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Child undernutrition in one of the cities with greater nutritional risk in Brazil: population-based study in the Western Brazilian Amazon

Desnutrição infantil em um dos municípios de maior risco nutricional do Brasil: estudo de base populacional na Amazônia Ocidental Brasileira

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ABSTRACT: ***Objective:*** To estimate the prevalence of child undernutrition and associated factors in a municipality with high nutritional risk in Brazil. ***Methods:*** This cross-sectional, population-based study was conducted with a sample of 478 children aged under 5 years in the city of Jordão, Acre, Brazil. The following indicators were calculated: weight for age (W/A), height for age (H/A), and weight for height (W/H), using the growth curves of the WHO as reference, which adopts a cutoff of -2 z scores for identification of malnourished children. Adjusted prevalence ratios (PRs) were obtained using multiple Poisson regression models with robust error estimate ($p < 0.05$). ***Results:*** A high prevalence of stunting (35.8%) was observed. Children with indigenous ancestry living in rural areas showed the highest prevalence of malnutrition (59.4%). After controlling for age, gender, and indigenous ancestry, the factors associated with stunting risk were: living in rural area (PR = 1.6; 95%CI 1.2 – 2.1); lower tertile of household wealth index (PR = 1.6; 95%CI 1.1 – 2.3); living in houses made of walking palm (PR = 1.6; 95%CI 1.1 – 2.4); maternal height less than or equal to 146.4 cm (PR = 3.1; 95%CI 1.9 – 5.0); and history of introduction of cow's milk before 30 days of age (PR = 1.4; 95%CI 1.0 – 1.8). Children with updated vaccination cards were inversely associated with stunting risk (PR = 0.7; 95%CI 0.5 – 0.9). ***Conclusion:*** Child undernutrition remains a serious public health problem in the Amazon, indicating additional difficulties in facing the problem in this region of the country.

Keywords: Malnutrition. Rural population. Nutritional status. Child health. Nutritional epidemiology. Minority health.

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RESUMO: ***Objetivo:*** Estimar a prevalência de desnutrição infantil e fatores associados em um município de elevado risco nutricional do Brasil. ***Métodos:*** Estudo transversal de base populacional com amostra de 478 crianças menores de 5 anos do município de Jordão, Acre. Foram calculados os indicadores peso para idade (P/I), altura para idade (A/I) e peso para altura (P/A) utilizando como referências as curvas de crescimento da Organização Mundial da Saúde de 2006, que adota ponto de corte -2 escores z para identificação dos desnutridos. Razões de prevalência (RP) ajustadas foram obtidas por modelos múltiplos de regressão de Poisson com estimativa de erro robusta ($p < 0,05$). ***Resultados:*** Observou-se elevada prevalência de déficit de A/I (35,8%). Crianças com ascendência indígena residentes na área rural do município apresentaram as maiores prevalências de desnutrição (59,4%). Após ajuste para sexo, idade e ascendência indígena, os fatores positivamente associados ao déficit de crescimento foram: residir na área rural (RP = 1,6; IC95% 1,2 – 2,1); menor terço do índice de riqueza domiciliar (RP = 1,6; IC95% 1,1 – 2,3); morar em casa de paxiúba (RP = 1,6; IC95% 1,1 – 2,4); altura materna inferior ou igual a 146,4 cm (RP = 3,1; IC95% 1,9 – 5,0) e introdução de leite de vaca antes de 30 dias de idade (RP = 1,4; IC95% 1,0 – 1,8). Apresentar cartão de vacina em dia foi inversamente associado ao déficit de crescimento (RP = 0,7; IC95% 0,5 – 0,9). ***Conclusão:*** A desnutrição infantil permanece um grave problema de saúde pública no interior da Amazônia, indicando dificuldades adicionais para o enfrentamento do problema nessa região do país.

Palavras-chave: Desnutrição. População rural. Estado nutricional. Saúde da criança. Epidemiologia nutricional. Saúde de minorias.

INTRODUCTION

Undernutrition in children under 5 years of age remains a serious public health problem in low- and middle-income countries owing to its high magnitude and impact on infant mortality[1], with prevalence rates ranging from 43 to 59%[2]. It directly affects cognitive development[3], the risk of infection[4], the development of chronic diseases[5,6], and even the country's economic growth[5], besides being considered an underlying factor in up to 45% of deaths in children under 1 year of age[7]. It has a complex causative factor and is linked to socioeconomic, environmental, and maternal conditions, to infant feeding practices, morbidities, and access to health services[2,5,8,9].

Reducing undernutrition constitutes a priority on the international political agenda and is part of the eight Millennium Development Goals (MDGs), and its importance was ratified by the Rome Declaration on Nutrition in 2014[10]. In Brazil, although the indicators have pointed to improvements in the children's nutritional profile, with values for the deficit of height for age in children under 5 years having declined from 37 to 7% (1975 – 2007), allowing for the early achievement of the first goal of the millennium[11]. Child undernutrition is still a problem in the North. Its prevalence (14.7%) is equivalent to twice the national average[12], showing that some interregional and social inequalities still remain, emphasizing the diversity of the country and the persistence of segments with high prevalence of undernutrition[13].

In the North, there is the hypothesis that other important variables or the maintenance of determining factors already described[2,8,11,13] may be contributing to this region having

not been able to follow the downward trend observed for the Northeast. Among these factors, a few stand out: the difficulties of traveling within that territory, the persistence of unfavorable socioeconomic indicators, and the fact that this area concentrates the largest share of the national indigenous population (48.6%)[14], which has been growing sharply[15]. Moreover, in the Amazonian context, aspects such as the demographic and spatial dynamics that affect the movement of people and goods, the lack of transport infrastructure, and the high proportion of individuals with low material and educational resources impact the development of this region[16].

In this scenario, the peculiar condition of municipalities that are located far from large urban centers and have difficulties in communication are noteworthy factors, as is the case of Jordão, one of the least developed municipalities in the country[17]. This locality was classified in 2006 as the city with the highest estimated risk of undernutrition in Brazil[18]. This context prompted the conduction of this study, whose objective was to directly investigate the prevalence and factors associated with undernutrition in children under 5 years in this city in the interior of the Western Brazilian Amazon.

METHODS

This is a cross-sectional, population-based study conducted with children aged 0–59 months in the municipality of Jordan, Acre State. This district has predominantly rural population that cannot be accessed by land (4,634 inhabitants in 2005, with 30.0% of indigenous Kaxinawás). In 2000, it was ranked as the Brazilian municipality with the second lowest Municipal Human Development Index (MHDI = 0.475), remaining among the seven municipalities with the lowest index in the 2010 ranking, with MHDI = 0.469[19]. It is located 640 km away, in a straight line, from Rio Branco, Acre State capital, and it borders with Peru. It covers an area of 5,429 km^2, bathed by Jordão and Tarauacá rivers, with its urban center located at the meeting point of the two rivers.

A total of 478 children living in urban (n = 211) and rural (n = 267) areas of the municipality were evaluated. A census was conducted in the urban area, because, according to projections made with data from the Brazilian Institute of Geography and Statistics (IBGE) for 2005, a total of 196 children were expected. In rural areas, because of the difficult access owing to low water levels of rivers in the region in the data collection period, we used a nonprobability sample proportional to that of the urban area[20]. There were no refusals, and eight children were not found at home on both possible visiting occasions: one on the way up and another on the way down the river. The children were considered of indigenous descent who had at least one parent or grandparent who self-reported as indigenous when inquired about their race at the interview.

Data collection took place in June 2005. A structured questionnaire was applied to parents or guardians of the children during household interviews. Moreover, a wealth index was built for assessment of economic conditions, owing to the high proportion of

families with no formal income, based on the methodology of Filmer and Pritchett[21]. The interviewers were trained to apply the questionnaires. Weight and height were measured in duplicate by trained researchers, following standardized procedures and using calibrated equipment. The average of the two values was used for the anthropometric assessment. The indexes used to assess the nutritional status of children were weight/age (W/A), height/age (H/A), and weight/height (W/H), expressed by the z score criterion, using the 2006 growth curves of the WHO as reference[22], calculated in the Antro software[23]. Children with W/A, H/A, W/H at or below -2 z score, compared with the standard curve, were considered undernourished. Stunting was defined as H/A <-2 z score. For the severe identification of stunting (severe H/A deficit), the cutoff point of -3 z score of the H/A indicator was used. Children with values higher or equal to +2 Z score of the indicator body mass index for age (BMI/A) were considered overweight. Mothers of the children identified with undernutrition were referred to the local health service.

The questionnaires were double entered using the software Epi Info 6 with subsequent validation. The hierarchical selection of variables to compose multiple models was performed through Pearson's χ^2-test, with a cutoff of $p < 0.20$. Adjusted prevalence ratios (PRs) and 95% confidence intervals (CIs) for stunting, adjusted by gender, age, and indigenous descent, were obtained by multiple models of Poisson regression with robust variance, according to a previously elaborated determination conceptual model, adapted from Olinto et al.[8]. Hierarchical data analysis was performed. The variables of each block were introduced simultaneously. Within each block, the variables that did not present statistical significance ($p < 0.05$) in the Wald test were removed one by one, respecting the descending order of p values. Variables removed that caused changes of more than 10.0% in the magnitude of the PRs of the variables in the block were returned to the model[24]. Variables that, after adjusting for the factors of the same hierarchical level or above, presented $p < 0.05$ in the final model were considered factors associated with stunting.

The variables tested were:

- 1st block: place of residence (urban and rural areas);
- 2nd block: socioeconomic and environmental conditions (third of the wealth index), maternal education (illiterate, one to four, and five or more years of study), type of household (processed wood/masonry and walking palm or shanty), number of rooms in the household (one, two or three, four or more rooms);
- 3rd block: maternal characteristics and access to health services (mother's height in quartiles), maternal body mass index (underweight, eutrophic, overweight, and obese), number of pregnancies (quartile), up-to-date with the vaccination schedule (yes or no), prenatal consultation (did not undergo, three or less, and four or more visits), and follow-up by the health service (yes and no);
- 4th block: breastfeeding and complementary diet (time of exclusive breastfeeding/before and after 30 days), and introduction of cow's milk (median-based cutoff point);
- 5th block: morbidities (diarrhea in the 15 days preceding the survey, pneumonia in the 12 months preceding the interview) both were dichotomous: yes and no.

Analyses were performed in the Stata software, version 10.0 (Stata Corp., College Station, United States).

The study was approved by the Research Ethics Committee of the Acre State Hospital Foundation (FUNDHACRE), with research protocol no. 171/2005, in accordance with the requirements of Resolution of the National Health Council (CNS 466/2012) and its complementary resolutions.

RESULTS

This study identified stunting in 35.8% (95%CI 31.5 – 40.3) of the children, with 11.5% (95%CI 8.9 – 14.8) with severe stunting. The prevalence of the stunting was higher in rural areas, especially among children of indigenous descent. The latter group also showed the highest prevalence of severe stunting (20.3%; 95%CI 13.7 – 28.3). The overall deficit of W/A was 7.3% (95%CI 5.2 – 10.1), with higher incidence also among those of indigenous descent residing in rural areas. The deficit of W/H was 0.8% (95%CI 0.3 – 2.3). The prevalence of overweight among children in Jordão was low (2.1%; 95%CI 1.1 – 3.9; n = 10). Table 1 shows the anthropometric indicators according to place of residence and indigenous descent.

The average age of children in the study was 29.1 months with standard deviation (SD) of 16.9 months (data not shown in table). The prevalence of stunting rose with increasing age, being higher among children aged 2 years or more and was also distributed between the genders. Children living in the rural area of Jordão showed twice the prevalence of stunting compared with residents in the urban area. Regarding socioeconomic variables, children from families belonging to the lower third of the wealth index showed the highest level

Table 1. Prevalence of stunting and deficit of weight for age according to indigenous descent and place of residence in children (< 5 years) living in the city of Jordão, Acre, 2005.

	Anthropometric indicators (Z-score)					
	H/A < -2		H/A < -3		W/A < -2	
	n (%)	95%CI	n (%)	95%CI	n (%)	95%CI
Overall prevalence (n = 478)	171 (35.8)	31.5 – 40.3	55 (11.5)	8.9 – 14.8	35 (7.3)	5.2 – 10.1
Prevalence according to indigenous descent and place of residence*						
No indigenous descent living in the urban area (n = 140)	27 (19.3)	13.1 – 26.8	6 (4.3)	1.6 – 9.1	5 (3.6)	1.2 – 8.1
Indigenous descent living in the urban area (n = 65)	22 (33.8)	22.6 – 46.6	8 (12.3)	5.5 – 22.8	6 (9.2)	3.5 – 19.0
No indigenous descent living in the rural area (n = 127)	37 (29.1)	21.4 – 37.9	12 (9.4)	3.5 – 15.9	10 (7.9)	3.8 – 14.0
Indigenous descent living in the rural area (n = 128)	76 (59.4)	50.3 – 68.0	26 (20.3)	13.7 – 28.3	13 (10.2)	5.5 – 16.7

95%CI: confidence interval of 95%; H/A: height for age (Stunting); W/A: weight for age; *no information of indigenous descent (at least one of the parents or grandparents is indigenous) n = 18.

of stunting. We observed a large number of mothers who were illiterate or who studied up to the fourth grade. The average height of children's mothers was 150.9 cm (SD = 6.5 cm; data not shown in table). Children whose mothers showed lower height showed a higher proportion of stunting (Table 2).

Regarding the coverage of actions of health services, there was a significant share of mothers who did not have the gestation of their children aged under 5 years accompanied by a health professional, and a high proportion of children who were not up-to-date with

Table 2. Prevalence of stunting according to biological, sociodemographic, and maternal variables in children (< 5 years) living in the municipality of Jordan, Acre, 2005.

	H/A deficit n (%)	PR (crude)	95%CI	Total n (%)
Gender				
Female	80 (32.9)	1		243 (50.8)
Male	91 (38.7)	1.2	0.9 – 1.5	235 (49.2)
Age group (months)*				
<12	20 (22.0)	1		91 (19.0)
12 – 23.9	39 (34.8)	1.6	0.9 – 2.5	112 (23.4)
≥24	112 (40.7)	1.8	1.2 – 2.8	99 (20.7)
Indigenous descent*#				
No information	9 (5.3)			18 (3.8)
No	64 (24.0)	1		267 (58.0)
Yes	98 (50.8)	2.1	1.6 – 2.7	193 (42.0)
Place of residence*				
Urban	50 (23.7)	1		211 (44.1)
Rural	121 (45.3)	2.0	1.4 – 2.5	267 (55.9)
Wealth index*				
3rd tertile	28 (21.4)	1		131 (27.4)
2nd tertile	58 (37.9)	1.8	1.2 – 2.6	153 (32.0)
1st tertile	85 (43.8)	2.0	1.4 – 2.9	194 (40.6)
Maternal education*				
No information	6 (3.5)			12 (2.5)
5 years or more	40 (23.7)	1		169 (36.3)
1 to 4 years	88 (41.0)	1.7	1.3 – 2.4	215 (46.1)
Illiterate	37 (45.1)	1.9	1.3 – 2.7	82 (17.6)
Mother's height (quartile)*				
No information	10 (5.8)			33 (6.9)
≥155.5	17 (15.2)	1		112 (25.2)
151.0 – 155.4	29 (25.9)	1.7	1.0 – 2.9	112 (25.2)
146.5 – 150.9	42 (37.5)	2.5	1.5 – 4.1	112 (25.2)
≥146.4	73 (67.0)	4.4	2.8 – 6.9	109 (24.4)
Total	171 (35.8)			478 (100.0)

H/A: height for age (Stunting); PR: prevalence ratio; 95%CI: confidence interval of 95%; *χ^2-test ($p < 0.05$); #indigenous descent (at least one of the parents or grandparents is indigenous).

their vaccination schedule at the day of the interview. The prevalence of stunting was higher among children whose mothers did not undergo prenatal care and among those who were not up-to-date with the vaccination schedule (Table 3). The children of Jordão presented a prevalence of diarrhea of 45%. Among those who had indigenous ancestry, this percentage was 53% and in those with no indigenous ancestry was 40% (data not shown in table).

Infant feeding practices also showed peculiar and troubling characteristics. The median for exclusive breastfeeding was 15 days (mean = 45.5 days; SD = 71.7 days) and the median of introduction of cow's milk was 30 days (mean = 68.5 days; SD = 100.4 days). Children who were exclusively breastfed for a minimum of 30 days or more showed a 40.0% lower prevalence of stunting than those who were weaned before that period. Children taking cow's milk before this same period also showed a higher proportion of stunting (Table 3).

Table 4 presents the factors associated with child undernutrition in this population. After adjustment for gender, age, and indigenous descent, the variable place of

Table 3. Prevalence of stunting according to health care, breastfeeding, and morbidity in children (< 5 years) living in the city of Jordão, Acre, 2005.

	H/A deficit n (%)	PR (crude)	95%CI	Total n (%)
Prenatal consultation*				
No information	18 (10.5)			62 (13.0)
≥ 4 consultations	9 (16.7)	1		54 (13.0)
≤ 3 consultations	39 (37.5)	2.2	1.2 – 4.3	104 (25.0)
Did not undergo prenatal consultations	105 (40.7)	2.4	1.3 – 4.5	258 (62.0)
Up-to-date with the vaccination schedule*				
Yes	21 (32.3)	1		65 (13.6)
No	109 (40.1)	1.2	0.6 – 1.4	272 (56.9)
Vaccination card not seen	41 (29.1)	0.9	0.7 – 1.3	141 (29.5)
Time of exclusive breastfeeding*				
No information	19 (11.1)			42 (8.8)
More than 30 days	33 (25.0)	1		132 (30.3)
30 days or less	122 (40.1)	1.6	1.2 – 2.2	304 (69.7)
Introduction of cow's milk*				
No information	19 (11.1)			43 (9.0)
After 30 days	48 (27.1)	1		258 (59.3)
Before 30 days	104 (40.3)	1.2	1.1 – 1.4	177 (40.7)
Pneumonia in the last 12 months*				
No information	13 (7.6)			28 (5.9)
No	123 (32.8)	1		75 (16.7)
Yes	35 (46.7)	1.4	1.1 – 1.9	375 (83.3)
Total	171 (35.8)			478 (100)

H/A: height for age (stunting); PR: prevalence ratio; 95%CI: confidence interval of 95%; *χ^2-test ($p < 0.05$).

residence, inserted in the first block, remained associated with the stunting. Among the variables inserted in the second block, only the wealth index and the type of household remained associated with low stunting. From the third block, the following variables remained associated: maternal height and being up-to-date with the vaccination

Table 4. Factors associated with stunting in children (< 5 years) living in the city of Jordan, Acre, 2005.

	H/A deficit		
	Adjusted PR*	95%CI	p-value
Gender			
Female	1		
Male	1.1	0.9 – 1.4	0.316
Age group (months)			
< 24	1		
≥ 24	1.4	1.1 – 1.8	0.016
Indigenous descent#			
No	1		
Yes	2.1	1.6 – 2.7	< 0.001
Place of residence			
Urban	1		
Rural	1.6	1.2 – 2.1	0.001
Wealth index			
3rd tertile	1		
2nd tertile	1.5	0.9 – 2.2	0.058
1st tertile	1.6	1.1 – 2.4	0.025
Type of household			
Processes wood/masonry	1		
Walking palm or shanty	1.6	1.1 – 2.4	0.017
Mother's height (quartile)			
≥ 155.5	1		
151.0 – 155.4	1.4	0.9 – 2.4	0.169
146.5 – 150.9	2.0	1.2 – 3.4	0.006
≤ 146.4	3.1	1.9 – 5.0	< 0.001
Up-to-date with the vaccination schedule			
No	1		
Yes	0.7	0.5 – 0.9	0.023
Vaccination card not seen	0.7	0.5 – 1.0	0.072
Introduction of cow's milk			
After 30 days	1		
Before 30 days	1.4	1.0 – 1.8	0.027

H/A: height for age (stunting); PR: prevalence ratio; 95%CI: confidence interval of 95%; *adjusted for other with of the same or higher level following the hierarchical conceptual model; #indigenous descent (at least one of the parents or grandparents is indigenous).

schedule. From the fourth block, only the introduction of cow's milk before 30 days of age remained associated. No variable from the child morbidity block remained in the final multiple model.

DISCUSSION

A high prevalence of stunting was observed among children living in the city of Jordão[2,25], classified as severe by the WHO[26]. This finding may have resulted from a long process of food deprivation or severe or recurrent episodes of morbidities, which may have affected the growth of these children during the first years of life[27]. Overweight was little prevalent in this region (2.1%), concentrated among children with indigenous descent living in the urban area of the municipality.

The prevalence of stunting observed in this study (35.8%) was close to that found for the group of developing countries (32.0%) and the countries of subSaharan Africa (38.0%), an extremely poor and arid region, with a high prevalence of HIV[28]. Jordão is very distant from the undernutrition prevalences for Latin America and the Caribbean (16.0%)[28], the nutritional scenario in Brazil (7.0%), and of the North region (14.8%)[12], as the stumping rates in this municipality were close to those registered in the country in the 1970s (32.9%)[29], suggesting a delay of over 30 years compared to the national reality. These data show that the preschool population of Jodão live with growth limiting factors, partially overcome by most Latin American and Caribbean countries for all the municipalities in Brazil and even for other vulnerable segments of the population of Brazil such as children living in quilombola communities, from the state of Alagoas (11.5%)[30], from the Northeastern semiarid region (Paraíba) in the urban (12.9%) and rural areas (16.8%)[31], and even in other parts of the interior of the state of Acre (< 10.8%)[9].

Moreover, there are still great differences in the prevalence of stunting between various population groups within the municipality. Children with indigenous descent in Jordão showed a prevalence of stunting 2.1 times than that seen among children without indigenous descent. In the first group, the prevalence of stunting (50.8%) was higher than in those observed among some indigenous populations living in villages (34.1%) of Mato Grosso do Sul (Kaiowá and Guaraní)[32] and lower than in the Yanomami of Roraima (80.5%)[13], revealing that even among indigenous populations, the North region presents a high prevalence of undernutrition.

The prevalence of stunting found in Jordão for children of indigenous descent residing in rural areas (59.4%) was higher than that estimated for Brazil's indigenous population (25.7%) and for the North region (40.8%), according to the first National Survey of Indigenous Health[33]. This information points to heterogeneity of nutritional scenarios present in the city, revealing the complexity of this phenomenon, even in a seemingly very homogeneous municipality, with children of indigenous descent presenting prevalence rates similar to those seen for indigenous populations living in villages.

Owing to the significant number of children with indigenous descent, differences in genetic potential cannot be completely ruled out for the people of Jordão. It is known that children in their first years grow in much the same way around the world[34], which indicates that differences in potential should be evaluated with caution and genetic and evolutionary possibilities of adaptation of the body to the Amazon environment[35]. However, socioeconomic factors linked to the difficulty of access to food, eating habits, hygiene, and sanitary conditions are likely to have a major influence in determining a higher prevalence in this population than just genetic differences[36], especially among indigenous peoples, being attributed mainly to the fact that the process of incorporation of traditional people occurs in the more disadvantaged social classes[37]. The few epidemiological information available for this location points to a scenario of high morbidity and mortality from infectious and parasitic diseases, especially diarrhea and pneumonia, which reinforces the adverse conditions in which this population lives.

Although it is a municipality with predominantly rural characteristics, there was a marked difference in the prevalence of stunting when comparing children living in urban and rural areas of the municipality of Jordão. For Brazil, data from the 2006 National Survey on Demography and Health (PNDS)[12] suggest a decrease in the differences between the prevalence rates of stunting when comparing these two locations, with the rural area presenting a prevalence only 1% larger, revealing an improvement in the economic, health, sanitary, and dietary aspects in the rural setting, which favored the infant growth. It has also been observed that, in recent decades, there is an intense migration flow from the countryside to the city, which certainly impacted this positive result achieved for the country in its rural context[14,38]. However, this difference is approximately two times higher in Jordão, indicating that, in this locality, the urban/rural differences are still significant. This may reflect the importance that the access to available goods and services[39], even in urban areas with limited development, has in determining the child's physique. Living in rural inland districts of the Amazon such as Jordão has a number of other implications. For example, the performance of daily activities is hampered by various physical barriers banks, channels, flooded areas and lots of mud in the rainy season), and the need to face long journeys to travel to the city, often under a very bright and hot sun, and factors that could cause further overload to the child's organism.

Among the maternal variables analyzed and those related to the access to health services, the height of the mother and being up-to-date with the vaccination schedule showed statistically significant association with stunting. Maternal height was also important in identifying differences in the prevalence of growth deficits in Jordão, with this finding being corroborated by other authors[2,5,6,11]. This relationship may be associated with limitations of the fetal growth in the womb[40]. The maintenance of the vaccination schedule shows the importance of access to primary health care and assists in the prevention of infectious episodes, another important factor for the development of a stunting[41]. The role of infectious

diseases on height deficits has been well documented and attributed, among other factors, to a shift in energy expenditure to combat the infectious process to the detriment of growth[42].

The introduction of cow's milk was premature and inadequate, being statistically associated with stunting. These findings may relate to the fact that cow's milk has different characteristics than those displayed by breastmilk, such as much higher protein concentration and acidity[43], which causes an irritation of the intestinal wall, increased risk of developing diarrhea, and causing microhemorrhages, which further aggravate this situation[44].

The results presented should be considered in light of the limitations of the study. Owing to logistical difficulties, we could not use a random sample in the rural area of the municipality, which may have caused an underestimation of the prevalence of stunting for not including children living in remote areas of the urban zone of the municipality, such as those residing of the headwaters of rivers. This fact was minimized in the identification of associated factors with the adjustment through the variable place of residence.

We could not obtain information about birth weight because the majority of births occurred at home. Evaluations of intestinal parasites and food intake in this population have not been carried out owing to budgetary constraints and logistical difficulties. The collection of information in situ in areas of difficult access, as in the case of Jordão, especially in its rural area, is a unique initiative, which will improve the understanding of undernutrition inside the Amazon and improving the way that health services cope with this situation. This region of Brazil has a large number of municipalities with similar characteristics, and owing to its demand for budgetary increases and challenging logistics, they are generally excluded from investigations and even actions by health managers.

CONCLUSION

The study identified a high prevalence of stunting in children Jordão, especially among those living in rural areas and of indigenous descent. These findings underscore the influence that living in places of difficult access, with significant social and health inequalities, has on nutritional status, a reality that is common in the Amazon inland regions. Undernutrition is expressed heterogeneously even in a seemingly homogeneous scene, indicating complex interrelationships of the factors related to stunting in this municipality. The study shows the influence that factors such as isolation and the large numbers of vulnerable populations can have in the maintenance of high prevalence rates of stunting. More comprehensive research is needed in order to elucidate the influence of these complex interrelations in the magnitude of the growth deficit in the different population groups existing in the city, which can contribute to the understanding of the problem in the North region of the country.

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