high cholesterol (≥ 170 mg/dL), low HDL (≤ 45 mg/dl), high LDL (≥ 110 mg/dL), high TGs (from 0 to 9 years ≥ 75 mg/dl and 10 to 19 years ≥ 90 mg/dL), and a high TG/HDL ratio (≥2.73), when assessing data from the population of children who reside in rural and urban areas regarding the lipid profile.

Table 2 compares averages of SBP and DBP measurements, WC, and lipid variables. The SBP, WC, TG, and TG/HDL ratio presented higher averages in the excess weight group.

Regarding 117 eutrophic children, 111 schoolchildren (94.9%) were normotensive, and 6 (5.1%) presented high BP, while 20 children (95.2%) of the excess weight group were normotensive and one child (4.8%) presented high BP, with no difference between the groups (p = 0.944).

The percentage of the students in the eutrophic group with high cholesterol was 38.8% (n = 47), and in the excess weight group, 47.6% (n = 10). Regarding low HDL, in the eutrophic group, the percentage was 5% (n = 6), and 4.8% in the excess weight group (n = 1). As for the high LDL, 18% (n = 21) of the children were from the eutrophic group and 33.3% (n = 7) were from the excess weight group. As for high TG, 37.6% (n = 44) of the students

Table 1 – Clinical and laboratory characteristics of children from rural and urban areas

Variables	Rural area (41.30%)	Urban area (58.70%)	
	Mean ± SD	**Mean ± SD**	**P value (t)**
Stature	1.31 ± 0.08	1.30 ± 0.11	0.360
TC	174.67 ± 32.54	163.34±31.10	0.043*
HDL cholesterol	69.74 ± 15.66	66.48 ± 13.24	0.203
Diastolic BP	59.66 ± 7.37	60.88 ± 5.18	0.283
	Median (IQ)	**Median (IQ)**	**P value (ρ)**
Age	8.00 (6.00 – 10.00)	8.00 (6.00 – 10.00)	0.559
Weight	26.8 (19.4 -34.2)	25.30 (12.7 – 37.9)	0.458
Waist/height	0.43 (0.38 – 0.48)	0.44 (0.40 – 0.48)	0.217
BMI	15.71 (13.51-17.91)	16.20 (11.7 – 20.7)	0.122
WC	55.50 (48.25-62.75)	55.00 (46.00 – 64.0)	0.674
LDL cholesterol	85.00 (45.00 -125.00)	75.00 (40.5 – 109.5)	0.280
TGs	70.00 (22.5 – 117.5)	61.00 (20.00 – 102.00)	0.082
SBP	89.00 (76.32 – 101.68)	86.00 (74.00 – 98.00)	0.028 I *

*Units used: Age – years, Height – m, Waist circumference – cm, Weight – Kg, Total cholesterol, LDL cholesterol, HDL cholesterol, Triglycerides - mg/dl, Systolic BP, Diastolic BP – mmHg, ρ – Mann-Whitney Test, "t" – Student's t Test, p-value – probability value. IQ = (Q75 – Q25). Subtitle: *- significant at 5% probability, **- significant at 1% probability. BMI: body mass index; SBP: blood pressure; LDL: low-density lipoprotein; HDL: high-density lipoprotein; WC: Waist circumference; TC: Total cholesterol; TG: triglycerides; SD: Standard Deviation; IQ: Interquartile Range.*

Table 2 – BP and lipid profile characteristics in children according to nutritional status

Variables	Eutrophic n (%) 117 (84.8%)	Excess weight n (%) 21 (15.2%)	
	Mean ± SD	Mean ± SD	P value (t)
TC	167.42 ± 31.21	171.38±31.21	0.649
HDL cholesterol	68.57 ± 14.52	63.66 ± 12.70	0.122
Diastolic BP	60.06 ± 6.32	62.09 ± 5.14	0.119
	Median (IQ)	Median (IQ)	P value (ρ)
WC	54.5 (48.75 - 60.25)	70.00 (60.75 - 79.25)	0.000**
LDL cholesterol	78.00 (44.50 - 111.50)	85.00 (30.50 - 139.50)	0.541
TGs	63.00 (33.00 - 103.00)	82.00 (1.50 - 162.50)	0.003**
SBP	86.00 (74.70 - 97.30)	95.00 (85.50 - 104.50)	0.000*|*
TG/HDL	0.9508 (0.2508 - 1.6508)	1.30 (0.03 - 2.57)	0.009**

*Units used: Age – years, Height – m, Waist circumference – cm, Weight – Kg, Total cholesterol, LDL cholesterol, HDL cholesterol, Triglycerides - mg/dl, Systolic BP, Diastolic BP – mmHg, ρ – Mann-Whitney Test, "t" – Student's t Test, p-value – probability value. IQ = (Q75 – Q25). Subtitle: *- significant at 5% probability, **- significant at 1% probability. HDL: high-density lipoprotein; SBP: systolic blood pressure; LDL: low-density lipoprotein; TG: triglycerides; WC: Waist circumference; TC: Total cholesterol; TG: triglycerides; SD: Standard Deviation; IQ: Interquartile Range.*

belonged to the eutrophic group, while 61.9% (n = 13) belonged to the excess weight group. Concerning high TG/HDL, 3.4% (n = 4) were in the eutrophic group and 14.3% (n = 3) in the excess weight group. The TG and TG/HDL ratio variables were higher in the excess weight group (p = 0.037).

Among the families of the evaluated students, 73.19% had a history of hypertension, and 31.9% presented obesity.

In the group of 117 eutrophic students, 84 (71.8%) children did not present a family history of obesity, while 33 (28.2%) had a positive history of obesity. Among the excess weight children, 10 (47.6%) had no family history of obesity (FHO), and 11 (52.4%) presented a positive FHO, showing an association between FHO and excess weight (p = 0.029).

According to this study, the WC values for the excess weight group reached the 75 percentile values for children in each age group of 6, 7, 8, 9, and 10 years, as compared to Eutrophic Group[11] (Chart 1a).

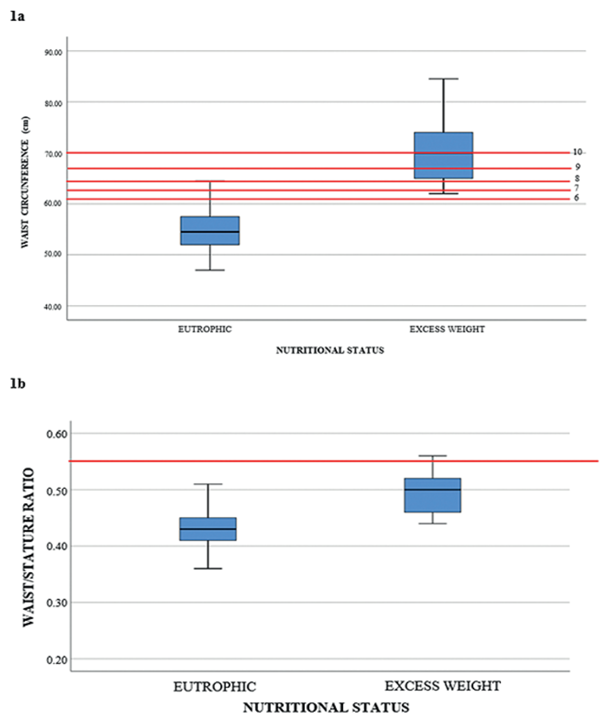
Graph 1b describes the eutrophic and excess weight groups and waist/stature ratio values. Again, the excess weight group shows values close to the reference value (≥ 0.55).[13]

Figure 1a simultaneously evaluated: (1) nutritional status (eutrophic and excess weight); TG classification (standard or high); (2) HDL (≤ 45 mg/dl or> 45 mg/dl); (3) LDL (≤ 110 mg/dl or > 110 mg/dl); (4) TC risk (≤ 170 mg/dl or > 170 mg/dL), and TG/HDL risk (< 2.73 or ≥ 2.73). This perceptual map shows the association between eutrophic, regular TG, normal HDL, normal LDL, and regular TC, while the excess weight group is closer to the low and high TG, high LDL, high TC, high HDL groups, and high TG/HDL.

Figure 1b shows another perceptual map showing the characteristics of nutritional status (eutrophic or excess weight), BP classification (high BP or normal BP), and location (rural or urban area).

Discussion

This study demonstrated that the prevalence of the excess weight group (overweight, obesity, and severe obesity) totaled 15.2% (view Central Figure). The study describes a population of schoolchildren, aged 6 to 10 years. Oliveira et al.[14] evaluated children, aged 5 to 9 years, and found a lower prevalence of overweight and obesity, corresponding to 9.3% and 4.4%, respectively. WHO[15] data indicate that overweight and obesity prevalence in children and adolescents, aged 5 to 19, calculated at 4% in 1975, increased to 18% for girls and 19% for boys in 2016.



Graphic 1 – Distribution of eutrophic and excess weight groups in schoolchildren from the Brazilian semiarid region (Sertão of Bahia).

In the ERICA study,[6] the prevalence of overweight and obesity was 17.1% and 8.4%, involving adolescents, aged 12 to 17 years. Santos et al.[11] recorded the prevalence of obesity in each age group, which ranged from 17% (6 years of age) to 21.6% (9 years old) among boys, and from 14.1% (7 years old) to 17.3% (9 years old) among girls. Pereira et al.,[16] among 911 schoolchildren, aged 6 to 10 years, found a prevalence of overweight of 17.7% and obesity of 16.2%, which is similar to that found in the present study.

The COSI[5] study found that the percentages of overweight children reached 28.7% for boys and 26.5% for girls. In the study conducted by Bont et al.,[17] the prevalence of excess weight, including overweight and obesity, was 39.9% for children aged 10.8 years. Boys were more likely to be overweight/obese when compared to girls (42.2% vs. 36.9%). According to the WHO, being overweight and obese have been considered a serious problem in high-income countries and, for some years, have been on the rise in low- and medium-income countries, particularly in urban environments.[15] In the present study, the most significant percentage of children with excess weight (overweight, obesity, and severe obesity) was found in the metropolitan area (12.31%), when compared to the countryside (2.89%). These data agree with the study of Garibaldi et al.,[18] which evaluated 174 children, aged 7 to 17 years; 16.66% of the urban children were overweight, while in the countryside, this number was 12.64%. Some considerations can explain these results; urban regions have an easy supply of more caloric foods associated with reduced physical activity and greater access to electronic devices without using time controls.[19] It is essential to highlight that children in the countryside often walk to school transportation or to school, and participate in working activities with their parents, which can increase physical activity.[20]

Dyslipidemic children presented a change in at least one of the lipid fractions ,given that the present study shows that the rural children had a higher level of TC (p=0.041),as well as higher levels of SBP (p=0.028), when compared to urban schoolchildren. One of the possible causes of dyslipidemic changes is becoming more present in the countryside. This may well be due to this population's greater access of to fat-rich foods. Costa et al.,[21] in the adjusted analysis of healthy and unhealthy food consumption markers, observed a higher bean consumption (OR = 1.20; 95% CI: 1.14-1.26) and excessive meat or chicken fat (OR = 1.48; 95% CI: 1.42-1.55), as

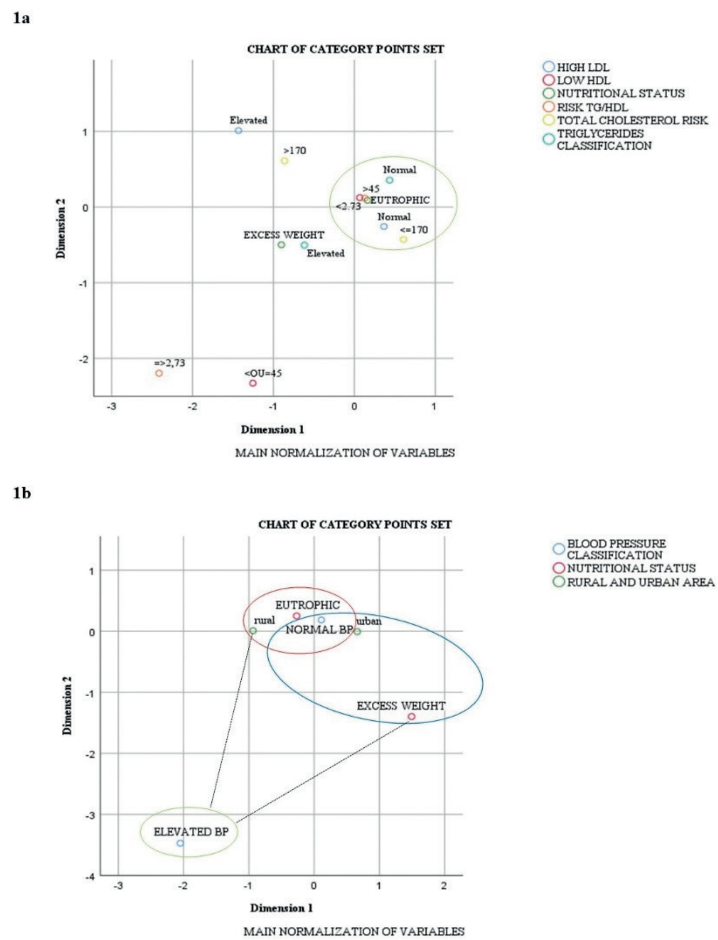


Figure 1 – Perceptual maps of eutrophic and excess weight groups among schoolchildren from the Brazilian semiarid region (Sertão).

well as fewer fruits and vegetables (OR = 0.89; 95% CI: 0.85-0.96), fish (OR = 0.88; 95% CI: 0.84-0.92), soft drinks (OR = 0.55; 95% CI: 0.52-0.59), and snack meal replacement (OR = 0.59; 95% CI: 0.51-0.66) in rural areas. The same study states that Brazilian residents in rural areas are more likely to maintain a traditional food pattern, consuming minimally processed foods, especially beans, and less ultra-processed food consumption, but with less consumption of fruits, vegetables, and fish.

Due to globalization and urbanization, residents of rural areas may be accompanying the eating patterns of urban areas, including more sedentary habits, the consumption of processed foods, and access to the most diverse forms of electronic entertainment, which make children exercise less, causing a decrease in HDL levels.[22]

For Oliveira et al.,[12] the TG/HDL ratio helps identify insulin resistance in overweight young people. Iwani et al.[23] also associated this marker with obesity, and the TG/HDL ratio was indicated as a possible marker to replace fasting blood glucose in the diagnosis of insulin resistance. In this study, an association was found between the TG/HDL ratio and the excess weight group, reinforcing the role of the TG/HDL ratio as a cardiovascular risk marker.

In the present study, no difference was observed between eutrophic and excess weight groups in the frequency of high BP, with a general prevalence of 5.07%. By contrast, Pereira et al.[16] evaluated 911 schoolchildren (6 to 10 years), finding a prevalence of 34% high BP, and no statistical difference between the sexes, with excess weight associated with high BP in the group of schoolchildren aged 8 to 9 years (p =0.004), while obesity was associated in both groups of schoolchildren aged 6-7 years (p = 0.004) and 8-9 years (p = 0.001). Moreover, in the study of Brandão-Souza et al.,[24] which evaluated 899 schoolchildren, aged 7 to 10 years, excess weight (overweight + obesity) was associated with increased BP, and the latter was more commonly related to schoolchildren from rural schools.

Our study found a prevalence of 31.9% FHO in the studied population. This data becomes relevant, since studies address heredity as a risk factor for obesity in the pediatric population. Frutoso et al.[8] demonstrated maternal obesity is also a risk factor for obesity in adolescence.[8]

Graph 1 (1a) of the present study demonstrates that the excess weight group reaches the values of P75, suggesting that this group is at a greater risk of developing cardiovascular disease. Graph 1 (1b) also describes the waist/height ratio values of both the eutrophic and excess weight groups, and the excess weight group shows a more unfavorable profile, with values close to the reference (≥ 0.55),[13] indicating the presence of abdominal adiposity and, consequently, more significant risk of cardiometabolic disease.

These data reinforce the knowledge that obesity in the pediatric population involves a complex web of genetic, hormonal, nutritional, physical, environmental, and social factors. In addition, obesity is different in ethnic groups and monogenic obesity types differ from each other.[25] This sheds new light on the molecular mechanisms of obesity, opening the door to new forms of treatment.

Conclusion

The present study demonstrated that overweight and obesity indicators among schoolchildren, aged 6 to 10 years, in the Brazilian semiarid region the state of Bahia (Serrinha Region), were significantly associated with cardiometabolic risk factors such as WC, TG, and the TG/HDL ratio. A higher prevalence of excess weight was found in schoolchildren from urban areas as compared to rural areas. A higher prevalence of lipid alterations was also observed in rural areas, calling attention to a possible unfavorable pattern in this population (according to Central Figure attached).

The present study reinforces the importance of monitoring and controlling cardiovascular risk factors directly related to excess weight, opening the door to more comprehensive studies involving the monitoring of diet quality and levels of physical activity, as well as measurements of anthropometric data, lipid profiles, and the BP of these students over time.

Author Contributions

Conception and design of the research: Mendonça L, Lago R, Ladeia A; acquisition of data: Mendonça L, Gomes A, Lago R, Menezes C; analysis and interpretation of the data: Mendonça L and Gomes A; statistical analysis: Carvalho S; obtaining financing: Ladeia A; writing of the manuscript and critical revision of the manuscript for intellectual content: Mendonça L and Ladeia A.

Potential Conflict of Interest

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

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Study Association

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Ethics Approval and Consent to Partivipate

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.

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