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Sex differences in the relationship between food insecurity and weight status in Brazil

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Abstract

Obesity and undernutrition are manifestations of malnutrition that affect many people worldwide. A lack of access to food may explain the association of food insecurity (FI) with both undernutrition and obesity, but there are other factors that are specifically related to obesity. Studies have also found that FI is related to both overweight and obesity among women but not among men. The present study aimed to evaluate the association between FI and weight status among adults from a nationally representative sample of Brazil and to consider the impacts of sex. Data from the 2017–2018 Household Budget Survey (*n* 28 112), a national cross-sectional study, were analysed using the Brazilian Household FI Scale (EBIA) and BMI (measured in kg/m^2) by individual self-reported weight and height. Associations were estimated by OR with 95 % CI considering a multinomial logistic regression model. Women with severe FI were more than twice (OR = 2·36) as likely to be underweight and had a higher frequency of obesity (OR = 1·39). Among men, severe FI status was a protective factor for overweight (OR = 0·58) and obesity (OR = 0·61). In conclusion, FI was a risk factor for underweight and obesity among women but not among men.

Keywords: **Obesity: Overweight: Underweight: Food insecurity: Brazil**

Food insecurity (FI) is defined as a lack of access to a sufficient amount of nutritious food and is a potential risk factor for adult malnutrition[1]. Paradoxically, FI has been associated with obesity in many countries, including Brazil[2–4].

The prevalence of obesity has continually increased in Brazil. The last National Health Survey, published in 2019, showed increased rates of overweight and obesity – 34·4 and 25·9 %, respectively[5] – with the prevalence of obesity being higher among women (29·5 %) than among men (21·8 %). The prevalence rates in Brazil are much higher than the current worldwide prevalence rates of 25·8 and 13·1 % for overweight and obesity, respectively[6].

'The Global Syndemic' is a recently developed conceptual frame that embraces the coexistence and synergy of three pandemics: obesity, undernutrition and climate change. Obesity and undernutrition are manifestations of malnutrition that, together with climate change, affect most people in all countries and regions of the world due to issues in food production, food transport and marketing, urban design and land use[7]. This conceptual framework may explain the association of FI with both undernutrition and obesity, but there are other factors that are specifically related to obesity, such as living in a disadvantaged neighbourhood with less access to adequate food[8–10], binge-eating disorders,[11] the affordability of high-energy foods, consuming processed foods[12], the resource scarcity hypothesis[2] and the insurance hypothesis[13].

The resource scarcity and insurance hypotheses are related to an increased need for energy intake among individuals living in poverty, leading to a *perception* that the food supply is inadequate or low, even when high-energy foods are available[2,13]. The resource scarcity hypothesis is also related to high metabolic efficiency among chronically disadvantaged populations[2]. However, not all individuals living with FI and individuals with some access to high-energy foods are at risk of obesity. There is no association between FI and obesity among men[14,15]; the positive association between FI and obesity has mostly been observed among adult women living in high-income countries[16,17]. Studies from Brazil have also found that FI has a relationship with both overweight and obesity among women but not among men[18–21].

Evidence indicates that after the trend of decreasing FI among the years 2004, 2009 and 2013 in Brazil, the results obtained by the National Dietary Survey (NDS) carried out between 2017 and 2018 were marked by a reduction in the prevalence of Brazilian private households that had access to adequate food[22]. A total of 36·7 % of the households registered in the country were living with some degree of FI, that is, families who were concerned

Abbreviations: FI, food insecurity; FS, food security.

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about the possibility of restrictions due to the lack of resources to purchase more food or had not quality and/or the amount of food consumed[22].

Due to the increase in obesity rates, mainly among women in Brazil, a recent increase in FI, and the importance of understanding this seemingly paradoxical relationship, the present study aimed to evaluate the association between FI and weight status among adults from a nationally representative sample of Brazil and to consider the impacts of sex.

Methods

Study design

The present cross-sectional study was based on the NDS, which was administered by the Brazilian Office of Geography and Statistics (IBGE) from 2017 to 2018 as a part of the Household Budget Survey. The study adopted a two-stage cluster sample design. In the first stage, census tracts were randomly selected; in the second stage, households were selected by simple random sampling within the selected census tracts. Census tracts were grouped into household strata with geographical and socio-economic homogeneity, and the number of tracts in each stratum was proportional to the number of households in the stratum. Household visits in each stratum were uniformly distributed throughout the 12 months to encompass seasonal variations in food intake and prices. The sample represented five regions of the country (the North, Northeast, Southeast, South and Midwest), urban and rural areas, and different socio-economic levels. The number of households selected was 20 112, and all individuals aged 10 years or older (46 164) were included in the dietary survey. In this article, we included only adults (20–59 years old) and excluded pregnant and lactating women, yielding a final sample of 28 112 individuals.

The subsample allowed separated analysis estimates for the construction of results for the five major regions of the country (North, Northeast, Southeast, South and Central-West). Detailed information on the Integrated System of Household Surveys is available from the IBGE[23].

Data collection

FI was assessed with a validated Brazilian questionnaire[24]. Trained interviewers met residents face-to-face and used portable computers for registration and data entry. The database was subjected to data quality control by trained technical staff to assess the coherence of the information. Further details of the sample design, the total number of primary sampling units interviewed by state, data quality control and the imputation of variables are described in the IBGE official report[23]. Information on the socio-demographic characteristics of the household members, such as age, education level of the head of the family and income level of the household, was also collected.

The BMI (kg/m^2) of the participants was calculated based on their self-reported weight and height. Using the WHO cut-off points[25], BMI was classified into the following categories: underweight (BMI < 18·5 kg/m^2), normal weight (BMI 18·6–24·9 kg/m^2), overweight (BMI 25–29·9 kg/m^2), obese grade 1 (BMI 30–34·9 kg/m^2), obese grade 2 (BMI 35–39·9 kg/m^2) and obese grade 3 (BMI ≥ 40 kg/m^2).

Assessment of household food insecurity

The Brazilian Food Insecurity Scale (EBIA) was used to classify the households into the following mutually exclusive food security (FS) or FI categories using the recommended cut-off points for households[24]: FS (when the family/household had regular and permanent access to quality food at an adequate amount); mild FI (concern or uncertainty about access to food in the future); moderate FI (a quantitative reduction of food among adults and/or a disruption in eating patterns resulting from a lack of food among adults) and severe FI (a quantitative reduction of food among adults and among those under 18 years of age, that is, a disruption in eating patterns resulting from a lack of food among all household members; in this situation, hunger was a lived experience at home). The EBIA consists of fourteen dichotomous questions ('yes' or 'no'), including eight items that apply only to households with adults (19 years old or older) and six items that apply to households with children and/or adolescents[23]. The scale was completed by the reference person in the family who was responsible for the purchasing and preparation of meals.

Other variables

The analyses included information about self-reported skin colour (white, black, brown, other), years of schooling (≤4, 5–8, ≥9 years), per capita family income (<0·5 minimum wage, 0·5–1 minimum wage, > 1 minimum wage; the categories were defined by converting the values of the Brazilian minimum wage in dollars: 1 dollar ≈ 3·31 Brazilian reals in 2017–2018/minimum wage = US $288·21), geographical region (North, Northeast, Southeast, South, Central-West) and location of the household (urban, rural).

Analyses

To test the interaction of sex in the relationship between FI and weight status, a variable sex × FI was included in the model. *P*-value < 0·05 indicates a possible effect modification. In the first step, the prevalence and CI for each socio-economic variable were estimated, using the χ^2 test to compare the relationship to the FS/FI strata and weight status separately. The variables with a level of significance in the first analysis, defined as a $P < 0{\cdot}20$, were included in the multivariable analysis. The decision to adopt a more conservative level of statistical significance followed the recommendations used in the literature[26]. In the second step, a multinomial regression model was used to verify the variables associated with the FS/FI strata (mild FI, moderate FI, severe FI) and weight status by men and women and to adjust for covariates. The data are expressed as OR and 95 % CI. The '*svy*' command of Stata 16 was used to account for the complex sample design[27].

Table 1. Sample size, household food security and insecurity* weighted prevalences (%) according to socio-demographic characteristics. National Dietary Survey (NDS). Brazil, 2017–2018
(Percentages)

Socio-demographic characteristics	Sample size	Food security %	Food insecutiry			*P*†
			Mild %	Moderate %	Severe %	
Age						
20–29·9	6651	57·9	28·0	9·4	4·7	<0·001
30–39·9	7584	57·5	31·4	7·2	3·9	
40–49·9	7269	59·7	25·8	9·2	5·3	
50–59·9	6608	63·5	22·6	9·4	4·5	
Sex						
Men	13 317	60·4	26·2	8·7	4·6	<0·001
Woman	14 795	58·6	28·1	8·8	4·5	
Skin colour						
White	10 341	70·0	22·0	5·4	2·6	<0·001
Black and Brown	17 465	51·4	31·2	11·4	6·0	
Others	306	69·0	18·5	6·5	6·0	
Years of schooling						
≤4	4140	41·7	30·6	16·4	11·3	<0·001
5–8	6076	51·0	30·5	11·3	7·2	
≥9	17 896	64·9	25·6	6·8	2·7	
Per capita family income (minimum wage‡)						
<0·5	5366	27·5	39·6	20·7	12·2	<0·001
0·5–1	7837	47·3	35·8	11·0	5·9	
> 1	14 909	73·1	20·2	4·7	2·0	
Geographical region						
North	4121	38·0	32·8	17·2	12·0	<0·001
Northeast	9708	46·6	32·0	14·1	7·3	
South	7016	65·0	26·5	6·1	2·4	
Southeast	3693	76·9	18·1	3·0	2·0	
Midwest	3574	63·4	25·2	6·9	4·5	
Household area						
Urban	21 825	61·2	26·7	8·0	4·1	<0001
Rural	6287	49·0	29·9	13·5	7·6	

* According to the Brazilian Household Food Insecurity Measurement Scale[24].
† *P* values refer to the χ^2 test for differences in proportions.
‡ Minimum wage in 2017–2018 = US $288·21.

Results

The prevalence of FS was highest among the oldest group, males and white people with higher levels of schooling and income. Considering the Brazilian regions, the prevalence of FS in the Southeast, which is the richest region of the country, was approximately twice as high as that in the North (Table 1).

Regarding the weight status of individuals, there was an increasing prevalence of overweight, obesity grade 1 and obesity grades 2 + 3 with age. Women had a greater prevalence of underweight and obesity grades 2 + 3 than men. A higher level of education was associated with a lower prevalence of overweight and obesity grades 2 + 3. The prevalence of overweight and obesity grades 2 + 3 was greater in urban areas than in rural areas (Table 2).

Figure 1 shows the prevalence of the weight status categories according to the FS/FI strata and sex. The weighted prevalence of underweight was lower than 6 %, but among both men (Fig. 1(a)) and women (Fig. 1(b)), it increased with increasing household FI, whereas the prevalence of overweight among men decreased with increasing levels of FI. The prevalence of obesity increased with FI among women but not among men.

The important difference in the relationship of FI with weight status between men and women was unchanged after adjusting for age and socio-economic factors (Table 3). For women, the OR of underweight was 2·36 times higher among those with severe FI than among those with FS. The OR of obesity was 1·39 times higher among those with severe FI than among those with FS. Among men, severe FI status was a protective factor for overweight (OR = 0·58) and obesity (OR = 0·61) (Table 3).

Discussion

The results from this study are consistent with the literature and suggest that FI is a risk factor for obesity among women but not among men. Women with any level of FI had twice the prevalence of underweight in comparison to those with FS. Additionally, findings showed that severe FI among Brazilian women was associated with both underweight and obesity. Both conditions result from poor eating habits and are likely to be related to the process of nutritional changes over time[28]. This process of nutritional transition paradoxically involves undernutrition (i.e. micronutrient deficiencies, underweight and childhood stunting and wasting), overweight/obesity and chronic diet-related diseases[29].

In studies conducted in high-income and middle-income countries, FI was mainly a risk factor for obesity among women[16,17]. In poorer countries, where there are inequalities in food intake, sanitation and health care, FI is mainly associated with undernutrition[30]. Our findings suggest both possibilities.

Table 2. Sample size, weight status* (%) according to socio-economic characteristics. National Dietary Survey (NDS). Brazil, 2017–2018 (Percentages)

Socio-economic characteristics	Sample size	Underweight %	Normal weight %	Overweight %	Obesity 1 %	Obesity 2 + 3 %	*P*†
Age							<0·001
20–20·9	6651	3·8	55·1	29·9	8·4	2·8	
30–39·9	7584	1·6	40·9	41·1	12·9	3·5	
40–49·9	7269	2·0	36·0	41·6	15·6	4·8	
50–59·9	6608	1·5	36·4	42·8	14·3	5·0	
Sex							<0·001
Men	13 317	1·6	39·9	42·2	12·9	3·4	
Woman	14 795	2·9	44·5	35·4	12·6	4·6	
Skin colour							0·553
White	10 341	2·3	42·0	39·3	12·2	4·2	
Black and Brown	17 465	2·1	42·2	38·6	13·1	4·0	
Others	306	1·8	48·1	34·0	14·8	1·3	
Years of schooling							<0·05
≤4	4140	2·2	40·9	40·3	11·8	4·8	
5–8	6076	2·1	39·2	39·4	14·7	4·6	
≥9	17 896	2·24	43·28	38·42	12·37	3·7	
Per capita family income (minimum wage‡)							<0·001
<0·5	5366	2·7	46·4	35·4	11·6	3·9	
0·5–1	7837	2·9	42·7	38·5	12·2	3·7	
> 1	14 909	1·8	40·9	39·9	13·3	4·1	
Geographical region							<0·001
North	4121	2·0	45·0	38·8	11·2	3·0	
Northeast	9708	2·9	44·3	36·7	12·1	4·0	
South	7016	2·3	41·0	39·5	12·9	4·3	
Southeast	3693	1·0	41·8	40·3	13·2	3·7	
Midwest	3574	2·0	39·8	39·8	14·4	4·0	
Household area							<0·001
Urban	21 825	2·2	41·5	39·2	13·0	4·1	
Rural	6287	2·6	46·5	36·2	11·6	3·1	

* According to the WHO cut-off points[26].
† *P* values refer to the χ^2 test for differences in proportions.
‡ Minimum wage in 2017–2018 = US $288.21.

The risk of underweight is twice as high among women with severe FI than among families with FS, but FI is associated with obesity only among women.

The policy implication of this result is that FI should be addressed in tandem with other nutritional challenges[1], but the mechanisms to explain the association between FI and obesity are complex and include both individual and environmental factors[31].

The affordability of a low-quality diet of cheap and energy-dense food that is high in added sugar and fat may lead to greater energy intake and has been identified as a possible mechanism for the association between FI and obesity in low- and middle-income countries[12,32]. However, our findings do not support this mechanism. Unhealthy food intake is likely to work in varying combinations with other context–mechanism relationships[12].

The expenditures on food acquisition observed in a survey of Brazilian families also showed that family expenses per capita on fruits and vegetables decreased as FI severity increased. Conversely, the family expenses per capita on flours, tubers and pasta increased with the level of FI; families with moderate and severe FI spend more money buying foods from these food groups than families with FS[22].

There are three major hypotheses that may explain the link between FI and obesity: the insurance hypothesis[13], which suggests that people store fat to provide a buffer against a shortfall in the food supply; the resource scarcity hypothesis proposed by Dhurandhar[2], which combines storage with metabolic efficiency; and stress-related binge-eating disorder[11,33]. Another possible explanation for the relationship between obesity and FI is inflammation, as shown by the United States population having a higher level of C-reactive protein and a high leucocyte count[34]. Neither of these theories explain the distribution of obesity or the sex differences observed in the present study.

Severe FI was a protective factor for overweight and obesity in men but not in women. In a study by Castañeda in Mexico[14], a similar association was observed. Men with FI may have intense labour-related physical activity in the context of a developing country, which demands greater energy expenditure[35].

New theories should explore the major metabolic basis that explains obesity dependence on sex, with women with FI having risks of obesity and undernutrition, which are dependent on early-in-life exposure to the scarcity of food.

Limitations of the study

The FS score only reflects experiences in the past 3 months, whereas nutritional outcomes, such as weight, and particularly, height, accrue over much longer periods. However, the association of FS with all socio-economic indicators suggests that individuals classified as having FI are at chronic risk of scarcity.

Another possible limitation was the use of self-reported height and weight to calculate BMI for the weight classification.

Table 3. Adjusted* OR and 95 % CI of underweight, obesity and overweight by sex and household food security/food insecurity levels†. National Dietary Survey (NDS). Brazil, 2017–2018
(Odds ratios and 95 % confidence intervals)

	Men			Woman		
	OR	CI	*P*	OR	CI	*P*
Underweight (BMI‡ < 18·5 kg/m^2)						
Food security	1·00			1·00		
Mild insecurity	0·77	0·43, 1·37	0·376	0·91	0·63, 1·32	0·630
Moderate insecurity	1·07	0·55, 2·09	0·837	1·80	1·01, 3·19	<0·05
Severe insecurity	1·69	0·64, 4·45	0·292	2·36	1·42, 3·92	<0·001
Overweight (BMI‡ 25–30 kg/m^2)						
Food security	1·00			1·00		
Mild insecurity	0·90	0·78, 1·03	0·135	1·11	0·96, 1·28	0·166
Moderate insecurity	0·75	0·61, 0·92	<0·05	1·18	0·96, 1·45	0·114
Severe insecurity	0·58	0·45, 0·75	<0·001	0·96	0·75, 1·23	0·748
Obesity (BMI‡ ≥ 30 kg/m^2)						
Food security	1·00			1·00		
Mild insecurity	0·87	0·73, 1·05	0·144	1·36	1·15, 1·62	<0·001
Moderate insecurity	0·75	0·58, 0·99	<0·05	1·36	1·07, 1·72	<0·05
Severe insecurity	0·61	0·43, 0·87	<0·05	1·39	1·05, 1·84	<0·05

* Adjusted for age (<30, 30, 39·9, 40–49·9, 50–59·9), skin colour (white = reference category, black and brown, others), years of schooling (≥9 = reference category, 5–8, ≤4), per capita family income, minimum wage (>1 = reference category, <0·5, 0·5–1; minimum wage in 2017–2018 = US $288·21), geographical region (North = reference category, Northeast, Southeast, South, Midwest), area of residence (urban = reference category, rural).
† According to the Brazilian Household Food Insecurity Measurement Scale[24].
‡ According to the WHO cut-off points[26].

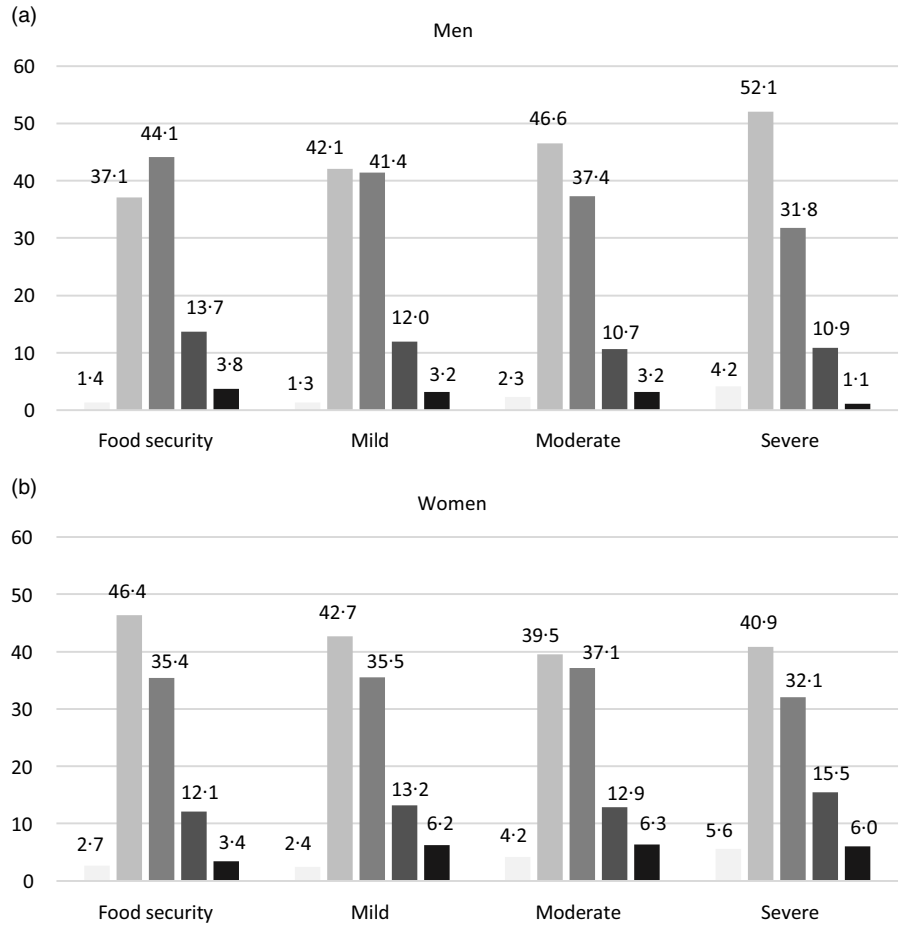

Fig. 1. Prevalence of ( ) underweight, (■) overweight, (■) normalweight, (■) obesity grade 1 and (■) obesity grades 2 + 3, according to food security and food insecurity levels among men and women. National Dietary Survey (NDS). Brazil, 2017–2018.

However, in an analysis of a large survey in Brazil using both reported and measured weight and height, Moreira *et al.*[36] observed high agreement between both methods for estimating anthropometric measurements. Similar results have corroborated that self-reported weight, height and BMI are reasonably accurate[37,38].

Conclusions

There is a strong relationship between severe FI and weight status in Brazilians. Women in families classified as having severe FI had more than twice the risk of underweight compared with that of families classified as having FS, and women with severe FI had a greater frequency of obesity grade 2 or 3. More detailed studies should compare metabolic differences among men and women living in scarcity scenarios as a way to understand the underlying mechanisms and moderators that contribute differently to the weight status of the sexes.

Furthermore, the Covid-19 pandemic caused a drop in income for more than half of the adult Brazilian population[39]. Found from the first National Survey of FI in the context of the Covid-19 pandemic in Brazil[40], household severe FI increased dramatically in the country. Thus, the results of this study reinforce the importance of evaluating the relationship among the factors that associate the most severe level of FI with underweight and obesity among women. Public health programmes should focus on access to food and nutrition security for the world's population to help reduce both underweight and obesity.

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T. B. D. participated in the data analysis, the manuscript concept and writing; R. S. participated in the manuscript concept, supervision and revising; R. S.-C. participated in the manuscript concept, supervision and revising.

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