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Prevalence and associated factors with the double burden of malnutrition among children aged 0 to 36 months in the city of Lavras, Minas Gerais, Brazil

Prevalência e fatores associados à dupla carga da má nutrição em crianças de 0 a 36 meses na cidade de Lavras, Minas Gerais, Brasil

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ABSTRACT

Objective

This study aimed to estimate the prevalence and identify factors associated with anthropometric nutritional disorders in children aged 0 to 36 months.

Methods

A cross-sectional study was conducted with 323 children followed at the ten health units in Lavras/Minas Gerais-Brazil, from January to December 2022. Data collection included the application of a questionnaire and anthropometric measurements (weight and height). Nutritional disorders were grouped and evaluated in sets: failure to thrive (WAZ<-2, WHZ<-2, HAZ<-2 or BAZ<-2) and double burden (WAZ<-2, WHZ<-2, HAZ<-2 or BAZ>2). Descriptive analyses and simple and multiple logistic regression models were performed to identify factors associated with the outcomes, with estimates reported as odds ratios and 95% confidence intervals. Multiple regression models were adjusted for the child's sex and age.

Results

The prevalence of children with at least one nutritional disorder was 22.3%. Stunting (low height for age) was the most prevalent nutritional disorder (10.5%) and wasting (underweight for height) was the least prevalent (4.3%).

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Conclusion
Low birth weight was a risk factor associated with both failure to thrive and the double burden groups. The lack of the Child Health Handbook during routine visits was also associated with the double burden group, and the lack of "salty food" consumption the previous day was also associated with failure to thrive group. In the presence of these risk factors, children should receive careful monitoring to prevent nutritional disorders.

Keywords: Anthropometry. Childhood nutrition disorders. Malnutrition. Overweight.

RESUMO

Objetivo
O objetivo foi estimar a prevalência e identificar fatores associados a distúrbios nutricionais antropométricos em crianças de 0 a 36 meses.

Método
Estudo transversal com todas as 323 crianças acompanhadas em dez unidades de saúde do município de Lavras/MG, de janeiro a dezembro de 2022. A coleta de dados incluiu aplicação de questionário e realização da antropometria (peso e altura). Os distúrbios nutricionais foram agrupados e avaliados em conjuntos: failure to thrive (ZP/I<-2, ZP/E<-2, ZE/I<-2 ou ZIMC/I<-2) e double burden (ZP/I<-2, ZP/E<-2, ZE/I<-2 ou ZIMC/I>2). Foram realizadas análises descritivas e regressões logísticas simples e múltiplas, com estimativas de odds ratio e respectivos intervalos de confiança de 95%, para identificar os fatores associados aos desfechos estudados. As análises múltiplas foram ajustadas por sexo e idade da criança.

Resultados
A prevalência de crianças com pelo menos um distúrbio nutricional foi de 22.3%. A baixa estatura para a idade foi o distúrbio nutricional mais prevalente (10.5%) e o baixo peso para a estatura foi o menos prevalente (4.3%).

Conclusão
O baixo peso ao nascer foi fator de risco associado tanto ao conjunto failure to thrive quanto ao double burden. A ausência da Caderneta de Saúde da Criança na consulta de rotina também se associou ao conjunto double burden e a ausência do consumo de "comida de sal" no dia anterior também se associou ao conjunto failure to thrive. Na presença desses fatores de risco, as crianças devem receber acompanhamento cuidadoso para prevenir distúrbios nutricionais.

Palavras-chave: *Antropometria. Transtornos da nutrição infantil. Desnutrição. Sobrepeso.*

INTRODUCTION

Nutrition plays a fundamental role in child growth and development, directly affecting short-, medium-, and long-term health. However, nutritional disorders, including both undernutrition and obesity, affect millions of children and represent one of the greatest public health challenges of the 21st century [1]. Worldwide, 6.8% of children under 5 years of age are wasted, and 22% are stunted. Most of these children live in Asian and African countries. In Brazil, the prevalence of wasting among children under 5 years of age was 2.9%, while the prevalence of stunting was 7% [2].

Rates of overweight among children range from 22% to 31%, depending on the area considered, given the substantial socioeconomic and cultural differences across regions. In Brazil, the prevalence of overweight among children under 5 years of age was 10.1% [2]. The global prevalence of these nutritional disorders is a concern for the World Health Organization (WHO), which aims to reduce the prevalence of wasting from 8% to 3%, reduce stunting by 50%, and lower the prevalence of overweight to below 3% [1–3].

Undernutrition encompasses both insufficient and excessive nutrient intake, as well as impaired body nutrient utilization [1,4]. Efforts have traditionally focused on combating undernutrition in low- and middle-income countries. However, the rapid nutrition transition, driven by urbanization, globalization, and technological development, has increased the production and availability

of industrially processed foods with low nutritional value, while reducing the consumption of healthy diets.

Additionally, excessive screen exposure and spending prolonged periods indoors provide few opportunities for physical activity. This process has resulted in the coexistence of both anthropometric abnormalities – undernutrition and overweight – highlighting the double burden of malnutrition. Furthermore, inadequate dietary patterns associated with the nutrition transition have led to micronutrient deficiencies regardless of weight gain and, in the medium and long term, to an increased risk of developing noncommunicable chronic diseases [1,3,5].

Recent studies have shown that anthropometric nutritional disorders in early childhood are associated with multiple factors operating at different determination levels, including socioeconomic and maternal characteristics, birth conditions, breastfeeding and complementary feeding practices, and comorbidities. Low birth weight, prematurity, and food insecurity have been associated primarily with undernutrition, whereas inappropriate feeding practices and maternal factors are also related to overweight. Moreover, the coexistence of different forms of nutritional disorders within the same population reinforces the need to understand their determinants jointly, particularly during the first years of life [2,6,7].

In this regard, it is important to investigate the factors associated with nutritional disorders, both individually and jointly, so that health professionals can identify vulnerable children. This knowledge can inform the development and implementation of strategies aimed at preventing these disorders.

The first three years of life represent the period of greatest risk for the development of nutritional disorders and their clinical consequences. During this period, children experience rapid physical growth, intensive acquisition of developmental skills, rapid proliferation of central nervous system cells, and metabolic programming that influences the life course. Disorders related to both nutritional deficiency and excess are multifactorial, and some of their determinants may overlap because they encompass not only proximal factors but also distal factors related to socioeconomic and cultural characteristics [2,8–11].

Although previous studies have identified several factors associated with nutritional disorders in early childhood [2,6,7], evidence evaluating, within the same population, the factors associated with different groups of anthropometric nutritional disorders remains limited, particularly among children in the first years of life. Therefore, this study aimed to estimate the prevalence of anthropometric nutritional disorders and identify associated factors among children aged 0 to 36 months followed at ten health care units in the municipality of Lavras, Minas Gerais, Brazil.

METHOD

Study design

This cross-sectional study is nested in the thematic project "Child Health Handbook: Implications for Food and Nutrition Security in Early Childhood", conducted by the Department of Nutrition at the Federal University of Lavras (CAAE 43815221.2.0000.5148).

Study location

The study was conducted in the municipality of Lavras, in the state of Minas Gerais, specifically at all ten health care units where pediatricians and professors from the Federal University of Lavras

participated and that implemented the Family Health Strategy program, which included follow-up only for children without chronic diseases. Data were collected during routine well-child pediatric visits and vaccination campaigns.

Population and sample

All children aged 0 to 36 months followed at the ten selected health care units between January and December 2022 (n=329) were invited to participate in the study. Consecutive sampling was used, including all eligible children seen at the health care units during the study period (Figure 1).

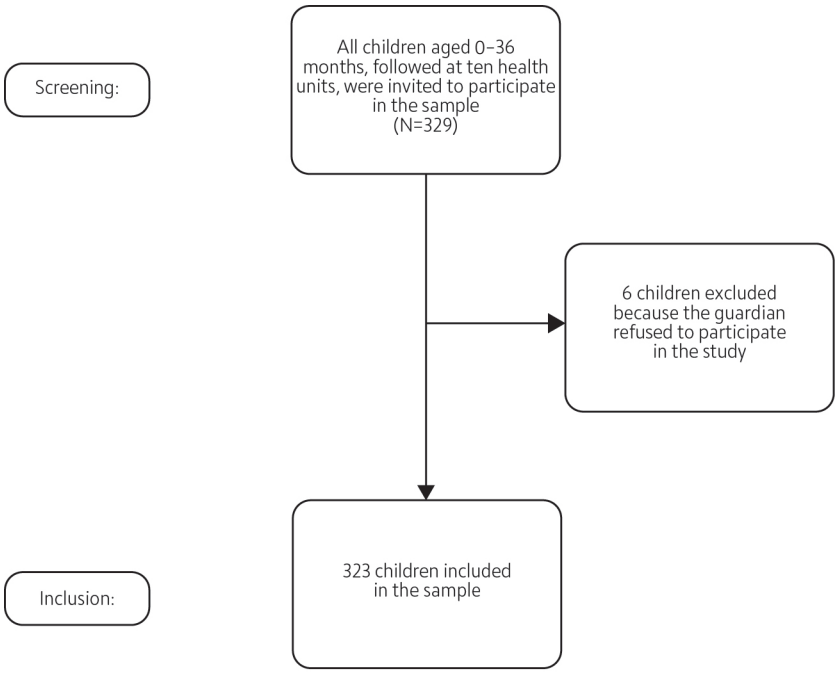


Figure 1 – Flowchart of the recruitment and selection process for the children studied, who were served by the Family Health Strategy program in Lavras, MG (2022).

Children whose parents or legal guardians did not consent to their participation in the study (n=6) were excluded. A total of 323 children were included, corresponding to a sample loss of 1.8%. The inclusion of 323 participants, with a 1:1 ratio of exposed to unexposed individuals, during the recruitment period was sufficient to detect a risk ratio of approximately 1.53 (alpha = 0.05, beta = 0.20), assuming an estimated prevalence of the categorical outcome of 30% in the unexposed group.

Data collection and description of study variables

Data collection included administering a questionnaire on the children's clinical, epidemiological, and dietary intake characteristics. In addition, body measurements (anthropometry) were obtained. The children's mothers or legal guardians completed the questionnaire during pediatric visits.

The semistructured questionnaire was developed by the thematic project team to assess family organization, household location, and socioeconomic status. The independent variables

examined were household income, maternal schooling, housing conditions (housing structure, occupancy status, number of household members and rooms, basic sanitation, essential household appliances, and garbage collection frequency), access to infrastructure and use of health services (receipt of visits from community health workers and use of the public health care network and health services), and maternal age. Maternal health status was also investigated, including information on pregnancy and delivery. For the children, the study assessed diseases, possible complications during delivery, breastfeeding history, and food consumption frequency.

The questionnaire underwent a pretesting phase to assess its format and content. After this stage, adjustments were made, and redundant or excessively lengthy questions were removed. The research team was also trained to ensure standardized questionnaire administration.

The children's and mothers' diets were assessed based on food consumption on the day before the questionnaire was administered, according to the Food and Nutrition Surveillance System food consumption markers. These markers include the consumption of healthy (breast milk, beans, fruits, and vegetables) and unhealthy (porridge and processed meats) foods. Specifically, consumption of the main meals (lunch or dinner) was assessed using the variable "savory food" [12,13].

Gestational age of less than 37 weeks and birth weight below 2,500 g were defined as prematurity and Low Birth Weight (LBW), respectively. Mothers whose partners were present in the family dynamic, regardless of marital status, were considered to be in a Common Law marriage status. The use of the Child Health Handbook (CHH) was also investigated. The CHH is a document provided to children upon hospital discharge after birth and used by families and health professionals during medical visits to monitor growth, development, vaccination status, and other aspects of primary care and health protection [14].

Anthropometric measurements of the children were obtained according to the Food and Nutrition Surveillance System protocol [15,16]. For children older than 2 years, body weight was measured using a portable WISO digital scale (W801), with a capacity of 180 kg and an accuracy of 100 g. Height was measured using a portable vertical Alturexata® stadiometer, graduated in centimeters with an accuracy of 1 mm. For children younger than 2 years, a Caumaq® digital infant scale was used. Length was measured using a rigid infant anthropometric board, graduated from 0 to 100 cm with an accuracy of 1 mm. The instruments were calibrated before being released for field use, and all measurements were taken three times with the child undressed. The final value was calculated as the arithmetic mean of the three measurements.

For the present study, anthropometric indices were classified according to the World Health Organization reference standards [17]. Children with Z-scores above 2 standard deviations from the reference values were considered to have nutritional disorders. Z-scores < −2 for weight-for-age (WAZ), weight-for-height (WHZ), height-for-age (HAZ), and body mass index-for-age (BAZ) were defined, respectively, as low/very low weight-for-age, low/very low weight-for-height, low/very low height-for-age, and low/very low BMI-for-age. Conversely, a BMI-for-age Z-score > 2 was defined as overweight/obesity.

Nutritional disorders were assessed according to their determinants and grouped into two categories. The first, *failure to thrive*, included the following criteria: WAZ < −2, WHZ < −2, HAZ < −2, or BAZ < −2. The second, double burden, included: WAZ < −2, WHZ < −2, HAZ < −2, or BAZ > 2. The terms *failure to thrive* and double burden were retained in English because they correspond to the terminology used in the international scientific literature to characterize different groupings of nutritional disorders.

Data analysis

The researchers assessed the quantitative data for internal consistency before releasing them for data entry and calculation of associations. The data were entered into an EPIINFO 7.2 electronic database using double data entry, followed by verification and validation of the entered information to correct errors.

Univariate and bivariate descriptive statistics were used to examine associations. Data were presented as means with standard deviations and prevalence estimates with 95% confidence intervals (95% CI). Initially, the prevalence of sociodemographic characteristics, anthropometric nutritional disorders, and food consumption variables available in the questionnaire was estimated. Specifically, food consumption markers were analyzed individually as dichotomous categorical variables (consumption or no consumption of the food in the previous 24 hours) and presented as absolute and relative frequencies. Subsequently, univariate analyses using simple logistic regression were performed to identify factors associated with the groups of anthropometric nutritional disorders investigated.

To control for confounding variables in assessing the effects of the independent variables on the outcomes studied, multiple logistic regression was performed to estimate odds ratios (ORs). Only variables with p values <0.20 were selected for inclusion in the multivariate model among all associations tested. Variables were entered using a backward stepwise procedure and removed according to the greatest loss of statistical significance in the associations (p-values >0.05). The criteria for retaining explanatory and control variables in the final multivariate models were associations with the outcomes at $p<0.05$.

Specifically, prematurity showed a statistically significant risk association with the *failure to thrive* group but was not included because it exhibited perfect collinearity with low birth weight. Moreover, child gender and age were included to adjust the estimated effects. Statistical analyses were performed using STATA 14. A maximum significance level of 0.05 (maximum α error of 5%) was adopted to indicate a statistically significant association.

Ethical aspects

In accordance with Resolution No. 196/96 of the Brazilian National Health Council and Resolution No. 466/12 of the Brazilian Ministry of Health, which establish the regulatory guidelines and standards for human research, this project was submitted to the Research Ethics Committee of the Federal University of São Paulo (CAAE: 66082722.0.0000.5505; Opinion No. 5,969,043).

The Informed Consent Form was read to the children's parents or legal guardians. The study objectives and the risks and benefits of participation were explained before consent was provided and the form was signed. Data confidentiality, voluntary participation, and the right to withdraw from the study at any time without providing justification were also guaranteed.

RESULTS

Most (83.9%) of the 323 children included in the study and followed through the Family Health Strategy (ESF) were younger than 2 years. There was a slight predominance of girls (51.4%), and only 11.6% were born before 37 weeks of gestation. Approximately 25% of the mothers had 9 schooling years or less (23.5%), nearly half did not live in their own homes (44.6%), and 48.1%

were unemployed. Furthermore, 21.4% of households had a monthly income equal to or below one minimum wage, and the mean household size was 4.3 people (SD=1.38). Most families (89.5%) reported bringing the CHH to well-child visits. Around 62.7% of the children did not consume human milk, only 40.0% ate fruits, and 35.4% ate savory foods on the previous day. Most mothers consumed beans (86.1%), fruits (57.9%), and vegetables (74.6%). The main sociodemographic and food consumption characteristics of the children and their mothers/families are shown in Table 1.

Table 2 presents the prevalence estimates and their respective 95% confidence intervals (95% CIs) for the *failure to thrive* and *double burden* outcomes according to the categories of the independent variables, which were compared using simple logistic regression.

Table 1 – Sociodemographic and dietary intake characteristics of children and mothers participating in the Family Health Strategy program in Lavras, MG (2022).

1 of 2

Children's characteristics	n	%	(95% CI)
Child's ethnicity			
White	103	31.9	(27.0-37.2)
Non White	220	68.1	(62.8-73.0)
Child's gender			
Male	157	48.6	(43.2-54.1)
Female	166	51.4	(45.9-56.8)
Child's age			
<2 years	271	83.9	(79.5-87.5)
>2 years	52	16.1	(12.5-20.5)
Prematurity			
Yes	37	11.6	(8.5-15.6)
No	282	88.4	(84.4-91.5)
Birth weight			
Yes	40	12.5	(9.3-16.7)
No	279	87.5	(83.3-90.7)
Maternal and family characteristics	n	%	(95% CI)
Maternal schooling			
≤9 years	76	23.5	(19.2-28.5)
>9 years	247	76.5	(71.5-80.8)
Maternal Common Law marriage			
Yes	179	56.8	(51.3-62.2)
No	136	43.2	(37.8-48.7)
Mother employed			
Yes	165	51.9	(46.4-57.4)
No	153	48.1	(42.6-53.6)
Own home			
Yes	179	55.4	(49.9-60.8)
No	144	44.6	(39.2-50.0)
Low household income			
Yes	68	21.4	(17.2-26.3)
No	250	78.6	(73.7-82.8)
Enclosed sewer			
Yes	311	96.6	(93.9-98.1)
No	11	3.4	(1.9-6.0)
Brings the CHH to the visit			
Yes	281	89.5	(85.6-92.4)
No	33	10.5	(7.6-14.4)
Children's food intake over the last 24 hours	n	%	(95% CI)
Breastfeeding			
Yes	101	37.3	(31.7-43.2)
No	170	62.7	(56.8- 68.3)

Table 1 – Sociodemographic and dietary intake characteristics of children and mothers participating in the Family Health Strategy program in Lavras, MG (2022).

2 of 2

Children's characteristics	n	%	(95% CI)
Ate porridge			
Yes	22	8.2	(5.5-12.2)
No	245	91.8	(87.8-94.5)
Savory food			
Yes	225	70.1	(64.8-74.8)
No	96	30.0	(25.1-35.2)
Beans			
Yes	204	87.9	(83.0-91.6)
No	28	12.1	(84.4-17.0)
Fruits			
Yes	192	60.0	(54.5-65.2)
No	128	40.0	(34.7-45.5)
Cold cut			
Yes	19	8.2	(5.3-12.6)
No	212	91.8	(87.4-94.7)
Maternal food intake over the last 24 hours	n	%	(95% CI)
Beans			
Yes	267	86.1	(81.8-89.6)
No	43	13.9	(10.4-18.2)
Fruits			
Yes	187	57.9	(52.4-63.2)
No	136	42.1	(36.8-47.6)
Vegetables			
Yes	241	74.6	(69.5-79.0)
No	82	25.4	(20.9-30.4)
Cold cut			
Yes	86	26.3	(22.0-31.7)
No	237	76.4	(68.3-77.9)

Note: Prematurity: gestational age at birth <37 weeks; Birth weight: birth weight <2500g; Low household income: household income ≤1 minimum wage. CHH: Child Health Handbook.

Table 2 – Prevalence rates and their respective confidence intervals (95% CI) for the outcomes "failure to thrive" and "double burden" among children participating in the Family Health Strategy program in Lavras, MG (2022), according to the categories of the independent variables studied.

1 of 2

Children's characteristics	Failure to thrive		*p*-value*	Double burden %		*p*-value*
	%	(95% CI)		%	(95% CI)	
Child's ethnicity						
White	19.4	(12.8-28.4)	0.435	25.9	(17.4-36.8)	0.989
Non White	15.9	(11.6-21.4)		18.6	(14.2-24.0)	
Child's gender						
Male	19.7	(14.2-26.8)	0.208	25.5	(19.2-33.0)	0.003
Female	14.5	(10.0-20.7)		15.7	(10.8-22.1)	
Child's age						
<2 years	17.3	(9.1-30.8)	0.953	21.2	(11.9-34.8)	0.888
>2 years	17.0	(12.9-22.0)		20.3	(15.5-25.5)	
Prematurity						
Yes	32.4	(18.9-49.7)	0.009	29.7	(16.8-47.0)	0.137
No	14.9	(11.2-19.6)		19.1	(14.9-24.2)	

Table 2 – Prevalence rates and their respective confidence intervals (95% CI) for the outcomes "failure to thrive" and "double burden" among children participating in the Family Health Strategy program in Lavras, MG (2022), according to the categories of the independent variables studied.

Children's characteristics	Failure to thrive		*p*-value*	Double burden %		*p*-value*
	%	(95% CI)		%	(95% CI)	
Birth weight						
Yes	35.0	(21.4-51.5)	0.001	37.5	(23.5-54.0)	0.003
No	13.6	(10.1-18.2)		17.2	(13.2-22.1)	
Maternal and family characteristics						
Maternal schooling						
≤9 years	18.4	(11.1-29.0)	0.712	19.7	(12.1-30.5)	0.863
>9 years	16.6	(12.4-21.8)		20.6	(16.0-29.2)	
Maternal Common Law marriage						
Yes	17.6	(12.1-25.1)	0.836	22.8	(16.4-30.7)	0.342
No	16.8	(11.9-23.0)		18.4	(13.4-24.9)	
Mother employed						
Yes	15.2	(10.4-21.5)	0.368	19.4	(14.0-26.2)	0.735
No	19.0	(13.4-26.0)		20.9	(15.1-28.2)	
Own home						
Yes	17.3	(12.4-23.6)	0.877	22.9	(17.3-29.7)	0.221
No	16.7	(11.4-23.8)		17.4	(12.0-24.5)	
Low household income						
Yes	23.5	(14.8-35.3)	0.090	19.1	(11.3-30.5)	0.815
No	14.8	(10.9-19.8)		20.4	(15.8-25.9)	
Enclosed sewer						
Yes	17.0	(13.2-21.7)	0.921	20.3	(16.1-25.1)	0.866
No	18.2	(3.5-58.0)		18.2	(3.5-58.0)	
Brings the CHH to the visit						
Yes	14.9	(11.2-19.6)	0.010	17.4	(13.4-22.4)	<0.001
No	33.3	(18.9-51.8)		45.5	(28.8-63.2)	
Children's food intake over the last 24 hours						
Breastfeeding						
Yes	18.8	(13.6-25.5)	0.535	18.8	(13.6-25.5)	0.248
No	15.8	(9.9-24.4)		24.8	(17.2-34.3)	
Ate porridge						
Yes	31.8	(15.0-55.3)	0.085	36.4	(18.2-59.5)	0.079
No	16.7	(12.5-22.0)		20.0	(15.4-25.5)	
Fruits						
Yes	14.1	(9.8-19.8)	0.071	19.8	(14.7-26.1)	0.652
No	21.9	(15.5-30.0)		21.9	(15.5-30.0)	
Savory food						
Yes	13.8	(9.8-19.0)	0.016	18.2	(13.7-23.9)	0.114
No	25.0	(17.2-34.8)		26.0	(18.1-35.9)	
Beans						
Yes	14.2	(10.0-19.8)	0.313	17.6	(13.0-23.6)	0.627
No	7.1	(1.6-26.3)		21.4	(9.4-41.7)	
Maternal food intake over the last 24 hours						
Beans						
Yes	18.4	(14.1-23.5)	0.152	21.0	(16.5-26.3)	0.479
No	9.3	(3.4-23.1)		16.3	(7.7-31.1)	
Fruits						
Yes	17.1	(12.3-23.3)	0.962	21.4	(16.1-27.9)	0.617
No	16.9	(11.4-24.3)		19.1	(13.3-26.7)	
Vegetables						
Yes	17.4	(13.1-22.8)	0.743	21.2	(16.4-26.8)	0.578
No	15.9	(9.3-25.7)		18.3	(11.2-28.4)	
Cold cut						
Yes	19.8	(12.5-29.7)	0.431	19.8	(12.5-29.7)	0.858
No	16.0	(11.9-21.3)		20.7	(16.0-26.3)	

Note: *p-value derived from simple logistic regression analysis. Prematurity: gestational age at birth <37 weeks; Birth weight: birth weight <2500g; Low household income: household income ≤1 minimum wage. CHH: Child Health Handbook.

The prevalence of at least one nutritional disorder, whether related to nutritional deficiency or excess, was 22.3% (95% CI: 18.1-27.2). Stunting was the most prevalent nutritional disorder among the children evaluated (10.5%), whereas wasting was the least prevalent (4.3%). The prevalence of nutritional disorders in the study population is shown in Figure 2.

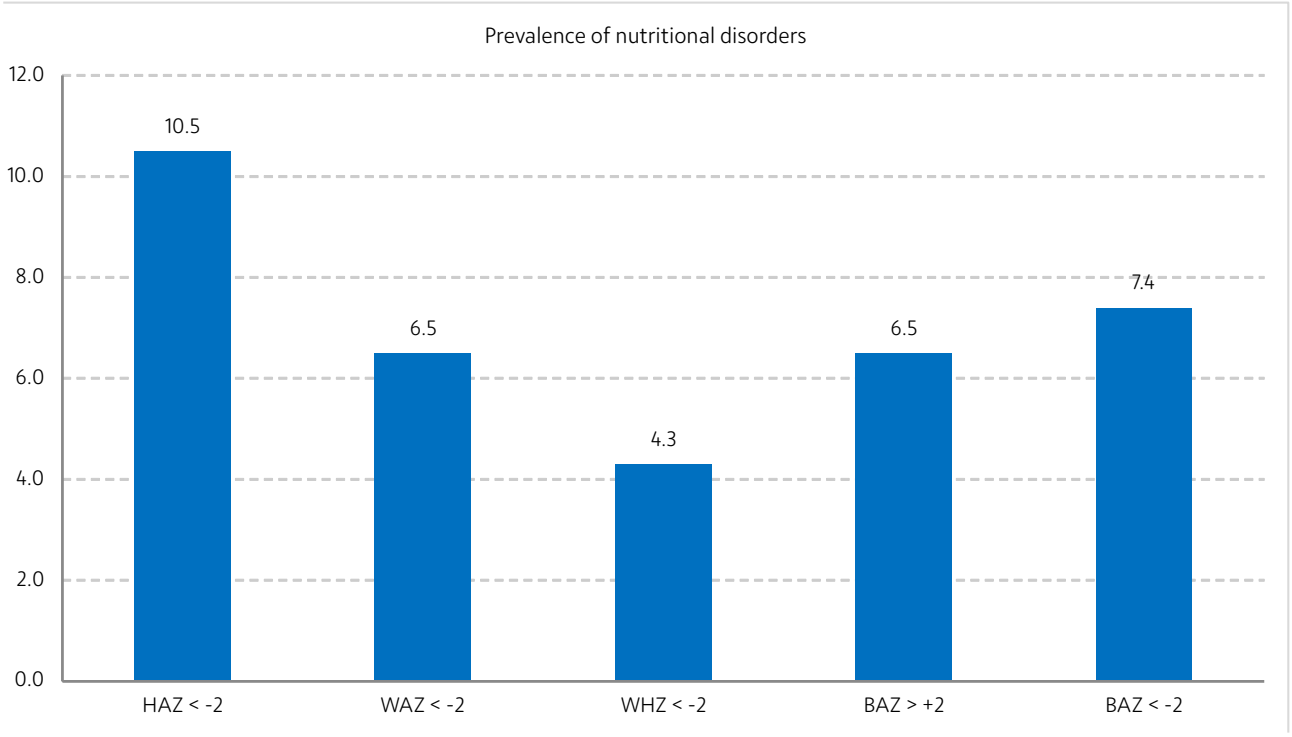


Figure 2 – Prevalence of nutritional disorders among children participating in the Family Health Strategy program in Lavras, MG (2022).
Note: BAZ: Body mass index-for-age z-score; HAZ: Height-for-age z-score; WAZ: Weight-for-age z-score; WHZ: Weight-for-height z-score.

The absolute numbers of individuals with nutritional disorders and the concomitant occurrence of these disorders in the same individual are shown in Figure 3. Figure 3A, representing the *failure to thrive* group, shows that 13 children had low WAZ and HAZ, while two children had low WAZ and HAZ as well as low WHZ. Figure 3B, representing the *double burden* group, shows that two children had all four nutritional disorders, four children had low WAZ, HAZ, and BAZ, and nine children had low BAZ and HAZ.

In the multivariate analysis of the groups of nutritional disorders, regardless of age and sex, low birth weight (LBW) (OR=3.67; 95% CI: 1.72-7.83; p=0.001) and no consumption of savory food by the child on the previous day (OR=2.79; 95% CI: 1.41-5.51; *p*=0.003) remained associated with the *failure to thrive* group. For the *double burden* group, LBW (OR=2.95; 95% CI: 1.39-6.24; *p*=0.005) and the caregiver not bringing the CHH to the medical visit (OR=3.76; 95% CI: 1.70-8.32; *p*=0.001) were the associated factors (Table 3).

DISCUSSION

In the present study, approximately one in four children had at least one anthropometric nutritional disorder, with stunting being the most prevalent. Factors associated with at least one

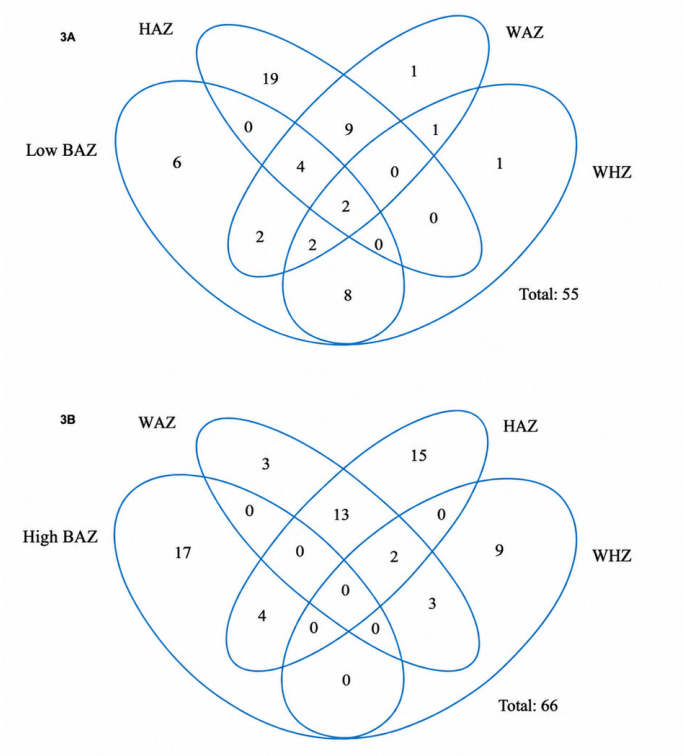


Figure 3 – Relationship between nutritional disorders (using high and low BMI) in children participating in the Family Health Strategy program in Lavras, MG (2022).

Note: HAZ < -2: Low height-for-age; High BAZ: BMI-for-age Z-score > +2; Low BAZ: BMI-for-age Z-score < -2; WAZ < -2: Low weight-for-age; WHZ < -2: Low weight-for-height.

Table 3 – Logistic regressions of factors associated with nutritional disorder clusters among children and mothers participating in the Family Health Strategy program in Lavras, MG (2022).

Independent variables	Odds ratio	(95% CI)	*p*-value
Failure to thrive*			
Birth weight	3.67	(1.72-7.83)	0.001
No savory food over the last 24h	2.79	(1.41-5.51)	0.003
Double burden*			
Birth weight	2.95	(1.39-6.24)	0.005
Does not bring CHH to the visit	3.76	(1.70-8.32)	0.001

Note: *Models were adjusted for the children's gender and age. Failure to thrive (WAZ < -2, WHZ < -2, HAZ, < -2, or BAZ < -2). Double burden (WAZ < -2, WHZ < -2, HAZ < -2, or BAZ > 2). Birth weight: birth weight < 2500g; CHH: Child Health Handbook.

of the groups of nutritional disorders investigated were LBW and the caregiver not bringing the CHH to the visit.

The prevalence of LBW in the present study was 12.5%, slightly higher than the national prevalence of 8.5% [18]. A possible explanation for the higher prevalence of LBW observed in this study is the unfavorable socioeconomic condition of the population evaluated. The fact that more than 20% of study participants had a household income below one minimum wage for households with an average of four members may reflect this condition. Maternal nutrition, postnatal diet, concomitant infectious diseases, and child health care are determinants of undernutrition and are directly affected by socioeconomic factors. Unfavorable financial conditions limit access to food and may contribute to undernutrition during pregnancy. In addition, industrially processed foods

are often more affordable and may provide greater satiety than fruits or vegetables, making them more likely to be chosen when financial resources are limited [19-23].

LBW was associated with both the *failure to thrive and double burden* groups, demonstrating its relationship with different anthropometric outcomes. Its association with the *failure to thrive* group may be explained by intrauterine growth restriction, which results in lower nutritional reserves for the fetus and, consequently, a greater risk of undernutrition during the first years of life. Moreover, the greater vulnerability of children with LBW to respiratory and gastrointestinal tract infections and to complications such as jaundice, anemia, and pulmonary diseases may impair physical growth [19,24].

Overall, children with LBW experience impaired homeostasis across organs and systems, which may hinder their ability to achieve their full potential for physical growth and neuropsychomotor development. LBW is, therefore, used in health information systems as a predictor of survival in epidemiological studies [25]. This impact of LBW on physical growth during the first years of life may consequently increase the risk of noncommunicable chronic diseases in adulthood [20,26-28].

Conversely, the association between LBW and the *double burden* group is consistent with the Barker hypothesis, which suggests that a mismatch in energy availability between fetal and postnatal environments may predispose individuals to adverse metabolic outcomes. A fetus exposed to an environment with limited calories and nutrients may develop an "energy-conserving" phenotype. After birth, this may favor lower energy expenditure and greater metabolic risk [29]. Another possible explanation for the association between LBW and the group of anthropometric abnormalities that includes high BAZ is the rapid catch-up weight gain experienced by many of these children during the first year of life, which increases the risk of obesity, metabolic syndrome, and type 2 diabetes in the medium and long term [30,31].

Not bringing the CHH to routine visits was associated with the *double burden* group. Regular monitoring of child health, including periodic anthropometric assessment, dietary review, and nutritional counseling, may influence the development of healthy behaviors, such as a high-quality diet and regular physical activity. During the growth and development period, this intervention contributes to the control and prevention of adverse nutritional outcomes, particularly among low-income households [23,32].

The lack of the CHH at routine visits may create operational difficulties and reflect limited parental awareness of its importance or less attention to fundamental child health care [33,34]. In this regard, the absence of this document may hinder effective well-child care and, consequently, increase the risk of anthropometric nutritional disorders related to either deficiency or excess [23,32].

The lack of "savory food" consumption on the previous day, used as a proxy for inadequate dietary intake, was associated with the *failure to thrive* group. This finding highlights that missing the main and more nutritious meals of the day (lunch and dinner) may contribute to the risk of undernutrition. A diet composed mainly of unhealthy snacks, such as ultra-processed foods, may have high energy density but is often poor in high-biological-value proteins, vitamins, and minerals essential for child growth and development, thereby favoring cumulative nutritional deficiencies over time [35].

One factor contributing to poor diet quality may be low monthly income, which can lead to food insecurity and increase the risk of undernutrition in children. The relationship between poverty and undernutrition is complex and multifactorial, involving not only limited quantitative access to food but also poorer diet quality, inadequate sanitation, and restricted access to health services. Childhood undernutrition in low- and middle-income countries remains strongly determined by

structural factors, including socioeconomic inequality, food insecurity, and maternal vulnerabilities, which act synergistically to impair child growth and development [20].

Notably, unfavorable socioeconomic characteristics such as those observed among the families of the children studied here – low household income, unemployment, and low maternal schooling – may compromise their ability to ensure essential health care for their children. This combination of circumstances hinders comprehensive child health care, creating a multifactorial risk context involving both distal and proximal determinants of nutritional disorders, developmental delays, and infectious diseases [36]. In addition, inadequate prenatal care, without the necessary attention to the mother-fetus dyad, increases the risk of obstetric and neonatal complications, such as low birth weight [20].

Therefore, child health is closely related to household socioeconomic conditions, highlighting the importance of health policies and programs that provide the conditions necessary for the population's social well-being, from prenatal care and routine low-risk well-child care to the provision of specialized care when needed [37].

Although the participants studied here were from a single Brazilian municipality, which may have specific socioeconomic, cultural, and health care access characteristics, the sample was representative of all children followed at primary health care units. Therefore, external validity should be considered cautiously when applying these findings to municipalities and other settings with different characteristics. Nevertheless, the associations identified with anthropometric nutritional disorders have biological plausibility (low birth weight and no consumption of savory food on the previous day) and social plausibility (the lack of CHH at the routine visit). These findings may be considered in the planning and management of health services across different settings.

Although the results of the present study are derived from a specific population, inadequate dietary intake and nutritional disorders early in life should be prevented because they are among the leading factors associated with an increased risk of noncommunicable chronic diseases, which have been the main cause of morbidity and mortality worldwide in recent decades. In this regard, nutritional care during the period known as the first 1,000 days deserves particular attention, and health strategies should be aligned with the most frequent regional demands and needs [38].

To address the multiple burden of malnutrition, these strategies should be cost-effective and based on coordination among the public health, education, and social sectors. In the Brazilian context, the Unified Health System plays a central role by providing a unified system that enables access to longitudinal and comprehensive health care for a growing number of individuals. However, the universal implementation of these actions remains a major challenge, particularly in developing countries such as Brazil [39,40].

CONCLUSION

In the study population, anthropometric nutritional disorders were observed across all indices assessed individually, as well as within the *failure to thrive* and *double burden* groups. Specifically, children born with low birth weight require careful follow-up to prevent nutritional disorders related to both deficiency and excess. Likewise, the lack of the CHH at routine child health visits may contribute to the double burden of malnutrition, while no consumption of "savory food" on the previous day may indicate a risk of undernutrition, highlighting the need for food and nutrition surveillance.

Recognizing these factors in clinical practice may contribute to more effective strategies for preventing and controlling childhood nutritional disorders. Consequently, this may promote appropriate child development and reduce the risk of noncommunicable chronic diseases in adulthood.

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