Status: Preprint has been submitted for publication in journal

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https://doi.org/10.1590/SciELOPreprints.2156

Submitted on (YYYY-MM-DD): 2021-04-21
Posted on (YYYY-MM-DD): 2021-04-23

Validity of a 2-item screen to identify families at risk for food insecurity in Brazil

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IN PRESS at Cadernos de Saude Publica, 2021

Abstract

This manuscript aimed to develop a brief 2-item screening tool to identify Brazilian households that include families with children at risk for food insecurity. Psychometric analyses including sensitivity, specificity, positive and negative predictive value, accuracy, and ROC curves were used to test combinations of questions to determine the most effective screener to assess households at risk for food insecurity when compared to a gold standard scale. Participants included National Demographic Health Survey on Women and Children (PNDS-2006) surveyed households with a valid Brazilian Household Food Insecurity Measurement Scale (EBIA) response. The sample included 3,920 households representing 11,779,686 households when expanded using PNDS sample weights. With overall prevalence of food insecurity at 21%, a Brazilian 2-item food-insecurity screen showed sensitivity of 79.31%, specificity of 92.95%, positive predictive value of 74.62%, negative predictive value of 94.50% and ROC area 86.13%. This screen also presented high convergent validity for children's nutrition and health variables when compared with the gold standard, the EBIA full scale. Based on its ability to detect households at risk for food insecurity, a 2-item screening tool is recommended for widespread adoption as a screening measure throughout Brazil, especially when rapid decision-making has been made fundamental, as under the COVID-19 pandemic. This screener can enable providers to accurately identify families at risk for food insecurity and promptly intervene to prevent or ameliorate adverse health and developmental consequences associated with food insecurity and swiftly respond to crises.

Keywords

Screening tools, food insecurity, hunger, nutrition, child development

Introduction

In 2004, the Brazilian Household Food Insecurity Measurement Scale (EBIA) [1] was adapted to Portuguese and validated using the United States Household Food Security Survey Module (US-HFSSM) as model. Since then, EBIA has been included in some national health surveys and a few smaller regional or local studies, capturing food insecurity information intermittently.

Results from national datasets allow for population food-insecurity prevalence surveillance, and its association with socioeconomic, demographic and health related variables generates scientific evidence to inform public policies. Because national surveys are developed primarily for generating national prevalence estimates, data collected from representative samples of the national population are not meant to identify individual food-insecure households for immediate intervention. To fill in this gap, data from regional or local surveys are considered, however these studies are not always done systematically.

In 2010, Hager et al. [2] validated a screening tool to identify individual households with young children at risk for food insecurity. The Hunger Vital Sign™ (HVS) is a 2-question food insecurity screening instrument, derived from the US Household Food Security Survey Module (HFSSM), showing high sensitivity, specificity, and convergent validity. The HVS measures families' concerns about access to food much the way health care providers check other key vital signs, such as pulse and blood pressure. Healthcare and social service providers, community-based outreach workers, teachers, and others who work with families with young children can use the HVS to identify households that may be in immediate need of food assistance. This tool has been recommended by the American Academy of Pediatrics [3] for use at all well-child visits, and in 2017, the Centers for Medicare and Medicaid Services incorporated the HVS into its Accountable Health Communities Screening Tool [4]. In 2015, the HVS was validated for use among youth and adolescents [5], and in 2017 it was validated for use among adults [6] as well. Others have suggested use of the HVS within healthcare systems for older adult populations [7], and it also has been translated to multiple languages [8].

The development and validation of a Brazilian 2-item screening tool based on the EBIA would allow for identification of families currently at risk for food insecurity while also functioning as a local or regional risk-monitoring tool. These capacities are especially useful during crises such as the one posed by COVID-19, for targeting effective evaluation of health care and nutrition interventions, following the Brazilian health services' priorities. In addition, inclusion of a 2-item screening tool for food insecurity in routine health center visits could strengthen the Brazilian Food and Nutrition Surveillance System (SISVAN) by helping to identify families living in food-insecure households in a timelier way. If a 2-item screening tool proves

as effective for the Brazilian population as it has been for the US, it will complement national/regional data collected by the extended EBIA questionnaire in beneficial ways. By generating individual/local data, a Brazilian "Hunger Vital Sign" could allow more timely social policy solutions to reduce food insecurity while permanent changes in government-supported social infrastructures are being designed and implemented. Thus, the aim of this study was to develop a brief 2-item screening tool to identify Brazilian households that include families with children at risk for food insecurity.

Methods

Gold Standard: EBIA at PNDS

The third edition of the National Survey on Demography and Health of Women and Children (PNDS 2006/07) aimed to describe the health and nutrition of reproductive-age women (15-49 years old) and their children under 5 years of age. This survey also gathered data on social, economic and cultural factors, including food insecurity at the household level using the Brazilian Food Insecurity Scale (EBIA). The PNDS 2006/07 used a complex probability sampling design, with national representativeness with data collected in two stages; the primary sampling unit was the census area and the secondary sampling unit the household. The sample included only non-institutionalized private households, from ten independent sampling strata obtained from the combination of five geographic regions and urban/rural areas within each. Eligible households were selected at random, considering the number of census areas in each region, and whether they were located in urban or rural areas. The survey methodology, including sample design and selection, data collection procedures, data consistency, weighting and expansion techniques for complex samples and ethical/human subjects' aspects are described elsewhere [9].

The PNDS 2006/07 used a modified EBIA, containing 16 questions, with question number five ("In the last three months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn't enough money to buy food") split into two parts ("In the last three months, did you or other adults in the household ever cut the size of your meals because there wasn't enough money to buy food", and "In the last three months, did you or other adults in the household ever skip meals because there wasn't enough money to buy food"). For analysis purposes, as recommended by PNDS, these two questions were recombined as a negative answer ("no") when both parts had negative responses, or "do not know" to one part, and "no" to the other. For other response combinations the answer was marked positively ("yes").

The number of questions affirmed indicates the level of food security in a household, and is the basis for classifying households in one of the four food security categories. In this version of EBIA, the four food security categories for households with children under 18 years are: Food Secure (0 questions affirmed); Mild Food Insecurity (1-5 questions affirmed); Moderate Food Insecurity (6-10 questions affirmed); and Severe Food Insecurity (11-15 questions affirmed) [10]. All questions in the EBIA refer to the three months preceding the survey. Prevalence estimates and inferential analyses were conducted using the food security status variable dichotomized as households not considered at risk, including the Food Secure and Mild Food Insecurity categories (Food Security) and households at risk, comprising Moderate and Severe Food Insecurity categories (Food Insecurity). The Food Insecurity composite category represents the greater severity of food scarcity in a household, wherein adults and children could be experiencing hunger during the three months preceding the interview. When responses were "do not know" to questions regarding conditions of access to food (1st to 4th questions), the interview was terminated and that record was eliminated (n=17, corresponding to 0.35% of sample).

Eligibility and selection criteria for the study sample

For this research, eligible children included those ≤59 months of age, living in the same house as their mothers, with the EBIA filled correctly, totaling 4,800 children. Because the study unit is the household, PNDS replicated EBIA answers for all individuals living in a particular household. Therefore, it was necessary to select one child per household to avoid duplication of sample unit representation in the data analysis. When a woman had more than one child younger than five years, the younger child/children was/were dropped out of the sample and the oldest child was retained (n=784). When there were two or more children under age five, and they were children of different mothers residing in the same household, the younger child/children was/were excluded (n=61). In addition, when there were twins in the household, we retained in the sample only the twin who was born in better condition, using birth weight as reference. We excluded the twin with the lower birth weight noted on the child's official Brazilian health record card. If the card was unavailable, birth weight reported by the mother was used. If neither of these was available, the younger twin was excluded (n=35) using the variable stating the children's order of birth. Selection criteria followed a rationale of maintaining in the sample children who had lived longer under respective environmental conditions. After exclusions, 3,920 children (one per household) were available for analysis representing 11,779,686 households when expanded using PNDS sample weights.

Development of the 2-item Screening Tool

Seven steps were involved in development of the screen: calculation of sensitivity, specificity, positive and negative predictive values (with ROC curves), accuracy and convergent validity. Sensitivity identifies the screen's ability to correctly identify food-insecure households (minimizing false negatives), while specificity describes the screen's ability to correctly identify food-secure households (minimizing false positives). Positive predictive value shows the percent of those identified by the screen as food insecure that are actually food insecure, negative predictive value displays the percent of those not identified by the screen as food insecure that are actually food secure. The area under a ROC curve exposes the screen test's ability to diagnose households with and without the food insecurity, and the accuracy reveals the degree to which the screen correctly describes food insecurity. And the convergent validity assesses the relationships between screening results and variables theoretically related to food insecurity, such as socioeconomic, demographic and health variables.

Combinations of 1, 2, 3 and 4 questions were tested as possible screening tools using contingency table procedures. Sensitivity, specificity, positive and negative predictive value, and accuracy were calculated and a Receiver Operating Characteristic curves (ROC) was plotted for each combination of candidate screening items. The combination of 2 questions that exhibit the best sensitivity, specificity and convergent validity was selected as the screen.

Convergent Validity

Socioeconomic and child nutrition and health variables were used to test the convergent validity of candidate screens. To test the hypothesis that children under five living in a moderate or severe food-insecure household would have significantly worse health conditions when compared to their food-secure peers, we performed Poisson regression analysis [11] in two separate sets of analyses, one using the gold standard and the second using the 2-item screening tool. Variables with $p<0.20$ in bivariate analyses with the food security predictor or the health outcome variable were considered eligible for inclusion as potentially confounding variables in the multivariate analysis. The final model contained only the strongest associated variables, with $p<0.05$, using a backward stepwise elimination technique. Dependent, health outcome variables were selected according to their association with food insecurity in a previous study [12]. All models were adjusted for macro-region, urban-rural classification, living conditions, economic status, cash transfer program participation, maternal education, marital status, number of children in the household, child's gender and age. These covariates were chosen on the basis of theoretical and bivariate associations with both food insecurity and the outcomes.

Macro-region was dichotomized to contrast Brazilian development areas, with the North (N) and Northeast (NE) identified as less-developed regions and Midwest (MW), Southeast (SE)

and South (S) as more-developed regions. Urban or rural household status was also included as a covariate. Representing household's economic status, the Brazilian Economic Classification Criterion (CCEB) was used as an indicator of families' purchasing power [13]. A dichotomized variable was used grouping household economic status in wealthier classes - from A1 to C2, and less wealthy classes - D/E. A dichotomized Living Conditions variable was considered "adequate" if the household contained all five of the following items: indoor availability of water, water connected to a sewage system, shingle or concrete slab on house roofs, brickwork walls and wooden floor, vinyl floor covering, ceramic tiles, cement or carpet floor, otherwise the household Living Conditions were classified as "inadequate". Cash Transfer Program (CTP) participation was dichotomized to indicate whether a resident of the household received at least one of the seven available social safety-net programs in 2006.

Maternal Education was dichotomized as "≤ eight years of study" or "more than eight years". This categorization of education attainment is equivalent to graduation from middle school or not, respectively. The Marital Status variable followed PNDS criteria: when a woman was formally married or was in a stable union, she was considered "having a partner". If a woman was single, widowed, separated, legally separated, or divorced, she was considered "without a partner". The Number of Children living in the same household was dichotomized as "1-2 children", or "≥ 3 children".

Dietary intake was obtained using the PNDS qualitative food frequency questionnaire (FFQ) composed of 20 typical Brazilian foods. The frequency of children's consumption of each food was reported by the mother for the 7 days preceding the interview [14]. For children aged 6 months to 5 years variables were coded as follows: four types of meat were chosen from the FFQ to reflect the child's consumption of meat (cow/pig, liver, chicken, and fish). A dichotomous variable was created indicating that either a child had eaten meat at least one time per day in the past seven days (coded as "at least 1x/day"), or a child had eaten meat but not every day in the past seven days (coded as "not every day"). To compose the Fruits & Vegetables variable, three food groups were selected from the FFQ. Daily consumption of fruits and vegetables (from the Brazilian questionnaire: "frutas", "verduras", "legumes") indicates the child consumed at least three healthy foods daily, as recommended by the Brazilian Ministry of Health [15,16]. A dichotomous variable was created indicating either a child had eaten fruits and vegetables every day in the past seven days (coded as "every day"), or a child had eaten fruits and vegetables but not every day in the past seven days (coded as "not every day"). Children under six months of age were included in the analysis by adding children in the "every day" category who had not eaten fruits and vegetables or meat on any given day

in the past seven days, implying that breastfeeding or formula feeding were the only forms of food they had eaten.

Anthropometric measurement equipment, training and standardization of interviewers, supervision and quality control of measurement techniques used to obtain all measurements followed standard PNDS procedures [17,18]. Weight-for-Age categories, described in Z-scores (WAZ), were based on the World Health Organization standards [19]. For analysis purposes a dichotomous variable named Nutritional Status was created considering a child "underweight" if WAZ < -2.0, and "not underweight" if WAZ ≥ -2.0. Hospitalizations were based on mother's report of whether children were hospitalized for diarrhea or pneumonia at least once in the 12 months prior to interview (coded as "yes").

Data Analysis

To merge and analyze PNDS 2006/07 datasets, Stata/IC 14 (StataCorp LP, College Station, TX, USA) was used. To correctly reflect the stratification and clustering effects of the complex sampling design, all analyses were performed using the complex survey command (*svy*) to represent the Brazilian population. However, to avoid overestimating associations in subgroups, sample weights were only used in descriptive analysis[(11)]. Chi-square tests with a second-order Rao-Scott correction [20] were used in descriptive bivariate analysis of associations of socioeconomic, demographic, biological variables with disaggregated food insecurity. Unadjusted and adjusted multivariate analysis used Poisson regression.

Ethical Standards

This study was approved by the Ethics Committee in Research of the Universidade Federal de São Paulo/Hospital São Paulo (080567/2016).

Results

A sample of 3920 households was selected for analysis representing 11,779,686 households. Table 1 describes socioeconomic, demographic and child nutrition and health variables by food security status. As expected, food insecure households were more prevalent in the north and northeast regions and rural areas. Majorities of families living in food-insecure households were from low economic strata, had inadequate living conditions and participated in safety net programs. More mothers living in food-insecure households reported less than 8 years of education, being without a partner, and having 3 or more children, who were prominently older than 2 years of age. More children living in food-insecure households did not eat meat, or fruits and vegetables every day. Food insecurity was also associated with undernutrition (WAZ< -2.0 Z-score) and children´s hospitalizations during the year preceding the interview.

Table 1. Description of demographic, socioeconomic and biological variables by food security status in households with children younger than five years. Brazil; 2006/07.

Characteristics	Number of households N (%)	Food Security* % (95% CI)	Food Insecurity* % (95% CI)	p-value*
Macro-region	3920			0.0001
MW+SE+S	2406 (61.4)	89.9 (86.6; 92.4)	10.1 (7.6; 13.4)	
N+NE	1514 (38.6)	69.3 (66.1; 72.3)	30.7 (27.7; 33.9)	
Urban-Rural Classification	3920			0.0025
Urban	2601 (66.3)	83.8 (81.0; 86.2)	16.2 (13.8; 18.9)	
Rural	1319 (33.7)	76.5 (72.2; 80.3)	23.5 (19.7; 27.9)	
Economic Status	3919			0.0001
Classes A1 to C2	2463 (62.8)	90.6 (88.6; 92.3)	9.4 (7.7; 11.4)	
Classes D/E	1456 (37.1)	66.0 (61.4; 70.4)	34.0 (29.6; 38.6)	
Living Conditions	3918			0.0001
Adequate	1894 (48.4)	87.8 (85.1; 90.0)	12.2 (10.0; 14.9)	
Inadequate	2024 (51.6)	73.8 (69.8; 77.5)	26.2 (22.5; 30.2)	
Cash Transfer Program	3917			0.0001
Not receive	2714 (69.3)	88.1 (85.9; 89.9)	11.9 (10.1; 14.1)	
Receive	1203 (30.7)	67.0 (61.7; 71.9)	33.0 (28.2; 38.3)	
Maternal Education	3896			0.0001
>8 years	1578 (40.5)	92.1 (89.7; 94.0)	7.9 (6.1; 10.3)	
0-8 years	2318 (59.5)	74.3 (70.8; 77.5)	25.7 (22.5; 29.2)	
Marital Status	3918			0.0114
With partner	3336 (85.1)	83.8 (81.7; 85.8)	16.2 (14.3,18.3)	
Without partner	582 (14.9)	74.8 (65.9; 82.0)	25.2 (18.0; 34.1)	
Number of Children	3920			0.0001
1-2	2905 (74.1)	85.2 (82.5; 87.5)	14.8 ([12.5; 17.5)	
≥3	1015 (25.9)	70.8 (66.2; 74.9)	29.2 (25.1; 33.8)	
Gender of Children	3920			0.7894
Female	1894 (48.3)	82.2 (78.5; 85.3)	17.8 (14.7; 21.5)	
Male	2026 (51.7)	82.7 (79.9; 85.1)	17.3 (14.9; 20.1)	
Age of Children	3920			0.0253
<24 months	1299 (33.1)	86.3 (81.4; 90.1)	13.7 (9.9; 18.6)	
≥24 months	2621 (66.9)	80.2 (77.7; 82.6)	19.8 (17.4; 22.3)	
Meat	3826			0.0267
At least 1x/day	2510 (65.6)	84.1 (81.6; 86.4)	15.9 (13.7; 18.4)	
Not every day	1316 (34.4)	79.4 (75.0; 83.3)	20.6 (16.7' 25.0)	
Fruits & Vegetables	3884			0.0093
Every day	513 (13.2)	92.4 (83.9; 96.6)	7.6 (3.4; 16.2)	
Not every day	3371 (86.8)	80.7 (78.3; 82.9)	19.3 (17.1; 21.7)	
Nutritional Status	3646			0.0140
WAZ ≥ -2.0 Z-score	3551 (97.4)	82.3 (79.9; 84.6)	17.7 (15.5; 20.2)	
WAZ < -2.0 Z-score	95 (2.6)	67.9 (52.7; 80.0)	32.1 (20.0; 47.3)	
Hospitalization	3920			0.0353
No	3712 (94.7)	82.8 (80.3; 85.1)	17.2 (14.9; 19.7)	
Yes	208 (5.3)	74.2 (65.0; 81.6)	25.9 (18.4; 35.0)	

* Food security includes food security and mild food insecurity categories. Food insecurity includes moderate and severe categories. 95%CI: 95% confidence interval; p: probability. *Qui-square test with Rao-Scott correction. Household variables: macro-region, urban-rural classification, economic status, living-conditions, cash transfer program, maternal education, marital status and number of children. Children's variables: gender, age, meat, fruits & vegetables intake, nutritional status and hospitalization.

Food Insecurity Screen

After detailed examination of each EBIA positive response using cross tabulations, the combination of questions 2 and 4 showed higher sensitivity, specificity, positive and negative predictive values and ROC area when compared with the gold standard. Question number 2 in the EBIA ("Nos últimos três meses a comida acabou antes que você tivesse mais dinheiro para comprar mais") corresponds to HFSSM question Q2: "In the past 12 months the food that (I/we) bought just didn't last, and (I/we) didn't have money to get more"); and EBIA's question number 4 ("Nos últimos três meses, você teve que se arranjar com apenas alguns alimentos para alimentar os moradores com menos de 18 anos, porque o dinheiro acabou?") corresponds to HFSSM question Q4: "In the past 12 months, did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?". Prevalence of food insecurity assessed by EBIA was 20.7 percent and the Brazilian 2-item food-insecurity screen comprised by questions 2 and 4 provided prevalence of 22 percent, sensitivity of 79.31 percent, specificity of 92.96 percent, positive predictive value of 74.62 percent, and negative predictive value of 94.50 percent. Its accuracy was 90.13 percent and the area under the ROC curve was of 86.13 percent (Tables 2 and 3).

Table 2. Contingency table of EBIA as gold standard and the 2-item screen tool in identifying food insecure households.

EBIA / 2-item screen	Identified by EBIA, n (%)	Not identified by EBIA, n (%)	Total, n (%)
Identified by the 2-item screen	644 (79.3)	219 (7.1)	863 (22.0)
Not identified by the 2-item screen	168 (20.7)	2,889 (92.9)	3,057 (78.0)
Total	812 (20.7)	3,108 (79.3)	3,920 (100.0)

Table 3. Statistical tests of the 2-item screening tool.

Statistic	Value	95% CI
Sensitivity	79.31%	76.36% to 82.05%
Specificity	92.95%	92.00% to 93.83%
Positive Predictive Value	74.62%	72.03% to 77.05%
Negative Predictive Value	94.50%	93.76% to 95.16%
Accuracy	90.13%	89.15% to 91.04%
ROC area	86.13%	84.67% to 87.60%

95% CI: 95% confidence interval.

Convergent validity analyses using Poisson logistic regression models compared results conducted with the EBIA and the Brazilian 2-item food-insecurity screen separately. The 2-item screening tool discriminated nutrition and health outcomes associated with living in food-insecure households similarly to the EBIA 15-item gold standard. Using the Brazilian 2-item

food-insecurity screen, when compared with children living in food secure households, children in food insecure households were 1.1 and 1.5 times more likely to not eat meat or fruits and vegetables every day, respectively. In addition, children living in food insecure households were 1.3 times more likely to have their weight-for-age lower than -2.0 z-scores and 1.4 times more likely to be hospitalized by diarrhea or pneumonia. Showing similar results of high nutritional and health risks when using the Brazilian 2-item food-insecurity screen and the EBIA gold standard (Table 4).

Table 4. Association of children younger than five years biological variables with food-insecure households by different instruments. Poisson Regression Model. Brazil, PNDS 2006/07.

	EBIA 15-item*				2-item screen*			
Variables	**cPR (95% CI)**	**p**	**aPR (95% CI)**	**p**	**cPR (95% CI)**	**p**	**aPR (95% CI)**	**p**
Meat	1.4 (1.2; 1.6)	.001	1.2 (1.1; 1.4)	.001	1.3 (1.1; 1.4)	.001	1.1 (1.1; 1.3)	.022
Fruits & Vegetables	3.1 (2.3; 4.1)	.001	1.7 (1.3; 2.3)	.001	2.6 (1.9; 3.4)	.001	1.5 (1.2; 2.0)	.003
Nutritional Status	1.9 (1.5; 2.5)	.001	1.4 (1.1; 1.7)	.008	1.7 (1.3; 2.2)	.001	1.3 (1.1; 1.6)	.047
Hospitalization	1.6 (1.3; 2.0)	.001	1.3 (1.1; 1.6)	.009	1.6 (1.3; 1.9)	.001	1.4 (1.2; 1.7)	.001

cPR: crude prevalence ratio; aPR: adjusted prevalence ratio; 95% CI: 95% confidence interval; p: probability. *Adjusted for: macro-region, urban-rural classification, living conditions, economic status, cash transfer program, maternal education, marital status, number of children in the household, child's gender and age.

Discussion

The Brazilian 2-item food-insecurity screen showed sensitivity of 79.31%, specificity of 92.95%, positive predictive value of 74.62%, negative predictive value of 94.50% and ROC area 86.13%. This screen also presented high convergent validity for children's nutrition and health variables when compared with the gold standard, the EBIA full scale, becoming a valid tool to identify families at risk for food insecurity in clinical and other settings.

Food security, when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life [21,22] is a critical part of the ideal environment in which to raise a child. However, this ideal setting can be disrupted. Difficulty in accessing food can include lack of money to buy food, environmental or health crises such the COVID-19 pandemic, leading families to experience different levels of severity of food insecurity. Access to nutritious food is particularly critical during the first years of life when a child is experiencing rapid growth and brain development [23]. Decreasing food quality and/or quantity – behaviors often seen in food insecure households – are strategies used to avoid experiencing hunger [22].

Over the years, EBIA was incorporated as part of the data collection routine of national/regional surveys [24]. Despite efforts, high implementation costs force long intervals

between surveys in Brazil. The National Household Sample Survey (PNAD) included EBIA in three of its editions, 2004, 2009 and 2013. The National Survey on Demography and Health of Women and Children (PNDS) included EBIA in its 2006 edition. The Family Budget Survey (POF) included EBIA for the first time in its 2017/2018 edition. In addition, its long form demands time and effort which could heavily interfere with its implementation in the hurried routine of health care professionals in clinical contexts.

Indeed, Brazil enjoys shorter survey versions such as the adult eight-item [25] and the five-item scales [26]. However, the country does not yet have a very short screening instrument to promptly assess individual households at risk for food insecurity. The adoption of a 2-item screen will allow Brazil to rapidly identify families likely living in food-insecure households, thus helping to avoid health and development consequences for children and adults associated with food insecurity and hunger, or responding to immediate crises such as COVID-19. For a more comprehensive assessment of the severity of food insecurity and its prevalence in populations, the longer version of EBIA should be administered.

To assess validity, accuracy and effectiveness of the proposed Brazilian 2-item food insecurity screen, a combination of all seven components of its psychometric profile is required: sensitivity, specificity, positive and negative predictive values, accuracy, area under the ROC curve, and convergent validity.

The proposed Brazilian 2-item food insecurity screen provided sensitivity of 79.3 percent, attesting satisfactory foundations of the screening test. Moreover, the screen demonstrated specificity of 92.96 percent, indicating that the screen correctly identifies almost all families that live in food-secure households. Supporting this result, the negative predictive value of 94.50 percent shows that among those screening negative practically all households were in fact food-secure. Namely, the screen effectively rules out families that are not at risk for food insecurity, avoiding unnecessary interventions and use of financial resources. Further, the Brazilian 2-item food insecurity screen exhibited accuracy of 90.13 percent and an area under the ROC curve of 86.13 percent, indicating acceptable overall ability of the screen to identify households with and without food insecurity based on its results.

The positive predictive value of 74.62 percent indicates the proportion of households with a positive screening result that actually are food-insecure. In other words, it focuses on the usefulness of the test in clinical practice. Given that the screen is a risk assessment tool, respondents screening positive will further respond to the EBIA full scale. In this sense, the positive predictive value of approximately 25 percent of households (false positives) indicates that one quarter of the sample will be responding to the full scale despite being classified as

food secure by the gold standard. It leads us to further the discussion on the gold standard food security cut-off point used in this project.

EBIA's sum of affirmative items classifies households into four levels using cutoffs arising from expert discussions informed by psychometric analyses and policy considerations. The cut-off points validated for households with children in Brazil are as follows: Food Secure (0 questions affirmed); Mild Food Insecurity (1-5 questions affirmed); Moderate Food Insecurity (6-10 questions affirmed); and Severe Food Insecurity (11-15 questions affirmed). Consequently, when combining Food Security and Mild Food Insecurity, we considered food secure all households with up to 5 affirmative responses. In other words, some of the false positives are in fact mild food-insecure households. Thus, families in these households might benefit from being classified as positive in the screen, further responding the EBIA full scale to be correctly identified as food secure or insecure. To spark the conversation, a study published in 2016 [27] suggested that, in terms of raw score, Brazilian households endorsing only one item of the scale would be better classified by being placed in the same stratum as those with negative responses on all items, or considered food-secure using EBIA. This way, we could more appropriately distinguish food-secure from food-insecure households, decreasing the number of false positives in the model.

The correspondence between the food insecurity screen and theoretically related health variables displayed by the convergent validity adjusted by socioeconomic and demographic variables showed significance in four variables. These results suggest that EBIA and the Brazilian 2-item food insecurity screen have similar power to capture the negative impacts food insecure pose on children's health. Children living in food-insecure households are more likely to not eat meat or fruits and vegetables every day, to be classified as underweight and be hospitalized by diarrhea or pneumonia. These health conditions suggest increased vulnerability among children living in food-insecure households and the need for immediate referrals to desirable services is imperative.

The Brazilian 2-item food insecurity screen and the COVID-19 pandemic: a practical example of how this tool can be used

The COVID-19 pandemic has created public health and economic crises worldwide that are likely to test the ability of national, state, and local governments and policymakers to protect their populations from extreme deprivation for an extended period of time. Constraints on available resources resulting from the worldwide economic downturn will also increase stresses involved in efforts to respond to the need for assistance of all kinds, particularly food assistance [28, 29]. In this context, a brief screener to identify families and individuals at risk for food

insecurity is urgently needed for use in clinical settings, and by public health workers and social service providers.

In summary, the adoption of a Brazilian 2-item food insecurity screen is likely to identify families at risk for food insecurity and place fewer demands on the healthcare system, be more accessible, less expensive and less time-consuming. In addition, the screen can encourage appropriate and timely decision making in times of crisis, such as the one posed by COVID-19 regarding this invisible and harmful condition called food insecurity.

There were limitations to this study. First, the authors acknowledge that while the methods used for identifying items to be included in a screening tool were systematic and met established standards and the replicability criteria from the Hunger Vital Sign™ set for this study, they were not as conservative or rigorous as item-response theory (IRT) methods. Second, these analyses were conducted using households with at least one child under 5 years of age. Consequently, it is not possible to assert that the 2-item screening tool proposed here would have the same applicability in assessing risk for food insecurity in households containing older children, adults, or elderly people. Conversely, the Hunger Vital Sign™ validation also used a similar sample, and currently the American tool has been validated to be used in households with youth, adolescents and adults. Therefore, additional validation studies of the proposed Brazilian 2-item screening tool need to be conducted using samples from older populations and other types of households.

Acknowledgements and statement of author's contributions to manuscript

Dr. Ana Poblacion contributed substantially with the conception and design, data acquisition, analysis and interpretation. Also, Dr. Poblacion was responsible for drafting the article and was primary responsible for the final version submitted to publication.

Dr. Ana Maria Segall-Correa, Dr. John T. Cook, and Dr. Jose Augusto Aguiar Carrazedo Taddei contributed substantially with the conception, design, and data interpretation. Drs. Segall-Correa, Cook, and Taddei revised the manuscript critically and approved the final version to be published.

Conflict of Interest and Funding Disclosure

All authors declare "no conflicts of interest".

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