Original Article

Understanding the double burden of malnutrition in food insecure households in Brazil

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Abstract

Household food insecurity (HFI) has been associated with both obesity among mothers and undernutrition among children. However, this association has not been well investigated in mother/child pairs living in the same household. The objective of this study was to examine the relationship of coexistence of maternal overweight and child stunting with HFI in Brazil. We conducted secondary data analyses of the 2006 Brazilian National Demographic and Health Survey. We analyzed the nutritional status of 4299 pairs of 15–49-year-olds mothers and their children under 5 years of age. The double burden of malnutrition (DBM) was defined as the presence of an overweight mother and a stunted child in the same household. HFI was measured with the Brazilian HFI Measurement Scale. The association between DBM and HFI was examined with hierarchical multivariable logistic regression analyses. Severe HFI was associated with DBM after adjusting for macroeconomic and household level socio-economic and demographic variables (Adjusted OR: 2.65 – CI: 1.17–8.53). Findings suggest that policies and programmes targeting HFI are needed to prevent the coexistence of child chronic undernutrition and maternal overweight/obesity in the same household. These investments are likely to be highly cost-effective as stunting has been identified as one of the major risk factors for poor child development and adult overweight/obesity and a strong risk factor for the development of costly chronic diseases including type 2 diabetes and cardiovascular disease.

Keywords: food insecurity, dual-burden, overweight, stunting, malnutrition, demographic health survey.

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Introduction

Food security is a complex multidimensional process that covers the entire food chain, determined by aspects such as access and biological utilization of food (United Nations, 2015). Household food insecurity (HFI) has been associated with both undernutrition and obesity (Shamah-Levy et al., 2014), which is expected because both conditions result from poor eating habits and are likely to be related to the process of nutritional transition observed in Brazil and worldwide (Ghattas, 2014). In this context, overweight and obesity continue to be associated with poverty and other unfavourable social and environmental conditions such as HFI (Frongillo & Bernal, 2014), especially among women (Franklin et al., 2012; Santos, 2013). Among children, HFI has been consistently associated with

undernutrition (Ali et al., 2013) and less consistently with overweight/obesity (Franklin et al., 2012; Kac et al., 2012a; Metallinos-Katsaras et al., 2012).

Studies reveal that women experiencing HFI have a higher prevalence of overweight and obesity, especially those experiencing mild and severe HFI (Franklin et al., 2012; Kac et al., 2012b; Kac et al., 2012a). Overweight in these women may be related to short stature caused by energy metabolism abnormalities linked to stunting in childhood (Hoffman et al., 2000), enhanced food reinforcement resulting from earlier food deprivation and restricted food choice even when food later becomes plentiful (Lin et al., 2013) or low levels of physical activity (To et al. 2014).

In children, the risk of stunting increases as the level of food and nutritional insecurity becomes more severe (Ali et al., 2013; Bernal et al., 2014; Mutisya et al.,

2015). Thus, it is plausible for overweight mothers and stunted children to be living together in the same household (Conde & Monteiro, 2014; Abdullah, 2015).

Although previous studies have examined the association between HFI and the nutritional status of women and children, the association between HFI and the double burden of malnutrition (DBM) requires further investigation, especially in settings like Brazil, where the nutrition transition is very advanced (Conde & Monteiro, 2014). The 2006 Brazilian National Demographic and Health Survey (DHS) (Ministerio da Saude, 2009) provides a unique opportunity for analyzing this relationship. Therefore, the specific objective of this study was to examine the association between HFI severity and risk of DBM in a nationally representative cross-sectional sample of Brazilian households.

Subjects and methods

Secondary data analyses were performed with national data from the 2006 Brazilian DHS (Demographic Health Survey). The survey was conducted in civilian households randomly selected using complex sampling procedures, involving the stratification of Brazilian census tracks (primary sampling units) and the selection of households within each track (secondary sampling units). Households were distributed across all the five country's macro-regions and areas (urban and rural) (Ministerio da Saude, 2009).

Our study evaluated the association of interest in a representative sample of women of childbearing age (15–49 years) and their children under 5 years of age who participated in the 2006 Brazilian DHS. The original sample included 15 575 women and 4817 children under 5 living with their mothers. The initial analytical sample included 4323 mother/child pairs with complete data regarding maternal-child anthropometry and HFI. Nutritional status was assessed using maternal body mass index, and children's height-for-age (H/A) *z*-score (World Health Organization, 2006). In our study, households were excluded if the target children or mother had implausible anthropometric data (children $H/A < \text{or} > 4$ *z*-scores (excluded 88 cases, 2.0%) and maternal IMC less than 13 kg m^{-2} or higher than 55 kg m^{-2} (excluded 24 cases, 0.6%). The final

analytical sample for this study included the remaining 4299 mother/child pairs.

Household food insecurity was assessed with the Brazilian HFI Measurement Scale (Escala Brasileira de Insegurança Alimentar, EBIA). EBIA consists of 14 questions and the score is calculated by the sum of affirmative answers to EBIA items. As recommended, households were then classified into four mutually exclusive categories: secure (score = 0), mildly insecure (score = 1 to 5), moderately insecure (score = 6 to 9) and severely insecure (score = 10 to 14) (Instituto Brasileiro de Geografia e Estatística., 2014; Segall-Corrêa et al., 2014).

Each mother and child were grouped into pairs and classified in terms of the presence or absence of DBM. The pair was considered as having DBM when the mother had a body mass index equal to or higher than 25 kg m^{-2} and the child's H/A was lower than -2 *z*-scores. In our sample, 140 pairs (2.6%) had DBM, i.e., the coexistence of maternal overweight and child undernutrition (low H/A) in the same household. Because of their exceedingly low prevalence, four pairs (0.09%) consisting of a malnourished (underweight) mother and an overweight child were excluded from the analysis. The decision of using maternal overweight instead of obesity was made based on the low prevalence of DBM when using obesity as the criteria (0.9%). We included all children under 5 years old allowing for the inclusion of more than one child in the same house.

The 2006 Brazilian DHS protocol was approved by the Research Ethics Committee of the DST/AIDS Referral and Training Center of the Department of Health of the State of São Paulo, Brazil. All mothers signed the consent form before the interview.

Statistical analyses

Statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS) software (Version 20.0) using the Complex Samples module. Data were weighted for unequal sampling probabilities: a complex three-level design with stratification was applied to the sampled subjects included in the survey. The primary units were constituted by Brazilian census sectors. The secondary units were sector clusters, and

the third sampling units were the homes. The sample was comprised by the universe of civilian households including favelas or shanty towns and is representative of all five Brazilian geographic regions, including urban and rural areas.

Descriptive characteristics are presented as percentage and confidence intervals for categorical variables. Pearson's chi-square test was used to test nutritional status (maternal overweight and stunting) and DBM differences across HFI, socio-economic and demographic variables (child's sex, maternal race/skin colour, Brazilian macro-region, source of water, urban or rural area and educational level of the head of the household) categories. Adjusted odds ratios and their corresponding 95% CIs were estimated by logistic regression analyses adjusting for sex of the child, Brazilian regions, household food security status and education level of the head of household.

To better understand the association of interest, we conducted hierarchical multivariable logistic regression analysis including DBM as a binary outcome and HFI as the key independent variable. Variables with bivariate associations at the $P < 0.20$ level were included in the multivariate analyses to minimize the chances of a type II error. Models were adjusted first for macroeconomic variables then for household/individual socio-economic and demographic variables and lastly for both sets of variables. The macroeconomic covariates included in the final model were Brazilian macro-region and area of residence (urban or rural). The socio-economic and demographic covariates were maternal self-reported skin colour/race (black/brown, yellow/indigenous and white) maternal parity and age and educational level of the head of the household. We also conducted multivariable analyses to identify

the risk factors for stunting and maternal obesity to be able to compare them against the risk factors for DBM. All statistical analyses used sampling weights to take into account the complex sampling design of the survey. For the DBM and child stunting analyses, the children sampling weights were used, and for the maternal overweight/obese analyses, the women's sampling weights were used.

Results

Sample characteristics

Almost half of the households (48.4%) experienced HFI during the 3 months preceding the interview. Whereas 42.6% of the mothers were overweight or obese, 7.2% of their children were stunted. Approximately, a third of the households did not have access to a public water supply and/or to adequate sanitation (septic tank or sanitary sewer). The educational level of the head of household was below 4 years of schooling in 37.3% of households (Table 1).

Among the women classified as overweight, 37.0% had short stature (height ≤ 150 cm) (Gudmundsson et al., 2005), and 63.0% had normal height. Furthermore, 52.7% had normal weight and height. Similarly, 4% of overweight children were stunted. Additionally, 92.4% of children with normal height had also normal weight (data not shown in tables).

Bivariate analyses

A statistically significant association was observed between DBM and both the independent variable and all covariates analyzed (Table 2). The prevalence of

Key messages

- In Brazil, severe household food insecurity was associated with the double burden malnutrition in the same household.
- Life course policies and programmes targeting household food insecurity are needed to prevent the double burden malnutrition.
- Household food insecurity should be included as a key evaluation indicator of maternal-child nutrition programmes.
- Prospective research is needed to better understand the mechanisms explaining the simultaneous risk for maternal overweight/obesity and child stunting and to identify modifiable factors that affect this relationship.

Table 1. Description of the study population. Brazilian National Demographic and Health Survey 2006

Variables	<i>n</i>	%
Double burden of malnutrition in mother/child pairs		
No	4159	97.4
Yes (overweight/stunting)	140	2.6
Child's nutritional status *		
Height/age		
Stunting	392	7.2
Normal	3907	92.8
Body mass index/age		
Thinness	114	1.9
Normal	3991	94.7
Overweight	194	3.4
Maternal nutritional status		
Underweight	192	4.6
Normal weight	2315	52.8
Overweight	1170	28.8
Obesity	622	13.8
Sex of the child		
Male	2202	52.2
Female	2097	47.8
Maternal race/skin colour		
White	1438	32.9
Black or brown	2588	61.5
Yellow or indigenous	224	5.6
Macro-region		
Northern	962	10.7
Northeast	862	28.6
Southeast	847	41.1
Southern	785	12.1
Midwest	843	7.5
Household food security status [†]		
Food security	2096	51.6
Mild food insecurity	1184	28.5
Moderate food insecurity	661	14.5
Severe food insecurity	358	5.4
Adequate sanitation		
Yes	2118	66.3
No	1669	33.7
Adequate water supply		
Yes	2956	69.5
No	1308	30.5
Household location		
Urban	2819	80.9
Rural	1480	19.1
Educational level of the head of the household		
4 years of education or less	1744	37.3
5 to 8 years of education	1279	29.9
9 years of education or more	1153	32.8

*This variable refers to the nutritional status of all the children under five included in the study. [†]As assessed by the Brazilian Household Food Insecurity Measurement Scale (Escala Brasileira de Medida Domiciliar de Insegurança Alimentar, EBIA). Raw sample sizes reported, sampling weights used to compute prevalence estimates.

DBM was associated with HFI severity level following a dose-response pattern, and it was more prevalent in households: (1) with a male child; (2) located in the Northern region; and (3) where the head had lower educational levels. The prevalence of stunting was also associated with the degree of HFI severity following a dose-response relationship, and it was also higher for male child, children living in the North of Brazil and among children living in household where the head had lower educational levels. There were no associations between HFI and any of the socio-demographic covariates with maternal overweight.

The crude odds for DBM were 4.56 times higher among households with severe food insecurity compared with their food secure counterparts. DBM was also more likely to occur in households with a male child (OR: 1.86). Households in the Northern were almost three times more likely than those in the Midwest region (OR: 2.84) to experience DBM. Similar associations were found with regard to risk of DBM among lower in comparison with higher maternal education level (OR: 2.97) (Table 3).

In order to understand if including more than one child per household affected the findings, we replicated the analyses using only the youngest child followed by using only the oldest one in the 12.5% of households where siblings were included. The association between DBM and severe food insecurity remained, but it tended to be underestimated for the youngest child (OR: 2.45 for severe insecurity compared with those with food security) and overestimated for the oldest child (OR: 5.16) (data not shown in tables).

The crude odds for stunting were 2.58 times higher among households with severe food insecurity compared with their food secure counterparts. Stunting was also more likely to occur in male children (OR: 1.47) and in children living in households located in the Northern (OR: 2.64) compared with those in the Midwest region. The crude odds for stunting were three times higher if the head of household had less than 4 years of education compared with those with 4 years or more.

Multivariable analyses

The associations detected in the bivariate analyses remained significant even after adjustment for each of

Table 2. Maternal overweight, children stunting and double burden of malnutrition according to associated factors. Brazilian National Demographic and Health Survey 2006

Variables	Maternal overweight			Children stunted			Double burden of malnutrition		
	Yes (%)	No (%)	<i>P</i> -value*	Yes (%)	No (%)	<i>P</i> -value*	Yes (%)	No (%)	<i>P</i> -value*
Sex of the child									
Male	42.0	58.0	0.640	8.5	91.5	0.028	3.3	96.7	0.021
Female	43.3	56.7		5.9	94.1		1.8	98.2	
Maternal race/skin colour									
White	44.3	55.7	0.218	6.6	93.4	0.577	1.8	98.2	0.363
Black or brown	42.9	57.1		7.7	92.3		2.8	97.2	
Yellow or indigenous	31.5	68.5		5.8	94.2		3.2	96.8	
Macro-region									
Northern	37.5	62.5	0.317	14.5	85.5	0.004	5.0	95.0	0.056
Northeast	40.9	59.1		6.3	93.7		2.3	97.7	
Southeast	44.8	55.2		6.0	94.0		2.0	98.0	
Southern	45.1	54.9		8.2	91.8		3.2	96.8	
Midwest	40.4	59.6		6.1	93.9		1.8	98.2	
Household food security status [†]									
Food secure	44.6	55.4	0.371	5.7	94.3	0.011	1.9	98.1	0.001
Mild food insecure	41.4	58.6		7.7	92.3		2.4	97.6	
Moderate food insecure	37.4	62.6		9.7	90.3		2.8	97.2	
Severe food insecure	44.9	55.1		13.4	86.6		8.3	91.7	
Adequate sanitation									
Yes	44.8	55.2	0.080	6.0	94.0	0.222	2.0	98.0	0.234
No	39.7	60.3		7.8	92.2		2.9	97.1	
Adequate water supply									
Yes	44.5	55.5	0.069	6.8	93.2	0.415	2.7	97.3	0.277
No	38.2	61.8		8.0	92.0		2.0	98.0	
Household location									
Urban	42.6	57.4	0.954	7.2	92.8	0.777	2.5	97.5	0.577
Rural	42.8	57.2		7.6	92.4		2.9	97.1	
Educational level of the head of the household									
4 years of education or less	38.9	61.1	0.078	10.0	90.0	0.001	3.4	96.6	0.019
5 to 8 years of education	46.5	53.5		8.3	91.7		3.1	96.9	
9 years of education or more	43.8	56.2		3.6	6.4		1.2	98.8	

Numbers in bold indicate statistically significant estimates. **P*-value referring to the chi-square test with statistical significance set at $P < 0.05$. Analyses were performed using sampling weights. [†]As assessed by the Brazilian Household Food Insecurity Measurement Scale (Escala Brasileira de Medida Domiciliar de Insegurança Alimentar. EBIA).

the variables under study (Table 3). The risk of stunting was higher for male than female children, for those living in the Northern compared with those living in the Midwest region, and for pairs living in households where the head of household had low educational level. Multivariable analyses confirmed a lack of association between maternal overweight and any of the socio-economic variables.

The adjusted odds for DBM were 3.33 times higher among households with severe food insecurity compared with their food secure counterparts. Moreover, the association of DBM with male child (OR: 1.96)

and households located in the Northern (OR: 2.98) compared with Midwest region became stronger. DBM was more likely to occur among heads of household with lower compared with higher educational level (OR:2.54) (Table 3).

Hierarchical multivariable analyses (Table 4) showed that the association between DBM and severe HFI remained after controlling for macroeconomic (OR: 4.14) and socio-economic-demographic (OR: 2.65) variables, and when both sets of covariates were included (OR: 3.64).

Table 3. Crude and adjusted odds ratio for maternal overweight, child stunting and double burden of malnutrition for mother/child pairs according to associated factors. Brazilian National Demographic and Health Survey 2006

Associated factors	Presence of maternal overweight		Presence of child stunting		Presence of double burden of malnutrition	
	OR (95%CI)	Adjusted OR (95%CI)*	OR (95%CI)	Adjusted OR (95%CI)*	OR (95%CI)	Adjusted OR (95%CI)*
Child's sex						
Female	1	1	1	1	1	1
Male	0.95 (0.76–1.18)	0.95 (0.76–1.18)	1.47 (1.04–2.09)	1.54 (1.06–2.24)	1.86 (1.09–3.17)	1.96 (1.14–3.38)
Race/skin colour						
White	1	1	1	1	1	1
Black/brown	0.94 (0.75–1.18)	1.03 (0.81–1.30)	1.17 (0.79–1.74)	1.06 (0.67–1.68)	1.55 (0.81–2.94)	1.61 (0.80–3.24)
Yellow/indigenous	0.58 (0.29–1.17)	0.58 (0.29–1.17)	0.86 (0.39–1.90)	0.75 (0.35–1.60)	1.74 (0.56–5.36)	1.64 (0.58–4.69)
Macro-region						
Midwest	1	1	1	1	1	1
Northern	0.89 (0.65–1.22)	0.91 (0.65–1.25)	2.64 (1.70–4.08)	2.36 (1.51–3.70)	2.84 (1.44–5.63)	2.98 (1.38–6.45)
Northeast	1.02 (0.72–1.45)	1.08 (0.75–1.55)	1.04 (0.64–1.68)	0.95 (0.59–1.53)	1.28 (0.62–2.66)	1.33 (0.60–2.92)
Southeast	1.20 (0.89–1.62)	1.23 (0.91–1.66)	0.99 (0.53–1.85)	1.09 (0.58–2.03)	1.10 (0.47–2.58)	1.37 (0.57–3.29)
Southern	1.21 (0.90–1.63)	1.23 (0.91–1.67)	1.39 (0.86–2.23)	1.47 (0.92–2.36)	1.76 (0.82–3.79)	2.20 (0.99–4.88)
Household food security status [†]						
Food secure	1	1	1	1	1	1
Mild food insecure	0.88 (0.66–1.16)	0.92 (0.69–1.24)	1.39 (0.85–2.3)	1.23 (0.73–2.09)	1.26 (0.61–2.61)	1.10 (0.51–2.36)
Moderate food insecure	0.74 (0.51–1.08)	0.84 (0.57–1.23)	1.79 (1.09–2.93)	1.40 (0.82–2.37)	1.47 (0.73–2.94)	1.16 (0.56–2.41)
Severe food insecure	1.01 (0.64–1.61)	1.26 (0.79–2.03)	2.58 (1.44–4.62)	1.75 (0.96–3.18)	4.56 (2.11–9.82)	3.33 (1.41–7.84)
Adequate water supply						
Yes	1	1	1	1	1	1
No	0.77 (0.58–1.02)	0.81 (0.59–1.01)	1.19 (0.79–1.79)	1.17 (0.74–1.86)	0.73 (0.41–1.30)	0.69 (0.39–1.24)
Household location						
Urban	1	1	1	1	1	1
Rural	1.01 (0.70–1.45)	1.10 (0.77–1.57)	1.06 (0.70–1.62)	0.82 (0.55–1.22)	1.17 (0.67–2.03)	0.94 (0.56–1.58)
Educational level of the head of the household						
4 years of education or below	0.82 (0.62–1.07)	0.85 (0.65–1.12)	3.01 (1.80–5.04)	2.71 (1.48–4.94)	2.97 (1.37–6.43)	2.54 (1.10–5.89)
5 to 8 years	1.12 (0.84–1.48)	1.13 (0.84–1.52)	2.45 (1.39–4.23)	2.30 (1.25–4.24)	2.71 (1.20–6.13)	2.53 (1.14–5.65)
9 years of education or more	1	1	1	1	1	1

Numbers in bold indicate statistically significant estimates. *OR, odds ratio; CI, confidence interval; Adjusted OR, adjusted odds ratio; logistic regression adjusting for sex of the child, macro-region, food security status, household location and educational level of the head of the household. Analyses were performed using survey weights. [†]As assessed by the Brazilian Household Food Insecurity Measurement Scale (Escala Brasileira de Medida Domiciliar de Insegurança Alimentar. EBIA).

Discussion

The results of this study show that the coexistence of child undernutrition and maternal overweight (characterized here as DBM) in the same household in Brazil is not as frequent as in other countries (Lee et al., 2012; Freire et al., 2014; Sarmiento et al., 2014). This low prevalence of DBM was found in a previous study and was expected given the very advanced stage of the nutrition transition in Brazil, where women are experiencing weight gain from one generation to the next that exceeds the height gain rate (Conde & Monteiro, 2014).

Household food insecurity as a risk factor for double burden of malnutrition

Our study confirmed our primary hypothesis that severe HFI was significantly associated with the DBM in Brazil. Even after controlling for covariates related to DBM, severe HFI remained as the main factor associated with DBM. Previous studies showed an association between economic variables and the existence of DBM (Lee et al., 2012), but the association between DBM and food insecurity had not been explored in previous studies emphasizing the innovative nature of our findings.

Table 4. Crude odds ratio for double burden of malnutrition according to food security and adjusted for groups of factors related to food insecurity and maternal nutritional status

OR for double burden of malnutrition	Household food security status			
	Secure	Mild food insecurity	Moderate food insecurity	Severe food insecurity
Crude OR (95% CI)	1	1.26 (0.61–2.61)	1.47 (0.73–2.94)	4.56 (2.11–9.82)
Adjusted OR – macroeconomic variables (95% CI)*	1	1.29 (0.61–2.70)	1.45 (0.74–2.84)	4.14 (1.80–9.54)
Adjusted OR – socio-economic and demographic variables (95% CI) [†]	1	1.02 (0.47–2.23)	1.04 (0.48–2.22)	2.65 (1.17–6.04)
Adjusted OR (95% CI) [‡]	1	1.11 (0.52–2.40)	1.22 (0.59–2.56)	3.64 (1.55–8.53)

Adjusted OR, OR adjusted odds by logistic regression. All analyses were performed using survey weights. *Food security adjusted for macroeconomic variables: household location and administrative macro-region. [†]Food security adjusted for socio-economic and demographic variables: race/skin colour, maternal age, maternal parity and educational level of the head of the household. [‡]Food security adjusted for macroeconomic, socio-economic and demographic variables.

Food and nutritional insecurity, especially when reaching severe levels, has been shown to be a key factor associated with maternal overweight (Franklin et al., 2012; Santos, 2013) and child stunting (Ali et al., 2013; Felisbino-Mendes et al., 2014). HFI is determined by socio-economic factors and leads to other vulnerabilities related to food access, such as overweight in adult women and malnutrition in children, a condition that influences their growth, cognitive development and overall health (Gundersen & Ziliak, 2015). The association between HFI and DBM may be related to low-dietary quality including low food variety and high-energy density (Shamah-Levy et al., 2014). Maternal stunting during childhood may also underlie the association between severe HFI and DBM in the same household (Felisbino-Mendes et al., 2014). Mothers having experienced stunting early in life and who remain stunted have a higher chance of developing overweight in adulthood perhaps because of epigenetic factors (Reinhardt & Fanzo, 2014) that were not examined in our study.

We acknowledge as a limitation of our study that HFI measured in the last 3 months preceding the survey may have been different from when stunting in children and maternal obesity developed earlier in life. Thus, prospective studies are needed to better understand the nature of the HFI–DBM association detected in our study. However, it is important to acknowledge that previous prospective studies have shown an association between excessive weight gain and HFI among adults (Cheung et al., 2015) and between stunting and HFI in children (Saha et al., 2009). Another limitation of

our study is that we did not have enough statistical power to test for interactions between HFI and each one of the covariates as there were only 140 pairs with DBM.

Other factors associated with the double burden of malnutrition

In addition to HFI, sex (male), Northern region and lower educational level of the head of the household were also associated with DBM.

The difference in the prevalence of DBM among the Brazilian macro-regions reflects the well-known country's social and economic inequalities. The highest prevalence of DBM was found in the Northern region, which has the worst socio-economic indicators and the highest prevalence of HFI (Instituto Brasileiro de Geografia e Estatística, 2014) and stunting (Instituto Brasileiro de Geografia e Estatística, 2010; Ministerio da Saude, 2009) and a high prevalence of overweight among women (46.7%) (Instituto Brasileiro de Geografia e Estatística, 2010).

The results of the present study show that the risk of DBM is higher in households where the head has lower education levels. This was expected, as educational level is a strong social determinant of health. It is also important to recognize that the annual increment in obesity rates among Brazilian women between the years of 1974–2009 was always higher for the bottom household income quintile compared with the highest (Conde & Monteiro, 2014). For stunting, as expected,

the prevalence is higher among the poorest households (Instituto Brasileiro de Geografia e Estatística, 2010).

Comparison of risk factors for maternal overweight, child stunting and double burden of malnutrition

There were no socio-demographic covariates associated with maternal overweight. Previous studies had shown that in Brazil women's overweight is not associated with severe HFI (Velasquez-Melendez et al., 2011) and its prevalence is similar across income quintiles (45.0% in the bottom and 47.4% in the upper quintile so that it reads upper quintile) (Instituto Brasileiro de Geografia e Estatística, 2010).

The covariates associated with stunting were the same as those for DBM: child sex (male), region (Northern) and lower education level of the head of household. These data lead us to hypothesize that perhaps stunting of the index child may reflect maternal stunting since childhood which in turn is a risk factor for maternal overweight (Gluckman et al., 2011). A study using data from 54 Demographic Health Surveys conducted in different countries between 1991 and 2009 had previously shown that maternal overweight is the principal predictor for DBM, but when maternal overweight is held constant, child stunting becomes a positive predictor of DBM prevalence (Dieffenbach & Stein, 2012). In our study, child stunting seems to be the key-risk factor for the occurrence of DBM. It is possible that the well-documented intergenerational transmission of obesity risk from mother to children through epigenetic mechanisms (Gluckman et al., 2011) helps explain these findings. As the maternal-child obesity cycle has been proven to be hard to break (Gluckman et al., 2011), the coexistence of maternal overweight and child stunting in the same household can be reflecting this kind of epigenetic accommodation.

Conclusion

In Brazil, severe HFI is associated with the occurrence of DBM. Future longitudinal studies are needed to understand the factors and complex pathways linking HFI with DBM risk. These studies can also help to understand how early childhood chronic malnutrition interact with maternal overweight/obesity to increase the long-term risk of obesity in the offspring.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

MBG, RP-E and AMS-C designed the research; MBG and AMS performed statistical analysis; RP-E and AMS-C supplied technical assistance and advice; MBG, AMS, RP-E and AMS-C wrote the paper, and MBG had primary responsibility for the final content. All authors read and approved the final manuscript.

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