# Relationship between food insecurity and nutritional status of Brazilian children under the age of five

## *Relação entre insegurança alimentar e estado nutricional de crianças brasileiras menores de cinco anos*


### *Abstract*

**Objective:** The aim of this study was to investigate the relationship between food insecurity and nutritional status of Brazilian children. **Methods:** The National Demographic and Health Survey 2006 database is available on the worldwide web. Thus, the analyzed variables were obtained in this study, including nutritional indices, food insecurity and other socioeconomic and demographic variables. The height-for-age, weight-for-age and weight-for-height indices were evaluated as the Z-score of the World Health Organization reference curves. Food insecurity was defined by using the Brazilian Food Insecurity Scale. Averages of three indices according to the presence of food insecurity were analyzed, including other variables. Linear regression evaluated the effect of food insecurity on the Z-score of the three nutritional indices. **Results:** The sample included 4,817 children, out of whom 7% had deficit in height, 7% were overweight and 47% had food insecurity. It was found that the average of height-for-age, weight-for-age and weight-for-height were -0.31, 0.12 and 0.40, respectively, being lower among children with food insecurity. **Conclusion:** The regression analysis showed that children living with some level of food insecurity have worse rates of height-for-age, even controlling for demographic and socioeconomic factors.



**Keywords:** Food and Nutritional security. Child development. Nutritional transition. Body height. Anthropometry.



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## *Resumo*

**Objetivo:** O objetivo foi verificar a relação entre insegurança alimentar e estado nutricional de crianças brasileiras. **Métodos:** O banco de dados da Pesquisa Nacional de Demografia e Saúde de 2006 está disponível na internet. Assim, foram obtidas as variáveis analisadas no presente estudo, incluindo índices nutricionais, insegurança alimentar e outras variáveis socioeconômicas e demográficas. Os índices estatura-para-idade, peso-para-idade e peso-para-estatura foram avaliados como escore Z, por meio das curvas de referência da Organização Mundial de Saúde. A insegurança alimentar foi definida pelo uso da Escala Brasileira de Insegurança Alimentar. Foram analisadas as médias dos três índices segundo a presença de insegurança alimentar e das demais variáveis. O efeito da insegurança alimentar sobre o escore Z dos três índices foi avaliado utilizando regressão linear. **Resultados:** Das 4.817 crianças, 7% tinham déficit de estatura, 7% tinham excesso de peso e 47% apresentaram insegurança alimentar. As médias de estatura-para-idade, peso-para-idade e peso-para-estatura foram -0,31; 0,12 e 0,40, respectivamente e menores em crianças com insegurança alimentar. **Conclusão:** A análise de regressão mostrou que crianças vivendo com algum grau de insegurança alimentar têm piores índices de estatura-para-idade, mesmo controlando para fatores de confusão.



**Palavras-chave:** Segurança alimentar e nutricional. Estado nutricional. Desenvolvimento infantil. Transição Nutricional. Estatura. Antropometria.


## Introduction

Child malnutrition is expressed in different ways, by means of low height-for-age, low weight-for-height or low weight-for-age[1]. Even though it is a major challenge for low income countries, recent estimates suggest that malnutrition is decreasing in most countries, being replaced by problems related to excessive weight[2].

Considering that child nutritional status is closely related to the socioeconomic condition of the child, there are differences in this relationship between countries. While nutritional deficits are more prevalent in developing nations and in the lower social classes of these countries[3], the relationship between socioeconomic level and excessive weight is more complex. Even though the prevalence of excessive weight among children is higher in high income countries, in the past two decades the medium and low income countries presented increased proportions of this condition[4]. In the adult population of Brazil, studies point out that there is a direct association between socioeconomic level and obesity among men, while for women obesity is related to poverty[5,6]. As to children, this relationship is not so clear, but national estimates suggest that the prevalence of excessive weight is discreetly higher in the most favored social classes[7].

Besides nutritional status, other indicators are also related to the socioeconomic level of a family. One of these indicators is food insecurity, since some studies suggest that this condition is associated with low income, low schooling, high home agglomeration, among others[8,9]. Besides, several studies point to the direct relationship between food insecurity and damages on child nutritional status[10-14].

Since food insecurity and problems related to child nutritional status are mostly associated with low income families, several studies have been investigating the association between these two conditions. Some of them observe that, in places with high prevalence of food insecurity, children have more chances of presenting worse nutritional status, developing some sort

of deficit[13,14]. On the other hand, other investigations suggest that food insecurity can increase the risk of obesity in the child population[12,15]. However, recent findings of a study conducted with the Brazilian child population suggest that a situation of food insecurity does not increase the risk of overweight among the studied children[16].

Studies that measure the relationship between food insecurity and nutritional status among children are mostly conducted in developed nations, and, therefore, they frequently assess the effect over excessive weight or obesity. There are still only a few investigations in medium or low income countries, where such relationship can be more complex because of several factors, such as social inequity, poverty, among others. Therefore, The objective of this study was to verify the relationship between food insecurity an nutritional status of Brazilian children aged less than five years old, analyzed in the National Demographic and Health Survey (PNDS) of 2006.

## Methodology

Data in this study were obtained in the last PNDS survey performed between 2006/07 in Brazil, which aimed at studying maternal and child health of women at reproductive age and children aged less than five years old[7].

This survey included a probability sample with national representativeness and cross-sectional design. Ten sample strata based on the combination of five Brazilian geographic macroregions and on the urban and rural areas were defined in the first stage of the sampling process. In each of these strata, two other stages were selected: primary units, which are the census sectors, and secondary units, which are the private households, with or without occupation, identified within the census sectors. This complex sampling process requires the expansion of the sample with household adjustment inside each census sector. This adjustment, as well as calibration according to estimates of the official Brazilian population from the Brazilian Institute of Geography and Statistics (IBGE)[17], published in 2007, considered the losses that took place during data collection and the proportion of women at reproductive age found in each household. More information about this sampling process can be found in the PNDS report[7].

Data were collected in the selected households, by interviewers who were trained to use the instruments containing demographic, socioeconomic and health information of women and children aged less than five years old. The latter included data on lifestyle, nutrition, medication, food security and anthropometry of the interviewees. The collection of anthropometric measures was in accordance with the recommendations by the World Health Organization (WHO)[18], and two weight and height measures were obtained for each individual, using the arithmetic mean to calculate the Z score. The weight measure was obtained by using the portable electronic scale by Dayhome®, for up to 150 kg and 0.1 kg precision. Among children aged less than two years old, height was obtained by measuring length, with the child lying down, in an infantometer. Among children aged two years old or more and women, the measure was taken in the standing position, in a device called stadiometer. Portable infantometers and stadiometers were developed especially for PNDS – 2006 in the Laboratory of Nutritional Assessment of Populations (LANPOP), of the Nutrition Department of Universidade de São Paulo. The former was 110 cm long and had 0.1 cm precision; the latter was 210 cm long and had 0.1 cm precision, respectively. All of the equipment was calibrated in the beginning and in the end of each work day.

Household food insecurity was defined by the Brazilian Scale of Food Insecurity (EBIA), validated for the Brazilian scenario between 2003 and 2004[18]. All of the questions of this scale referred to a reminiscent period of three months prior to the interview, and each affirmative answer received value "1".

For the classification of food security/insecurity, a score was calculated according to the number of positive answers in each

item of the scale (1 point for "yes" and 0 point for "no" or "do not know") and to the age composition of the household. For households with no participants aged less than 18 years old, it was only possible to apply eight questions. Therefore, the highest possible score was eight. For households with people aged less than 18 years old, the full questionnaire was applied and accounted for 16 points. The score and cutoff point criteria of EBIA enables the division in 4 categories and 3 levels of intensity: food security (FS), mild, moderate and severe food insecurity, which are distributed according to the presence or absence of people aged less than 18 years old. The validity of the scale and the adaptation of the adopted cutoff points was confirmed by the high internal validity of the scale (Chrombach's $\alpha = 0.91$)[19].

The main exposure of this study was defined by the classification of the interviewed families according to the presence of food insecurity and their different levels of severity. Therefore, mild food insecurity was considered when households accounted from 1 to 5 points; moderate, for households that had 6 to 10 points; and severe food insecurity for 11 to 16 points. The situation of food security was defined for those families with negative answers for all of the questions.

In this study, the outcome was defined based on the height-for-age, weight-for-age and weight-for-height indices, assessed as Z score by means of WHO reference curves[20]. The distribution of Z score means of the three indices according to demographic and socioeconomic variables was observed, with the objective of detecting differences between groups, especially concerning those differences that would not be noticed in case the variables were in dichotomous format. Therefore, extreme values were ruled out (lower than Z scores -5 and -6 higher than Z scores +5 and +6 for weight and height, respectively), according to WHO[18].

The other variables used in this analysis were: household macroregion (North, Northeast, Southeast, South, Center-West), situation of the household (urban, rural), receiving the Bolsa Família Program (PBF), number of people in the household (2 to 4, 5 or more), household income quartiles (≤ 340, 350 – 520, 525 – 980, ≥ 1000 reais in the month prior to the interview), age of the mother (15 – 19, 20 – 35, 36 – 49 years old), skin color of the mother (white, black/mulatto, other), child's age (0 – 12, 13 – 24, 25 – 36, 37 – 48, 49 – 59 months) and gender (male, female).

Descriptive analyses include the distribution of sociodemographic variables (gender, household macroregion, situation of the household, household income quartiles, age of the mother, skin color of the mother, and child's age) and food insecurity according to Z scores means for height-for-age, weight-for-age and weight-for-height. Linear regression was used in the analysis to assess the crude and adjusted effect of food insecurity over the Z score of the three nutritional indices. Confusion factors were those variables with $p < 0.2$ in the crude analysis. Therefore, results are presented by regression coefficient (beta) and its respective 95% confidence intervals (95%CI). Analysis were performed in the statistical software Stata, version 11.0, and all of the estimates were pondered, considering the design effect, as well as calibration according to the estimates of the Brazilian population, by means of the svy command in Stata.

This study presents no real, potential or apparent conflict of interest by none of the authors, and was approved by the Research Ethics Committee of the Medical School of Universidade Federal de Pelotas.

## Results

The sample of PNDS 2006/07 was comprised of 15,575 women, aged from 15 to 49 years old, and 5,461 children aged less than five years old. The results in this study refer to 4,817 children (about 88% of the original sample) whose information about household, including family food insecurity, was available. Our of these 4,817 children, 4,410 had information about the height-for-age index, 4,496 had information about weight-for-age index, and 4,374 had information on weight-for-height index.

The distribution of this population, considering the sample design, reveals that almost half of them lived in the Southeast region of the country (42%), and most of them lived in the urban zone (81%). In relation to PBF, about 1 out of 4 families received this benefit, and 38% of the studied children lived in households with 5 or more inhabitants. As to maternal age, while 11% of the children had adolescent mothers (15 to 19 years old), 76% had mothers aged from 20 to 35 years old, and 13% had mothers aged more than 35 years old, and more than half of the mothers reported their skin color as nonwhite.

The nutritional status classification shows that the prevalence of height-for-age deficit was of 7.6% (95%CI 6.7 – 8.5) among the children included in this study. For weight-for-age and weight-for-height deficits, these proportions did not reach 2.5%, which would be expected in population with normal distribution. On the other hand, 6.6% (95%CI 5.5 – 7.8) of the children were classified with excessive weight in relation to height. Concerning the household food situation, it was observed that half of the children (45.6%) lived in a household with some level of food insecurity.

The mean values of the Z scores for height-for-age, weight-for-age and weight-for-height were, respectively, -0.31 (± 0.04), 0.12 (± 0.03) and 0.40 (± 0.03). The means for these three indices in relation to exposure variables are presented in Table 1.

It is possible to observe that the mean Z score for height-for-age was significantly lower among children living in the North region of the country. On the other hand, higher Z score means for this index were found in children who did not receive PBH, living in households with two to hour inhabitants with higher income. Besides, the analysis suggests that female children present with higher Z score mean for height-for-age (p = 0.05). With regard to children's age, a positive mean, close to zero, was observed in those aged up to 12 months old. In relation to older children, these means were negative. Concerning food insecurity, negative Z score means were observed for height-for-age, regardless of the classification level. However, for children living in households classified as secure, this mean was significantly higher when compared to the other groups (Table 1).

In Table 1, it is observed that the Z score mean for weight-for-age was equally lower among children in the North region of the country, those receiving PBF and the ones living in households with more inhabitants (five or more). Inversely, these means were significantly higher for younger children, living in households with food security and coming from families with higher income.

With regard to weight-for-height, unlike what has been observed for height-for-age, Z score means were positive, regardless of demographic, socioeconomic of food insecurity level characteristics. Children coming from more developed regions of the country (South and Southeast) and who did not receive the PBF presented significantly higher means for this index. Besides, it was observed that the higher the number of people living in the same household as the child, the lower the income and the more severe the food insecurity situation, therefore, the Z score mean for weight-for-height was lower (Table 1).

In the regression analysis, it was observed that the more severe the food insecurity level, the lower the Z score of the three nutritional indices, being height-for-age the one that mostly suffers negative influence from the food situation. However, it was observed that only the height-for-age index was associated with the food insecurity situation after the control for confusion factors included in this analysis (Table 2).

## Discussion

The main result of this study refers to the fact that children suffering from some level of food insecurity have worse nutritional indices. After adjustment for confusion factors, it was observed that only the height-for-age index was still affected by the food insecurity level experienced by the child. Such result is in accordance with literature, since depending on the level of development of a nation, food insecurity can be related to nutritional status, both towards deficit, in the case of medium or low income countries, and towards excessive weight, in developed nations[12-16].

**Table 1 -** Mean and 95% confidence interval of the Z scores for height-for-age, weight-for-age and weight-for-height according to demographic and socioeconomic characteristics of children studied. Brazil, 2006 (n = 4,496)[#].

***Tabela 1 -*** *Média e intervalo de confiança de 95% do escore Z de estatura-para-idade, peso-para-idade e peso-para-estatura de acordo com as características demográficas e socioeconômicas das crianças estudadas. Brasil, 2006 (n = 4.496)[#].*

| Variables | Height-for-age | | | | Weight-for-age | | | Weight-for-height | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | Mean | 95%CI | p-value | Mean | 95%CI | p-value | Mean | 95%CI | p-value |
| Macroregion | | | | < 0. 001 | | | < 0. 001 | | | 0. 001 |
| North | 988 | -0. 76 | -0. 89 to -0. 64 | | -0. 19 | -0. 31 to -0. 07 | | 0. 35 | 0. 27 to 0. 42 | |
| Northeast | 882 | -0. 37 | -0. 55 to -0. 18 | | 0. 02 | -0. 10 to 0. 15 | | 0. 28 | 0. 18 to 0. 38 | |
| Southeast | 893 | -0. 21 | -0. 35 to -0. 08 | | 0. 21 | 0. 12 to 0. 30 | | 0. 45 | 0. 34 to 0. 57 | |
| South | 835 | -0. 22 | -0. 35 to -0. 09 | | 0. 23 | 0. 11 to 0. 34 | | 0. 50 | 0. 38 to 0. 62 | |
| Center-west | 898 | -0. 19 | -0. 30 to -0. 08 | | 0. 21 | 0. 12 to 0. 30 | | 0. 45 | 0. 35 to 0. 54 | |
| Household situation | | | | 0. 3 | | | 0. 06 | | | 0. 08 |
| Urban | 2.944 | -0. 29 | -0. 37 to -0. 21 | | 0. 15 | 0. 09 to 0. 21 | | 0. 42 | 0. 35 to 0. 49 | |
| Rural | 1.552 | -0. 42 | -0. 66 to -0. 19 | | -0. 01 | -0. 15 to 0. 14 | | 0. 31 | 0. 21 to 0. 41 | |
| Receive bolsa família | | | | 0. 004 | | | < 0. 001 | | | < 0. 001 |
| Yes | 1.334 | -0. 50 | -0. 66 to -0. 35 | | -0. 15 | -0. 27 to -0. 04 | | 0. 18 | 0. 06 to 0. 30 | |
| No | 3.159 | -0. 25 | -0. 34 to -0. 17 | | 0. 21 | 0. 15 to 0. 27 | | 0. 47 | 0. 41 to 0. 54 | |
| People in the household | | | | 0. 006 | | | < 0. 001 | | | 0. 002 |
| 2 to 4 | 2.300 | -0. 25 | -0. 34 to -0. 15 | | 0. 21 | 0. 14 to 0. 28 | | 0. 47 | 0. 39 to 0. 54 | |
| 5 or more | 2.196 | -0. 42 | -0. 53 to -0. 32 | | -0. 03 | -0. 11 to 0. 06 | | 0. 29 | 0. 20 to 0. 38 | |
| Income quartiles | | | | < 0. 001 | | | < 0. 001 | | | < 0. 001 |
| 1st quartile (lower) | 902 | -0. 67 | -0. 81 to -0. 53 | | -0. 24 | -0. 37 to -0. 11 | | 0. 19 | 0. 07 to 0. 30 | |
| 2nd quartile | 943 | -0. 36 | -0. 57 to -0. 15 | | 0. 07 | -0. 06 to 0. 20 | | 0. 34 | 0. 21 to 0. 48 | |
| 3rd quartile | 848 | -0. 16 | -0. 27 to -0. 05 | | 0. 32 | 0. 21 to 0. 44 | | 0. 59 | 0. 46 to 0. 71 | |
| 4th quartile (higher) | 999 | -0. 11 | -0. 27 to 0. 05 | | 0. 31 | 0. 19 to 0. 43 | | 0. 48 | 0. 36 to 0. 61 | |
| Age of the mother | | | | 0. 3 | | | 0. 13 | | | 0. 3 |
| 15 –19 | 386 | -0. 51 | -0. 74 to -0. 27 | | -0. 07 | -0. 23 to 0. 09 | | 0. 30 | 0. 09 to 0. 51 | |
| 20 – 35 | 3.543 | -0. 28 | -0. 37 to -0. 19 | | 0. 15 | 0. 08 to 0. 21 | | 0. 41 | 0. 34 to 0. 47 | |
| 36 – 49 | 567 | -0. 34 | -0. 54 to -0. 14 | | 0. 12 | -0. 02 to 0. 26 | | 0. 44 | 0. 31 to 0. 57 | |
| Skin color of the mother | | | | 0. 5 | | | 0. 4 | | | 0. 7 |
| White | 1.499 | -0. 24 | -0. 35 to -0. 13 | | 0. 17 | 0. 08 to 0. 29 | | 0. 44 | 0. 34 to 0. 54 | |
| Black/ Mulatto | 2.711 | -0. 33 | -0. 44 to -0. 23 | | 0. 08 | 0. 01 to 0. 15 | | 0. 37 | 0. 29 to 0. 44 | |
| Others | 234 | -0. 48 | -0.70 to -0.25 | | 0. 23 | 0. 03 to 0. 42 | | 0. 54 | 0. 36 to 0. 72 | |
| Gender | | | | 0. 05 | | | 0. 2 | | | 0. 9 |
| Male | 2.311 | -0. 38 | -0.47 to -0. 28 | | 0. 09 | 0. 01 to 0. 16 | | 0. 40 | 0. 33 to 0. 47 | |
| Female | 2.185 | -0. 24 | -0. 35 to -0. 14 | | 0. 15 | 0. 08 to 0. 23 | | 0. 40 | 0. 31 to 0. 48 | |
| Child's age | | | | 0. 002 | | | 0. 04 | | | 0. 2 |
| 0 – 12 | 993 | 0. 01 | -0.15 to 0.17 | | 0. 19 | 0. 07 to 0. 31 | | 0. 27 | 0. 13 to 0. 40 | |
| 13 – 24 | 896 | -0. 40 | -0. 60 to -0. 20 | | 0. 11 | -0. 01 to 0. 23 | | 0. 39 | 0. 26 to 0. 52 | |
| 25 – 36 | 901 | -0. 50 | -0.60 to -0.39 | | 0. 14 | 0. 05 to 0. 23 | | 0. 55 | 0.46 to 0. 64 | |
| 37 – 48 | 885 | -0. 40 | -0.53 to -0.26 | | 0. 12 | 0. 00 to 0. 23 | | 0. 52 | 0.41 to 0.62 | |
| 49 – 59 | 821 | -0.34 | -0.48 a -0.19 | | 0.00 | -0.11 to 0.12 | | 0.28 | 0.17 to 0.40 | |

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**Table 1 -** Continuation.

***Tabela 1 -*** *Continuação.*

| Variables | Height-for-age | | | | Weight-for-age | | | Weight-for-height | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | Mean | 95%CI | p-value | Mean | 95%I | p-value | Mean | 95%CI | p-value |
| Food situation | | | | < 0. 001 | | | < 0. 001 | | | 0. 01 |
| Food security | 2.170 | -0.17 | -0.28 to -0.06 | | 0. 21 | 0.14 to 0.29 | | 0. 44 | 0.36 to 0.51 | |
| Mild FI | 1.242 | -0.36 | -0.47 to -0.25 | | 0. 12 | 0.02 to 0.22 | | 0. 44 | 0.33 to 0.54 | |
| Moderate FI | 604 | -0.52 | -0.69 to -0.35 | | -0. 08 | -0.22 to 0.07 | | 0. 30 | 0.14 to 0.46 | |
| Severe FI | 480 | -0.77 | -0.97 to -0.57 | | -0. 23 | -0.41 to -0.04 | | 0. 17 | 0.00 to 0.34 | |

[#]Estimates were weighted taking into account the complex sample design; The largest number of missing values was to the weight-for-height index ; FI: Food insecurity.
*[#]Estimativas foram ponderadas levando em conta o complexo desenho da amostra; O maior número de valores perdidos foi para o índice peso-para-estatura; FI: insegurança alimentar.*

**Table 2 -** Multivariate linear regression model of the relationship between Z scores for height-for-age, weight-for-height and weight-for-age and level of food insecurity. Brazil, 2006[#].

***Tabela 2 -*** *Modelo de regressão linear multivariada da relação entre escore Z de estatura-para-idade, peso-para-estatura e peso-para-idade e nível de insegurança alimentar. Brasil, 2006[#].*

| Variables | Crude | | | Adjusted | | |
|---|---|---|---|---|---|---|
| | β | 95%CI | p-value | β | 95%CI | p-value |
| Height-for-age | | | | | | |
| Food insecurity | -0.19 | -0.25 to -0.13 | < 0.001 | -0.08* | -0.16 to -0.01 | 0.03 |
| Weight-for-height | | | | | | |
| Food insecurity | -0.14 | -0.19 to -0.09 | < 0.001 | -0.03** | -0.08 to 0.03 | 0.3 |
| Weight-for-height | | | | | | |
| Food insecurity | -0.07 | -013 to -0.02 | 0.01 | -0.02** | -0.07 to 0.05 | 0.7 |

[#]Estimates were weighted taking into account the complex sample design; *Adjusted by income quartile, region of housing, transfer income, household density, sex and children's age; **Adjusted by income quartile, region of housing, household situation, transfer income, household density, mother's age, sex and children's age; ***Adjusted by income quartile, region of housing, household situation, transfer income, household density and children's age.
*[#]Estimativas foram ponderadas levando em conta o complexo desenho da amostra; *Ajustado para quartil de renda, macrorregião de moradia, recebimento do PBF, densidade domiciliar, sexo e idade da criança; **Ajustado para quartil de renda, macrorregião de moradia, situação do domicílio, recebimento do PBF, densidade domiciliar, idade da mãe, sexo e idade da criança; ***Ajustado para quartil de renda, macrorregião de moradia, situação do domicílio, recebimento do PBF, densidade domiciliar e idade da criança.*

Global data about nutritional indices of children aged less than five years old show that the mean for height-for-age decreases with age, and it is always lower when compared to weight-for-age and weight-for-height indices[21]. Likewise, the height-for-age mean in this study was lower (-0.31) than weight-for-age (0.12) and weight-for-height means (0.40), and also decreased with age.

The height mean was below expected for all of the analyzed children, since a mean Z score value of zero would be expected from a normal distribution population. However, it was observed that such values were even lower for those living with some level of food insecurity. Besides, after the adjusted analysis, food insecurity remained negatively related to their height, together with income and, to a lower degree, to the household macroregion (data not shown). This shows that this relationship has been connected to the socioeconomic level of the children, since these determiners are closely related.

Despite the low prevalence of excessive weight, with regard to weight-for-height it was observed that the mean values of this index were high, regardless of the food insecurity situation. However, these values were higher in the group living with food security, and food insecurity did not have any influence on this index.

This situation, in which the height mean was below expected and weight mean was above expected, suggests that excess weight problems can be present in these children. In the last Survey of Household Budgets (POF) of 2008/09, it was mainly observed in children aged from 5 to 9 years old, once about one third of them presented with excessive weight[22].

The effect of food insecurity on nutritional status has been investigated by other national studies that used the PNDS database[14,16,23].

The first study indicated that children with food insecurity can show worse anthropometric indicators. However, there was no comparison between the means of nutritional indices of those living with food insecurity and the means of the individuals who did not experience such situation, and the main objective of the study was to investigate the association between food insecurity and health and nutrition indicators of children[14]. The other two investigations aimed at observing the relationship between food insecurity and excessive weight among children[16] and women[23]. The first one also analyzed the child population of PNDS and observed similar results to those of this study, and found no relationship between these two health indicators. However, the authors did not present results for the height-for-age index, and included different variables in relation to this study in the analysis model. On the other hand, the study conducted with women[23] suggested that moderate food insecurity can lead to excessive weight.

Considering international studies that assessed the relationship between food insecurity and nutritional status, it is observed that the results are not similar when considering the development stage of the location of the study. Therefore, in high income countries, most studies relates food insecurity with overweight/obesity, since in these places the frequency of excessive weight among children is twice as high as the one found in developing countries, so problems related to nutritional deficit are rare[10,11,24,25]. These studies present the effects of mild, moderate or severe food insecurity on the prevalence of excessive weight, showing that such condition is sometimes more common among children with food insecurity, and sometimes more common among those who do not experience this situation. In this study, in which the prevalence of excessive weight for height was lower in comparison to the aforementioned studies (6.6%), it was observed that children with severe food insecurity had weight-for-height means significantly lower in comparison to children with food security. Besides, weight-for-height means were always higher in groups with of higher socioeconomic level (children in the urban zone, without PBH, in households with fewer people and higher income), which is opposed to the hypothesis of association between these two health conditions.

With regard to low and medium income countries, most studies associate the situation of household food insecurity to the possible nutritional deficits it can cause[13,14,26]. In this study, it was observed that food insecurity is negatively related to all of the nutritional indices, especially the height-for-age index. Besides, regardless of the food security situation lived by the household, for children older than 12 months old, the means of this index were always negative, reaching almost -1 Z score among those with moderate and severe insecurity. Similarly, studies conducted in different South America countries showed that children in households with food insecurity had more prevalence of height deficit[13,26]. However, none of the studies conducted in these locations has national representativeness, thus not presenting a population overview of this relationship.

There are many ways in which food insecurity influences child nutritional status, such as child's age, skin color, family income, among other determiners. However, food consumption is the most important mediator, being an essential component of this relationship[27]. Even though data on child food consumption are available in the database, it was not part of the study's scope to assess the food consumption of the analyzed children. However, evidence suggests differences among those living in good insecurity according to the household

location. Studies conducted in high income countries reported that children living with food insecurity present more consumption of energy, sugar and fat and less consumption of fruits, meat and dairy products[28,29]. Likewise, a nationally representative study about food consumption showed that Brazilian children, despite living in a country going through a long nutritional transition process, presented higher intake of sugar and fat and lower intake of fruits, vegetables and meat[30]. Even though the food consumption of Brazilian children is similar to that of children in developed countries, the difference in the relationship of food insecurity with overweight/obesity can be explained by the fact that, in Brazil, obesity levels began to increase recently, and still affect richer children, while in developed countries the problem of child obesity is older, reaching all social levels.

The main advantage of this study refers to the complex design of the sample selection that enabled the evaluation of the food insecurity effect on the nutritional indices of children aged less than five years old living in the five Brazilian macroregions, both in the urban and rural contexts. The methods applied by PNDS[7], like the standardization of data collection, including a rigorous training of the interviewers and the quality control during the period of field work, can be considered as other positive aspects of this study. On the other hand, the use of EBIA reflects a relative measure of the situation experienced by all of the individuals living in the same household; therefore, it is not an individual measure of food insecurity. However, despite this limitation, it is known that when a household experiences this situation, consequently, all of the inhabitants are affected[9].

To understand the relationship of food insecurity with child nutritional status is very important to develop policies and health and nutrition programs that can fight both food insecurity and nutritional issues. In this study, it was observed that the height-for-age mean was below expected among children with medium or severe food insecurity. These findings assume that these children are more exposed to the risk of malnourishment, which has serious consequences for their physical and mental development. Some studies report that problems related to food insecurity are not only nutritional, since there can be emotional, behavioral and mental development problems[31,32]. Such findings confirm the importance to promote proper nourishment in terms of quantity and quality, not only to prevent nutritional disorders, but also for the children to reach their full growth and development potential.

## Conclusion

Food insecurity has been negatively related to the height-for-age index at all ages, even controlling for some demographic and socioeconomic factors, such as household location, income, number of inhabitants of the household, skin color of the mother, among others. However, this relationship seems to be connected to the socioeconomic level of these Brazilian children, being strongly connected to the monthly income of the family and location of the household.

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