Research Article

Underweight, Overweight, and Obesity Trends in Low-Income Children from North Brazil, 2009-2019

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Abstract

Objective: Childhood obesity has been found in children in situations of vulnerability in which the underweight is usually more prevalent. However, trends in the prevalence of these outcomes in populations supported by an income transfer program are not usually reported. This study aimed to examine the underweight, overweight, and obesity trends in children in the North of Brazil.

Methods: A total of 242,465 children (aged five to 10 years), were evaluated in this population-based study with public data collected annually from 2009 to 2019. Children included were beneficiaries of the Bolsa Família Program, which is a conditional cash transfer policy. The prevalence of underweight, overweight, and obesity were estimated using the Body Mass Index for age. Logistic regression was used to determine significant trends in the prevalence of the investigated outcomes.

Results: Between 2009 and 2019, underweight prevalence increased significantly from 4.5% to 8.5% for boys and 4.6% to 7.1% for girls. In the same period, overweight declined from 13.3% to 11.7% for boys but increased from 10.5% to 12.8% for girls. Trends in increasing obesity were observed, from 8.0% to 9.9% in boys and from 5.5% to 7.8% in girls. Children in 2019 were more likely to present the outcomes investigated when compared to those in 2009, except for overweight in boys.

Conclusion: Low-income children have become increasingly obese, but underweight is still a persistent problem. It is necessary to develop public health promotion policies that do not increase obesity when the focus is to reduce underweight.

ABBREVIATIONS

HDI: Human Development Indexes; BFP: Bolsa Família Program; SISVAN: Sistema de Vigilância Alimentar e Nutricional; BMI: Body Mass Index; OR: Odds Ratio

INTRODUCTION

Overweight and obesity are multifactorial disorders resulting from a positive energy balance that results in increased adipose tissue [1]. Overweight and especially childhood obesity are considered a worrying public health problem, with increasing prevalence in many countries [2]. In addition to the greater likelihood of becoming an obese adult, the children with obesity is susceptible to comorbidities such as hypertension, diabetes mellitus, and dyslipidemias [2].

Despite the problems linked to childhood obesity, there more cases of underweight than obese children in the world, which are mainly concentrated in South Asia and Africa [3]. According to the World Health Organization, underweight is a sub-form of malnutrition, which indicates recent weight loss due to lack of enough food to eat or due to infectious diseases such as diarrhea [4]. Being underweight negatively affects physical, psychological, and social health throughout life [5], in addition to making it difficult to fight infections, recover from diseases, and academic achievement [6]. Thus, both weight conditions similarly lead to adverse health outcomes [2,4].

In Brazil, adequate estimates of the nutritional status of children are a challenge, especially due to the economic inequality between regions, causing disparities in the Brazilian nutritional epidemiological profile. For example, the regions with the highest Human Development Indexes (HDI) are the Southeast (HDI = 0.766) and the Midwest (HDI = 0.757). On the other hand, the Northern region (HDI = 0.667) presents a less favorable situation [7]. The Amazonas state (HDI = 0.674), located in the Northern region, may have been strongly impacted by the difficulties not found in other states, reflected in the nutritional status of its population [2].

Children living in the Northern region face major problems related to access to health services, worse socioeconomic and, environmental conditions [8]. Poor and extremely poor families are usually included in a direct income transfer program, the Bolsa Família Program (BFP), with conditions that include: children's school attendance, immunization and, growth and development monitoring [9]. The BFP provides direct income to low income families. Despite this, a previous study indicated that children from the Northern region, in the period from 1975 to 2015, showed a decline in height deficit for their age until 2006, but it increased again in 2015 [8]. Additionally, the researchers

found a downward trend in the weight deficit in the North region in the aforementioned period, and Amazonas was the state with the worst trends found. The Amazonas state has been rapidly urbanizing, and its capital, which concentrates more than half of the state's total population, has practically doubled in size in the last 30 years [10]. These changes may have impacted children's nutritional status over the years since urbanization has been considered a protective factor against underweight and a risk factor for overweight and obesity [6,11]. Thus, it is assumed that declining trends in underweight have occurred concurrently with the increase in overweight and obesity even in poor and extremely poor children. However, this hypothesis needs to be confirmed.

Trends in children's nutritional status, especially underweight, have not been investigated in Brazilian populations participating in income transfer programs. Monitoring these trends is essential for planning, evaluating, and guiding public health policies, as also for verifying the success of the strategies employed. Thus, this study aimed to examine trends in underweight, overweight, and obesity in children in the Northern region of Brazil.

MATERIALS AND METHODS

This is an ecological study of time series, carried out from the analysis of a secondary database, from public reports of Sistema de Vigilância Alimentar e Nutricional (SISVAN), (available at https://sisaps.saude.gov.br/sisvan/relatoriopublico/index). Since it is research using public data of free access, obtained through SISVAN web, there was no need for its appreciation by a Research Ethics Committee. Data used in this study corresponds to children (five to 10 years old), from the city of Manaus, capital of Amazonas state, Brazil, based on surveys carried out from 2009 to 2019. The data from the present study were accessed on February 20, 2021. Data for the year 2020 are absent because there was no collection of information in the health units due to the novel coronavirus COVID-19 pandemic.

The Northern region of Brazil is made up of seven states, the most notable being Amazonas, which has the largest territorial area (1,559,167.889 km^2), among all Brazilian states, whose population is currently estimated at 4,144,597 inhabitants [12]. The capital Manaus has an estimated population of 2,182,763 inhabitants, concentrating more than 52.0% of the total population of Amazonas. In the last Brazilian census released in 2010, it was estimated that Manaus had 165,911 children aged five to nine years old. In 2018, when the Brazilian minimum wage was R$ 954.00 (approximately US$ 249.86), about 37.9% of the population of Manaus had a monthly income of up to half a minimum wage, placing the city in the last place among the 62 municipalities of State.

For the present study, public data from the BFP Management System available on the SISVAN web were used. The BFP is a direct income transfer policy aimed at families in social vulnerability to promote immediate relief from poverty and hunger, access to basic rights of life, and the development of families in the fight against vulnerability [9]. Created in 2003, the BFP was initially targeted at poor and extremely poor families containing children up to the age of five, pregnant or breastfeeding women, and all families in extreme poverty even if they did not have children.

Currently, for the family to be included in the BFP, the income per person must be up to R$ 89.00 per month (approximately US$ 17.00). Another category refers to the family income per person that is from R$ 89.01 to R$ 178.00 (US$ 17.01 to US$ 34.08), monthly, as long as they have children or adolescents aged zero to 17 years. In 2009, approximately 97,000 benefits were granted in Manaus and in 2019 the number of benefits exceeded 130,000 families.

The nutritional status of children benefiting from the BFP is classified based on the measurement of the Body Mass Index [BMI; body mass (kg) / height^2 (m)]. For this purpose, the World Health Organization cutoff points [13,14], adopted by SISVAN since 2008 were used to categorize nutritional status based on the BMI-for-age Z-scores. All measures were collected following SISVAN standards [15]. Families are invited to attend health posts twice a year (once a semester), and the most current measures of body mass and height are updated in the system. Body mass is obtained using a calibrated scale, which can be platform mechanics or digital electronics. Height is obtained using a vertical stadiometer or an anthropometric tape attached to the wall. The measurements are collected by primary care health professionals, who are responsible for data collection following the procedures in the SISVAN manual [15]. For the present study, the cutoff points for BMI, which vary according to age, were calculated by SISVAN in Z-score, classified as underweight (<-2 Z-scores), overweight (> 1 Z-score and <2 Z-scores), and obesity (> 2 Z-scores).

Statistical Analyses

Data analysis was performed using descriptive statistics (frequency distribution), and using estimates of 95% confidence intervals for each year, sex, and age. The possible differences between the subgroups can be observed based on the absence of overlapping confidence intervals. Binary logistic regression was used to estimate the odds ratio of possible trends using the 2009 data as a reference. Statistical analysis was performed using BioEstat 5.0 (Mamirauá, Belém, PA, Brazil) with a 5% level of significance.

RESULTS

Data presented in this study are from a sample of 242,465 children (59.8% girls) from the BFP. The proportion of boys was similar to that of girls until 2011. From 2012 until 2019, the proportion of girls became visibly higher than boys. Table 1 shows the general information of the sample stratified by sex according to each SISVAN survey.

Underweight prevalence remained stable from 2009 to 2018 in both sexes, with an increase of 88.9% in boys and 54.3% in girls in 2019, compared to their 2009 peers. Regarding overweight, substantial increases were observed in both boys and girls from 2012, and mainly between 2015 and 2018. In boys, specifically, there was a 12.0% decline in the prevalence of overweight between 2009 and 2019. In girls, the high prevalence of overweight increased from 2010 and showed an increase of 21.9% from 2009 to 2019. When considering obesity, there was a sustained increase from 2010 for both sexes, with increments of 23.8% in boys and 41.8% in girls in 2019. The prevalence of outcomes and confidence intervals were shown in Table 2.

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Table 1: Distribution of Bolsa Família Program children according to sex and survey. Manaus, AM. (SISVAN 2009-2019).

Year	Boys n (%)	Girls n (%)	Total
2009	6,295 (51.6)	5,905 (48.4)	12,200
2010	7,099 (51.1)	6,891 (49.3)	13,990
2011	5,031 (49.3)	5,181 (50.7)	10,212
2012	6,832 (47.8)	7,461 (52.2)	14,293
2013	10,404 (47.5)	11,514 (52.5)	21,918
2014	10,987 (37.9)	18,039 (62.1)	29,026
2015	11,044 (34.5)	21,000 (65.5)	32,044
2016	9,347 (35.3)	17,141 (64.7)	26,488
2017	10,414 (36.6)	18,074 (63.4)	28,488
2018	9,850 (37.3)	16,558 (62.7)	26,408
2019	10,057 (36.7)	17,341 (63.3)	27,398

Table 2: Prevalence of underweight, overweight and obesity in children according to sex in each survey. (SISVAN 2009-2019).

Year		Underweight P (95% IC)	Overweight P (95% IC)	Obesity P (95% IC)
BOYS	2009	4.5 (4.0-4.9)	13.3 (12.5-14.0)	8.0 (7.3-8.6)
	2010	4.7 (4.2-5.1)	12.4 (11.6-13.0)	13.0 (12.2-13.7)
	2011	5.1 (4.6-5.5)	13.8 (13.0-14.5)	10.0 (9.3-10.6)
	2012	4.2 (3.8-4.5)	14.5 (13.8-15.1)	10.3 (9.7-10.8)
	2013	4.3 (3.9-4.6)	14.6 (13.9-15.2)	10.9 (10.3-11.4)
	2014	4.3 (4.0-4.6)	15.3 (14.7-15.9)	11.8 (11.2-12.3)
	2015	4.0 (3.7-4.3)	16.0 (15.3-16.6)	12.7 (12.1-13.2)
	2016	4.4 (4.0-4.7)	15.5 (14.8-16.1)	12.1 (11.4-12.7)
	2017	5.3 (4.9-5.7)	14.7 (14.0-15.3)	10.7 (10.1-11.2)
	2018	5.0 (4.6-5.4)	14.4 (13.7-15.0)	10.7 (10.1-11.2)
	2019	8.5 (8.0-9.0)	11.7 (11.1-12.2)	9.9 (9.3-10.4)
GIRLS	2009	4.6 (4.1-5.0)	10.5 (9.7-11.1)	5.5 (4.9-6.0)
	2010	4.6 (4.1-5.0)	12.2 (11.4-12.9)	9.4 (8.7-10.0)
	2011	4.6 (4.1-5.1)	10.9 (10.1-11.6)	6.1 (5.5-6.7)
	2012	4.6 (4.2-5.0)	12.3 (11.6-12.9)	7.4 (6.8-7.9)
	2013	4.2 (3.9-4.5)	12.8 (12.2-13.3)	8.4 (7.9-8.8)
	2014	4.0 (3.7-4.2)	14.2 (13.7-14.6)	8.5 (8.2-8.9)
	2015	3.9 (3.7-4.1)	14.7 (14.2-15.1)	9.3 (8.9-9.6)
	2016	4.1 (3.8-4.4)	13.9 (13.4-14.3)	9.1 (8.7-9.5)
	2017	4.6 (4.3-4.9)	14.0 (13.5-14.4)	8.6 (8.2-8.9)
	2018	4.7 (4.4-5.0)	13.9 (13.4-14.4)	8.3 (7.9-8.6)
	2019	7.1 (6.7-7.4)	12.8 (12.3-13.2)	7.8 (7.4-8.1)

Abbreviations: P: prevalence; 95% IC: 95% confidence interval.

The odds ratios for the prevalence of underweight, overweight, and obesity for each sex in the different years were estimated compared to 2009 (Figure 1). Regarding underweight prevalence, substantial increases were observed in boys in 2017 (OR = 1.19; 95%CI = 1.02-1.37), and 2019 (OR = 1.94; 95% CI =1.69-2.23), when compared to those of 2009. In girls, underweight prevalence remained stable until 2018, with an increase in 2019 (OR = 1.54; 95% CI = 1.39-1.82), compared to 2009. Moreover, the chances of underweight decreased in 2015 compared to 2009. As for overweight, there were increases in the boys from 2012 to 2018 and girls from 2012 to 2019 when compared to those in 2009. In 2019, boys were less likely (OR = 0.87; 95%CI = 0.79-0.95), to be overweight compared to their 2009 peers. The obesity prevalence in boys was significantly higher in all periods evaluated compared to those in 2009. The same trend was observed in girls, except for girls in 2011 (OR = 1.11; 95% CI = 0.94-1.30).

DISCUSSION

In this study, we examined simultaneously, the underweight, overweight, and obesity trends in children from the North of Brazil in the period from 2009 to 2019. Overall, there was an increase in the prevalence of the investigated outcomes among children, even with the underweight remaining stable for most years. In boys, however, the prevalence of overweight declined in 2019, but remained high in most years compared to 2009. The
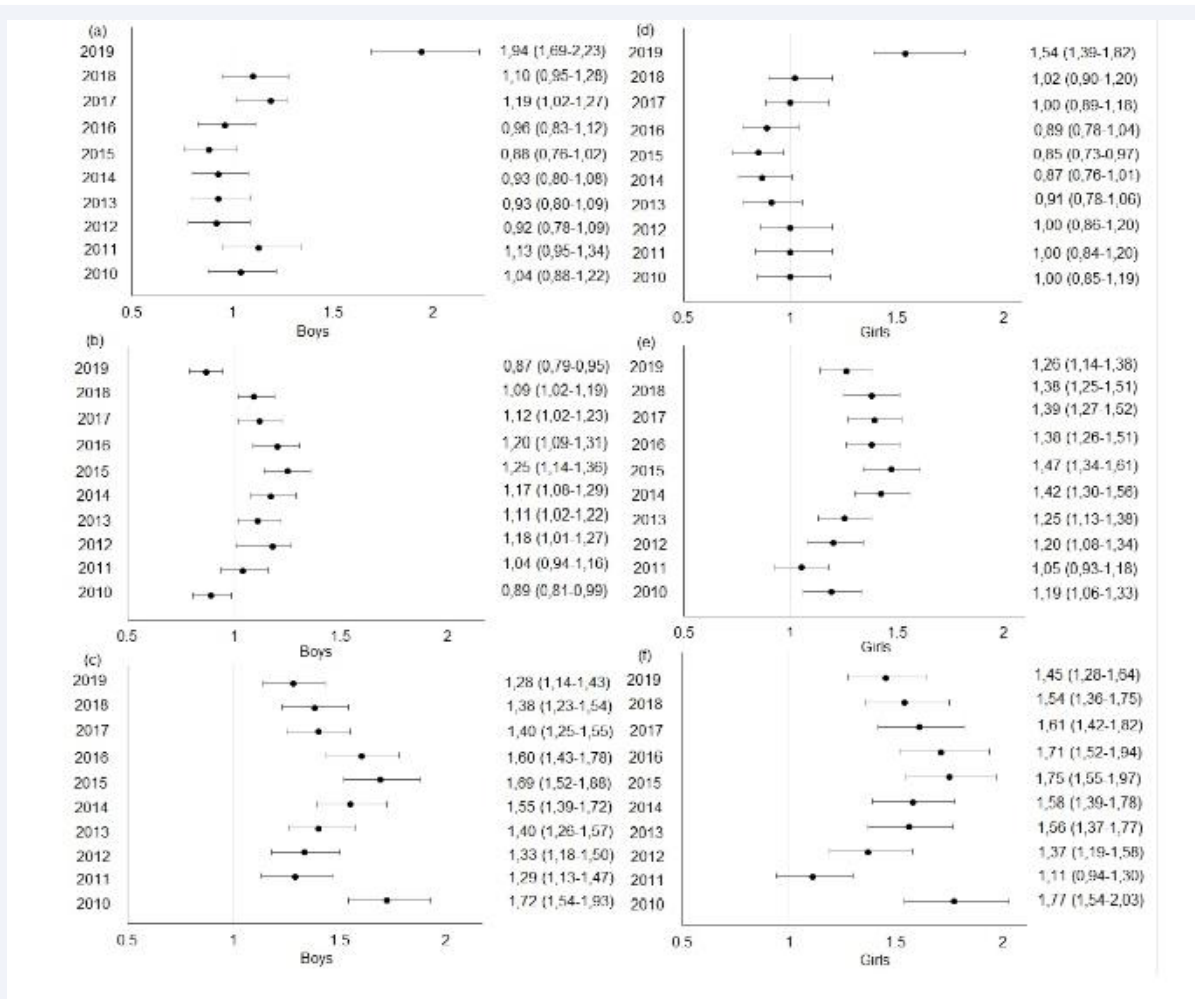
Figure 1 Odds ratios, with 95% confidence intervals, of the prevalence of (a) underweight, (b) overweight, and (c) obesity for boys and (d) underweight, (e) overweight, and (f) obesity for girls, in the different surveys of SISVAN compared to 2009.

three conditions are negatively affecting children whose data come from information from the direct cash transfer program of Brazil. The new contribution of this study is the finding that the investigated outcomes are increasing (from 2009 to 2019), especially the underweight that has remained stable over the years, revealing a public health challenge. These findings indicate that Brazilian public health policies urgently need to be reviewed.

Though the underweight prevalence remained stable in most periods, it increased in 2019 compared to 2009 in both sexes, and in 2017 in boys. This finding corroborates previous studies indicating an increase in the underweight prevalence, from 3.8% in 1980/81 to 7.2% in 2011/16 in children in Serbia [1], and 10.5% in 2013 to 16.1% in 2017 in France [5]. The opposite result, however, was observed in a study using data from several countries, in which the underweight prevalence declined from 12.0% in 1975 to 10.4% in 2016 [3]. The underweight prevalence also declined from 1.84% in 2009 to 0.63% in 2015 in an analysis of more than 71,000 Chinese children [16]. In Romania, researchers investigating the trend of underweight in more than 25,000 children reported that in 2005 about 8.9% of children had the outcome, increasing to 13.3% in 2013 and

declining considerably to 3.3% in 2014 [11]. In a study carried out in Ethiopia, underweight declined from 41.0% in 2000 to 24.0% in 2016 [17]. In Brazil, few trend studies have been found in national samples. However, research conducted with children from different regions showed that about 2.6% of children were underweight in 2005/06, increasing to 3.1% in 2009/11 [18]. In Ilhabela, in São Paulo state, researchers observed in 1990/91 that no child was underweight, whereas in 2010/11 the prevalence was 3.5% [19].

These findings are of concern, as they reveal that malnutrition that has remained stable over the years in Brazilian children is still a problem, especially in recent years in the face of rising trends. However, it is necessary to highlight that the sample analyzed in the present study has, a socioeconomic characteristic of low-income and very low-income, which may partly explain the increase of underweight trends found. Despite being part of a cash transfer program focused on combating hunger and poverty, BFP users were almost 10 times more likely to experience food insecurity when compared to users of other population-based surveys [20]. This may indicate that the financial resources received by families are insufficient, making access to properly

nutritious food difficult or that they only supply a limited food capacity. Thus, the living conditions of these children corroborate the close relationship between food insecurity and underweight, resulting from the reduction in the number of meals, portion sizes, and less food variety [21,22]. Another possible explanation may be linked to the city's basic sanitation conditions, which is considered the third-worst among the 100 largest ranked Brazilian cities [23]. Thus, since they are exposed to unhealthy environments because of poor basic sanitation, these children are subject to several enteric pathogens that lead to malnutrition [24]. The public school might play an important role in combating the trends found, as these children spend much of their time in school, which is one of the conditions for integrating the BFP. Thus, the food composition provided at school, if scientifically appropriate and solid, might contribute to control and diminish the problem of underweight that appears to worsen.

The overweight prevalence in boys increased from 2012 onwards, presenting a decline only in 2019 compared to 2009. A decline trend in overweight similar to that of the present study was observed in French boys, from 14.7% in 2013 to 11.2% in 2017 [5]. In Romania, on the other hand, the prevalence of overweight remained stable between the years 2006 (16.0%), and 2015 (18.0%) [11]. The findings of 2019 in the present study differ from a study with worldwide data, pointing out that there was an increase in overweight prevalence [3]. Although punctual, the decline in the overweight prevalence in 2019 may indicate some success linked to the cash transfer policy. For example, the BFP has intersectoriality as one of its principles, articulating with education, health and, social assistance areas [9]. We hypothesize that the integrated actions between the three aforementioned areas may have performed a positive role in children's weight control, at least in boys. This hypothesis is based on a previous study indicating a greater chance of these children having access to health services [25]. Also, because they have to comply with school attendance conditionality, children can benefit from the *National School Meals Program*, which offers school meals and actions on food and nutrition education [26]. This is a positive point since overweight during childhood tends to have a negative impact on health throughout life [3].

In general, the overweight and obesity prevalence increased circumstantially in the period considered in the present study. Although Brazilian BFP participants experience critical situations in relation to food insecurity [27] these trends corroborate previous studies conducted in China [28-30], Georgia [31], Australia [32], and in several Latin American countries [3]. Research conducted on Brazilian children also described trends of increase in overweight and obesity prevalence in the periods from 1974 to 2009 [33], 1992 to 2015 [2] and 2013 to 2015 [34].

The trends observed in the nutritional status of the children in the present study covered governments that implemented public policies, certainly aimed at improving the health conditions of the population [2]. However, the increasing overweight and obesity trends found here reinforces the discourse that these outcomes coexist with malnutrition, in the same contexts [6]. This double burden of malnutrition has also been observed in other Brazilian cities with low economic development [34]. These findings may be related to the trends towards a reduction

in weight deficit associated with an increase in height deficit described in low-income children in the Northern region of Brazil [8], leading to high BMI values. Despite living in a situation of social vulnerability, the BFP users have worse eating practices such as greater consumption of soft drinks [35], and processed foods [36] and ultra-processed [37]. This reveals that although the BFP promotes accessibility to food, families do not always opt for those who have nutritional quality [38], favoring overweight and obesity.

Additionally, the nutritional profile of the diet in Brazil has undergone a transition in recent years, with the replacement of minimally processed or fresh meals by ultra-processed ones [39]. These unhealthy foods can be easily accessed by the families of these children, as reductions in the prices of processed and ultra-processed foods and increases in the price of foods such as fruits and vegetables have been observed [40]. Thus, it is essential to stop the connection of public policies aimed at the underweight of those for overweight and obesity in children, addressing guidelines based on food education.

This study has limitations that need to be considered when interpreting its results. Despite the economic transition that is taking place in the region where these children live, which can affect immigration, agriculture, and urbanization policies, it was not possible to examine the impacts of these factors on the nutritional status of the children using the methodology employed. Another limitation refers to the reduced amount of information from children and their families, which could contribute to a better understanding of the children's nutritional status. The use of secondary data, for this study, may have implications for their quality and, therefore, needs to be carefully interpreted, mainly concerning nutritional status data. Still, concerning secondary data, the researchers could not control possible typing and/or registration errors. Additionally, these results may not, therefore, apply to the full population because only part of the SISVAN dataset was considered. The results may also reflect the effect of the intervention and changes in the intervention sample over time. The acknowledgment of these limitations might be useful in conducting future studies.

In contrast to the limitations, the present study provides an update on the data of children with underweight, overweight and obesity in the Northern region of Brazil, which has few studies on the subject. In addition, the large number of children included in this research deserves to be highlighted, as guarantee the external validity and generalizations of the findings for children with similar characteristics in the city where they live.

CONCLUSION

In the analyzed period (2009 to 2019), there were, at the same time, significant increases in the prevalence of underweight, overweight, and obesity in low-income and very low-income children who are part of the BFP. Underweight, however, remained stable in most of the periods analyzed, which may reveal some success of the BFP over children's eating conditions. Even so, given the trends analyzed, underweight was persistent, suggesting that malnutrition is a public health problem in the region. The trends of increasing overweight and obesity may be related, mainly, to the quality of the food obtained by the BFP

families. In any case, the findings of the present study suggest that these children need to be better assisted from the point of view of public policies, especially those that guide and condition access to and consumption of healthy foods. Therefore, when considering that the investigated problems can affect children's health, efforts must be made to prevent and control not only obesity but also underweight in childhood. Regular monitoring of prevalence, public policies that promote nutritional education, and physical exercise can be crucial in solving the problems encountered. The findings of the present study should be considered when planning strategies to combat these multifactorial nutritional disorders.

REFERENCES

1. Pavlica TM, Rakić RS, Popović BK, Puškaš VP. Secular trend in growth and nutritional status in a sample of girls aged 7-9 years from Serbia. HOMO. 2018; 69: 280-286.

2. Ferreira HD, Albuquerque GT, Santos TR, Barbosa RD, Cavalcante AL, Duarte LE, et al. Stunting and overweight among children in Northeast Brazil: prevalence, trends (1992-2005-2015) and associated risk factors from repeated cross-sectional surveys. BMC Public Health. 2020; 20: 736.

3. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in children's and adolescents' body mass index, underweight, overweight and obesity, in comparison with adults, from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies with 128· 9 million participants. Lancet. 2017; 390: 2627-2642.

4. World Health Organization. Reducing stunting in children: equity considerations for achieving the global nutrition targets 2025. 2021.

5. Vanhelst J, Baudelet JB, Thivel D, Ovigneur H, Deschamps T. Trends in the prevalence of overweight, obesity and underweight in French children, aged 4–12 years, from 2013 to 2017. Public Health Nutri. 2020; 24: 2478-2484.

6. Arthur SS, Nyide B, Soura AB, Kahn K, Weston M, Sankoh O. Tackling malnutrition: a systematic review of 15-year research evidence from INDEPTH health and demographic surveillance systems. Glob Health Action. 2015; 8: 28298.

7. Programa das Nações Unidas para o Desenvolvimento; Instituto de Pesquisa Econômica Aplicada. Desenvolvimento humano nas macrorregiões brasileiras [Internet]. Brasília, DF; 2016.

8. Cunha MPL, Marques RC, Dórea JG. Child nutritional status in the changing socioeconomic region of the northern Amazon, Brazil. Int J Environ Res Public Health. 2018; 15: 15.

9. Ramos DB, Burlandy L, Dias PC, Henriques P, Castro LM, Teixeira MR, et al. Propostas governamentais brasileiras de ações de prevenção e controle do sobrepeso e obesidade sob perspectiva municipal. Cad Saúde Pública. 2020; 36: e00116519.

10. Souza DO, Santos AR, Guedes MN. Urbanization effects on the microclimate of Manaus: A modeling study. Atmos Res. 2016; 167: 237-248.

11. Chirita-Emandi A, Barbu CG, Cinteza EE, Chesaru BI, Gafencu M, Mocanu V, et al. Overweight and Underweight Prevalence Trends in Children from Romania - Pooled Analysis of Cross-Sectional Studies between 2006 and 2015. Obes Facts. 2016; 9: 206-220.

12. Instituto Brasileiro de Geografia e Estatística. Cidades- Panorama Geral. 2019.

13. Onis MD, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ. 2007; 85: 812-819.

14. World Health Organization. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. World Health Organization; 2006.

15. Vigilância alimentar e nutricional - Sisvan: orientações básicas para a coleta, processamento, análise de dados e informação em serviços de saúde. Brasília: Ministério da Saúde; 2004.

16. Chen J, Chen W, Zeng G, Li G. Secular Trends in Growth and Nutritional Outcomes of Children under Five Years Old in Xiamen, China. Int J Environ Res Public Health. 2016; 13: 1104.

17. Fenta HM, Tesfaw LM, Derebe MA. Trends and Determinants of Underweight among Under-Five Children in Ethiopia: Data from EDHS. Int J Pediatr. 2020; 1: 3291654.

18. Flores LS, Gaya AR, Petersen RD, Gaya A. Trends of underweight, overweight, and obesity in Brazilian children and adolescents. J Pediatr. 2013; 89: 456-561.

19. Ferrari GL, Bracco MM, Matsudo VK, Fisberg M. Changes in adiposity levels in schoolchildren according to nutritional status: analysis over a 30-year period. Rev Bras Cineantropom Desempenho Hum. 2013; 15: 405-416.

20. Bezerra T, Olinda R, Pedraza D. Insegurança alimentar no Brasil segundo diferentes cenários sociodemográficos. Ciênc Saúde Colet. 2017; 22: 637-651.

21. Naser IA, Jalil R, Muda WM, Nik WS, Shariff ZM, Abdullah MR. Association between household food insecurity and nutritional outcomes among children in Northeastern of Peninsular Malaysia. Nutr Res Pract. 2014; 8: 304-311.

22. Betebo B, Ejajo T, Alemseged F, Massa D. Household Food Insecurity and Its Association with Nutritional Status of Children 6- 59 Months of Age in East Badawacho District, South Ethiopia. J Environ Public Health. 2017; 6373595.

23. Instituto Trata Brasil: Ranking do saneamento. 2020.

24. Rah JH, Cronin AA, Badgaiyan B, Aguayo VM, Coates S, Ahmed S. Household sanitation and personal hygiene practices are associated with child stunting in rural India: a cross-sectional analysis of surveys. BMJ Open. 2015; 5: e005180.

25. Shei A, Costa F, Reis MG, Ko AI. The impact of Brazil's Bolsa Familia conditional cash transfer program on children's health care utilization and health outcomes. BMC Int Health Hum Rights. 2014; 14: 10.

26. Pedraza DF, Melo NL, Silva FA, Araujo EM. Evaluation of the National School Food Program: review of the literature. Ciênc Saúde Colet. 2018; 23: 1551-1560.

27. Cardozo DR, Rossato SL, Oliveira MR, Costa VM, Almeida LM. Predictive power of indicators to the perception of food and nutritional insecurity in the Bolsa Família Program. Gest Prod. 2020; 27: e5168.

28. Zong XN, Li H, Zhang YQ, Wu HH. Child nutrition to new stage in China: Evidence from a series of national surveys, 1985–2015. BMC Public Health. 2019; 19: 402.

29. Wang H, Xue H, Du S, Zhang J, Wang Y, Zhang B. Time trends and factors in body mass index and obesity among children in China: 1997-2011. Int J Obes. 2017; 41: 964-970.

30. Fu LG, Sun LL, Wu SW, De Yang Y, Li XH, Wang ZH, Lu WU, et al. The Influence of Secular Trends in Body Height and Weight on the Prevalence of Overweight and Obesity among Chinese Children and Adolescents. Biomed Environ Sci. 2016; 12: 849-857.

31. Saint-Maurice PF, Welk GJ, Bai Y. The healthy fitness zone continuum score as a measure of change in body mass index of school-aged

children and adolescents, Georgia, 2012–2014. Public Health Rep. 2017; 132: 57S–64S.

32. Olds T, Schranz N, Maher C. Secular trends in the prevalence of childhood overweight and obesity across Australian states: a meta-analysis. J Sci Med Sport. 2017; 20: 480-488.

33. Conde WL, Monteiro CA. Nutrition transition and double burden of undernutrition and excess of weight in Brazil. Am J Clin Nutr. 2014; 100: 1617S-1622S.

34. Pereira LJ, Hinnig PD, Di Pietro PF, Assis MA, Vieira FG. Trends in food consumption of schoolchildren from 2nd to 5th grade: a panel data analysis. Rev Nutr. 2020; 33: e190164.

35. Carmo AS, Almeida LM, Oliveira DR, Santos LC. Influence of the Bolsa Família program on nutritional status and food frequency of schoolchildren. J Pediatr. 2016; 92: 381-387.

36. Bem Lignani J, Sichieri R, Burlandy L, Salles-Costa R. Changes in food consumption among the Programa Bolsa Família participant families in Brazil. Public Health Nutr. 2011; 14: 785-792.

37. Martins AP, Levy RB, Claro RM, Moubarac JC, Monteiro CA. Increased contribution of ultra-processed food products in the Brazilian diet (1987-2009). Rev Saude Publica. 2013; 47: 656-665.

38. Cotta RMM, Machado JC. Programa Bolsa Família e segurança alimentar e nutricional no Brasil: revisão crítica da literatura. Rev Panam Salud Pública. 2013; 33: 54-60.

39. Louzada ML, Martins AP, Canella DS, Baraldi LG, Levy RB, Claro RM, et al. Ultra-processed foods and the nutritional dietary profile in Brazil. Rev Saude Publica. 2015; 49: 1-11.

40. Claro RM, Maia EG, Costa BV, Diniz DP. Food prices in Brazil: prefer cooking to ultra-processed foods. Cad Saude Publica. 2016; 32: e00104715.

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