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The nutritional status of children and adolescents in the Pioneer North of Paraná: a cross-sectional study with 4,796 school students

O estado nutricional de crianças e adolescentes do Norte Pioneiro do Paraná: um estudo transversal com 4.796 escolares

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Abstract – This study aimed to analyze the nutritional status of children and adolescents in three cities in the Pioneer North region of Paraná state. The study comprised 4,796 students enrolled in municipal schools. The analyses were conducted on the *WHO AnthroPlus* software based on the following growth indicators: weight for age (W/A), height for age (H/A), and body mass index for age (BMI/A). These indicators were then classified as obese +3; overweight +2; risk for overweight +1; eutrophic -1 to 0; malnourished -2; and severely malnourished -3. The same software also provided growth curves. The results analysis showed that 18% of the students were overweight, and 41% were at risk of being overweight; therefore, 59% of the total percentage of overweight and only 25% of eutrophic individuals were observed, in addition to a significant percentage of child malnutrition of 16%. The individual growth curves provided by the software indicated that all obese children showed the same pattern, resulting in (+3) for all indicators and (-3) in malnutrition. In conclusion, BMI/A) increases as height increases, following the corresponding nutritional status, such as being overweight and malnutrition. Even as the children grow, they remain obese or malnourished compared to the percentage and the curves. 59% of the individuals were overweight and only 25% were eutrophic, a very low level compared to overweight, thus showing a worrying finding, in addition to the significant increase of 16% in child malnutrition.

Key words: Adolescent; Children; Malnutrition; Nutritional status; Obesity.

Resumo – *Este estudo teve como objetivo analisar o estado nutricional de crianças e adolescentes de três cidades do Norte Pioneiro do Paraná. Compuseram o estudo 4.796 escolares matriculadas nas escolas municipais. Utilizou-se o software WHO AnthroPlus, indicadores de crescimento: peso para idade (P/I), estatura para idade (E/I) e índice de massa corporal para idade (IMC/I). Em seguida, classificadas: obesos +3, sobrepeso +2, risco para excesso de peso +1, eutróficos -1 a 0, desnutridos -2, severamente desnutridos -3. Obteve-se também curvas de crescimento fornecidas pelo mesmo software. A análise dos resultados demonstrou que 18% dos escolares apresentavam excesso de peso, 41% risco para excesso de peso, portanto 59% de percentual total de excesso de peso e observou-se apenas 25% de eutróficos, além disso, observou-se também uma porcentagem significativa para desnutrição infantil de 16%. Em relação às curvas de crescimento individual fornecidas pelo software, todas as crianças obesas apresentaram o mesmo padrão, resultando em (+3) para todos os indicadores e (-3) em desnutrição. Em conclusão, quando a estatura aumenta, o (IMC/I) também aumenta, acompanhando o estado nutricional correspondente, como: excesso de peso e desnutrição, mesmo a criança crescendo ela permanece obesa ou desnutrida comparado ao percentual e às curvas. Encontrou-se 59% de percentual total de excesso de peso e apenas 25% de eutróficos, nível muito baixo comparado a excesso de peso, tornando-se uma variável preocupante, além do aumento significativo de 16% em desnutrição infantil.*

Palavras-chave: *Adolescente; Criança; Desnutrição; Estado nutricional; Obesidade.*

INTRODUCTION

Child nutritional status is a health indicator that monitors growth and detects potential health problems and nutritional risks, enabling the planning of intervention strategies. In Brazil, the population's nutritional status has shown changes in recent decades, triggering changes in the geographic, social, and biological distribution of diseases, with a significant prevalence of overweight leading to childhood obesity[1].

The nutritional transition process is also an impacting factor that shows a change in the dietary profile, being closely associated with the epidemiological transition, which, in turn, involves lower prevalence of infectious and parasitic diseases due to the increase in Chronic Noncommunicable Diseases (NCDs)[2].

Obesity is a multifactorial chronic inflammatory disease that is related to genetic, individual, and environmental factors, being associated with a greater chance of premature death and disability in adult life[3], affecting ⅓ of the child population[4], compounded by the social isolation of COVID-19[5]. Meanwhile, child malnutrition commonly results from socioeconomic conditions, such as inadequate nutrient intake, no or short-term breastfeeding, infectious diseases, and problems in child care[6,7].

Given this problematic scenario, the World Health Organization (WHO) used the WHO AnthroPlus software to launch and rebuild a growth reference for global application, known as WHO 2007 Reference, aimed at the proper monitoring of children and adolescents aged 5 to 19 years[8]. WHO *AnthroPlus* provides references with (z-scores) confidence intervals and standard errors of prevalence estimates through indicators of child nutritional status[8].

Considering the lack of studies on nutritional status for growth, this study aimed to analyze the nutritional status of children and adolescents. Our sample was comprised of children and adolescents enrolled in municipal schools in three cities in the Pioneer North region of Paraná state, based on the records for 2019. All analyses were conducted in the WHO AnthroPlus software.

METHODS

Study design

This is a cross-sectional study based on data from the project "THE PREVALENCE OF CHILDHOOD OBESITY OR MALNUTRITION IN THE PIONEER NORTH: A LONGITUDINAL STUDY", approved by the Ethics Committee (Opinion: 4,029,796. CAAE: 25138219.4.0000.8123), based on the National Health Council resolutions – CNS 466/12 and 510/16, which regulate research in human beings.

Sample and data collection

Biometric data were collected (sex, age, body mass, and height) from the State System of School Registration – SERE, an information system developed mainly to rationalize the bureaucratic activities of the school secretariat.

The sample consisted of 4,796 students enrolled in 2019, aged between 5 and 14 years. The WHO AnthroPlus software does not distinguish children over 10 years of age for the weight-for-age (W/A) indicator, according to the period of their pubertal growth spurt, causing a sample loss for this indicator.

Inclusion and exclusion criteria

All children regularly enrolled in public schools of three cities in the Pioneer North of Paraná state were included in the study. Children transferred to other municipal schools not participating in the research were excluded.

Data classifications

The sample was imported into the WHO AnthroPlus v.1.0.4 software in Microsoft Excel 2016 format and exported in *TXT* format for the analysis. The resulting file was then converted to Excel, generating the following growth indicators: weight for age (W/A), height for age (H/A), and body mass index for age (BMI/A). These indicators were then classified as obese +3; overweight +2; risk for overweight +1; eutrophic -1 to 0; malnourished -2; and severely malnourished -3. The WHO AnthroPlus software also provided growth curves[9,10].

Statistical analysis

Data were calculated on Microsoft Excel 2016 and presented in absolute values and proportions (%) for categorical variables, as well as mean and standard deviation for continuous variables. The chi-square test was used to compare the female and male groups, at a significance value of $p \leq 0.05$*.

RESULTS

Table 1 shows the sample characteristics organized based on descriptive statistics, with values of mean and standard deviation.

Table 1. Characterization of the students' biometric data for the three cities.

BIOMETRIC VARIABLES (N = 4,796)	AVERAGE ± (STANDARD DEVIATION) 2019
AGE (years)	8 ± 1.97
MASS (kg)	31.47 ± 11.65
HEIGHT (M)	1.32 ± 0.13
BMI kg/m²	17.57 ± 4.67

Note. Body Mass Index (BMI), measured in kg/m².

Among the participants, 29.8% were from City 1 (n = 1,431), 31.8% were from City 2 (n = 1,528), and 38.4% from City 3 (n = 1,837), with 47.6% (n = 2,285) of female individuals and 52.4% (n = 2,511) of male individuals.

Table 2 shows the WHO AnthroPlus classification of the variables between the female and male groups.

Table 2. Comparison of body composition classification between the female and male groups, according to the WHO AnthroPlus software.

CLASSIFICATION	FG and MG		MG		FG		*p*-value
	N (%)		N (%)		N (%)		
TOTAL	4796 (100%)		2511 (100%)		2285 (100%)		
OBESE	267 (6%)	(18%) #	192 (8%)	(20%) #	75 (3%)	(13%) #	*

Note. FG: female group. MG: male group. N: sample number. %: percentage. #overweight. ##total percentage of overweight. *p-value of <0.05.

Table 2. Continued...

CLASSIFICATION	FG and MG		MG		FG		*p*-value
	N (%)		N (%)		N (%)		
OVERWEIGHT	556 (12%)		309 (12%)		247 (10%)		*
R. OVERWEIGHT	1971 (41%)	(59%) ##	1593 (63%)	(83%) ##	1556 (68%)	(81%) ##	*
EUTROPHICS	1178 (25%)		592 (24%)		398 (17%)		*
MALNOURISHED	774 (16%)		386 (15%)		388 (18%)		*
SEVER. MALNOURISHED	50 (1%)		31 (%)		19 (1%)		p =1

Note. FG: female group. MG: male group. N: sample number. %: percentage. #overweight. ##total percentage of overweight. *p-value of <0.05.

Our findings indicated that 18% of the individuals were overweight and 41% were at risk of being overweight in the three cities studied. Therefore, 59% of the total percentage of the sample corresponded to overweight individuals. Meanwhile, our results show only 25% of eutrophic individuals. In addition, Table 2 shows a significant percentage of 16% of child malnutrition.

Our results revealed high percentages of both childhood obesity and malnutrition in both groups. According to the WHO AnthroPlus method, the male group had a higher level of overweight than the female group. 13% of the individuals in the female group were found to be overweight, 81% of the total percentage of overweight, while 17% were eutrophic. In turn, the male group had 20% of overweight individuals, 83% at risk of overweight, while 24% were eutrophic.

The overweight risk classification of the WHO AnthroPlus method detected an alarming factor for the female group, reaching 68%. Such a percentage indicates a high risk for the female group of being at the same level as the male group in terms of overweight in a few years. As for malnutrition, the male group reached the percentage of 15%, while the female group reached 18%, which presented a 2% higher frequency of malnutrition.

Subsequently, we analyzed the graphs generated by the WHO AnthroPlus for the W/A, H/A, and BMI/A indicators, whose curves showed the pattern for obese (Figure 1) and malnourished children (Figure 2). More than half of the analyzed child population tends to become obese or malnourished adults.

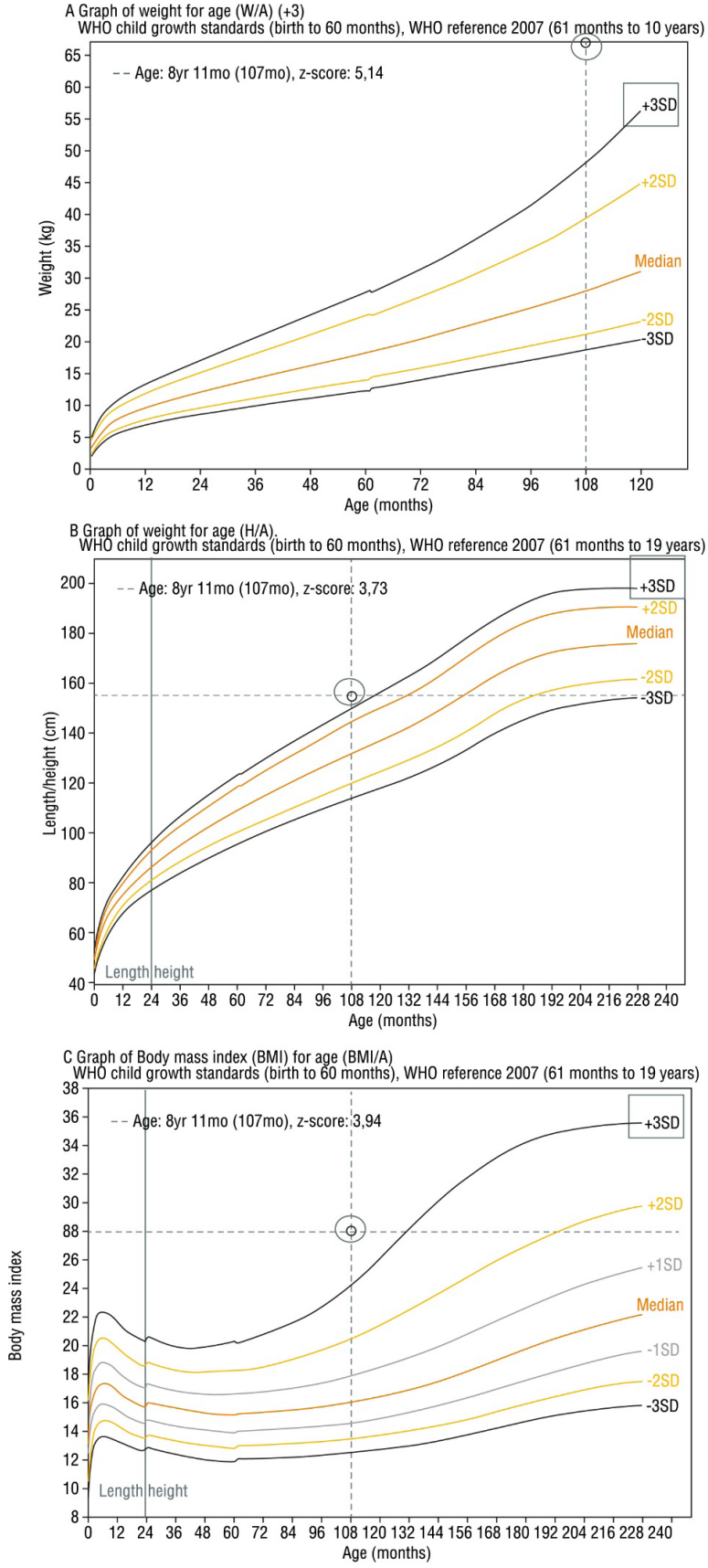

Figure 1. Growth curve pattern of a child with childhood obesity. Note: (A) Graph of weight for age (W/A) (+3); (B) Graph of height for age (H/A); (C) 3 Graph of Body Mass Index (BMI) for age (BMI/A).

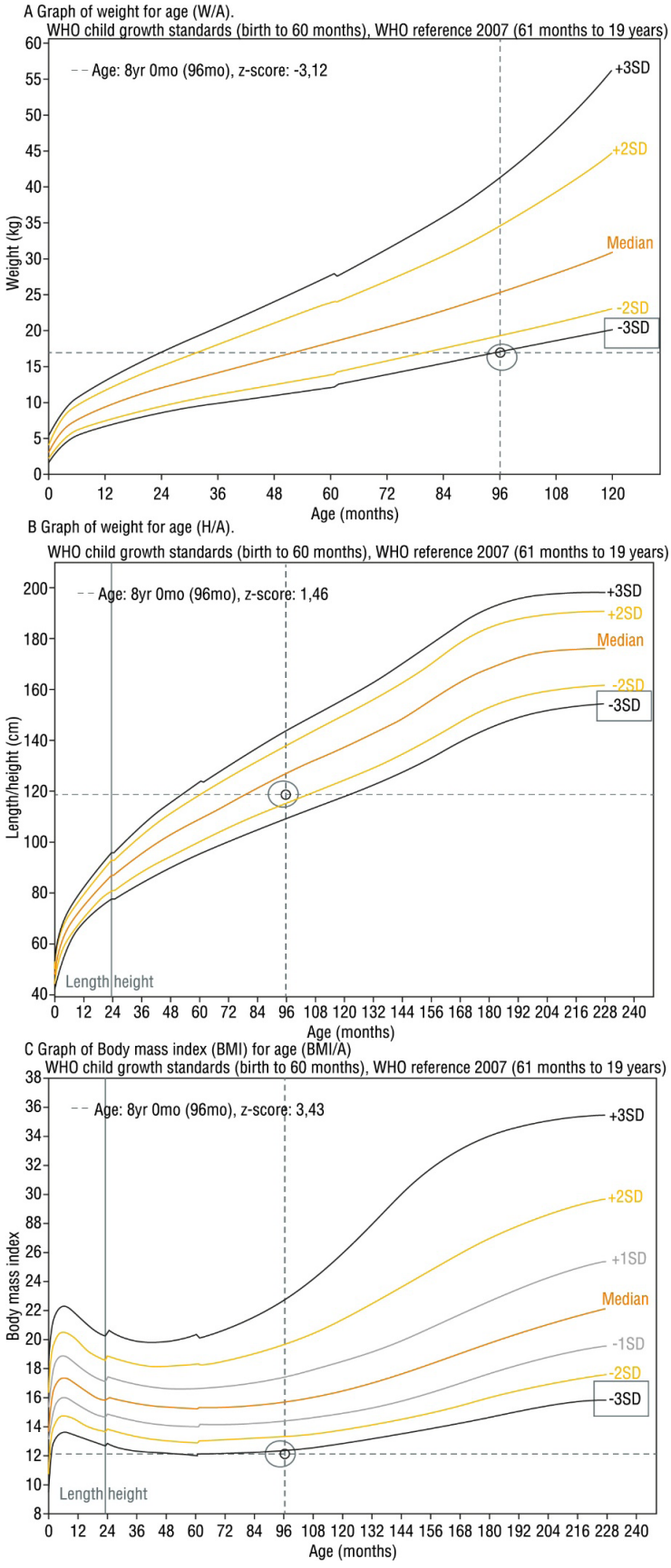

Figure 2. Growth curve pattern of a child with childhood malnutrition. Note: (A) Graph of weight for age (W/A); (B) Graph of height for age (H/A); (C) Graph of Body Mass Index (BMI) for age (BMI/A).

DISCUSSION

The WHO AnthroPlus software found that the three cities studied comprised 18% of overweight, 41% of risk of overweight, 59% of the total percentage of overweight individuals. In turn, only 25% corresponded to eutrophic individuals, which is a very low level compared to the overweight or at risk of overweight individuals, thus representing a worrying finding. In addition to these findings, we also found a significant percentage of child malnutrition of 16%.

Obesity has been increasing among children and adolescents aged 5 to 19 years. In this context, it is worth mentioning the national average, according to the last National School Health Survey[4], showing 33.5% of overweight and 4% of malnourished individuals. Compared to these data, our findings showed a 25.5% higher percentage of overweight and 12% higher for child malnutrition, according to the WHO AnthroPlus method.

The WHO AnthroPlus method was also used in Colombia for nutritional diagnosis, showing a total percentage of overweight in the entire population of 41%. Meanwhile, the total percentage of overweight in the Brazilian population was found to be 18% higher than that of Colombians, whereas malnutrition was 7% in Brazil compared to 9% in Colombia. The study also showed that children who were overweight either were an only child or had only one sibling, in addition to their mothers working outside the home, also associating food with higher daily and weekly consumption[11].

Individual and behavioral factors that may be associated with obesity include no or short-term breastfeeding; infectious diseases and problems in childcare; excessive consumption of calorie-dense ultra-processed rich in fats, sugars, and sodium foods; low levels of physical activity worsened by the social isolation of COVID-19; increased sedentary lifestyle; and inadequate sleep habits[5,6,12,13].

The coexistence of malnutrition problems involves micronutrient deficiencies and growth retardation. Although obesity has been increasing among children and adolescents aged 5 to 19 years, malnutrition remains a major problem in many low and middle-income countries[12].

Our study found an increase in height that corresponds to the natural growth of the child. The BMI for age was also higher, following the corresponding nutritional status, such as being overweight and malnutrition. Thus, even as they grow, these children remain obese or malnourished, leading to obesity or malnutrition in adulthood.

Furthermore, there was a systematic error in the WHO AnthroPlus software that limited the analysis of the 2021 data, making it impossible to analyze this period, thus hindering the conduct of a cohort study.

CONCLUSION

High percentages of childhood obesity and malnutrition were found in both groups, with the occurrence of overweight individuals in more than half of the population studied. We also found a significant increase in child malnutrition. Childhood obesity was more prevalent in the male group than in the female, while malnutrition was more prevalent in the female. However, overweight and underweight levels are predominant in both.

Considering these findings, it is crucial to alert the studied population regarding the presence of both nutritional problems, as well as apply public policies on an

emergency basis. In this context, preventive action programs should avoid the complications of both overweight or underweight conditions, which trigger a multifactorial inheritance that can be associated mainly with a lack of access to food, poor eating habits, and a sedentary lifestyle.

COMPLIANCE WITH ETHICAL STANDARDS

Funding

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – State University of Northern Paraná (UENP) and the protocol (no. 25138219.4.0000.8123) was written following the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interest to declare.

Author Contributions

Elaboration and design of the experiments: PTO, BRSM; Conduct of the experiments: PTO, BPT, CCC, IB; Data analysis: JPF; Contribution of reagents/materials/analysis tools: BRSM; Writing: PTO.

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