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Household food insecurity and early childhood development in Brazil: an analysis of children under 2 years of age

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Abstract

Objective: To determine if household food insecurity (HFI) is associated with the risk of developmental delays.
Design: Cross-sectional study of a representative sample of children under 2 years old. Risk of developmental delays was assessed with the Denver Developmental Screening Test II. HFI was measured with the Brazilian Food Insecurity Measurement Scale. Multivariable logistic regression was used to test the association between HFI (food secure/insecure) and risk of developmental delays, adjusting for household, maternal and child variables.
Setting: Community Health Centers in the Federal District, Brazil.
Participants: 1004 children under 2 years old.
Results: Among participants, 15 % were at risk of developmental delays and about 40 % of children lived in food-insecure households. HFI was associated with the risk of developmental delays (adjusted OR 2·61; 95 % CI 1·42, 4·80) compared with food-secure households after adjusting for key confounders.
Conclusions: HFI was strongly associated with the risk of developmental delays in children under 2 years. Investments that prevent or mitigate HFI are likely to be key for improved human and national development.

Keywords
Household food insecurity
Early childhood development
Language
Motor skills
Personal-social

Investing in early childhood development (ECD) is linked with better health, human capital and lifelong well-being[1–4]. Despite advances in improving child survival, millions of children are at risk of not reaching their full development potential, especially in low- and middle-income countries[5]. According to UNICEF's Early Childhood Development Index, 33 % of children in low- and middle-income countries have low cognitive and/or socioemotional development[1]. This may be a result of the continued exposure to multiple adversities such as poverty, violence and household food insecurity (HFI) that affect brain architecture by limiting child's social, cognitive and emotional development, causing negative impacts throughout their life[6–12].

HFI is the lack of regular access to enough safe and nutritious food for normal growth and development and an active and healthy life[13]. Over one-quarter (25·9 %) of the world population has been found to experience moderate and severe HFI[14]. In Brazil, more than a third of the population (36·7 %) have HFI and almost one in two young children (49·9 %) live in food-insecure households[15]. HFI has been associated with poor health outcomes in children; e.g. children had a greater likelihood of having cough and being hospitalised for diarrhoea[16,17]. Furthermore, HFI has been linked to food scarcity[18,19], poor diet quality[20,21], psycho-emotional stress[7] and poor maternal mental health[22–24] – all of which are also risk factors for poor ECD. Literature reviews have consistently found that HFI, even at mild levels, is negatively associated with developmental outcomes[8,25] compared with children living in food-secure households[7]. A comprehensive systematic review and meta-analysis found that HFI was associated with developmental risk and poor math skills in high-income countries and with poor vocabulary skills in low-, middle- and high-income countries[26].

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Recent evidence from a pooled analysis of thirteen low- and middle-income countries found that low birth weight, preterm birth and anaemia in infancy were significant risk factors for poorer cognitive and motor development[27]. In addition, parental factors such as low maternal education and short maternal stature have been positively associated with cognitive, motor and language development scores, but HFI was not investigated as a risk factor[27]. There is a lack of evidence exploring the association between HFI and risk of developmental delays, specifically among young children under 2 years of age. Focusing on children under 2 years is important due to their brain plasticity. In the first years of life, the brain is more prone to changes in responses to environmental experiences and adapts to adversities experienced, setting either a positive or a negative developmental trajectory for life[28–31]. This study aimed to fill this gap by evaluating the association between HFI and risk of developmental delays among Brazilian children under 2 years of age.

Methods

Sampling and data collection

This is a cross-sectional study conducted in Community Health Centers (CHC) in the Federal District, Brazil. The sampling process included two stages. In the first stage, twenty out of 131 existing CHC that monitor child growth and development in the Federal District were randomly selected. In the second stage, the number of children to be included in each CHC was estimated based on self-weighted sampling stratified into two age groups (0–12 and 12–24 months). The study sample was designed to be a representative of children attending primary care visits in the Federal District. Assuming a confidence level of 95 %, an error of 5 % and considering a maximum sample loss of 10 %, the minimum sample size calculated was 856 mother–child dyads. Full-term children up to 2 years of age accompanied by their biological mothers were eligible for the study. Preterm, twins or children with congenital malformations or diagnosed pathologies that impact on physical or cognitive development were not included in the study. Children with previous medical diagnosis of developmental delays or who had undergone major surgery were excluded from the study.

In the selected CHC, on the days of data collection, a trained research assistant invited mothers and their children under 2 years of age to participate in the research. The data collection instrument included closed-ended questions related to the children and mother's socio-economic, demographic and biomedical profiles as well as standard tools for assessing the ECD and HFI. Data were collected between March 2017 and March 2018. Quality control was carried out with a random subsample of 20 % of the sample, through the replication of three different questions by telephone within 4 weeks after participating in the research.

Measurements

Outcome variable

ECD was assessed using the Denver Developmental Screening Test II (DDSTII)[32]. This tool had been previously translated and adapted in Brazil[33]. DDSTII assesses the child's risk of developmental delays across the four domains: personal-social (child's socialisation skills inside and outside the family environment); fine motor (hand eye coordination skills and small object manipulation); language (sound emission and ability to recognise, understand and use language) and gross motor (body motor control and ability to perform broad muscle movements)[34]. According to the DDSTII, developmental skills were classified as normal (0 item performed as delay for age and ≤1 item performed as caution for age) or suspect (≥1 item performed as delay for age and/or ≥2 items performed as caution for age)[32,34]. The outcome considered in this study was the risk of developmental delays which included children who had suspect performance across one or more developmental domains.

ECD was evaluated in a private room in the selected CHC by previously trained researchers. To ensure accuracy when applying the test, the researchers answered a self-administration checklist of DDSTII[34] during the first ten evaluations. Concurrent examiner–observer reliability was determined in a random subsample of 5 % of the sample, and interobserver reliability analysis was performed by agreement on the classification of developmental skills ($\kappa = 0{\cdot}62$, $P < 0{\cdot}0001$).

After the assessment, mothers of children found to be at risk of developmental delays were offered information about early life actions to foster ECD, such as adequate stimulation, strengthening caregiver/child bonds and healthy eating practices. In addition, mothers were encouraged to discuss these results in the follow-up appointment with the child's paediatrician.

Independent variable

HFI was measured with the experience-based Brazilian Food Insecurity Measurement Scale (Escala Brasileira de Insegurança Alimentar, EBIA), which contains fourteen questions about experiencing HFI in the previous 90 d[15]. EBIA is a reliable and valid scale derived from the Household Food Security Survey Module and is the official household food security measure in Brazil[15,35]. In this study, the additive score of affirmative responses to EBIA's items was used to classify households as food secure (0) and food insecure (1–14) (initially recoded as mild, moderate or severe HFI, and subsequently recoded as food secure *v.* HFI due to sample size limitations)[15].

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Covariates

The covariates or potential confounders were selected based on theoretical grounds and empirical evidence supporting their associations with both HFI and ECD[27]. The household variables included were head of household (mother, other (i.e. both parents, father, grandparents)), participation in any social government programme (yes, no), number of children under 5 years of age at home (1, ≥2) and number of rooms in the home (1, ≥2). The maternal variables included were educational level (≤8 years, ≥9 years), employment status (working outside home, not working outside home/on maternity leave), parity (nulliparous, multiparous), interpregnancy interval (<2 years, ≥2 years), type of delivery (vaginal, caesarean), early initiation of prenatal care (≤12 weeks of gestation) (yes, no) and the habit of drinking alcoholic beverages during pregnancy (yes, no). The child variables were age (<12 months, 12–24 months), gender (male, female), skin colour (white, other), low birth weight (≤2·500 g) (yes, no), hospitalisation for any health problem in the previous year (yes, no), breast-feeding (yes (still breastfed), no (never breastfed or stopped breast-feeding)), food allergy/intolerance (yes, no), bottle feeding in the previous 24 h (yes, no) and pacifier use in the previous 24 h (yes, no).

Statistical analysis

The analytical sample of this study was 1004 children under 2 years of age. Out of the 1285 mothers who answered the survey, 87 (6·7 %) refused to participate, 33 (2·6 %) were excluded because ≥10 % of data missing of the total number of variables, 95 (7·4 %) had missing information on ECD or HFI, 33 (2·6 %) had untestable results according to the DDSTII assessment (i.e. refusal ≥1 item performed as delay for age or >1 item performed as caution for age), 20 (1·5 %) had previous medical diagnosis of developmental delays and 13 (1·0 %) had a major surgery. Potential confounders were collected from all invited mothers. The characteristics of the participants with complete data compared with the participants who refused to participate or had incomplete data were similar for key potential confounders such as maternal age, maternal educational level and child's age.

Analyses were conducted with the Statistical Package for the Social Sciences software (IBM SPSS, version 21.0). Descriptive analyses of the outcome, independent variable and covariates were performed. Bivariate analyses were conducted to verify the association between risk of developmental delays, HFI and covariates using χ^2 test. Covariates were selected for inclusion in a multivariable model when the association had a $P < 0{\cdot}20$ in the bivariate analyses. Multivariable logistic regression coefficients examining the association of HFI with the risk of developmental delays were expressed as unadjusted and adjusted OR and corresponding 95 % CI. In all analyses, HFI was modelled as a dichotomous variable (household food secure *v.* food insecure).

Results

Descriptive statistics of the sample are showed in Table 1. A total of 15·1 % of the children were at risk of developmental delays. Nearly 40 % of children lived in food-insecure households (Table 1).

Bivariate analyses indicated that the prevalence of risk of developmental delays was higher among children living under conditions of HFI than among children in food-secure households (55·9 % *v.* 44·0 %, respectively). Mother-headed households, short interpregnancy interval, child's age (more than 12 months) and low birth weight were associated with a higher prevalence of risk for developmental delays (Table 1).

Unadjusted analyses indicated that HFI was negatively associated with the risk of developmental delays (OR 2·17; 95 % CI 1·53, 3·08). Multivariable logistic regression confirmed a strong negative association between HFI with the risk of developmental delays after adjusting for confounders (adjusted OR 2·61; 95 % CI 1·42, 4·80) (Table 2).

Discussion

This study found that HFI is an independent risk factor for poor ECD outcomes among Brazilian children under 2 years of age. Our findings fill an important knowledge gap given the scarcity of literature focusing on HFI and ECD during the first 2 years of life, which is a highly sensitive period for brain development[36,37]. Furthermore, our results documenting the independent association between HFI and risk of developmental delays among Brazilian children are consistent with findings from previous studies conducted in high-income countries[7,8,25], indicating that HFI is associated with increased risk of developmental delays across contrasting socio-economic and cultural contexts. Our results are also consistent with previous studies that found young children living in food-insecure households have an increased chance for risk of developmental delays[7,8,25,26].

The prevalence of risk for developmental delays found in our study is similar to prior US-based research examining ECD outcomes among children under 3 years of age (range: 14·0 %[38] to 15·2 %[39]) and 4 years of age (11·5 %)[40]. Our findings are consistent with previous estimates of risk for poor development in Brazil (range: 11 % to 14 %) based on the prevalence of stunting among children younger than 5 years and poverty ratios in 2010[5]. Likewise, the prevalence of HFI found in

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Table 1 Descriptive characteristics and prevalence of risk of developmental delays of children under 2 years and their mothers by household–maternal–child characteristics (*n* 1004). Federal District, Brazil, 2018

			Risk of developmental delays		
Variables	*n*	%	%	*n*	*P*
Outcome variable					
Risk of developmental delays					
No	852	84·9	–		
Yes	152	15·1	–		
Independent variable					
Food secure	605	60·3	44·1	67	<0·0001*
Food insecure	399	39·7	55·9	85	
Covariates					
Household variables					
Head of household					
Mother	148	14·8	22·4	34	<0·01*
Other	853	85·2	77·6	118	
Participation in any social government programme					
Yes	206	20·5	22·4	34	0·54
No	798	79·5	77·6	118	
Number of children under 5 years of age at home					
1	730	72·7	71·1	108	0·61
≥2	274	27·3	28·9	44	
Number of rooms in the home					
1	255	25·4	27·6	42	0·49
≥2	749	74·6	72·4	110	
Maternal variables					
Educational level (years)					
≤8	225	22·5	26·5	40	0·19
≥9	777	77·5	73·5	111	
Employment status					
Working outside home	182	18·4	23·7	36	0·06
Not working outside home/on maternity leave	807	81·6	76·3	116	
Parity					
Nulliparous	485	48·3	50·0	76	0·65
Multiparous	519	51·7	50·0	76	
Interpregnancy interval (years)					
<2	36	7·0	22·7	17	<0·0001*
≥2	478	93·0	77·3	58	
Type of delivery					
Vaginal	563	56·1	50·0	76	0·09
Caesarean	440	43·9	50·0	76	
Early initiation of prenatal care					
Yes	793	79·6	76·5	114	0·30
No	203	20·4	23·5	35	
Habit of drinking alcoholic beverages during pregnancy					
Yes	82	8·2	11·8	18	0·07
No	921	91·8	88·2	134	
Child variables					
Age (months)					
<12	636	63·3	55·3	84	<0·05*
12–24	368	36·7	44·7	68	
Gender					
Male	507	50·5	53·3	81	0·45
Female	497	49·5	46·7	71	
Skin colour					
White	381	38·0	36·8	56	0·75
Other	622	62·0	63·2	96	
Low birth weight					
Yes	38	4·1	9·8	13	<0·0001*
No	884	95·9	90·2	120	
Hospitalisation for any health problem in the previous year					
Yes	87	8·7	11·2	17	0·23
No	914	91·3	88·8	135	
Breast-feeding					
Yes	806	80·3	77·6	118	0·37
No	198	19·7	22·4	34	
Food allergy/intolerance					
Yes	36	3·7	6·2	9	0·08
No	940	96·3	93·8	136	

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Table 1 *Continued*

Variables	*n*	%	Risk of developmental delays %	*n*	*P*
Bottle feeding in the previous 24 h					
Yes	453	45·2	50·7	77	0·14
No	550	54·8	49·3	75	
Pacifier use in the previous 24 h					
Yes	305	30·5	27·2	41	0·33
No	453	69·5	72·8	110	

*$P < 0·05$.

Table 2 Unadjusted and adjusted OR and 95 % CI for early childhood development outcomes according to household food insecurity status (*n* 1004). Federal District, Brazil, 2018†

	Risk of developmental delays			
	Unadjusted OR	95 % CI	Adjusted OR	95 % CI
HFI				
Food secure (ref.)	1		1	
Food insecurity	2·17	1·53, 3·08**	2·61	1·42, 4·80*

*$P < 0·01$.
**$P < 0·001$.
†Logistic regression analysis was performed. Risk of developmental delays was adjusted for maternal educational level, employment status, head of household, type of delivery, interpregnancy interval, habit of drinking alcoholic beverages during pregnancy, child's age, low birth weight, food allergy/intolerance and bottle feeding in the previous 24 h.

our study was similar to the Brazilian nationally representative estimates for households with children <4 years of age. In 2017–2018, 49·9 % of Brazilian households with children <4 years old were found to be living in households with mild, moderate or severe food insecurity[15].

The association between HFI and risk of developmental delays among children under 2 years of age in Brazil, which is an upper-middle income country, is consistent with prior studies in high-income[26,38–40] and low-middle income settings[26,41,42]. HFI can negatively impact the development of children and the well-being of caregivers in different ways. First, childhood hunger and/or inadequate nutrition can lead to micronutrient deficiencies, as well as lack of energy or increased fatigue, distraction and irritability[6,11]. As a result, children exposed to food insecurity can become less active and reduce the level of nurturing interactions with their caregivers. In return, this limits their opportunities to explore the environment, compromising their gross motor as well as their social and language development[6,11]. Prior evidence has demonstrated that motor development is closely linked to language development, i.e. motor skills enable the child to interact with the environment and this interaction is required by the child to develop proper language skills[43]. Second, HFI can compromise parental well-being, including maternal mental health[7,44–46], and interferes with parent–child interactions and the emotional environment at home[47,48], which may lead to delays in ECD due to poor interaction between child and caregivers[7,8]. In summary, the nutrition- and psycho-emotional stress related to HFI may lead to a lack of responsive and stimulating care by caregivers[37,49], limiting early stimulation and learning opportunities needed for proper child development, including activities such as talking to children, telling stories, playing and well-supervised explorations of environments outside the home[50].

Regarding the association between HFI with the risk of developmental delays, some limitations must be considered when interpreting our findings. First, we acknowledged that the limited sample size influenced the somewhat wide CI in the relationship between HFI and delayed ECD multivariable analysis. Du Prel *et al.* (2009)[51] emphasise three types of information provided by CI: (i) the direction of the effects; (ii) its strength and (iii) the presence of a statistically significant result. Through this lens, our findings are innovative and useful as they show the direction of the associations between HFI and risk of ECD delays in very young children in a middle-income country where data on ECD are scarce. Furthermore, our findings can be used for postulating clinical and policy hypotheses that can be tested through studies with larger sample sizes. Second, due to the cross-sectional nature of our data, no causal relationships between ECD outcomes and independent variable can be established. In our study, ECD outcomes were assessed at the individual level, while HFI was measured at the household level. Therefore, individuals in the same household may experience different levels of food insecurity. Previous literature has indicated that in homes with children, parents tend to protect them from food insecurity by ensuring they have food[52–54], yet young children may experience poor cognitive outcomes as a consequence of adults experiencing food insecurity[55]. Our findings add to the literature that suggests that HFI is a stressor in children, even when HFI was reported by adults in the household. Further studies need to be conducted to better understand the direct and indirect effects of HFI through nutrition and psycho-emotional stress pathways on ECD outcomes[7].

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When interpreting our findings, it is important to note that HFI is an important but not the only factor influencing the risk of developmental delays. One strength of our analyses is the inclusion of known confounders in the multivariable analysis. However, we acknowledge that additional confounders influencing the relationship between HFI and poor ECD were not assessed in our study, e.g. caregivers' stress and mental health problems (maternal anxiety and depression), micronutrient deficiency and lower-quality home environment (lack of stimulating objects, books and play materials). Last, because we focused on children who received services through the Universal Health Care System (SUS) in Brazil, which targets families with low incomes, our study may have overestimated the prevalence of HFI and ECD risks. Nevertheless, our results add to the emerging evidence previously showing in other contexts that HFI is a risk factor for developmental delays among children under 2 years of age.

Supporting household food security during infancy and toddlerhood, a highly sensitive period for the development of synapses or neural networks[28], can help improve the chances that children will have the opportunity to reach their full development potential[56]. Hence, we call for food security interventions and policies targeting children and families to ensure that they routinely prioritise pregnancy and the early years of postnatal life. This recommendation is consistent with the UN's Sustainable Development Goals, which include achieving food security and the full potential development of young children as an international priority for the twenty-first century[56,57]. It is also consistent with recent evidence-based recommendations[29,58,59] emphasising that effective interventions which integrate child's health, development and well-being must be designed and implemented considering all the nurturing care dimensions. Promoting ECD under nurturing care includes supporting parents, caregivers and families that provide responsive and stimulating care to meet the needs for healthcare, nutrition/food security, education, social protection and child protection[29]. Additionally, consistent with American Academy of Pediatrics recommendations, HFI and ECD surveillance and screening during visits to CHC may assist paediatricians and other healthcare professionals to identify children who are at risk of developmental delays and the lifelong implications they carry with them[60–63].

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