ABCS HEALTH SCIENCES

ORIGINAL ARTICLE

OPEN ACCESS

Nutritional status of schoolchildren living on a city in Brazilian Western Amazon: a cross-sectional study

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ABSTRACT

Introduction: Childhood is an important phase in the formation of eating habits and in determining nutritional status. **Objective:** To analyze the association of socio-environmental characteristics and food consumption with the BMI of schoolchildren from the interior of the state of Amazonas, Brazil. **Methods:** Cross-sectional study carried out with schoolchildren, where information was collected on the birth of children, socioeconomic, anthropometric and food consumption characteristics. BMI for age served as the dependent variable, representing the evaluated outcome. After bivariate analysis, the variables that were associated with the outcome were selected for inclusion in a multivariable linear regression model. **Results:** The sample size corresponds to 97 children and their mothers. Most children were born with adequate weight (84.54%). A significant proportion of children were identified as being overweight (20.61%). The most consumed foods were fresh fruits (76.29%), followed by ultra-processed candies (56.7%) and vegetables (54.64%). Furthermore, more than half of the children consumed processed meats (50.52%) and sugary drinks (54.17%). Birth weight, gestational age, maternal BMI and family income showed a positive correlation with the students' BMI, while the absence of consumption of sugary drinks had a protective effect on the students' higher BMI. **Conclusion:** Higher birth weight, gestational age at birth, maternal BMI and family income were the main factors associated with higher BMI among students. Excess weight is a public health problem of moderate magnitude, reflecting the phase of nutrition transition in which the studied population is inserted.

Keywords: anthropometry; child nutrition; nutritional status; nutrition surveys; birth weight.

How to cite this article: Soares et al. Nutritional status of schoolchildren living on a city in Brazilian Western Amazon: a cross-sectional study. ABCS Health Sci. 2025;50:e025222 https://doi.org/10.7322/abcshs.2023301.2617

Received: Nov 22, 2023
Revised: Jul 16, 2024
Approved: Aug 26, 2024

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Declaration of interests: nothing to declare
Funding: UFAM (scolarship to SAS)

INTRODUCTION

In recent decades, important global socioeconomic and demographic changes have affected the nutritional profile of the world's population. In Brazil, public policies that initially focused on conditions of nutritional deficiencies and malnutrition have focused on the growing prevalence of excess weight and its metabolic disorders in a worrying scenario of climate change and its impacts on the population's food system and consumption[1].

Not unlike trends in other age groups, excess weight in school-age children is seen as an important public health problem and has been the focus of intersectoral strategies[2], considering the relevance of this stage of life, in which adequate nutrition and, consequently, meeting daily nutrient needs will guide the physical, psychological and motor development of children[3]. Thus, habits, conduct and behaviors, especially those related to food and physical activity, are relevant in determining the nutritional status of children[4].

During this period, children reflect on their environment, which multifatorial influences their routines, behaviors, and personalities[5]. These factors, in addition to genetic, physiological, metabolic, environmental, and behavioral aspects, are commonly investigated in studies that seek to understand the risk of developing overweight[1], including during childhood[2-4].

Recent evidence shows that children at school age and even before that, contrary to the recommendations of health agencies, have access to and preferences for unhealthy foods with a predominant composition of fats and sugars and are commonly accompanied by attractive packaging aimed at children[6,7]. Called ultra-processed foods, the Food Guide for the Brazilian Population[8] recommends that their consumption be avoided, and studies have shown that regular consumption of these types of foods has been associated with overweight and its consequences[6,7,9].

Following this global transition, the eating pattern of populations in the Western Amazon has undergone a series of transformations. These changes in food consumption are represented by the replacement of local products obtained through fishing, hunting, and subsistence agriculture, with processed and ultra-processed foods purchased in supermarkets and other outlets from the food industry[10,11].

Demonstrating possible consequences of this change in pattern, analysis of food and nutrition surveillance information has identified that in Northern Brazil, the region with the worst social and infrastructural conditions in the country, an increase in the prevalence of overweight among children can already be observed[12].

Children's nutritional status during their development can be affected by numerous factors, especially concerning food and consumption mode during meals[4,5,6], Considering this is a remote region, understanding these aspects is of paramount importance for the direction of public policies and actions aimed at preventing childhood overweight, a condition considered a current public health problem[2,13].

Based on the above framework, this study aimed to analyze the association of socio-environmental characteristics and food consumption with the body mass index of public school students in the interior of the state of Amazonas, Brazil.

METHODS

Study characterization and sampling

This is a cross-sectional study involving children born between 2009 and 2012, attending urban municipal schools and living in the municipality of Coari, Amazonas state, Brazil. This research was approved by the Research Ethics Committee of the Federal University of Amazonas # 3,670,679 and CAAE 20000919.0.0000.5020.

The sampling was by convenience and random, in which 97 children enrolled in the 1st to 5th grade were selected. The universe considered was four of the nine urban municipal elementary schools in the municipality, those that granted authorization for the research to be carried out.

Children of both sexes, aged between 7 and 10 years, whose legal guardians authorized their participation in the research were included. All children were evaluated prior to inclusion in the sample for pathologies and/or receiving treatment that could influence their growth, aiming to avoid false diagnoses and, consequently, undue conclusions related to nutritional status.

Data Collection Instrument

Data collection to characterize the study population was carried out through interviews conducted on the days of parent meetings at schools; guardians were informed in advance about the research being conducted by the school board.

The interviews were based on a structured questionnaire that included questions about the type of delivery (vaginal or cesarean section) and the weeks of gestation at the time of birth, as well as the duration of exclusive breastfeeding (in months) and the total time after the inclusion of complementary foods.

The socioeconomic characteristics asked included monthly family income, maternal education level, marital status, and receipt of government benefits.

Food consumption data were collected using dichotomous variables for the intake of beans, fresh fruits, vegetables, legumes, sausages, sweetened beverages, sweet ultra-processed foods, savory ultra-processed foods, and also regarding screen time (television, computer, or smartphone) during mealtimes.

Furthermore, information was collected from the children's health notebooks, including type of birth (to verify maternal reports), sex of the child (male or female) and weight and length at birth. After reading these documents, the information was recorded on the research data collection forms.

Evaluation and classification of anthropometric data

At birth

Birth weight classification was performed according to the WHO criteria[14], following the categories of very low birth weight

(<1,500 grams), low birth weight (≥1,500 to <2,500 grams), normal birth weight (≥2,500 to ≤4,500 grams), and macrosomia (>4,500 grams). From length at birth values, and according to sex, the WHO reference calculated the z-score values[14]. Subsequently, the nutritional status was defined according to the standards of the Brazilian Ministry of Health (MS)[15,16].

Schoolchildren

The anthropometric measurements of the children, weight and height, were measured on the same day of the interviews. Weight was measured in kilograms (kg) using an anthropometric scale, while height was measured in centimeters (cm) using a stadiometer. Body mass index (BMI) was calculated based on the anthropometric measurements and nutritional status was assessed using the WHO Anthro Survey tool. Thus, the classification of nutritional status was performed based on the z-score values of weight for age, height for age and BMI for age[16].

Mothers

Just like with children, mothers' weight and height measurements were taken at the schools, on the same day of the interviews. The methods established by the WHO[16] were used to measure weight and height and BMI was used to classify nutritional status, using the categories of underweight (BMI <18.5), normal weight (BMI 18.5 to 24.9), overweight (BMI 25.0 to 29.9) and obesity (BMI ≥30.0).

Statistical Analysis

The collected data were typed in a double entry in Excel program (Microsoft Office, version 2013). After comparing files and correcting divergences, statistical analyses were performed. Individual characteristics of schoolchildren, maternal information, and dietary intake indicators were expressed as total and percentage values with 95 percent confidence intervals (95 % CIs).

Associations were analyzed using bivariate and multivariate regression models. Bivariate regression models were employed to identify potential factors associated with nutritional status in schoolchildren. The BMI-for-age score served as the dependent variable, representing the outcome assessed. After bivariate analysis, variables that showed an association with the outcome were selected for inclusion in a multivariable linear regression model. The results were evaluated based on a significance level of p≤0.05. Statistical analyses were conducted using Stata software, version 15.1 (StataCorp, College Station, TX, USA).

RESULTS

Table 1 presents the individual characteristics of the children assessed according to gestational information, type of delivery and profile of anthropometric indicators at birth and current age. The highest percentages of children aged between 8 and 9 years were observed (22.68 and 41.24%, respectively). Approximately three-quarters of the children were born vaginally (76.29%), and, in general, with adequate weight (84.54%).

The anthropometric assessment of the children using the BMI z-score showed that, although most of the children were eutrophic (79.38%), there was a significant proportion of children with excess weight, approximately 20.61%, when the proportion of overweight and obese children was added (Table 1). Bivariate regression models identified birth weight (p<0.001) and gestational age at birth (p=0.033) was factors associated with schoolchildren's BMI.

The profile of maternal and socioeconomic characteristics of the schoolchildren is presented in table 2. Most mothers were 30 years old or older (57.73%) and, at the time of data collection,

Table 1: Individual characteristics at birth and school age and classification of anthropometric indicators of schoolchildren attending the municipal school network. Coari, Amazonas/Brazil, 2019 (n=97).

Variable	Records	%	(95% CI)
Sex			
Female	49	50.52	(40.50 - 60.79)
Male	48	49.48	(39.51 - 59.50)
Actual age (years)			
7	17	17.53	(11.09 - 26.58)
8	22	22.68	(15.31 - 32.24)
9	40	41.24	(31.74 - 51.43)
10	18	18.56	(11.92 - 27.73)
Gestational age at birth (weeks)			
36	8	8.25	(4.13 - 15.81)
37 to 38	22	22.68	(15.31 - 32.24)
39 to 40	56	57.73	(47.54 - 67.30)
41 or more	11	11.34	(6.32 - 19.50)
Characteristics at birth			
Vaginal delivery	74	76.29	(66.65 - 83.82)
Cesarean delivery	23	23.71	(16.18 - 33.35)
Weight at birth			
Low	11	11.34	(6.32 - 19.50)
Adequate	82	84.54	(75.74 – 90.54)
Macrosomia	4	4.12	(1.53 – 10.65)
Z-score - Length at birth			
Very short height for age	45	46.39	(36.57 - 56.50)
Short height for age	14	14.43	(8.66 - 23.09)
Height appropriate for age	38	39.18	(29.84 - 49.38)
Z-score – Weight for age			
Underweight	4	4.12	(1.53 - 10.65)
Adequate	88	90.72	(82.95 - 95.16)
High	5	5.15	(2.13 - 11.96)
Z-score – Height for age			
Short	4	4.12	(1.53 - 10.65)
Adequate	93	95.88	(89.35 - 98.47)
Z-score – BMI for age			
Normal (Eutrophy)	77	79.38	(70.00 - 86.40)
Overweight	15	15.46	(9.46 - 24.26)
Obesity	5	5.15	(2,13 – 11,96)

Legend: % - Percentage; 95% CI - 95 percent confidence interval.

were overweight (43.30%) or obese (25.77%). In general, they were married or living in a stable union (67.01%) and approximately half had completed only the ninth grade of elementary school or less (50.51%). Among the families of the schoolchildren, 88.66% received benefits from an income transfer program and, notably, the majority had a monthly income of less than R$880.00 (76.72%). Only family income (stratum of R$ 881 to 1760) had significant relationship (p=0.021) with schoolchildren's BMI.

Regarding the dietary information presented in table 3, it was observed that most of the schoolchildren were exclusively breastfed until 6 months of age (56.70%). Total breastfeeding offered together with complementary feeding was concentrated between 10 and 12 months of age (36.08%) and then until 24 months (30.93%).

The consumption reported on the day before the interview showed a significant participation of fresh fruits (76.29%), followed by sweet ultra-processed foods (56.7%) and vegetables (54.64%). On the other hand, beans were little consumed among the schoolchildren. Furthermore, more than half of the children consumed processed meats (50.52%) and sweetened beverages (54.17%). It was also observed that 50.52% of the schoolchildren ate while watching television or playing on the computer or smartphone on the day before the interview (Table 2).

About the associations between nutritional status and food consumption, only the absence of soft drink consumption showed a significant association (p=0,005) with BMI for the age of the students.

The multiple variable analysis (Table 4) showed that the variables birth weight, gestational age, soft drinks consumption and income were those that showed a significant association with the BMI z score of the children studied. In the sample studied, birth weight, gestational age, maternal BMI and family income (range R$881 to R$1760) have a positive correlation with the student's BMI, while the absence of consumption of sweetened beverages has a protective effect on the higher BMI of the students.

DISCUSSION

In regions with precarious socio-environmental conditions, such as the North of Brazil, an improvement in indicators has been observed in recent decades, including height for age, considered an essential component for assessing child health, a consequence of historical economic growth and income transfer programs that directly or indirectly impact on health conditions[12].

However, the significant proportion of low height for age and length at birth, which indicates the chronicity of malnutrition,

Table 2: Descriptive analysis of maternal anthropometric and socioeconomic characteristics of schoolchildren attending the municipal school network. Coari, Amazonas/Brazil, 2019 (n=97).

Characteristics	Records	%	(95% CI)
Age (years)			
24 to 30	41	42.27	(32.70 - 52.46)
30 or more	56	57.73	(47.54 - 67.30)
Nutritional Status*			
Underweight	1	1.03	(0.14 - 7.18)
Normal weight (Eutrophy)	29	29.90	(21.51 - 39.90)
Overweight	42	43.30	(33.66 - 53.47)
Obesity	25	25.77	(17.93 - 35.56)
Marital status			
Single	27	27,84	(19.71 - 37.74)
Married/Stable Union	65	67.01	(56.90 - 75.76)
Other	5	5.15	(2.13 - 11.96)
Education			
Up to the fourth grade of elementary school	14	14.43	(8.66 - 23.09)
Up to the ninth grade of elementary school	35	36.08	(27.02 - 46.26)
Up to the third grade of high school	44	45.36	(35.59 - 55.50)
Started college but did not finish it	3	3.09	(0.98 - 9.33)
Graduated from college	1	1.03	(0.14 - 7.18)
Beneficiary of a governmental cash transfer program			
Yes	86	88.66	(80.50 - 93.68)
No	11	11.34	(6.32 - 19.50)
Monthly family income (Reais – R$)			
Up to 220	15	15.46	(9.46 - 24.26)
221 to 440	31	31.36	(23.32 - 42.04)
441 to 880	29	29.90	(21.51 - 39.90)
881 to 1,760	17	17.53	(11.09 - 26.58)
1,761 or more	5	5.15	(2.13 - 11.96)

*Body Mass Index (BMI) – kg/m²; %: Percentage; 95% CI: 95 percent confidence interval.

possibly reflects the repercussions that indicators of social inequalities and population well-being[17] have had on the linear growth of these children. Similar conditions have already been identified in other studies; in a recent literature review[18], prevalence rates ranging from 7.7 to 25.1% of growth deficits were observed in Amazonas. On the other hand, the trend regarding these rates for children under 5 years of age has been stable for this region, evidencing the result of public policies to intervene in child malnutrition[19].

Table 3: Indicators of food consumption of schoolchildren attending the municipal school network. Coari, Amazonas/Brazil, 2019 (n=97).

Variable	Records	%	(95% CI)
Exclusive breastfeeding (months)			
1 to 3	9	9.28	(4.84 - 17.05)
4 to 5	23	23.71	(16.18 - 33.35)
6	55	56.70	(46.53 - 66.34)
7 or more	10	10.31	(5.57 - 18.29)
Total breastfeeding (months)			
1 to 9	22	22.68	(15.31 - 32.24)
10 to 12	35	36.08	(27.02 - 46.26)
13 to 24	30	30.93	(22.41 - 40.97)
25 or more	10	10.31	(5.57 - 18.29)
Food consumption			
Beans			
Yes	33	34.02	(25.16 - 44.16)
No	64	65.98	(55.84 - 74.84)
Fresh fruit			
Yes	74	76.29	(66.65 - 83.82)
No	20	20.62	(13.60 - 30.00)
Does not know	3	3.09	(0.98 - 9.33)
Vegetables			
Yes	53	54.64	(44.50 - 64.41)
No	41	42.27	(32.70 - 52.46)
Does not know	3	3.09	(0.98 - 9.33)
Processed meats			
Yes	49	50.52	(40.50 - 60.49)
No	48	49.48	(39.51 - 59.50)
Sweetened Beverages			
Yes	52	54.17	(43.99 - 64.01)
No	44	45.83	(35.99 - 56.01)
Does not know	1	1.03	(0,14 – 7,18)
Sweet ultra-processed foods			
Yes	55	56.70	(46.53 - 66.34)
No	41	42.27	(32.70 - 52.46)
Does not know	1	1.03	(0.14 - 7.18)
Salty ultra-processed foods			
Yes	46	47.42	(37.54 – 57,51)
No	49	50.52	(40.50 – 60.49)
Does not know	2	2,06	(0.50 – 8,05)
Meals exposed to TV, computer, or smartphone			
Yes	49	50.52	(40.50 - 60.49)
No	48	49.48	(39.51 - 59.50)

%: Percentage; 95% CI: 95 percent confidence interval.

Concomitantly with these characteristics regarding height growth, a significant proportion of schoolchildren are overweight, also reflecting malnutrition in childhood and in accordance with the trend identified at a national level for children[20]. Overweight prevalence among children has increased significantly, specifically in the North region, where a higher proportion was identified (12.8%) compared to the country as a whole (5.2%). It should be noted that this region, which was once the focus of discussions about child malnutrition, has also gained prominence when discussing obesity[18,21].

Corroborating the evidence, despite the nutritional transition occurring worldwide, even among families with lower socioeconomic status[19], mothers' high prevalence of overweight and obesity stands out. The simple regression model identified this significant correlation with the BMI z-score but lost its effect in the multivariate model. Evidence from the National Study of Child Feeding and Nutrition (ENANI-2019) drew attention to maternal malnutrition, including overweight, as a growing problem associated with the nutritional status of children in Brazil, in a context in which lower levels of education have also been shown to be associated with poor nutrition in the mother-child dyad[22].

The low level of education and other characteristics of the population studied, such as the significant proportion of families receiving government assistance, and the living conditions, reflected here by income, whose association was observed with overweight among schoolchildren, reinforce the need for public policies to prioritize families in vulnerable conditions. In this sense, evidence has shown differences in relation to the nutritional status of children whose families receive government assistance[23], and, although this information was not collected but concerns the region of the study, they have race, such as brown and indigenous[24], and belong to groups of traditional peoples and communities, such as indigenous and riverside communities[25].

Table 4: Associations between child BMI-for-age z-score and individual, maternal, and family income variables. Coari, Amazonas/Brazil, 2019.

Variable	Bivariate regression model			Multivariate regression model		
	b	R^2	p-value	b	R^2	P-value
Weight birth	0.63	0.13	**<0.001**	0.39	0.27	**0.033**
Gestational age at birth	0.15	0.05	**0.033**	0.14		**0.042**
Cesarean delivery	0.35	0.02	0.189	0.26		0.329
Absence sweetened beverages	-0.64	0.08	**0.005**	-0.44		**0.050**
Maternal BMI	0.05	0.05	**0.025**	0.03		0.152
Income R$ 881 to 1760	0.92	0.58	**0.021**	0.72		**0.047**

b - Angular coefficient; R^2: Coefficient of determination.

Changes in food consumption patterns are another factor associated with being overweight, which also concerns low-income populations that receive government aid, such as the profile identified in this study. Notably, the greater purchasing power of these families resulted in a positive reflection on access to food; however, the quality of the food purchased is questionable[26]. Studies based on the family budget have evidenced a greater inclination to purchase processed and ultra-processed foods[27], whose damage to health has been widely discussed, including its influence on childhood nutritional status[9].

Although no statistically significant associations were found, it should be noted that more than half of the children consumed fruits and vegetables and that, on the other hand, about half of the children consumed foods not recommended by the Food Guide for the Brazilian Population[8], such as sausages, sweet and salty ultra-processed foods, and sugary drinks.

According to the WHO, the dietary changes that occurred in recent years favor the intake of ultra-processed foods, which are nutrient-poor foods related to the development of childhood obesity. The consumption of breast milk, vegetables, and fruit, in turn, is a protective factor against obesity[13], highlighting the importance of educational interventions focused on reducing ultra-processed foods consumption and encouraging the current consumption of vegetables and fruit.

We also emphasize the need to encourage the adoption of healthy lifestyles since exposure to screens is also quite prevalent among children. Studies show that children usually spend an average of 5 to 6 hours a day watching TV, using the computer or smartphone, and are exposed to numerous advertisements and commercials that stimulate the consumption of industrialized products. In addition, time spent in front of the TV results in fewer hours available for recreational activities and can promote excessive food consumption[28].

Scientific literature presents a mix of findings that may corroborate or contradict the findings of the present study. In a population-based study conducted in Uruguay, high birth weight and weight gain were relevant risk factors for childhood obesity. However, children with higher family incomes are at lower risk for obesity, and boys are at lower risk for this outcome compared to girls[29]. The findings of a systematic review with meta-analysis indicate that excessive consumption of sweetened beverages is associated with increased BMI and waist circumference in children and adolescents[30]. Thus, it is evident that factors related to prenatal conditions and dietary habits during development can contribute to childhood overweight.

The sample size that possibly influenced the results of the statistical analysis is a limitation of this study. Convenience sampling is susceptible to selection bias and does not allow for generalization of findings to the population of interest[31]. However, it is noteworthy that this study was conducted with all the methodological care for collecting information from a population of high social vulnerability living in a remote municipality in the interior of the state of Amazonas. These aspects alone demand discussion and careful attention regarding the information collected, which is of utmost relevance to the health of children in the region and other locations with similarities in individual and socio-environmental characteristics.

Conclusion

A concerningly high prevalence of overweight was observed among schoolchildren in the inland Amazonas study sample. The nutritional assessment revealed that most of the schoolchildren's mothers presented overweight and a high proportion of obesity. Analysis of food consumption markers and dietary habits revealed the highest percentages of fresh fruits, vegetables, processed meats, and sweetened ultra-processed foods consumption, along with mealtimes spent in front of televisions, computers, or smartphones. Birth weight and gestational age at birth were identified as major factors associated with the schoolchildren's BMI.

In the context of a remote region in the Amazon, the findings of this study reinforce the need for public actions and policies to act in an intersectoral manner, given that adequate food and nutrition influence and are influenced by the different contexts of health and quality of life.

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