# A Model-Based Approach to Identify Classes and Respective Cutoffs of the Brazilian Household Food Insecurity Measurement Scale[1,2]

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## Abstract

**Background:** The Brazilian Household Food Insecurity Measurement Scale (EBIA) is the main tool for assessing household food insecurity (FI) in Brazil, assisting in monitoring and improving national public policies to promote food security. Based on the sum of item scores, households have been classified into 4 levels of FI, with the use of cutoffs arising from expert discussions informed by psychometric analyses and policy considerations.

**Objectives:** This study aimed to identify homogeneous latent groups corresponding to levels of FI, examine whether such subgroups could be defined from discriminant cutoffs applied to the overall EBIA raw score, and compare these cutoffs against those currently used.

**Methods:** A cross-sectional population-based study with a representative sample of 1105 households from a low-income metropolitan area of Rio de Janeiro was conducted. Latent class factor analysis (LCFA) models were applied to the answers to EBIA's items to identify homogeneous groups, obtaining the number of latent classes for FI measured by the scale. Based on this and a thorough classification agreement evaluation, optimal cutoffs for discriminating between different severity levels of FI were ascertained. Model-based grouping and the official EBIA classification cutoffs were also contrasted.

**Results:** LCFA identified 4 homogeneous groups with a very high degree of class separation (entropy = 0.906), endorsing the classification of EBIA as a 4-level measure of FI. Two sets of cutoffs were identified to separate such groups according to household type: 1/2, 5/6, and 10/11 in households with children and adolescents (score range: 0–14); and 1/2, 3/4, and 5/6 in adult-only households (score range: 0–7).

**Conclusion:** Although roughly classifying EBIA as in previous studies, the current approach suggests that, in terms of raw score, households endorsing only one item of the scale would be better classified by being placed in the same stratum as those remaining negative on all items. *J Nutr* 2016;146:1356–64.

**Keywords:** food insecurity, surveys, questionnaires, psychometric, statistical model

## Introduction

Food insecurity is defined as "a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life" (1). Epidemiologic studies and governmental assessments have shown that there is increasing interest in the evaluation of food insecurity at the household level (2–6). This has fostered strong interest in conducting research to improve the theoretical foundation of the household food insecurity construct and helping direct preventive action and policies to fight hunger in many countries (7).

[8] Abbreviations used: ABIC, adjusted Bayesian information criterion; BIC, Bayesian information criterion; CFA, confirmatory factor analysis; EBIA, Brazilian Household Food Insecurity Measurement Scale; LCA, latent class analysis; LCFA, latent class factor analysis; US HFSSM, US Household Food Security Survey Module; VLMR, Vuong–Lo–Mendell–Rubin likelihood ratio test.

This growing interest also has widened the number of instruments available to assess food insecurity. Among the many alternative measurement tools, the US Household Food Security Survey Module (US HFSSM)[8] has been at the forefront of this process (8). Its development history is comprehensive, showing many desirable psychometric properties (8–14). Although first developed for the North American milieu, the US HFSSM also has been cross-culturally adapted in many countries (15–20). According to a recent systematic review (21), there are 5 versions in Latin America, among which is the Brazilian Household Food Insecurity Measurement Scale (EBIA) (22, 23). In addition, a reduced version consisting of only 8 adult items of the US HFSSM was proposed by a recent initiative of the FAO within the Voices of the Hungry Project (24). Named the Food Insecurity Experience Scale, the instrument was applied in >140 countries, including Brazil and several other countries in Latin America.

The US HFSSM and the food insecurity experience-based scales derived from it, including the EBIA, have been tested through factor analysis methods, both exploratory and confirmatory (15, 25–28). Research consistently has shown that the US HFSSM lineage is one-dimensional, regardless of whether it is applied to adult-only families or households with children and adolescents. Moreover, all versions have shown to hold further interesting psychometric properties, such as local independence and good item reliability (14, 15, 18, 25–27, 29). High correlations with conditions traditionally associated with food insecurity, such as food supplies, dietary quality, and several socioeconomic and demographic factors, also have been documented (14, 16, 17, 29–33).

Another property of particular interest to this paper is scalability. The versions of the US HFSSM and derivative experience-based scales both for adults and for children and adolescents have been shown to contain adequate scalar properties. Several Rasch analyses have demonstrated the instrument's ability to map the increasing intensity of the underlying trait (food insecurity) along a purported continuum (2, 8, 14, 16, 25–29). In the same vein, throughout its development history, the instrument has been concomitantly proposed as an ordered categorical construct. For instance, in the original 18-item US HFSSM version tailored to households with children, the trait was classified into 4 levels, namely, "food secure" (scores 0–2), "food insecurity without hunger" (scores 3–7), "moderate food insecurity with hunger" (scores 8–12), and "severe food insecurity with hunger" (scores 13–18) (8, 14). The US HFSSM has undergone some changes in language and metrics throughout the years (8, 13, 34–37), and, more recently, food security has been characterized at 3 levels, namely, "high/ marginal" (scores 0–2), "low" (scores 3–7), and "very low" (scores 8–18) (6).

Similarly, all Brazilian adaptations consistently classify the construct into categorical strata, regardless of whether or not the scale is directed to adult-only households, or the number of component items of the version (14, 15, or 16 items) (28). For example, in a comprehensive national study that used a 14-item EBIA (5), food insecurity was classified as "absent" (score 0), "mild" (scores 1–5), "moderate" (notes 6–9), and "severe" (scores 10–14) in households with children and/or adolescents.

Although for some researchers and professional managers the rationale for grouping may be pragmatic—to enable summarizing the underlying continuous metric to the wider public (27, 36)—the categorized scale has been used either as a tool for drawing and monitoring public policies to fight hunger and extreme poverty (6, 35, 38, 39), or even to directly

classify subgroups in empirical research (5, 7, 40–44). Yet, as conveyed above, cutoffs based on the raw metric composed of the sums of item scores differ in time, across countries, and according to versions as the instruments are applied and refined.

Admittedly, these cutoffs have been established carefully while taking into account psychometric analyses, as well as expert judgment and usefulness for policymaking. Nevertheless, and regardless, what these different versions that use different cutoffs have in common is that they all assume a similar and consistent class separation. Labeling the categories—whether in the adult-only or the child-and-adolescent versions—assumes that the same homogeneous group is being detected across samples. This feature needs to be tested if all households are to be comparable, regardless of their demographic composition and population domain.

To draw some light on these important issues, this paper explores whether homogeneous latent groups corresponding to levels of food insecurity (or absence thereof) are identifiable and, if so, examines whether such subgroups can be mapped specifically from identifying discriminant cutoffs applied to the sums of raw item scores. The latent class factor analysis (LCFA) model, a model-based approach, is used to this end.

## Methods

### Sample, participants, and measurement

The data analyzed came from a survey conducted from April to December 2010 in a low-income population of the municipality of Duque de Caxias in the metropolitan region of Rio de Janeiro. Survey respondents were selected based on a 3-stage cluster-sampling procedure with unequal selection probabilities. In the first stage, 75 census tracts were selected out of the 322 comprising the study area at the time of data collection. In each sector, 15 households were randomly selected with the use of an inverse sampling procedure (45, 46). This consisted of specifying a number of interviews set in advance, rather than the total number of households to be sampled. The procedure allowed us to check how many $n$ units should be observed to obtain $k$ successful interviews. In the present study, this ensured that a sufficient number of households with children between 6 and 36 mo of age were sampled. The final sample consisted of 1121 households (99.6%), of which 1105 (98.6%) had the EBIA fully completed. Among the households included, 620 had children and/or adolescents, and 485 had only adults living in them. Respondents were mostly women responsible for buying food and preparing meals.

### The EBIA used in the analyses

The EBIA version examined in our analyses was proposed recently by Segall-Corrêa et al. (28). This version is a refinement of the 16- and 15-item versions of the EBIA scales in use since the original version was released in 2003–2004 (22, 23). Based on Rasch analyses, 2 items were removed in this version: "adult cut meal size" and "adult lost weight." The resulting scale has 14 items regarding families with children and/or adolescents, with 7 items referring to adult-only households. The summarized text of each item is presented in **Table 1**. The full wording of each item can be found in Segall-Corrêa et al. (28). As previously recommended (16, 47), response options to each item were analyzed as dichotomous (yes or no).

### Data analyses

The analyses involved 2 stages. Stage 1 involved the model-building process, with the aim of identifying possible underlying latent classes of the EBIA. The second stage consisted of ascertaining optimal cutoffs in the raw score of the scale with the use of the model-based variable that contained class membership levels as a benchmark.

**TABLE 1** One-dimensional factor analysis of the 14-item Brazilian Household Food Insecurity Measurement Scale applied in a representative sample of 1105 households from the Duque de Caxias metropolitan area of Rio de Janeiro, Brazil, 2010[1]

| Item[2] | $\lambda_i$[3] | $\delta_i$[4] | $b_i$[5] |
|---|---|---|---|
| i1—Worried | 0.893 | 0.202 | 0.507 |
| i2—Ran out of food | 0.836 | 0.301 | 1.131 |
| i3—Did not eat a healthy and varied diet | 0.945 | 0.108 | 0.586 |
| i4—C&A ate few foods | 0.954 | 0.090 | 0.792 |
| i5—AD skipped meal | 0.922 | 0.150 | 1.679 |
| i6—AD ate less | 0.956 | 0.087 | 1.321 |
| i7—AD felt hungry | 0.942 | 0.113 | 1.525 |
| i8—AD ate ≤1 meal/d | 0.901 | 0.189 | 1.914 |
| i9—C&A did not eat a healthy and varied diet | 0.905 | 0.181 | 0.893 |
| i10—C&A ate less | 0.984 | 0.032 | 1.571 |
| i11—C&A cut meal size | 0.992 | 0.017 | 1.557 |
| i12—C&A skipped meal | 0.981 | 0.037 | 1.714 |
| i13—C&A felt hungry | 0.985 | 0.030 | 1.919 |
| i14—C&A did not eat all day | 0.924 | 0.146 | 2.240 |

[1] AD, adult aged ≥18 y; C&A, child and/or adolescent <18 y of age.
[2] Each item (i) refers to conditions experienced because of a lack of resources to purchase food during a 3-mo period previous to the survey application.
[3] Standardized loading estimates.
[4] Residual variances.
[5] Item response theory difficulty (intensity) parameters obtained directly from $b_i = \tau_i / \lambda_i^u$, where $\tau_i$ is the estimated threshold (not shown) and $\lambda_i^u$ is the unstandardized loadings akin to those shown in the table. Estimates are provided automatically in the Mplus output.

*Stage 1: LCFA model building.* The modeling strategy used here was an adaptation of the 5-step procedure suggested by Clark et al. (48). Accordingly, the best conventional factor analysis and latent class analysis (LCA) models were first identified, followed by fitting an increasingly complex *f*-factor, *k*-classes LCFA model in search of the best-fitting and most meaningful solution.

Given the scale's consistent 1-dimensional history (8, 14, 25, 26), no further multidimensional factor structure was pursued. Thus, only a conventional 1-factor confirmatory factor analysis (CFA) was carried out initially in order to identify the factor analysis model for later comparison with the best LCFA model uncovered in the ensuing step. For the same purpose, conventional LCA models with 1–k classes were fitted to identify the benchmark LCA model. These simpler CFA and LCA models were needed to determine when to stop the fitting process of the ensuing factor mixture models.

After the decision was made to restrict the dimensional component of the models, only 1-factor, *k*-classes LCFA models were fitted, up to the number established by the best LCA model identified earlier. As mentioned before, an additional step entailed comparing the simpler 1-factor CFA and the best *k*-class LCA model to the best LCFA model in order to assess whether any fit and/or substantive improvement would be attained with this more complex model. The diagrams of the 1-dimensional CFA, the *k*-class LCA, and the LCFA models, with the use of the adult-only 7-item EBIA scale for illustration, are presented in **Figure 1**A–C. In Figure 1B, *k* indicates that there are *k*-classes and that the response pattern of items underlies class membership. In Figure 1C, the *k*-classes' latent variable points to the factor, signaling that class membership is based on each individual's location on the factor. Because the LCFA model is the simplest factor mixture model (48, 49), factor loadings and thresholds were assumed to be invariant across classes, and the single factor variance was set to zero. Classes thus are distinguished solely by their $\alpha_k$ factor means. Nonetheless, as in any LCA model, an LCFA model also yields conditional item probabilities (information regarding the probability that an individual in a given class will endorse a specific item) and class probabilities (the proportion of the population in a particular class), both of which are of key interest here. For model specifications and related equations, see Wang and Wang (50) and Clark et al. (48).

All models were fitted in Mplus 7.3 (51) with the use of the full information robust maximum likelihood estimator (52) to account for the complex sampling structure of the data set (clustering and unequal sampling weights), and to deal appropriately with the categorical/dichotomous characteristic of the manifest items. In order to accumulate the maximum informativeness per item, the analyses used the complete data set composed of families with and without children and adolescents. However, the ensuing assessments of cutoffs in the raw scores presented in the results section were held separately by family type.

Model fit assessments and comparisons used 4 statistics. The Vuong–Lo–Mendell–Rubin likelihood ratio test (VLMR) was used to compare models with the same parameterization, such as when selecting between models with different class numbers (LCA and LFCA models) (53). A statistically significant *P* value between a *k* and *k−1* class model (e.g., *P* < 0.05) favored the *k* more complex model. Beyond fit assessments between related models, the Bayesian information criterion (BIC), along with the sample-size adjusted Bayesian information criterion (ABIC) (54), is useful when models fit the data similarly and/or are not nested (e.g., in comparing LCA and factor analysis models). Lower BIC and ABIC values indicate better model fits. Entropy was used to assess how well the latent classes were distinguishable from each other (55). Values ranged from 0 to 1, unity indicating perfect class separation (56, 57).

According to Muthén (56), theoretic considerations should also play a relevant role in choosing from alternative models. Thus, complementing the formal evaluation of fit, item profiles (class conditional item probabilities), scatter plots, and local polynomial smooth plots that used a Epanechnikov kernel function are also provided. These and ensuing analyses (Stage 2 presented in the next section) were carried out in Stata with the use of the svy program to allow for the complex sampling structure (58).

*Stage 2: Identification of cutoffs on the overall raw score of EBIA based on identified classes (with classification agreement evaluation).* Once the best LCFA model was identified and individuals were assigned to their respective class membership categories, the overall raw score of the EBIA was tabulated against the classes defined. Raw scores were obtained by summing the component item scores. Through this analysis, we specifically sought *1*) to identify the optimal cutoffs discriminating adjacent (ordinal) severity levels of EBIA; *2*) by extension, to evaluate the proportion misclassified; and *3*) to assess the degree of agreement between the model-based classification and the empirical grouping based on the identified raw cutoffs. To this end, a quadratic weighted κ coefficient was used (59, 60).

Finally, the classification of EBIA proposed in the literature and traditionally used in research up to now was compared with both the model-based (LCFA) classification and the empirical classification based on the resulting identified raw cutoffs. Misclassification analysis was then conducted.

### Ethical aspects
All participants were informed about the ethical aspects of the study and signed the study's consent form before the interviews. This work is part of the larger study, which was approved by the Research Ethics Committee of the Public Health Studies Institute of the Federal University of Rio de Janeiro in 2009 (Process No 73/2009 of 18 May 2009).

## Results

At the US$–Brazilian real exchange rate of 1 July 2010, families had a monthly mean ± SE per capita income of $228.3 ± $8.90; households had mostly ≤4 individuals (81%; 95% CI: 77.4%, 84.2%); only 59.8% (95% CI: 55.7%, 63.8%) of households had basic sanitation; and 77.5% (95% CI: 73.8%, 80.8%) of them had potable water. The household main breadwinners were mostly men (64.1%; 95% CI: 60.2%, 68.0%) and had a mean ± SE age of 44 ± 0.58 y; 74.9% (95% CI: 71.0%, 78.3%) had not completed 9 y of schooling (which is the Brazilian basic
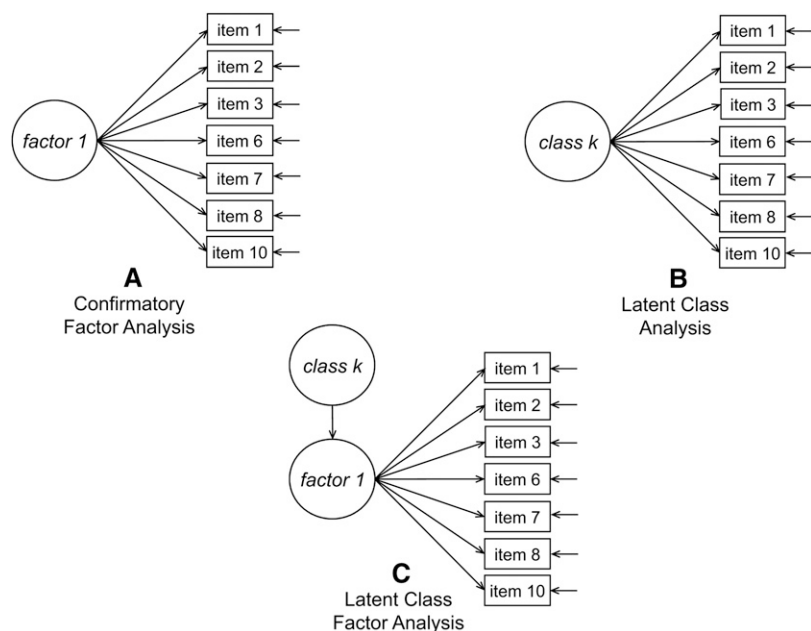
**FIGURE 1** Diagrams of the 1-dimensional confirmatory factor analysis (A), the $k$-class latent class analysis (B), and the latent class factor analysis (C) models, with the use of the adult-only 7-item Brazilian Household Food Insecurity Measurement Scale for illustration.

education level, equivalent to middle school in the United States and O-level in the United Kingdom). Women respondents had a mean ± SE age of 40.1 ± 0.60 y and 10.3% (95% CI: 7.8%, 13.4%) had not finished basic schooling.

For later comparison with the fitted LCFA models, the first evaluation step consisted of a 1-dimensional CFA that used the 14-item EBIA. Factor loadings were >0.90 and, by extension, had quite low residuals (Table 1). From an item response theory modeling perspective, items also seemed to follow a pattern depicting an intensity crescendo of severity of food insecurity as shown in the $b_i$ column. The BIC and ABIC fit indexes were 4935.3 and 4846.4, respectively.

The fit statistics of the LCA models with 1–5 latent classes are shown in **Table 2**. Entropy was within reasonable bounds in all pertinent $c_{k\,>\,1}$ models. Model $c_2$ was statistically different from $c_3$, showing that they are not interchangeable, and the BIC and ABIC values visibly decreased (improved) with the latter. A BIC and ABIC reduction also occurred from $c_5$ to $c_4$. Because $c_4$ is indistinguishable from both $c_3$ ($P = 0.38$) and $c_5$ ($P = 0.32$) alike, by extension, the latter was also indistinguishable from the more parsimonious $c_3$. Based on VLMR and BIC statistics in tandem, the best LCA fit remained with $c_3$, but ruling out $c_4$ would be unwarranted so far because the ABIC statistic favored the latter. Therefore, it was decided to analyze 4 increasingly complex 1-factor, $k$-classes ($k = 1$–4) models in the next step.

The fit statistics of these LCFA models also are presented in Table 2. Entropy stayed >0.9 as before, but the overall improvement (drop) in the BIC and ABIC values over the LCA models is noticeable. Although $c_3$ could be preferable over $c_4$ because of the borderline VLMR $P$ value of 0.1082, the LCFA 4-class model stood out with regard to both criterion-statistics. Conspicuously, only the BIC and ABIC values of this $c_4$ LCFA model proved to be lower than the respective values in the 1-factor CFA model shown in Table 1.

Staying on this best 1-factor, 4-classes LCFA model, the estimated class probabilities for the child-and-adolescent version of the instrument were 62.5%, 25.6%, 8.4%, and 3.5% for classes 1–4, respectively. In adult-only families, the values were 74.4%, 18.3%, 3.3%, and 3.9%, respectively, showing an overall

shift to the left. The plotted estimated conditional (on class membership assignment) probabilities per item are shown in **Figure 2**. Note that items here were ordered according to their estimated scalar intensities (increasing $b_i$ item response theory parameters as modeled in the CFA presented in Table 1).

The relation of the EBIA raw scores to the classes identified according to the best LCFA model, disaggregated by type of family, is shown in **Table 3**. Three limits emerged. In families with children and/or adolescents, the cutoffs were between scores 1/2, 5/6, and 10/11; in adult-only families, these were 1/2, 3/4, and 5/6.

The aggregate pattern of classification when the identified cutoffs are used is shown in **Table 4** (columns 2–5). The degree of misclassification is just above 0.5%, which resonates in a κ coefficient close to one. The trivial discrepancy shows only between classes 2 and 3, while indicating that there is no

**TABLE 2** Fit statistics of latent class analysis and latent class factor analysis models of the 14-item Brazilian Household Food Insecurity Measurement Scale applied in a representative sample of 1105 households from the Duque de Caxias metropolitan area of Rio de Janeiro, Brazil, 2010[1]

| $c_k$ | VLMR[2] | BIC | ABIC | Entropy |
|---|---|---|---|---|
| LCA | | | | |
| 1 | 0.000 | 7624.0 | 7579.6 | — |
| 2 | 0.006 | 5460.8 | 5368.7 | 0.926 |
| 3 | 0.380 | 5068.0 | 4928.3 | 0.921 |
| 4 | 0.320 | 5079.6 | 4892.2 | 0.915 |
| 5 | — | 5137.1 | 4902.1 | 0.934 |
| LCFA | | | | |
| 1 | 0.000 | 7715.1 | 7629.4 | — |
| 2 | 0.004 | 5460.8 | 5368.7 | 0.926 |
| 3 | 0.110 | 4986.8 | 4888.3 | 0.919 |
| 4 | — | 4920.5 | 4815.7 | 0.906 |

[1] ABIC, adjusted Bayesian information criteria; BIC, Bayesian information criteria; LCA, latent class analysis (model); LCFA, latent class factor analysis (model); VLMR, Vuong–Lo–Mendell–Rubin likelihood ratio test.
[2] $P$ value comparing a model that used $c_k$ classes with another that used $c_{k+1}$ classes.
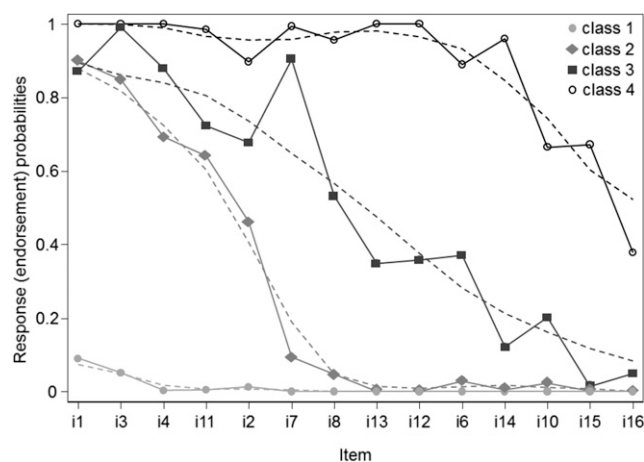
**FIGURE 2** Response (endorsement) probabilities of Brazilian House-hold Food Insecurity Measurement Scale items according to the 4 subgroups identified by the latent class factor analysis 1-factor, 4-classes model.

misclassification at both ends—classes 1 and 4. Turning back to Figure 2, the item response profile shows that 2 items in particular—i1 ("worried food would run out") and i3 ("ran out of money to buy healthy and varied diet")—have the most endorsements in class 1 and likely are responsible for most of the raw scores of 1 in those classified as belonging to this class. Actually, an interim analysis shows that in households with children and/or adolescents scoring 1, 51.8% and 26.2% of them endorsed item 1 and item 3, respectively, whereas values rose to 60.3% and 35.5% in adult-only families.

The contrast between the model-based grouping and the traditional Brazilian classification that uses cutoffs 0/1, 5/6, and 9/10 for families with children and/or adolescents and 0/1, 3/4, and 5/6 for adult-only families (5) is shown in Table 4 (columns

6–9). Whereas the classification pattern for classes 2, 3, and 4 is almost similar to the EBIA when model-based cutoffs are used, the discrimination at the lower end is different. Over 1 in 10 families would be misclassified.

## Discussion

This study explored a new approach to classifying household food insecurity based on the scores on the EBIA. The LCFA model suggested 4 food insecurity classes with a very high degree of separation. This representation echoed the original proposal of the EBIA classification (22, 23, 28), as well as the number of categories originally proposed by the US HFSSM scale that originated the Brazilian instrument (8). However, regarding the class-separating cutoffs identified thereafter, the current psychometric approach showed that, in terms of raw score, a first group should include not only households that remained negative on all items, but also those endorsing ≥1 item of the scale.

These results match the classification used in the Canadian version of the US HFSSM (2), as well as 1 of the 2 Iranian versions proposed so far (18). However, the US proponents have been admitting from the outset ≤2 endorsed items in the safe category (8), a recommendation that somehow has been reproduced in other versions of the instrument (15–18). Although this recommendation has been contested in other research (32, 33, 61–67), it may well be that, in some settings, the 0–2 classification effectively stands for the baseline category (usually called "food security"). Still, perhaps in other scenarios more akin to the Brazilian (such as in many Latin American and/or other low- or middle-income countries), and even in higher-income milieus as raised by the aforementioned literature, the profile may come closer to the one found here. Scrutinizing the measurement tool along the current approach in settings that traditionally have been using this more conservative

**TABLE 3** Percentage of families classified according to raw scores of the Brazilian Household Food Insecurity Measurement Scale, by food insecurity latent class membership identified through the best LCFA 1-factor, 4-classes model, applied in a representative sample of 1105 households from the Duque de Caxias metropolitan area of Rio de Janeiro, Brazil, 2010[1]

| | Latent classes (food insecurity) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Families with children and/or adolescents | | | | Families without children and/or adolescents | | | |
| Raw score | C1 | C2 | C3 | C4 | C1 | C2 | C3 | C4 |
| 0 | 51.7 | 0 | 0 | 0 | 63.4 | 0 | 0 | 0 |
| 1 | 10.8 | 0 | 0 | 0 | 11.1 | 0.13 | 0 | 0 |
| 2 | 0 | 4.77 | 0.04 | 0 | 0 | 9.57 | 0 | 0 |
| 3 | 0 | 6.81 | 0 | 0 | 0 | 8.60 | 0.10 | 0 |
| 4 | 0 | 7.16 | 0.03 | 0 | 0 | 0.02 | 1.63 | 0 |
| 5 | 0 | 6.14 | 0.52 | 0 | 0 | 0 | 1.60 | 0 |
| 6 | 0 | 0.74 | 1.89 | 0 | 0 | 0 | 0 | 1.97 |
| 7 | 0 | 0 | 2.32 | 0 | 0 | 0 | 0 | 1.96 |
| 8 | 0 | 0 | 3.16 | 0 | — | — | — | — |
| 9 | 0 | 0 | 0.19 | 0 | — | — | — | — |
| 10 | 0 | 0 | 0.22 | 0 | — | — | — | — |
| 11 | 0 | 0 | 0 | 1.19 | — | — | — | — |
| 12 | 0 | 0 | 0 | 1.14 | — | — | — | — |
| 13 | 0 | 0 | 0 | 0.41 | — | — | — | — |
| 14 | 0 | 0 | 0 | 0.73 | — | — | — | — |
| Total[2] | 62.5 | 25.6 | 8.4 | 3.5 | 74.4 | 18.3 | 3.3 | 3.9 |

[1] Values are percentages. C, class; LCFA, latent class factor analysis (model).
[2] Percentage of families in each class.

**TABLE 4** Percentage of families classified by the EBIA with the use of model-based cutoffs and expert-based cutoffs, by food insecurity latent class membership identified through the best LCFA 1-factor, 4-classes model, applied in a representative sample of 1105 households from the Duque de Caxias metropolitan area of Rio de Janeiro, Brazil, 2010[1]

| | EBIA | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Using model-based cutoffs[3] | | | | Using expert-based cutoffs[4] | | | |
| Latent classes (FI)[2] | No | Mild | Moderate | Severe | No | Mild | Moderate | Severe |
| Class 1 (70.3) | 70.3 | 0 | 0 | 0 | 59.3 | 11.0 | 0 | 0 |
| Class 2 (20.9) | 0.1 | 20.5 | 0.3 | 0 | 0 | 20.6 | 0.3 | 0 |
| Class 3 (5.1) | 0 | 0.3 | 4.8 | 0 | 0 | 0.3 | 4.7 | 0.1 |
| Class 4 (3.8) | 0 | 0 | 0 | 3.8 | 0 | 0 | 0 | 3.8 |
| Misclassification[5] | 0.61 | | | | 11.7 | | | |
| κ coefficient[6] | 0.965 (0.948, 0.982) | | | | 0.746 (0.700, 0.792) | | | |

[1] EBIA, Brazilian Household Food Insecurity Measurement Scale; FI, food insecurity; LCFA, latent class factor analysis (model).
[2] Percentage of families in each class.
[3] Cutoffs for families with children and/or adolescents: 1/2, 5/6, and 10/11; cutoffs for adult-only families: 1/2, 3/4, and 5/6.
[4] Cutoffs for families with children and/or adolescents: 0/1, 5/6, and 9/10; cutoffs for adult-only families: 0/1, 3/4, and 5/6.
[5] Sum of off-diagonal percentages.
[6] Quadratic-weighted (95% CIs) obtained via bootstrap (B = 1000) with the use of the Stata routine kapci (60).

classification thus would be desirable as well. Should the present results hold up, a good number of families with 2 endorsed items could end up classified as having food security, even though they are, in fact, more like those belonging to the adjacent category representing mild food insecurity or marginal food security.

Families scoring 1 in the total raw score were, in general, those supporting items 1 or 3 (jointly, 78% and 96% of endorsements in households with and without children and/or adolescents, respectively). Notably, these are the only items dwelling on issues not related to any quantitative reduction or halting of food, being limited either to concerns about the availability of food in the near future or to a qualitative restriction regarding the variety of available food. It is undeniable that experiencing feelings of uncertainties regarding access and monotony of food because of a money shortage may be part of a theoretical definition of food insecurity (68, 69). Nevertheless, our analyses showed that this subgroup tends to be closer to the one composed by strict food-secure families (scoring zero). In this sense, these model-based empirical findings are consistent with discussions that have been uttered by experts for a while now. For one, worrying that food will be lacking later on could be a reflection of the uncertainties regarding access to food resulting from a previous experience of food insecurity, without necessarily implying an overt food restriction within the recall period. Moreover, families that have never experienced food insufficiency or a full-sized absence may well become worried that they are on the verge of going food insecure (70), either because of family economic instability or other conditions known to have an impact on food access.

For these reasons, a reclassification may be fitting, blending the traditional "food security" and "mild food insecurity" categories into a single stratum. In this proposal, the first category would hold families in plain food security along with those undergoing fears and restraints, yet separated and discernible from those in overt quantitative food shortage (be it mild, moderate, or severe). This base category would be considered void of food insecurity, albeit manifestly containing also families on the verge of becoming quantitatively insecure. Provided the present proposition is tenable and acceptable, a label then could be worked out to indicate that families under both stable and unstable food security conditions have been joined into one group.

As for the other parts of the latent spectrum involving families with what could be understood as moderate and severe food insecurity, the classes obtained through the model-based approach strongly overlap those specified by the expert-based cutoffs traditionally used for the EBIA (Table 4). Families with more severe forms of food insecurity seem to be adequately classified regardless of the approach. A comment is due here, though. The joint use of the moderate and severe categories has been adopted for analysis purposes since the establishment of the EBIA in early 2000 (44, 71–73). This study, however, suggests some heterogeneity in these 2 classes, not only with respect to differences regarding the other categories, but also among themselves. For certain outcomes, such as food consumption, there may not be much gain in discretizing. Analyzing both levels as one is sensible. However, heterogeneity might not be overlooked for some outcomes, particularly those reflecting more severe situations, such as infant mortality. It may be reasonable to use the 2 food insecurity classes separately to distinguish groups in need of more or less supervision and/or intervention.

The results of this study require examination in light of some of the methodologic issues involved. For one, the full information maximum likelihood procedure allowed us to deal with the unavailability of data in households composed solely of individuals >18 y, in which specific items related to children and adolescents were not fitting (52). The use of full information maximum likelihood enabled jointly considered all the informativeness of the data, regardless of the demographic structure of the family and, therefore, the number of items forming the total score to which the identified cutoffs were applied. Adult-only families (7 items) and those with children <18 y of age (14 items) henceforth could be comprehensively classified into presumably 4 ordinal equivalent strata. From an applied research stance, the advantage is that one may now use groupings made out of the simple sum of item scores, but that are cogent also from a latent trait perspective, regardless of the household composition.

The fact that the data relate to a particular spectrum of the population composed of low-income families could be regarded as a possible limitation. One contention would be that the identification of the optimal cutoffs should also be sought in larger, more varied populations. To the best of our understanding, however, this does not seem to be an issue, but rather an

advantage. Focusing on a population with more food insecurity inflated the categories of highest intensity by design. This strategy allowed us to boost information arising from families in certain strata, thus achieving more precision and accuracy in the determination of cutoffs.

Because the 14 items analyzed here stem from the version first used in the 2006 Brazilian Demographic Health Survey (74), a potential problem could have emerged from item 4 on decreasing consumption due to money shortage being directed specifically to children and/or adolescents. This format differs from other national surveys (5, 42, 43) and the study presenting the shortened 14-item version (28), in which the item in point covers all residents in the household. However, the psychometric performance of item 4 in the present study—item response endorsement and model-based severity level—did not differ much from that shown by Segall-Corrêa et al. (28). Consistently belonging to class 2 (akin to the mild food insecurity category in the traditional classification), one could hence assume that it would have held the same function if it referred to all family members.

Although roughly grouping the EBIA as in previous studies, the current proposal suggests a reclassification of household food insecurity, particularly with regard to the milder category. If theoretically and empirically sustainable, the impact in doing so may be quite concrete. In this format, besides being a useful device for identifying and monitoring the problem, the EBIA may also prove suitable as an ancillary tool to oversee interventions, but not before further support is granted from further replication of our findings. Nationwide data would enable us to explore the consistency of class membership patterns throughout a range of population types and settings. Taking Brazil as an example, exploring data stratified by country regions or federal states may show whether or not geographical and sociocultural subtleties interfere with the observed configurations. Moreover, beyond the internal structural properties of the scale, assessing construct validity via hypothesis testing also would be auspicious (75). Comparing the scale holding the new set of cutoffs to others used on several key correlates (e.g., macro-level social indicators, infant and child morbidity, and mortality or food consumption) could shed further light to the appropriateness (if any) of the current proposal. More qualitative and epidemiologic research is needed to clarify some divergences between the accepted conceptual definition of food security/insecurity and the one arising from the presented results. New psychometric assessments also may contribute to guiding decisions about the most appropriate cutoffs to classify household food insecurity while taking into account real-life policy considerations.

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