A methodological proposal for assessing food insecurity from a multidimensional perspective

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Abstract *The aim of this study was to develop a methodological proposal for the assessment of food and nutritional insecurity (FNiS) in adults and older adults (Vigi-FNiS). The proposal was developed using data from the BRAZUCA Natal survey, a cross-sectional study with 411 people living in Natal in the state of Rio Grande do Norte, Brazil. The association between sociodemographic, health and nutrition variables and food insecurity (FI) was tested using Poisson multiple regression. Overall prevalence of FI was 42.1% (37.4%-46.9%) and was higher in women (47.5%), adults (48.2%) and black people (52.7%). The following variables were included in the Vigi-FNiS: people aged <18 years living in the household (A) (AdjPR=1.3; 1.1-1.6); family income (B) in quintiles (Q1: AdjPR=5, 4; 2.5-11.7; Q2: AdjPR=4.8; 2.2-10.5; Q3: AdjPR=3.8; 1.8-8.5; Q4 AdjPR=2.2; 1.0-5.1); inadequate treatment of drinking water (C) (AdjPR=1.3; 1.1-1.5); presence of chronic non-communicable diseases (D) (AdjPR=1.3; 1.1-1.7); not eating fruit for breakfast (E) (AdjPR=1.7; 1.3-2.5);eating meals on the couch or in bed (F) (AdjPR=1.3; 1.1-1.6); and skipping either lunch or dinner or dinner (G) (AdjPR=1.4; 1.2-1.7). A cutoff point for FNiS of 2.3 was adopted (Kappa=0.47; sensitivity=0.82; specificity=0.67; PPV=0.64; NPV=0.83).*

Key words *Public Health, Food and Nutrition Security, Food and Nutritional Surveillance, Questionnaire*

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Introduction

Food and nutrition security (FNS) is the realization of the right to regular and permanent access to quality food in sufficient quantity, without compromising access to other basic needs, based on healthy and environmentally, culturally, economically and socially sustainable food practices[1]. When people are unable to realize any one of its dimensions, food and nutrition insecurity (FNiS) occurs.

FNS has four dimensions: availability, access, utilization and stability, which include production and physical and economic access to food, adequate biological utilization, nutritional value, and regular access to adequate water and sanitation[2].

The rise in food insecurity (FI) in Brazil is worrying. Data from the 2018 National Household Budget Survey show a 63% increase in the prevalence of FI compared to 2013, when 22.6% of households experienced this problem. Rates are highest in the North (57.0%) and Northeast (50.3%). The state of RN had the 3rd highest prevalence of FI in the Northeast (54.7%) after Alagoas and Bahia[3].

The prevalence of severe FI increased by 27.6% between 2018 and 2020 in Brazil. Besides the political, social and economic crises, the upward trend in FI has been increased by the coronavirus pandemic, raising Brazil's deeply inequalities[4,5].

FI is associated with negative health outcomes such as malnutrition, chronic diseases and low quality of life[6,7]. It is therefore a structural problem and its determinants need to be monitored[8]. The Brazilian Food Insecurity Scale (BFIS), a psychometric scale, is the most widely used measure of household FI in Brazil[9].

Despite their use in epidemiological studies, the results obtained from subjective scales may be affected by the respondent's perceptions of FI, which is a limitation for data interpretation, especially in contexts of socioeconomic instability[10]. In addition, because the BFIS only assesses access to food[9] and the food component of FNS[11], complementary indicators need to be used to assess other aspects such as nutrition, especially because of high prevalence of overweight, obesity and associated chronic morbidities in Brazil[12,13].

Moreover, the growing consumption of ultra-processed foods and unhealthy eating practices have a significant socioeconomic and environmental impact on food systems[14] and it is important to consider the relationship between the country's inequalities and FNiS. Monitoring FNiS is a crucial element of food and nutrition surveillance within Brazil's national health service, providing assessment indicators that help public health managers tailor polices to the population's needs[15].

Given its multiple facets, complementary indicators are needed to provide a broader picture of FNiS, including the dimensions of availability, access, utilization and stability[16]. The aim of this study was to develop a methodological proposal for the assessment of food and nutrition insecurity in adults and older persons.

Methods

The proposal Vigi-FNiS was developed using data from the cross-sectional study "Food insecurity, health and nutrition among adults and older adults in a state capital in the Northeast of Brazil: BRAZUCA Natal Survey", which is part of a population-based multicenter survey called the Brazilian Usual Consumption Assessment (BRAZUCA).

Study population

The BRAZUCA Natal survey used multistage cluster sampling to select census tracts and households. The size and allocation of the sample elements were defined based on the main outcomes assessed by the study. The sample design effect (deff) was assumed to be 1.5, non-response was expected to be 15% and "no one at home" households were added. The sample size for each tract (adults and older adults of both sexes) was calculated adopting an estimated prevalence of 50%, 8% margin of error and 95% confidence level.

The census tracts were selected using probability proportional to the number of households and stratified by region and income to ensure a spatial distribution considering socioeconomic status. The secondary units were selected by simple random sampling. The number of households was defined based on the minimum sample size and proportion of different elements of each demographic group per household, based on the 2010 Census. The correction factor was 0.9 to compensate for losses, resulting in the selection of 71 census tracts and an estimated sample of 1,032 people (258 per tract).

Data collection was interrupted due to the COVID-19 pandemic. This article presents a

cross-section from the data collected before that. People of both sexes, physically and cognitively able to answer the questionnaires and have their anthropometric measurements taken were assessed from June 2019 to March 2020, totaling 411 respondents.

Twenty-seven of the 71 census tracts were included (38%). To determine the equivalence of the collected and estimated samples, the effects of census tract loss were analyzed by comparing the socioeconomic and demographic variables in the studied and non-studied tracts, testing for potential sampling bias. The following variables were analyzed using t-test and missing value analysis (p-value<0.05): "number of permanent private households", "number of residents living in the permanent private households", "mean number of residents", "mean nominal income" and "sex ratio". The analysis showed that the losses were random (p=0.135, Little's MCAR test).

The study was undertaken in accordance with the regulatory norms and standards for research involving human subjects set out in National Health Council Resolution 466/2012 and approved by Onofre Lopes University Hospital/Federal University of Rio Grande do Norte's research ethics committee (CAAE No. 96294718.4.2001.5292, Approval No. 3.531.721). Risks and benefits of the study were explained to potential participants and all respondents signed an informed consent form.

Data collection

The socioeconomic, demographic, nutrition and health data were collected using an electronic questionnaire Epicollect5 App (https://five.epicollect.net/). The interviews were conducted by previously trained interviewers at the respondent's home or the local health center. All stages of data collection were explained in a data collection manual and guide to anthropometry developed by the research team containing instructions about standardized questionnaires and standard operating procedures for carrying out physical examinations and taking anthropometric measurements.

The anthropometric measurements (weight, height) were taken according to the procedures recommended by World Health Organisation (WHO)[17]. Body weight was measured using a 150 kg capacity and 50 g accuracy electronic scale. Height was measured using a 1 mm precision portable stadiometer. Body mass index (BMI) (kg/m²) was classified according to WHO criteria[17] for adults and to Lipschitz[18] for older adults.

Eating practices were assessed using a scale for measuring the healthy eating practices recommended in the Dietary Guidelines for the Brazilian Population (DGBP) developed by Gabe and Jaime[19]. This scale was used because Brazil's dietary guidelines[20] considers the multiple dimensions of eating practices and food choices, including environmental, cultural, socioeconomic and behavioral aspects[21], such as the concept of FNS. Adherence to guidelines was classified based on an adaptation of the original classification as follows: low (<32 points), moderate (32 to 41 points) and high (>41 points)[22]. Each scale item was assessed to determine associations between different eating practices and FI.

Health was assessed by the presence of self-reported chronic non-communicable diseases CNCD (hypertension, diabetes, arthritis, stroke, depression, cancer, cardiovascular diseases, chronic lung diseases, chronic kidney disease).

Theoretical framework and item selection

The selection of items to be included in the Vigi-FNiS considered the theoretical plausibility of an association between the study variables and outcome (FI), based on the dimensions access, stability, and biological utilization. This is an innovative approach insofar as it provides a single set of variables that have a general relation to FI when analyzed in isolation.

FI was assessed using the BFIS, which is widely used in national epidemiological studies. For analysis purposes, FI was grouped into food security (FS) and food insecurity (mild, moderate and severe).

The study population was characterized by the sociodemographic variables: sex, age (20-59 years, 60 years and over), self-reported color/race (white, brown and others, black) and marital status (married/living in stable union, single/separated/divorced, widow).

The socioeconomic and health variables were selected according to the dimensions of FNS: (a) Access: family income in quintiles (Q1= up to R$ 1,091.80; Q2= R$ 1,091.81 to R$ 2,000; Q3= R$ 2,000.01 to R$ 3,000; Q4= R$ 3.000.01 to R$ 6,000; Q5= over R$ 6,000); number of residents living in the household (<3, 4-5, ≥6), people aged under 18 years living in the household; (b) Stability: occupation (employed, unemployed, retired), education level (illiterate, 1 to 4 years, 5 to 9 years, 10 to 11 years, 12 years or more); (c) Biological utilization: access to basic sanita-

tion (adequate, inadequate); frequency of water supply (daily, at least once a week, less than once a week); treatment of drinking water (treated, untreated); nutritional status - BMI (inadequate: underweight + excess weight, normal weight); CNCD (yes or no); eating practices (items from the healthy eating practices scale).

Development of a statistical model for measuring FNiS

Data were analyzed using SPSS® version 23. Bivariate analysis was performed to determine the association between each item on the healthy eating practices scale and FI based on crude prevalence ratios (PR) and their respective confidence intervals (95%CI). Variables that obtained a p-value of ≤0.20 in the bivariate analysis were retained in the second stage.

The aim of the methodological proposal was to create an easy-to-use, rapid and low-cost screening tool with a reliable, easy-to-understand scale. To this end, we recategorized the variables occupation (unemployed/without a job or employed and/or retired), frequency of water supply (inadequate - not daily or adequate - daily), and items from the healthy eating practices scale (never/rarely or almost always/always).

In the second stage, we performed Poisson multiple regression to define the statistical model that best predicts FI to make up the Vigi-FNiS. We used Poisson regression instead of logistic regression because this method is more suited to cross-sectional studies where the prevalence of outcomes is high[23]. Variables with a p-value of >0.10 were removed at each stage until the final model, where only variables with a p-value of < 0.05 were retained. The assumptions were tested using the omnibus test ($p<0.05$) and p-value for deviance ($p>0.05$) to determine significance and goodness-of-fit, respectively. Model efficiency was measured using the ROC curve.

In the third stage, each item on the scale was scored using the respective approximate regression coefficient value (β) of each variable. The cutoff point for FNiS was determined using the ROC curve.

Results

FI was present in 42.1% (37.4%-46.9%) of the respondents (26% mild, 9.2% moderate and 6.8% severe) and was significantly higher among women (47.5%; 95%CI 41.2-53.8), adults (48.2%; 95%CI 41.7-54.8) and black people (48.4; 95%CI 42.4-54.6).

Table 1 shows the socioeconomic, health and nutrition variables by dimensions of FNS. About the dimension Access, prevalence of FI was highest among people from households with persons aged under 18 (57.3%) and being from this group increased the likelihood of FI by 80%. Prevalence of FI increased proportionally to the number of residents living in the household and was 2.1 times higher in those with six or more residents than in those with up to three people (75.0% *versus* 35.7%).

In the dimension Stability, a significant association was found between not having a job or pension and FI (56.1%) (PR=1.5; 1.1-1.9), with lower prevalence among the retired (34.0%), followed by the employed (38.6%). FI prevalence varied significantly ($p<0.001$) according to education level, being higher among respondents who were illiterate (64.3%; PR=3.3) and those with 1 to 4 years of schooling (51.7%; PR=2.7).

About Biological utilization, prevalence of FI was high among residents from households with poor basic sanitation (48.4%) and being in this group increased the likelihood of FI by 140%. Inadequate water supply (not daily) increased the likelihood of FI by 50%. Prevalence in this group was 59.0%. Finally, the prevalence of FI among respondents who did not drink treated water (mineral, filtered or boiled) was 79.5% (PR=2.1; 1.7-2.6).

Regarding eating practices and nutritional status, no association was found between being underweight and excess weight and FI. However, the prevalence of inadequate nutritional status was high, with 70% of respondents being overweight and 4.7% underweight.

The analysis of adherence to healthy eating practices revealed an inverse association between FI and overall healthy eating practices scale score. Respondents with low adherence to the healthy eating practices were 1.8 times more likely to report FI than those with a high score (58.2% *versus* 32.5%), while those who obtained a low score (PR=1.8; 1.3-2.4) were 1.3 time more likely to report FNiS than those with a moderate score (1.5; 1.1-1.9).

Figure 1 shows the eating practices that showed a significant association ($p<0.05$) with FI and were therefore retained as marker of eating practices in the multiple analysis.

Skipping at least lunch and dinner (63.2%), eating meals on the couch or in bed (57.9%), snacking between meals (56.9%), drinking pro-

Table 1. Socioeconomic, health and nutrition characteristics of respondents according to the dimensions of food and nutrition security. BRAZUCA Natal survey (2019-2020).

Dimensions and indicators	n	Prevalence of FI	Crude PR	95%CI	p*
Access					
People under 18 living in the household					<0.0001
Yes	164	57.3	1.8	1.4-2.2	
No	247	32.0			
Number of residents living in the household					<0.0001
≥6	40	75.0	2.1	1.6-2.7	
4 to 5	130	43.8			
Up to 3	241	35.7			
Family income					<0.0001
Q1 (Up to R$ 1,091.80)	82	69.5	8.2	3.8-17.9	
Q2 (R$ 1,091.81 to R$ 2,000.00)	97	61.9	7.3	3.4-16.0	
Q3 (R$ 2,000.01 to R$ 3,000.00)	78	41.0	4.9	2.2-10.9	
Q4 (R$ 3,000.01 to R$ 6,000.00)	83	21.7	2.6	1.1-6.1	
Q5 (Over R$ 6.000.00)	71	8.5			
Stability					
Occupation					0.01
Without a job	123	56.1	1.5	1.1-1.9	
Employed	132	38.6			
Retired	156	34.0			
Education level					<0.001
Illiterate	28	64.3	3.3	1.9-5.6	
1 to 4 years	118	51.7	2.7	1.6-4.3	
5 to 9 years	63	44.4	2.3	1.3-3.9	
10 to 11 years	125	40.8	2.1	1.3-3.5	
12 years or more	77	19.2			
Biological utilization					
Access to basic sanitation					0.01
Inadequate	213	48.4	1.4	1.1-1.7	
Adequate	198	35.4			
Frequency of water supply					0.001
Inadequate	78	59.0	1.5	1.2-1.9	
Adequate	333	38.1			
Treatment of drinking water					<0.0001
Inadequate (not daily)	44	79.5	2.1	1.7-2.6	
Adequate (daily)	367	37.6			
Nutritional status					0.05
Inadequate (underweight + excess weight)	308	44.8	1.1	1.0-1.8	
Adequate (normal weight)	103	34.0			
Adherence to dietary guidelines					<0.0001†
Low	55	58.2	1.8	1.3-2.4	
Moderate	165	47.9	1.5	1.1-1.9	
High	191	32.5			
Chronic diseases					0.06
At least one	291	45.0	1.3	1.0-1.7	
None	120	35.0			

*Pearson's chi-square test. †Chi-square test for linear trend.

Source: Authors.

cessed juice drinks (56.5%), and using mealtimes to do other things (56.3%) were the markers that showed the highest prevalence of FI. About healthy eating practices, responding "never" or "rarely" for the following items was significantly associated with FI: eat calmly (54.2%), eat fruit for breakfast (52.5%), eat fruit for snacks (49.3%), preference for organic vegetables (45.0%), replace beans with peas, lentils or chickpeas now and again (43.4%), take part in preparing food (34.4%), eat around a table (34.1%), and buy food at markets (32.8%). The items take food with you when you go out in case you feel hungry (p=0.10) and use wholegrain flower (p=0.12) were also tested in the Poisson multiple regression analysis.

Table 2 shows the crude and adjusted prevalence of the variables selected to make up the methodological proposal for screening FNiS. The adjusted analysis showed that in the dimension Access, people aged under 18 years living in the household (adjPR=1.3; 1.1-1.6) and family income (Q1: adjPR=5.4; 2.5-11.7; Q2: adjPR=4.8; 2.2-10.5; Q3: adjPR=3.8; 1.8-8.5; Q4: adjPR=2.2; 1.0-5.1) continued to show a statistically significant association in the proposed model. None of the variables in the dimension Stability showed a statistically significant association in the multiple analysis.

In the dimension Biological utilization, only inadequate treatment of drinking water showed a statistically significant association in the final model (PR=1.3; 1.1-1.5). CNCD increased the likelihood of FI by 30% and showed a statistically significant association in the multiple analysis (PR=1.3; 1.1-1.7).

The following markers of eating practices were selected for the methodological proposal: eat fruit for breakfast; eat meals on the couch or in bed; and skip either lunch or dinner. The likelihood of FI was 1.7 times higher among respondents who rarely/never ate fruit for breakfast (adjPR=1.7; 1.3-2.5) and 1.3 times higher among those who almost always/always ate meals on the couch or in bed (PR=1.3; 1.1-1.6). The PR of skip either lunch or dinner was 1.4 (1.2-1.7).

The results of the omnibus test were statistically significant (p<0.001), while the p-value for

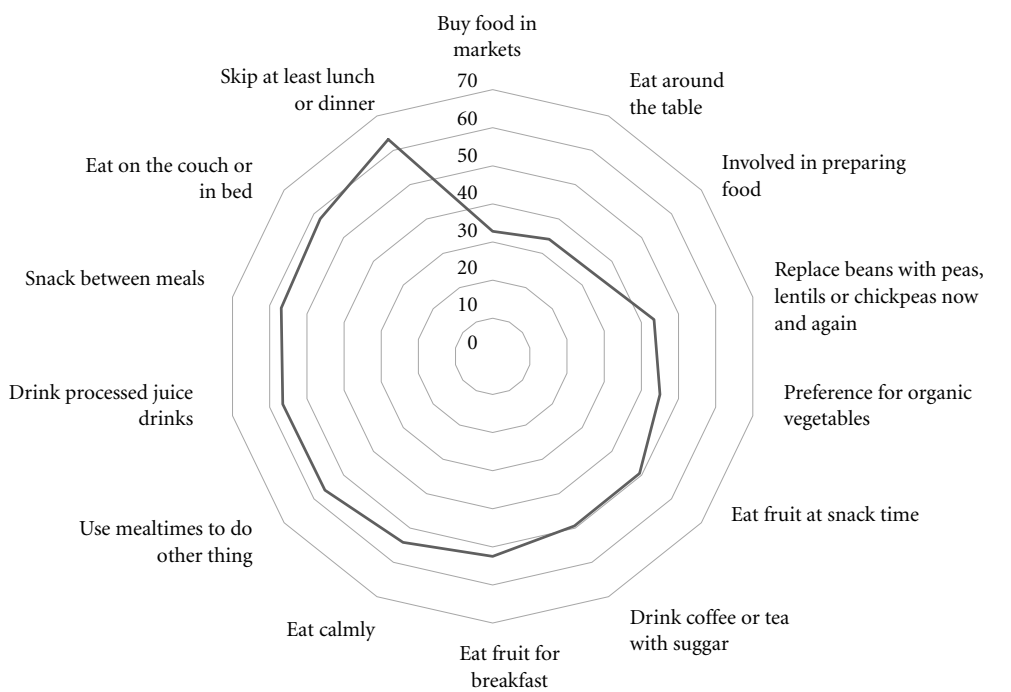

Figure 1. Prevalence of food insecurity according to the items on the scale for measuring adherence to the Dietary Guidelines for the Brazilian Population among respondents from the Brazuca Natal survey (2019-2020).

Source: Authors.

deviance was not significant (p=0.54), indicating goodness fit of the model. In the ROC analysis, the area under the curve was 0.83 (95%CI 0.79-0.87), indicating that the model is 83% accurate in predicting FNiS (Figure 2).

The scores for each item of the methodological proposal were allocated Poisson regression coefficient values (Chart 1). The cutoff point was defined based on the ROC curve, where a score of ≥2.3 indicates FNiS. The Kappa coefficient was 0.47, which according to Landis and Koch[24] indicates moderate agreement. The following results were obtained for the diagnostic accuracy criteria: sensitivity =0.82; specificity =0.67; positive predictive value (PPV) =0.64; and negative predictive value (NPV) =0.83.

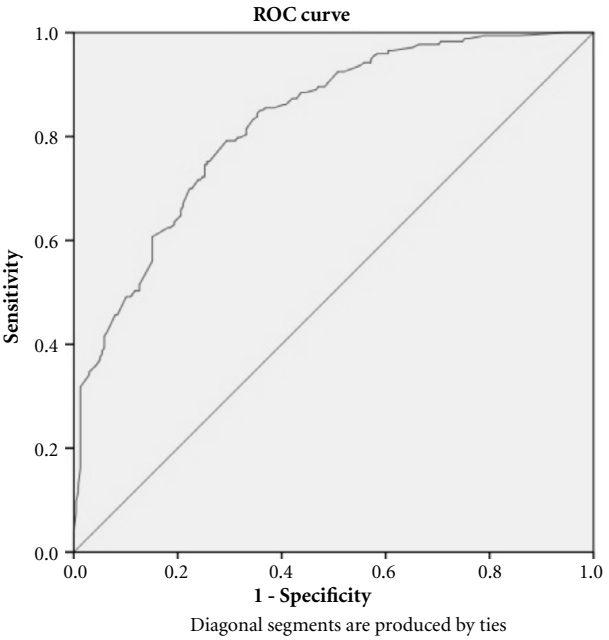

Figure 2. ROC curve of the predictive model for food and nutrition insecurity.

Fonte: Autores.

Discussion

Overall prevalence of FI among our sample was higher than the national average in urban areas (35.1%) and similar to the rate in the Northeast (49.7%)[3], but lower than the rate in RN (54.7%), which has increased by 22% over the last five years[3,25].

The proposal presented here considers different dimensions of FNS. People aged under 18 years living in the household, higher number of residents, and household income of less than one minimum wage increased the likelihood of FI. These conditions affect financial access to food, resulting in lower per capita income and higher spending on food and other basic needs, especially in larger families with children and adolescents[8,26-31].

The inverse association between education level and FI found by the present study was expected. Likewise, Bezerra *et al.*[32] found an association between level of education and being employed and FI in a study in Brazil. Low education level hampers access to employment in the formal labor market and, consequently, to getting a well-paid job[30].

This study assessed both the nutritional and food components of FNS by indicators of biological utilization. Water, sanitation and hygiene play a critical role in FNS due to the health impacts of the contamination of food through poor hygiene and lack of sanitation and safe water[33].

Despite an average reduction of 47.3% between 2004 and 2013, the increased likelihood of FI in households with poor sanitation has persisted in recent years in Brazil[8]. Various studies have confirmed an inverse relationship between basic sanitation and drinking treated water and FNiS[11,34,35].

Similarly to FNiS, water insecurity has a negative effect on quality of life, often causing anxiety because of the uncertainty of water supply and compromising household finances due to expenditure on obtaining drinking water[36,37]. Despite being a basic human right[38] and vital for guaranteeing the human right to adequate food and FNS, access to safe and clean water is not assessed by the BFIS.

Indicators of dietary intake are used to assess the nutritional component of FNS and are a proxy for FNiS when they do not meet the recommendations for specific food groups and/or nutrientes[16,39]. The DGBP is the country's main guide to healthy eating practices and is underpinned by principles that are consistent with the concept of FNS[21,22]. Using the indicators proposed by the healthy eating practices scale therefore provides a broader understanding of the multiple dimensions of FNS. Adherence to the dietary guidelines was inversely associated with

FI, with those experiencing FI being less likely to adopt healthy eating practices.

A large percentage of answers were inconsistent with the guidelines related to food choices and eating practices that recommend the consumption of fresh and minimally processed foods instead of ultra-processed foods[19]. Unhealthy practices included eating meals on the couch or in bed and skipping either lunch or dinner, both of which were included in the methodological proposal.

These aspects address how food consumption and meals occur, specifically about the regularity, attention and characteristics of the environment[19,20]. Eating meals in inappropriate places, such as on the couch or in bed, can stimulate overeating and consumption of ultra-processed foods, especially in environments with cellphones or TV, which interfere with food interaction and concentration while eating[20].

We highlight that ultra-processed foods are high in energy, unhealthy fats, refined sugars, and sodium, and low in dietary fiber, proteins and micronutrients. Due to their poor nutritional profile, excessive consumption of these foods is related to the obesity epidemic in Brazil and CNCD[14,40,41]. Thus, the high consumption of ultra-processed foods in Brazilian's diet is a major obstacle to realizing FNS.

While eating meals on the couch or in bed is not recommended, some homes do not have adequate eating environments. In small homes, for example, the dining table is commonly located in the sitting room close to the television,

Table 2. Crude and adjusted prevalence ratios of the indicators included in the multidimensional methodological proposal for screening food and nutrition insecurity.

Dimensions and indicators	n	Prevalence of FI	$p^{\star}$	Crude PR	Adjusted PR	$p^{\dagger}$
Access						
People under 18 living in the household						
Yes	164	57.3	<0.001	1.8 (1.4-2.2)	1.3 (1.1-1.6)	0.01
No	247	32.0				
Family income						
Q1 (Up to R$ 1,091.80)	82	69.5	<0.001	8.2 (3.8-17.9)	5.4 (2.5-11.7)	<0.0001
Q2 (R$ 1,091.81 to R$ 2,000.00)	97	61.9		7.3 (3.4-16.0)	4.8 (2.2-10.5)	
Q3 (R$ 2,000.01 to R$ 3,000.00)	78	41.0		4.9 (2.2-10.9)	3.8 (1.8-8.5)	
Q4 (R$ 3,000.01 to R$ 6,000.00)	83	21.7		2.6 (1.1-6.1)	2.2 (1.0-5.1)	
Q5 (Over R$ 6,000.00)	71	8.5				
Biological utilization						
Treatment of drinking water						
Inadequate	44	79.5	<0.001	2.1 (1.7-2.6)	1.4	0.01
Adequate	367	37.6				
Presence of chronic disease						
At least one	291	45.0	0.06	1.3 (1.0-1.7)	1.3	0.02
None	120	35.0				
Eat fruit for breakfast						
Never/rarely	282	52.5	<0.001	2.7 (1.9-3.9)	1.7 (1.3-2.5)	0.001
Almost always/always	129	19.4				
Eat meals on the couch or in bed						
Almost always/always	133	57.9	<0.001	1.7 (1.3-2.1)	1.3 (1.1-1.6)	0.01
Never/rarely	278	34.5				
Skip either lunch or dinner						
Almost always/always	87	63.2	<0.001	1.7 (1.4-2.2)	1.4 (1.2-1.7)	0.001
Never/ Rarely	324	36.4				

*Pearson's chi-square test; †Wald chi-square test.

Source: Authors.

which is often used to compensate for a lack of human company[42]. Thus, this practice reflects both quantitative and qualitative aspects of food, and can often be associated with poor housing conditions and lack of income[20,43].

Skipping meals is related to eating frequency. Reducing portion sizes or skipping meals is one of the main markers of FI, affecting the nutritional component of FNS due to lack of food[44]. However, it is necessary to understand FI beyond nutritional deficiency and hunger, especially given the high prevalence of excess weight in Brazil.

Similarly, the lack of adherence to the items referring to organization and planning indicates difficulties in preparing meals and eating at home. This study shows an association between not eating fruit at breakfast and FI and this item was included in the methodological proposal. Panigassi *et al.*[45] found that households with FI tended to have monotonous diets made up of high energy density foods, affecting intake of fresh foods such as fruit and vegetables. In another study, consumption of fresh and minimally processed foods was lower in these households, without affecting the intake of ultra-processed foods[46]. Data from Brazil's latest Household Budget Survey (2017-2018) reported lower consumption of fruit, vegetables, poultry, meat and eggs with increasing levels of FI and a higher intake of cereals, legumes and flours[3], and high energy density and non-perishable foods.

Nutritionally unbalanced diets increase the risk of CNCD and obesity[14]. Studies have shown associations between FNiS and multiple chronic conditions, especially in older adults. These relationships are bidirectional, meaning that FNiS can contribute to the development of the disease and/or deterioration of conditions and having a CNCD can compromise household finances due to the cost of treatment, creating a FI-chronic disease-FI loop[47,48].

Given this complexity, measuring FNiS has

Chart 1. Multidimensional methodological proposal for screening food and nutrition insecurity - Vigi-FNiS.

Access	**Score**
A. Are there any residents aged under 18 living in your home?	
Yes=0.3	
No=0	
B. What is your total family income, including the income of all people living in the household?	
Up to R$ 1,091.80= 1.7	
Between R$ 1,091.81 and R$ 2,000.00= 1.6	
Between R$ 2,000.01 and R$ 3,000.00= 1.4	
Between R$ 3,000.00 and R$ 6,000.00= 0.8	
Over R$ 6,000.00= 0	
Biological utilization	
C. Is your household drinking water treated?	
No (untreated)=0.2	
Yes (mineral, treated or boiled)=0	
D. Do you have one of the following conditions: hypertension, diabetes, arthritis, stroke, depression, cancer, cardiovascular diseases, chronic lung diseases, chronic kidney disease?	
Yes=0.3	
No=0	
E. Do you eat fruit at breakfast?	
No (rarely/never)=0.6	
Yes (almost always/always)=0	
F. Do you eat your meals on the couch or in bed?	
Yes (almost always/always)=0.3	
No (rarely/never)=0	
G. Do you skip either lunch or dinner?	
Yes (almost always/always)=0.3	
No (rarely/never=0	
Total score	

Source: Authors.

several challenges due to the need to use a range of indicators. The present proposal is innovative in this regard, as it includes variables with high sensitivity for identifying FNiS. The similarities between the Vigi-FNiS and BFIS (gold standard) suggest that it is a viable screening tool. The high sensitivity value shows that the tool correctly identifies individuals experiencing FNiS, while the specificity value (0.67) is satisfactory for identifying individuals who are experiencing FI. The high NPV shows that 83% of the individuals screened negatively by the Vigi-FNiS were food secure and therefore excluded by the model. A PPV of 64% shows the proportion of negatively screened individuals who experience FNiS. Población *et al.*[49] also proposed a screening tool for identifying FI using a statistical model similar to the one described in the present study.

By including items that refer to the biological utilization dimension (nutrition component) of FNS, the Vigi-FNiS can be used to complement the food component and access dimension measured by the BFIS and provides an alternative for situations in which its application is not feasible. Further steps need to be taken to use indicators that provide insight into elements that complement access to food and emphasize the nutritional dimension of FNS, especially in view of food, nutritional and epidemiological transitions and the current economic crisis exacerbated by the COVID-19 pandemic.

The main limitation of this study is that the cross-sectional design did not allow us to determine the cause-and-effect relationship between the variables and FI. Besides that, other relevant variables may not have been included in the multiple model due limitations of the study sample, since it was not possible to continue data collection due to the pandemic.

Despite these limitations, this study makes a valuable contribution by proposing a methodology that encompasses both the food and nutrition components of FNS. The Vigi-FNiS has the potential to be a FNiS tool for primary health care workers and providing inputs to inform the planning and implementation of intersectoral policies and actions to tackle FI.

Collaborations

NLA Cabral contributed to study conception and design, data analysis and interpretation, writing and critically revising the article, and approving the final version to be published. NPF Pequeno contributed to critically revising the article and approving the final version to be published. AGRC Oliveira contributed to critically revising the article and approving the final version to be published. DML Marchioni contributed to critically revising the article and approving the final version to be published. SCVC Lima contributed to critically revising the article and approving the final version to be published. CO Lyra contributed to study conception and design, writing and critically revising the article, and approving the final version to be published.

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References

1. Brasil. Lei nº 11.346, de 15 de setembro de 2006. Cria o Sistema Nacional de Segurança Alimentar e Nutricional – SISAN com vistas em assegurar o direito humano à alimentação adequada e dá outras providências. *Diário Oficial da União*; 2006.
2. Chitiga-Mabugu M, Nhemachena C, Karuaihe S, Motala S, Tsoanamatsie N, Mashile L. *A research and Policy Unit in collaboration with the Human Sciences Research Council Economic Performance and Development*. South Africa: HSRC; 2013.
3. Intituto Brasileiro de Geografia e Estatística (IBGE). *Pesquisa de orçamentos familiares 2017-2018: análise da segurança alimentar no Brasil*. Rio de Janeiro: IBGE; 2020.
4. Rede Brasileira de Pesquisa em Soberania e Segurança Alimentar (Rede PENSSAN). *Insegurança alimentar e Covid-19 no Brasil – VIGISAN – Inquérito Nacional sobre Insegurança Alimentar no Contexto da Pandemia da Covid-19 no Brasil*. Brasília: Rede PENSSAN; 2021;
5. Galindo E, Teixeira MA, Araújo M, Motta R, Pessoa M, Mendes L, Rennó L. *Efeitos da pandemia na alimentação e na situação da segurança alimentar no Brasil. Food for Justice Working Paper 4* [Internet]. Berlim; 2021 [acessado 2020 maio 18]. Disponível em: https://www.lai.fu-berlin.de/food-for-justice
6. Brown AGM, Esposito LE, Fisher RA, Nicastro HL, Tabor DC, Walker JR. Food insecurity and obesity: Research gaps, opportunities, and challenges. *Transl Behav Med* 2019; 9(5):980-987.
7. Russell JC, Flood VM, Yeatman H, Wang JJ, Mitchell P. Food insecurity and poor diet quality are associated with reduced quality of life in older adults. *Nutr Diet* 2016; 73(1):50-58.
8. Santos TG, Silveira JAC, Longo-Silva G, Ramires EKNM, Menezes RCE. Tendência e fatores associados à insegurança alimentar no Brasil: Pesquisa nacional por amostra de domicílios 2004, 2009 e 2013. *Cad Saude Publica* 2018; 34(4):1-17.
9. Brasil. Ministério do Desenvolvimento Social e Combate à Fome. Secretaria de Avaliação e Gestão da Informação. *Escala Brasileira de Insegurança Alimentar – EBIA: análise psicométrica de uma dimensão da Segurança Alimentar e Nutricional. Estudo Técnico*. Brasília: Ministério do Desenvolvimento Social e Combate à Fome; 2014.
10. Gregório MJ, Graça P, Nogueira J, Gomes S, Santos CA, Boavida J. Proposta Metodológica para a Avaliação da Insegurança Alimentar em Portugal. *Rev Nutricias* 2014; 21:4-11.
11. Morais DC, Dutra LV, Franceschini SCC, Priore SE. Insegurança alimentar e indicadores antropométricos, dietéticos e sociais em estudos brasileiros: Uma revisão sistemática. *Cien Saude Coletiva* 2014; 19(5):1475-1488.
12. Malta DC, Bernal RTI, Souza MDFM, Szwarcwald CL, Lima MG, Barros MBDA. Social inequalities in the prevalence of self-reported chronic non-communicable diseases in Brazil: National health survey 2013. *Int J Equity Health* 2016; 15(1):1-11.
13. Malta DC, Andrade SC, Claro RM, Bernal RTI, Monteiro CA. Evolução anual da prevalência de excesso de peso e obesidade em adultos nas capitais dos 26 estados brasileiros e no Distrito Federal entre 2006 e 2012. *Rev Bras Epidemiol* 2014; 17(Supl. 1):267-276.
14. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The un Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr* 2018; 21(1):5-17.
15. Brasil. Ministério da Saúde (MS). Departamento de Atenção Básica, Secretaria de Atenção à Saúde. *Marco de referência da vigilância alimentar e nutricional*. Brasília: MS; 2015.
16. Morais DC, Lopes SO, Priore SE. Evaluation indicators of food and nutritional insecurity and associated factors: Systematic review. *Cien Saude Coletiva* 2020; 25(7):2687-2700.
17. World Health Organization (WHO). Physical Status: The use and Interpretation of Anthropometry. Report of a WHO Expert Committee. *World Health Organ Tech Rep Ser* 1995; 854:1-452.
18. Lipschitz D. Screening for nutritional status in the elderly. *Prim Care* 1994; 21:55-67.
19. Gabe KT, Jaime PC. Development and testing of a scale to evaluate diet according to the recommendations of the Dietary Guidelines for the Brazilian Population. *Public Health Nutr* 2019; 22(5):785-796.
20. Brasil. Ministério da Saúde (MS). *Guia Alimentar para a População Brasileira.* Brasília: MS; 2014.
21. Monteiro CA, Cannon G, Moubarac JC, Martins APB, Martins CA, Garzillo J, Canella DS, Baraldi LG, Barciotte M, Louzada ML, Levy RB, Claro RM, Jaime PC. Dietary guidelines to nourish humanity and the planet in the twenty-first century. A blueprint from Brazil. *Public Health Nutr* 2015; 18(13):2311-2322.
22. Gabe KT, Jaime PC. Práticas alimentares segundo o Guia alimentar para a população brasileira: fatores associados entre brasileiros adultos, 2018. *Epidemiol Serv saude Rev SUS Bras* 2020; 29(1):e2019045.

23. Aluísio JD, Barros VNH. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol* 2003; 37(1):1-13.
24. Landis JR, Koch GG. The Measurement of Observer Agreement for Categorical Data. *Biometrics* 1977; 33(1):159.
25. Instituto Brasileiro de Geografia Estatística (IBGE), *Pesquisa Nacional por Amostra de Domicílios (PNAD). Segurança Alimentar: 2004/2013: Brasil, grandes regiões e unidades da federação*. Rio de Janeiro: IBGE; 2014.
26. Marin-Leon L, Francisco PMSB, Segall-Corrêa AM, Panigassi G. Bens de consumo e insegurança alimentar: Diferenças de gênero, cor de pele autorreferida e condição socioeconomic. *Rev Bras Epidemiol* 2011; 14(3):398-410.
27. Ferreira HS, Souza MEDCA, Moura FA, Horta BL. Prevalência e fatores associados à Insegurança Alimentar e Nutricional em famílias dos municípios do norte de Alagoas, Brasil, 2010. *Cien Saude Colet* 2014; 19(5):1533-1542.
28. Panigassi G, Segall-Corrêa AM, Marin-León L, Pérez-Escamilla R, Sampaio MDFA, Maranha LK. Insegurança alimentar como indicador de iniqüidade: Análise de inquérito populacional. *Cad Saude Publica* 2008; 24(10):2376-2384.
29. Maas NM, Mendoza-Sassi RA, Meucci RD, Cesar JA. Food insecurity in rural families in the extreme South of Brazil. *Cien Saude Colet* 2020; 25(7):2605-2614.
30. Sperandio N, Priore SE. Prevalência de insegurança alimentar domiciliar e fatores associados em famílias com pré-escolares, beneficiárias do Programa Bolsa Família em Viçosa, Minas Gerais, Brasil. *Epidemiol Serv Saude* 2015; 24(4):739-748.
31. Souza BFNJ, Marin-Leon L, Camargo DFM, Segall-Corrêa AM. Demographic and socioeconomic conditions associated with food insecurity in households in Campinas, SP, Brazil. *Rev Nutr* 2016; 29(6):845-857.
32. Bezerra TA, Olinda RA, Pedraza DF. Food insecurity in Brazil in accordance with different socio-demographic scenarios. *Cien Saude Colet* 2017; 22(2):637-652.
33. WASH Advocates. *Global Food Security: The Critical Role of Water, Sanitation, and Hygiene (WASH)*. Washington, D.C.: WASH and Food Security; 2013.
34. Figueroa-Pedraza D, Alves-Bezerra T, Dantas AC, Cerqueira R, Fonsêca JS. (In)Segurança alimentar de famílias residentes em um município do interior da Paraíba, brasil Food (in)security of families living in a city of Paraíba, Brazil. *Rev Salud Pública* 2017; 19(5):649-656.
35. Pedraza DF, Gama JSFA. Segurança alimentar e nutricional de famílias com crianças menores de cinco anos do município de Campina Grande, Paraíba. *Rev Bras Epidemiol* 2015; 18(4):906-917.
36. Stoler J, Pearson AL, Staddon C, Wutich A, Mack E, Brewis A, Rosinger AY; Household Water Insecurity Experiences (HWISE) Research Coordination Network. Cash water expenditures are associated with household water insecurity, food insecurity, and perceived stress in study sites across 20 low- and middle-income countries. *Sci Total Environ* 2020; 716:135881.
37. Workman CL, Ureksoy H. Water insecurity in a syndemic context: Understanding the psycho-emotional stress of water insecurity in Lesotho, Africa. *Soc Sci Med* 2017; 179:52-60.
38. Conselho Nacional de Segurança Alimentar e Nutricional (CONSEA). *O acesso e os usos da água no contexto da soberania e da Segurança Alimentar e Nutricional*. Brasília: CONSEA; 2008.
39. Kepple AW, Segall-Corrêa AM. Conceituando e medindo segurança alimentar e nutricional. *Cien Saude Colet* 2011; 16(1):187-199.
40. Canella DS, Levy RB, Martins APB, Claro RM, Moubarac JC, Baraldi LG, Cannon G, Monteiro CA.. Ultra-processed food products and obesity in Brazilian households (2008-2009). *PLoS One* 2014; 9(3):e92752.
41. Louzada MLC, Baraldi LG, Steele EM, Martins APB, Canella DS, Moubarac JC, Levy RB, Cannon G, Afshin A, Imamura F, Mozaffarian D, Monteiro CA. Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. *Prev Med* 2015; 81:9-15.
42. Menegassi B. Eat regularly and carefully, in appropriate environments and in company": A brief analysis of this recommendation of the Brazilian Food Guide. *Appetite* 2020; 149:104619.
43. Scagliusi FB, Pereira PR, Unsain RF, Sato PM. Eating at the table, on the couch and in bed: An exploration of different locus of commensality in the discourses of Brazilian working mothers. *Appetite* 2016; 103:80-86.
44. Rasmusson G, Lydecker JA, Coffino JA, White MA, Grilo CM. Household food insecurity is associated with binge-eating disorder and obesity. *Int J Eat Disord* 2019; 52(1):28-35.
45. Panigassi G, Segall-Corrêa AM, Marin-León L, Pérez-Escamilla R, Maranha LK, Sampaio MDFA. Insegurança alimentar intrafamiliar e perfil de consumo de alimentos. *Rev Nutr* 2008; 21(Supl.):135-144.
46. Araújo ML, Mendonça RD, Lopes Filho JD, Lopes ACS. Association between food insecurity and food intake. *Nutrition* 2018; 54:54-59.
47. Fernandes SG, Rodrigues AM, Nunes C, Santos O, Gregório MJ, Sousa RD, Dias S, Canhão H. Food insecurity in older adults: Results from the epidemiology of chronic diseases cohort study 3. *Front Med (Lausanne)* 2018; 5:203.
48. Jih J, Stijacic-Cenzer I, Seligman HK, Boscardin WJ, Nguyen TT, Ritchie CS. Chronic disease burden predicts food insecurity among older adults. *Public Health Nutr* 2018; 21(9):1737-1742.
49. Poblacion A, Segall-Corrêa AM, Cook J, Taddei JAAC. Validity of a 2-item screening tool to identify families at risk for food insecurity in Brazil. *Cad Saude Publica* 2021; 37(6):e00132320.

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