Food insecurity and the relationship between household income and child health in Brazil

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Resumo

Evidências empíricas indicam que crianças vivendo em domicílios mais ricos geralmente apresentam melhores condições de saúde. A insegurança alimentar, que está relacionada a uma alimentação inadequada por falta de recursos financeiros, pode ser apontada como uma das possíveis explicações para a relação entre renda e saúde infantil. Esse artigo investiga a associação entre renda domiciliar e insegurança alimentar de um lado e medidas de saúde infantil do outro. Usando dados de 2006 da DHS (Demographic and Health Survey), os resultados mostram que crianças vivendo em domicílios com insegurança alimentar têm piores indicadores de saúde. Além disso, a relação entre renda domiciliar e saúde infantil permanece significativa, apesar de atenuada, mesmo quando medidas de insegurança alimentar são consideradas na análise.

Abstract

Empirical evidence indicates that children living in wealthier households have better health. Food insecurity could be related to lack of adequate nutrition experienced by poor children and may be pointed out as one of the possible explanations for this relationship. This paper investigates the association between food insecurity and child health and the role of the former in the child health income gradient. Using data from the 2006 Brazilian DHS (Demographic and Health Survey), the results show that children living in households with food insecurity have worse health indicators. Despite the reduction in the child health income gradient, the relationship between household income and child health still remains significant when controlling for food insecurity.

Área 11 - Economia social e demografia

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1 – Introduction

Empirical evidence shows that children in richer households have better health than those living in poorer households. The child health income gradient could be found in studies for different countries (see, for example, Case et al., 2002 for US; Currie and Stabile, 2003 for Canada; and Currie et al., 2007 and Case et al., 2008 for England). Evidence from Brazil also indicates that household income and child health measures are positively related (Crespo and Reis, 2009).

Many different channels could be pointed out to explain the relationship between income and child health. Children in high-income households may have better nutrition, access to better medical care services and usually live in safer environments. Another possible explanation is the fact that there are other variables related to household income that could influence children's health, such as characteristics of their parents, for example. Although Case et al. (2002) find evidence that these other factors may play a role in the gradient, they show that the association between low income and children's poor health status persists in the United States even after controlling for genetic and behavioral elements.

Food insecurity, which could be related to nutritional deprivation, refers to missing meals and reductions in the quantity and quality of food intake arising from financial constraints. It should be expected that children who do not have appropriate nutrition may become more vulnerable to illness and that children who live in households with food insecurity are also those in poor families. Therefore, not only can children's malnutrition because of food insecurity lead to worse health status, but it can also help to explain part of the relationship between household income and child health.

Bhattacharya et al. (2004) investigate the way poverty and food insecurity are related to nutritional status in the United States. Using data from the National Health and Nutrition Examination Survey III (NHANES III), they find that poverty is negatively associated with nutrition for children aged between 2 and 5 years. Evidence also shows that, when poverty is controlled for, food insecurity is predictive of nutritional measures for older household members, but not for children.[1] As stressed by Bhattacharya and Currie (2001), nutritional problems in the United States are generally due to poor diet quality rather than to deprivation of basic food needs. In a developing country, however, lack of food resources and hunger are common situations for a significant share of the population. This fact could lead to different implications for the

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[1] Bhattacharya et al. (2004) use dietary recall data, anthropometric measures and blood test results to represent nutrition. Lee and Frongillo (2001) find similar results, i.e., food insecurity is related to lower nutrient intake and poorer self-reported health status among elderly persons in the United States.

way children's nutrition and health are affected by food insecurity in a developing country. The aim of this paper is to investigate whether food insecurity is related to child health in Brazil and how the child health income gradient changes when food insecurity is incorporated into the empirical analysis.

This paper uses data from the 2006 Brazilian DHS (Demographic and Health Survey), a nationally representative survey containing a vast range of socioeconomic and health-related variables for children. With the information available from this survey, it is also possible to construct food insecurity measures. The empirical analysis consists in regressing nutritional outcomes and health indicators on household income and food insecurity measures. According to the estimated results, children living in households with food insecurity seem to have worse nutrition and health. The empirical evidence suggests, however, that the relationship between household income and health indicators weakens but remains significant in most cases when food insecurity measures are included in the analysis.

The paper is structured as follows. Section 2 describes the construction of food insecurity variables. Section 3 presents the dataset and a descriptive analysis. Section 4 shows the estimated results relating children's nutritional outcomes and health measures to food insecurity and household income. Section 5 contains the main conclusions.

2 - Measuring food insecurity

In 1995, the Current Population Survey (CPS) included, for the first time, a supplement with a range of questions designed to measure food insecurity in the United States. These questions ask about adults' and children's hunger and skipped meals and reductions in the quality of food intake because of money restrictions. Using the 18-item set of questions in the CPS survey, the U.S. Department of Agriculture (USDA) developed a procedure to construct food insecurity measures. These measures are based on the number of affirmative responses to the set of 18 questions. It is important to mention that food insecurity measures apply to the household as a whole, not to a particular member.

Following the guidelines provided by Bickel et al. (2000), food insecurity could be represented by a scale expressed by numerical values ranging from 0 to 10, where a higher value indicates more severe food insecurity. Food insecurity could be also represented by a categorical classification. Households are classified into one of the following groups in the categorical food insecurity measure proposed by Bickel et al. (2000):

a)   Food secure: households show no or minimal evidence of food insecurity.
b)   Food insecure without hunger: household members are concerned about the adequacy of household food supply, but few or no reductions in members' food intake are reported.
c)   Food insecure with (moderate) hunger: Adults have repeatedly experienced the physical sensation of hunger.
d)   Food insecure with (severe) hunger: children have experienced hunger.

The Brazilian 2006 DHS also has a set of questions at the household level similar to that in the CPS Food Security Supplement.[2] The full set of questions is presented in the Appendix. Using this information, food insecurity is represented by four variables in the empirical analysis of this paper. The first variable is the number of affirmative responses to food insecurity questions, ranging from 0 to 18. The second one is the continuous food-insecurity scale measure in Bickel at al. (2000). The third variable is based on the categorical classification proposed by Bickel et al. (2000). In this case, a value is attributed to each household on a scale from 0 to 3, where 0=food secure, 1= food insecure without hunger, 2= food insecure with moderate hunger and 3= food insecure with severe hunger. The fourth variable used in the analysis is a dummy equal to one for households with any type of food insecurity, i.e., classified as 1, 2 or 3 on the categorical scale proposed by Bickel et al. (2000), and equal to zero otherwise.

3 - Data

This paper uses data from the 2006 Brazilian DHS (Demographic and Health Survey). This is a nationally representative survey that was conducted between November 2006 and April 2007. During this period, the DHS collected information from more than 50,000 individuals in about 15,000 households. In particular, women aged between 15 and 49 years provided detailed information about their sons and daughters.

The 2006 Brazilian DHS contains many demographic and socioeconomic variables about individuals in the sample. The survey also has an 18-item array of questions used to calculate food insecurity measures, as described in Section 2. The sample used in this paper is restricted to children who were born after January 2001, for whom information about nutritional outcomes and health status is available. The final sample has about 5,000 children aged 75 months or less, living in the same household as their mothers.

The survey includes children's health-related information provided by their mothers. Five health indicators are used in the empirical analysis to represent children's health status. These indicators are: the prevalence of fever, cough and diarrhea 14 days before the DHS interview, the occurrence of diarrhea in the past three months and an indicator of hospitalization episodes in the past 12 months.

The DHS also conducts a physical examination of the children who were born after January 2001, collecting height and weight measures and blood tests to assess hemoglobin and vitamin A levels. Z-score variables are constructed using anthropometric measures. The height-for-age z-score, for example, is calculated by subtracting the median and dividing this term by the standard error among children of the same age and gender in the reference group, comprised by well-nourished U.S. children in the NCHS (National Center for Health Statistics). Weight-for-age and

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[2] The difference between questions related to food insecurity in the CPS and the DHS regards the period of reference. In the CPS, the period of reference is 12 months, while in the DHS, the period of reference is three months. There are three items in the survey related to how often people did not eat and adults and children skipped meals. In these cases, an affirmative answer is attributed to those who skipped meals or did not eat for a whole day in three or more months in the past year in the CPS. In the DHS survey, the period of reference for these questions is three months and an affirmative response is attributed to those whose answers were three or more days.

weight-for-height z-scores are constructed in an analogous way. Children's height could be used as a long-term indicator of nutritional status, depending on accumulated investment in nutrition, while weight-for-height could be considered a short-term indicator of children's nutritional status.[3] The prevalence of anemia and low levels of vitamin A are calculated using blood test results. Anemia is represented by a hemoglobin concentration below 11.0 g/dl, as in Bobonis et al. (2004), while the second variable is characterized by a vitamin A serum level of less than 1.05 μmol/L, as in Bhattacharya et al. (2004).[4]

Descriptive statistics for children in the sample are separately presented in Table 1 for households with food security, food insecurity without hunger, food insecurity with moderate hunger and food insecurity with severe hunger. Table 1 shows that 65% of the children could be classified into the first group, that is, they live in a household with food security. About 22% of the children are in the group with food insecurity without hunger. Eight per cent of the children live in a household with food insecurity and moderate hunger, while food insecurity with severe hunger is found for 5% of the children.

Table 1: Descriptive statistics

	Food secure	Food insecure without hunger	Food insecure with moderate hunger	Food insecure with severe hunger
Household per capita income (R$)	333.34	142.73	93.02	70.81
Age (in months)	34.45	35.77	36.43	39.65
Girl (%)	0.48	0.48	0.50	0.47
Urban area (%)	0.81	0.82	0.71	0.73
Mother's education (>10 years)	0.35	0.13	0.12	0.05
Mother's age	27.76	25.97	26.59	27.86
Household size	4.39	4.78	4.91	5.52
Father present in the household	0.76	0.68	0.73	0.69
Anemia (%)	0.19	0.19	0.21	0.26
Low level of vitamin A (%)	0.59	0.63	0.59	0.62
Weight-for-age z-score	0.20	0.02	-0.06	-0.30
Height-for-age z-score	-0.20	-0.43	-0.60	-0.70
Weight-for-height z-score	0.54	0.46	0.43	0.20
Fever (2 weeks)	0.22	0.20	0.28	0.30
Cough (2 weeks)	0.32	0.41	0.36	0.45
Diarrhea (2 weeks)	0.09	0.15	0.08	0.17
Diarrhea (3 months)	0.19	0.29	0.29	0.29
Hospitalization episodes (12 months)	0.10	0.15	0.13	0.16
Observations	4,001	1,331	585	475
Population share	0.65	0.22	0.08	0.05

Notes:
All values, except the number of observatios, are weighted.
Anemia is characterized as a level of hemoglobin below 11 g/dL. A low level of vitamin A is defined as
a concentration below 1.05 ⬜mol.

The household per capita income decreases sharply with the intensity of food insecurity. In households with food security, the average household per capita income

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[3] See Strauss and Thomas (1998) for a discussion about the use of anthropometric variables as indicators of nutritional status.
[4] As stressed by Bhattacharya et al. (2004), although blood tests can offer objective evidence of poor diet, the serum levels of nutrients are influenced by genetic elements, and the fact that vitamins and minerals can be stored in human bodies for long periods could change the association between the first two variables in the short run.

(R$ 333) is more than twice that of households with food insecurity without hunger (R$ 143) and more than four times higher when compared to households with food insecurity and severe hunger (R$ 71). The proportion of children with mothers who had completed 11 years or more of schooling falls from 35% in column (1) to only 5% for households ranking in the higher category of food insecurity. Table 1 also shows that household size increases with the severity of food insecurity, but children in each one of the four groups have similar characteristics regarding age and proportion of girls.

Table 1 reports that children in households with food security tend to have better nutritional outcomes. The values presented for anthropometric measures decrease with the intensity of food insecurity, while the prevalence of anemia is higher for children in households with food insecurity and hunger. Average weight-for-age is 0.20 among children in households with food security and drops to -0.30 among children with food insecurity and severe hunger. Regarding the height-for-age z-score, Table 1 reports a reduction from -0.20 in column (1) to -0.70 in column (4), while the weight-for-height z-score decreases from 0.54 to 0.20. The prevalence of anemia is 19% for children in households with food security and increases to 26% for children in households with food insecurity and severe hunger.

According to Table 1, children in households with food security have better health indicators than children in households with food insecurity and severe hunger. The proportion of children who had fever, cough, or diarrhea in the past three months, as well as the occurrence of hospitalization episodes, increases about 50% from column (1) to column (4). Table 1 also shows that 9% of the children in households with food security had diarrhea two weeks prior to the survey, but among those in households with food insecurity and severe hunger, the prevalence of diarrhea during the same period of reference increases to 17%.

4 - Results

The empirical analysis consists in regressing children's health indicators on household per capita income and food insecurity measures. Equations are also estimated using a dummy for poverty instead of household income. All regressions control for children's characteristics (age, gender, region and a dummy for residence in urban areas), mother's age and education, household size and a dummy for father's presence. This section also reports regressions like those in Bhattacharya et al. (2004), using the nutritional outcomes described in Section 2 as dependent variables.

Table 2 presents the estimated coefficients for regressions of nutritional outcomes on the log of household per capita income and food insecurity measures. Each column displays the evidence for a different dependent variable and each panel shows the results using a different food insecurity measure. According to the evidence, weight-for-age and weight-for-height z-scores are positively related to household per capita income in all regressions. Table 2 also indicates that children in households with food insecurity have lower weight-for-age and height-for-age values. In addition, the prevalence of anemia is higher for children in households with food insecurity in Panels A and B and lower for children in households with higher income in Panel D.

Table 2
Household income, food insecurity and nutritional outcomes

	(1)	(2)	(3)	(4)	(5)
	Anemia	Low level of vitamin A	Weight-for-age z-score	Height-for-age z-score	Weight-for-height z-score
Panel A					
ln(household per capita income	-0.023	0.011	0.153	0.058	0.157
	[0.017]	[0.019]	[0.039]***	[0.056]	[0.032]***
Food insecurity 1	0.005	0.00	-0.014	-0.024	-0.008
	[0.003]*	[0.003]	[0.007]**	[0.008]***	[0.008]
Panel B					
ln(household per capita income	-0.023	0.011	0.151	0.052	0.158
	[0.017]	[0.019]	[0.039]***	[0.057]	[0.032]***
Food insecurity 2	0.009	-0.001	-0.026	-0.047	-0.013
	[0.005]*	[0.006]	[0.013]**	[0.015]***	[0.014]
Panel C					
ln(household per capita income	-0.024	0.014	0.157	0.063	0.162
	[0.017]	[0.019]	[0.039]***	[0.056]	[0.032]***
Food insecurity 3	0.022	0.006	-0.058	-0.105	-0.026
	[0.014]	[0.015]	[0.033]*	[0.042]**	[0.038]
Panel D					
ln(household per capita income	-0.029	0.017	0.16	0.063	0.166
	[0.016]*	[0.019]	[0.039]***	[0.055]	[0.032]***
Dummy for households with food	0.014	0.029	-0.084	-0.177	-0.018
insecurity	[0.025]	[0.029]	[0.062]	[0.071]**	[0.067]
Observations	3,964	4,012	3,814	3,740	3,725

Notes:

Regressions are estimated by Ordinary Least Squares.

The following variables are included as controls: children's gender, age (in months), region of residence, a dummy for urban areas, mother's age and education, household size and the presence of the father. .

Anemia is characterized as a level of hemoglobin below 11 g/dL. A low level of vitamin A is defined as a concentration below 1.05 □mol.

Robust standard errors in brackets

* significant at 10%, ** significant at 5%, *** significant at 1%.

Food insecurity 1 is represented by the number of affirmative responses to the set of 18 questions about food insecurity in the DHS survey.

Food insecurity 2 is based on the continous scale measure ranging from 0 to 10, as proposed by Bickel et al. (2000).

Food insecurity 3 is a measure ranging from 0 to 3 acoording to the categorical classification in Bickel et al. (2000).

Table 3 reports regressions of nutritional outcomes on food insecurity and a dummy variable for children in poor households. Poverty status is characterized by a household per capita income lower than R$ 171 (US$ 70), following the poverty line in Barros et al. (2007). Fifty-seven per cent of the children in the sample live in a household with per capita income below this cutoff point and the results in all panels indicate that children living in poverty have worse anthropometric measures. Regressions in Table 3 also show that food insecurity is associated with lower weight and height values, as well as with higher prevalence of anemia.

Bhattacharya et al. (2004) show that once poverty is controlled for, food insecurity does not have any additional predictive power on nutritional outcomes of children aged between 2 and 5 years in the United States. The results displayed in Tables 2 and 3 suggest that these variables are related in a different way in Brazil. Even controlling for household per capita income or poverty, food insecurity measures seem to have a deleterious effect on nutritional indicators for Brazilian children.

Table 3
Poverty, food insecurity and nutritional outcomes

	(1)	(2)	(3)	(4)	(5)
	Anemia	Low level of vitamin A	Weight-for-age z-score	Height-for-age z-score	Weight-for-height z-score
Panel A					
Poverty	0.015	0.00	-0.304	-0.252	-0.199
	[0.029]	[0.032]	[0.065]***	[0.084]***	[0.070]***
Food insecurity 1	0.006	-0.001	-0.016	-0.02	-0.014
	[0.003]**	[0.003]	[0.007]**	[0.008]**	[0.008]*
Panel B					
Poverty	0.014	0.001	-0.301	-0.245	-0.199
	[0.029]	[0.033]	[0.066]***	[0.084]***	[0.071]***
Food insecurity 2	0.011	-0.002	-0.03	-0.04	-0.024
	[0.005]**	[0.006]	[0.012]**	[0.016]***	[0.014]*
Panel C					
Poverty	0.016	-0.003	-0.311	-0.258	-0.207
	[0.028]	[0.032]	[0.066]***	[0.084]***	[0.070]***
Food insecurity 3	0.028	0.002	-0.069	-0.09	-0.055
	[0.014]**	[0.015]	[0.033]**	[0.042]**	[0.038]
Panel D					
Poverty	0.022	-0.008	-0.315	-0.258	-0.213
	[0.028]	[0.032]	[0.066]***	[0.084]***	[0.071]***
Dummy for households with food secure	0.025	0.021	-0.102	-0.149	-0.068
	[0.024]	[0.028]	[0.063]	[0.073]**	[0.067]
Observations	3,964	4,012	3,814	3,740	3,725

Notes:

Regressions are estimated by Ordinary Least Squares.

The following variables are included as controls: children's gender, age (in months), region of residence, a dummy for urban areas, mother's age and education, household size and the presence of the father. .

Anemia is characterized as a level of hemoglobin below 11 g/dL. A low level of vitamin A is defined as a concentration below 1.05 ☐mol.

Robust standard errors in brackets

* significant at 10%, ** significant at 5%, *** significant at 1%.

Food insecurity 1 is represented by the number of affirmative responses to the set of 18 questions about food insecurity in the DHS survey.

Food insecurity 2 is based on the continous scale measure ranging from 0 to 10, as proposed by Bickel et al. (2000).

Food insecurity 3 is a measure ranging from 0 to 3 acoording to the categorical classification in Bickel et al. (2000).

Table 4 reports regressions of health indicators on the log of household per capita income and food insecurity measures. First, estimated equations in Panel A do not include any food insecurity measure. Then, in Panels B, C, D and E, the four variables representing food insecurity are added, one in each set of regressions. The results in Panel A show that children in households with lower income were more likely to have diarrhea and reported more hospitalization episodes over the last 12 months.

In Panel B, the number of affirmative responses in the 18-item array of questions about skipped meals and hunger is added as a regressor. According to the results, this food insecurity indicator is related to higher prevalence of diarrhea in the past three months before the interview and hospitalization episodes in the past 12 months. Regarding the estimated coefficient for household income, it is almost the same as that in column (3) of Panel A, when diarrhea in the past two weeks is used as a dependent variable. However, in the regression for diarrhea during the period of three months, it could be noticed that the estimated coefficient associated with household per capita income is reduced in about 30% when food insecurity is added. In the regression for hospitalization episodes, the household income coefficient becomes nonsignificant when controlling for food insecurity.

Table 4

Household income, food insecurity and children's health indicatores

	(1)	(2)	(3)	(4)	(5)
	Fever (2 weeks)	Cough (2 weeks)	Diarrhea (2 weeks)	Diarrhea (3 months)	Hospitalization episodes
Panel A					
ln(household per capita income)	-0.008	-0.014	-0.025	-0.032	-0.019
	[0.011]	[0.013]	[0.009]***	[0.013]**	[0.008]**
Panel B					
ln(household per capita income)	-0.002	-0.008	-0.027	-0.023	-0.011
	[0.012]	[0.014]	[0.009]***	[0.013]*	[0.008]
Food insecurity 1	0.004	0.004	-0.001	0.006	0.005
	[0.003]	[0.003]	[0.002]	[0.003]*	[0.002]**
Panel C					
ln(household per capita income)	-0.004	-0.006	-0.026	-0.02	-0.01
	[0.012]	[0.014]	[0.009]***	[0.013]	[0.008]
Food insecurity 2	0.005	0.009	-0.001	0.014	0.01
	[0.005]	[0.006]*	[0.004]	[0.006]**	[0.004]**
Panel D					
ln(household per capita income)	-0.002	-0.008	-0.025	-0.022	-0.014
	[0.012]	[0.014]	[0.009]***	[0.013]*	[0.008]*
Food insecurity 3	0.02	0.021	0.002	0.032	0.017
	[0.013]	[0.015]	[0.011]	[0.017]*	[0.011]
Panel E					
ln(household per capita income)	-0.006	-0.005	-0.019	-0.017	-0.014
	[0.012]	[0.014]	[0.009]**	[0.013]	[0.008]*
Dummy for households with food insecurity	0.012	0.051	0.03	0.08	0.027
	[0.024]	[0.028]*	[0.024]	[0.032]**	[0.022]
Observations	5,409	5,406	3,621	3,624	5,418

Notes:

Regressions are estimated by Ordinary Least Squares.

The following variables are included as controls: children's gender, age (in months), region of residence and a dummy for urban areas, mother's age and education, household size and the presence of the father.

Fever and cough refer to a period of 2 weeks before the interview, while hospitalization episodes uses the period os 12 months as reference.

Robust standard errors in brackets

* significant at 10%, ** significant at 5%, *** significant at 1%.

Food insecurity 1 is represented by the number of affirmative responses to the set of 18 questions about food insecurity in the DHS survey.

Food insecurity 2 is based on the continous scale measure ranging from 0 to 10, as proposed by Bickel et al. (2000).

Food insecurity 3 is a measure ranging from 0 to 3 acoording to the categorical classification in Bickel et al. (2000).

Regressions in Panel C show that food insecurity, represented by the continuous measure proposed by Bickel et al. (2000), is associated with higher prevalence of cough, diarrhea in the past 3 months and hospitalization episodes in the past 12 months. The estimated coefficient for household income per capita in column (3) is similar to that in Panel A. However, the coefficients for household income become nonsignificant when diarrhea in the past 3 months and hospitalization episodes are used as dependent variables.

In Panel D, food insecurity is represented by a variable based on the categorical measure proposed by Bickel et al. (2000), ranging from 0 for households with food security to 3 for those households with food insecurity and severe hunger. It is possible to notice that the estimated results for household per capita income remain significant in columns (3), (4) and (5), despite the introduction of the food insecurity measure. As occurs in the comparison between Panels A and B, the income gradient is reduced for diarrhea in the past three months, but not for diarrhea during the period of two weeks relative to regressions that do not include food insecurity. Regarding the association

between food insecurity and health measures, the results show that it is significant only for the prevalence of diarrhea three months before the PNAD interview.

Regressions in Panel E of Table 4 include a dummy for households with food insecurity, i.e., households where the categorical food insecurity index proposed by Bickel et al. (2000) is equal to 1, 2 or 3. The results indicate that children living in households with food insecurity have higher probabilities of cough and diarrhea in the past three months. It is possible to notice also that the coefficients for household per capita income in columns (3) and (5) remain significant, despite the reduction in their absolute values relative to Panel A. However, the estimated coefficient becomes nonsignificant for diarrhea in the past three months in column (4) when food insecurity is included in the empirical analysis.

Table 5
Poverty, food insecurity and children's health indicatores

	(1)	(2)	(3)	(4)	(5)
	Fever (2 weeks)	Cough (2 weeks)	Diarrhea (2 weeks)	Diarrhea (3 months)	Hospitalization episodes
Panel A					
Poverty	-0.002	0.001	0.035	0.092	0.044
	[0.024]	[0.027]	[0.019]*	[0.027]***	[0.020]**
Panel B					
Poverty	-0.012	-0.011	0.036	0.08	0.032
	[0.025]	[0.028]	[0.020]*	[0.028]***	[0.021]
Food insecurity 1	0.004	0.005	0.00	0.005	0.005
	[0.003]	[0.003]*	[0.002]	[0.003]	[0.002]**
Panel C					
Poverty	-0.01	-0.014	0.035	0.076	0.031
	[0.026]	[0.028]	[0.020]*	[0.028]***	[0.021]
Food insecurity 2	0.006	0.011	0.000	0.012	0.009
	[0.005]	[0.005]**	[0.004]	[0.006]*	[0.005]**
Panel D					
Poverty	-0.013	-0.011	0.033	0.08	0.036
	[0.025]	[0.027]	[0.020]	[0.028]***	[0.022]*
Food insecurity 3	0.023	0.025	0.006	0.027	0.017
	[0.013]*	[0.014]*	[0.012]	[0.017]	[0.011]
Panel E					
Poverty	-0.007	-0.016	0.025	0.072	0.036
	[0.026]	[0.027]	[0.020]	[0.028]**	[0.021]*
Dummy for households with food insecurity	0.017	0.058	0.035	0.07	0.025
	[0.023]	[0.027]**	[0.025]	[0.032]**	[0.022]
Observations	5,409	5,406	3,621	3,624	5,418

Notes:
Regressions are estimated by Ordinary Least Squares.
The following variables are included as controls: children's gender, age (in months), region of residence and a
dummy for urban areas, mother's age and education, household size and the presence of the father.
Fever and cough refer to a period of 2 weeks before the interview, while hospitalization episodes
uses the period os 12 months as reference.
Robust standard errors in brackets
* significant at 10%, ** significant at 5%, *** significant at 1%.
Food insecurity 1 is represented by the number of affirmative responses to the set of 18 questions about
food insecurity in the DHS survey.
Food insecurity 2 is based on the continous scale measure ranging from 0 to 10, as proposed by Bickel et al. (2000).
Food insecurity 3 is a measure ranging from 0 to 3 acoording to the categorical classification in Bickel et al. (2000).

Table 5 reports regressions that include a dummy for poverty instead of household income. Panel A indicates that children living in poverty are more likely to have diarrhea and hospitalization episodes. By adding a food insecurity measure in

Panels B and C, the estimated coefficients for poverty are almost the same for diarrhea in the past two weeks, decrease slightly (1.2 percentage point in Panel B and 1.6 percentage point in Panel C) for diarrhea using the period of reference of three months and become nonsignificant for hospitalization episodes. In Panel D, the results show that children in households with food insecurity are more likely to have fever and cough, while estimated coefficients for poverty are still significant in columns (4) and (5) in this set of regressions. Finally, Table 5 shows that the results for poverty displayed in Panel E are similar to those in Panel D. With respect to the dummy for food insecurity, it is related to higher prevalence of cough and diarrhea in the past three months.

5 - Conclusion

This paper investigates the relationship between food insecurity and child health and whether food insecurity helps to explain the child health income gradient in Brazil. Using nationally representative data from the Brazilian 2006 DHS, the empirical analysis is conducted with information about 5,000 children aged 75 months or less.

The empirical findings show that children in households with food insecurity are more likely to have anemia and worse anthropometric measures, even when controlling for household income or poverty. Food insecurity seems to be related not only to nutritional outcomes, but also to children's health indicators. According to the estimated results in this paper, children in households with food insecurity have worse health indicators, represented by higher prevalence of diarrhea and hospitalization episodes. So, it seems that the lack of financial resources for food may have negative consequences for children's well-being in Brazil, leading to worse nutritional outcomes and health indicators.

The results also indicate that the relationship between household income and health still remains significant when controlling for food insecurity, despite the reduction in the child health income gradient. This evidence suggests that there are other factors related to household income – omitted in the empirical analysis – which are important for understanding the health income gradient. For example, rich and poor children may have differences regarding living environment and access to better medical assistance, even with free provision of health care in Brazil. It is important to emphasize that because food insecurity variables do not actually measure people's nutrition, part of the gradient could also be due to better dietary quality of richer children. However, according to the results presented in this paper, skipped meals and hunger may influence the health status of children in Brazil and help to understand at least part of the association between household income and child health.

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Appendix: Food insecurity questions

The 2006 Brazilian DHS contains a set of questions related to food insecurity similar to that in the CPS. The questions are the following:

"Now, I am going to read you several statements that people have made about their food situation. Please, tell me whether the statement was often, sometimes or never true for your household in the last 3 months".

1 – The first statement is: "We worried whether our food would run out before we got money to buy more". Was that often, sometimes or never true for your household in the last 3 months?

[ ] Often true   [ ] Sometimes true   [ ] Never true   [ ] don't know.

2 –"The food that we bought just didn't last and we didn't have money to buy more". Was that often, sometimes or never true for your household in the last 3 months?

[ ] Often true   [ ] Sometimes true   [ ] Never true   [ ] don't know.

3 – "We couldn't afford to eat balanced meals". Was that often, sometimes or never true for your household in the last 3 months?

[ ] Often true   [ ] Sometimes true   [ ] Never true   [ ] don't know.

4 – "We relied on only a few kinds of low-cost food to feed the children because we were running out of money to buy food". Was that often, sometimes or never true for your household in the last 3 months?

[ ] Often true   [ ] Sometimes true   [ ] Never true   [ ] don't know.

5 – "We couldn't feed the children a balanced meal because we couldn't afford that". Was that often, sometimes or never true for your household in the last 3 months?

[ ] Often true   [ ] Sometimes true   [ ] Never true   [ ] don't know.

6 – "The children were not eating enough because we just couldn't afford enough food". Was that often, sometimes or never true for your household in the last 3 months?

[ ] Often true   [ ] Sometimes true   [ ] Never true   [ ] don't know.

7 – In the last 3 months, did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?

[ ] Yes   [ ] No (skip 8)   [ ] don't know (skip 8).

8 – How often did this happen - almost every day, some days but not every day or in only one or two days?

[ ] Almost every day   [ ] Some days but not every day   [ ] Only 1 or 2 days   [ ] don't know.

9 – In the last 3 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?

[ ] Yes   [ ] No   [ ] don't know.

10 - In the last 3 months, were you ever hungry but didn't eat because you couldn't afford enough food?

[ ] Yes   [ ] No   [ ] don't know.

11 – In the last 3 months, did you lose weight because didn't have enough money for food?

[ ] Yes   [ ] No   [ ] don't know.

12 – In the last 3 months, did you or other adults in your household ever not eat for a whole day because there wasn't enough money or food?

[ ] Yes   [ ] No (skip 13)   [ ] don't know (skip 13).

13 – How often did this happen - almost every day, some days but not every day or in only one or two days?

[ ] Almost every day   [ ] Some days but not every day   [ ] Only 1 or 2 days   [ ] don't know.

The next questions are about children living in the household who are under 18 years old.

14 – In the last 3 months, did you ever cut the size of any of the children's meals because there wasn't enough money for food?

[ ] Yes   [ ] No   [ ] don't know.

15 – In the last 3 months, did any of the children ever skip meals because there wasn't enough money for food?

[ ] Yes   [ ] No (skip 16)   [ ] don't know (skip 16).

16 – How often did this happen? - almost every day, some days but not every day or in only one or two days?

[ ] Almost every day   [ ] Some days but not every day   [ ] Only 1 or 2 days   [ ] don't know.

17 – In the last 3 months, were the children ever hungry but you just couldn't afford more food?

[ ] Yes   [ ] No   [ ] don't know.

18 – In the last 3 months, did any of the children ever not eat for a whole day because there wasn't enough money for food?

[ ] Yes   [ ] No   [ ] don't know.