

Gender of respondent does not affect the psychometric properties of the Brazilian Household Food Security Scale

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Background Food insecurity is a major public concern that occurs when nutritional needs are not met, incorporates psychological and physiological coping mechanisms, and can range from basic concern over obtaining food to severe malnutrition. This study was performed to explore differences in female and male respondent psychometric characteristics of a locally adapted Brazilian Household Food Security Scale (Escala Brasileira de Medida da Insegurança Alimentar—EBIA).

Methods The 16-item EBIA was incorporated into the 2004 Brazilian National Household Sample Survey 2004 (Pesquisa Nacional por Amostra de Domicílios—PNAD; $n = 108\,606$). Rasch Modelling was used to evaluate survey one-dimensionality, construct and independence through analysis of infit and relative item severities of adult and children items by gender. Differences in estimated item severities between male and female respondents were assessed using Differential Item Functioning (DIF) models.

Results The scale presented good fitness and most item infit values were within adequate range (0.8–1.2), being practically identical when comparing female and male responses. Both female and male respondents presented similar relative item severities for adult and children items and followed the same pattern of increasing relative item severities with each item in the questionnaire. None of the items presented substantial DIF.

Conclusions This research demonstrates that the psychometric properties of the EBIA are not affected by respondent gender in Brazil. The results of this study support the validity of the proposed scale, suggesting that the scale will provide accurate information regardless of respondent gender for governments, researchers and agencies concerned with reducing epidemic levels of food insecurity and the resulting health disparities.

Keywords Food security, gender, Brazil, Rasch model, US Household Food Security Module

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Introduction

Food security is defined as ‘access by all people, at all times, to enough food for an active, healthy life’.¹ Food insecurity occurs when nutritional needs are not met, incorporates psychological and physiological coping mechanisms, and can range from basic concern over obtaining food to severe malnutrition. The measurement of food insecurity is important because it allows governmental and development agencies to estimate the prevalence of this phenomenon, better target high risk populations and monitor and evaluate the impact of their programs at the household level.² Household food insecurity measurements need to be simple to apply, cost efficient, easy to evaluate and accurate indicators of the actual level of food insecurity in the home. Economic indicators of food production and food availability historically have been used to assess food insecurity at national and regional levels. Although broadly used, these methods are expensive, time consuming and not necessarily the most accurate means for measuring this phenomenon.³ With the use of a more appropriate measurement tool, organizational resources can be appropriately channelled into reducing epidemic levels of food insecurity and hunger.

In 1996, representatives from nearly all countries met at the World Food Summit in Rome, Italy and affirmed that access to adequate, safe and nutritious food is an inherent human right.⁴ At that meeting, the goal was established to cut the number of hungry individuals by 50% before the year 2015. In 2003, the Brazilian government responded to the goal and implemented the national program Fome Zero (Zero Hunger), changing federal, economic and agriculture policies to increase income and food accessibility in Brazil thus alleviating hunger and food insecurity.⁵ To monitor the goal set at the World Food Summit, tools are needed that measure hunger and food insecurity accurately. One of the strategies emphasized was the development of methods for measuring people’s experiences of food insecurity and hunger. Consequently, researchers in Brazil adapted a Household Food Security Survey Module (US-HFSSM) developed in the US to identify vulnerable population groups for food insecurity and to evaluate Fome Zero.⁶

For the last 15 years, questionnaire-based measures of hunger and food insecurity have been developed and validated according to specific parameters. Radimer and colleagues at Cornell University initially developed indicators to assess hunger using open ended questions presented to low-income women on their and their children’s experiences with hunger and food insecurity.⁷ The survey questions were created to measure the different components of household, women and children hunger via self-reporting and became the foundation of the US-HFSSM.^{7,8} In the US, the 18-item US-HFSSM has been tested as a valid, inexpensive, and easy to use method for measuring household food insecurity.^{9–12} This

measurement takes into consideration a broad construct of food insecurity, categorizing households in various levels of severity.⁷

In Campinas, Brazil, the US-HFSSM was translated to Portuguese and adapted for cultural acceptability using in-depth focus groups, followed by other validation studies and applications with diverse population groups.^{6,13–15} As a result, the proposed Brazilian Household Food Security Scale (Escala Brasileira de Segurança Alimentar—EBIA) consisting of 16 questions was included in the 2004 National Household Sample Survey (Pesquisa Nacional por Amostra de Domicílios—PNAD) by the Brazilian Institute of Geography and Statistics.¹⁶ A Portuguese version of this scale can be found at: http://www.ibge.gov.br/home/presidencia/noticias/noticia_visualiza.php?id_noticia=600&id_pagina=1. Despite the broad use in Brazil and other countries of adapted versions of the US-HFSSM with diverse populations, the psychometric characteristics of the scale among female and male respondents has not been explored yet.^{17–21}

Gender and food security

Previous research shows that gender affects access and distribution of resources as well as health and nutrition outcomes, especially in cultures that discriminate against females.²² In addition, researchers have raised the concern that females and males do not experience nor interpret hunger and food insecurity in the same manner.^{23,24} Research by Monello and Mayer²³ reported that males experience more intense hunger cues than females. In addition to physiological differences, coping mechanisms also differ between genders. One coping method often used during food insecurity is ‘mother buffering’, when children are protected from the effects of food insecurity by alterations in maternal dietary intake.²⁵ Examples of this phenomenon were reported in Chad and Canada.^{26–28} Because both the US-HFSSM and the EBIA were initially developed by the responses of females, and PNAD includes both male and female respondents, it is important to assess possible variations in the psychometric properties of EBIA when applied to any individual in the household without regard of gender.⁷

Research design and methods

In 2004, household food security data were collected from 112 665 households as part of a large nationally representative household survey in Brazil (PNAD; $n=139\,157$; excluding non-permanent and institutional households). Respondents who were not a part of the target household were eliminated from this study, resulting in a sample size of 108 606. Interviewers were instructed to administer the questionnaire to the male head of household if the female was not found after three visits to the household.

Table 1 Brazilian Household Food Security Scale (Escala Brasileira de Segurança Alimentar – EBIA)

Code	Item ^a
Adult items	
Worried	Were you worried that you would run out of food before being able to buy or receive more food?
Ran out of food	Did you run out of food before having money to buy more?
Not healthy/varied	Did you run out of money to have a healthy varied diet?
Few foods	Did you have to base your diet on only a few kinds of foods because there was not enough money to buy food?
Reduced meal size	Did you ever reduce the size of your meals because there was not enough money to buy food?
Skipped meal	Did you ever have to skip a meal because there was not enough money to buy food?
Ate less	Did you ever eat less than what you thought you should because there was not enough money to buy food?
Hungry	Did you ever feel hungry but did not eat because there was not enough money to buy food?
Lose weight	Did you lose weight because you did not have enough money to buy food?
Ate one meal or less/day	Did you or any other adult in your household ever go without eating for a whole day or have just one meal in a whole day because there was not enough money to buy food?
Children items^b	
Not healthy/varied	Were you unable to offer your children/adolescents a healthy and varied diet because you did not have enough money?
Not enough	Did any of the children/adolescents not eat enough because there was not enough money to buy food?
Reduced meal size	Did you ever reduce the size of meals of your children/adolescents because there was not enough money to buy food?
Skipped meal	Did your children/adolescents ever have to skip a meal because there was not enough money to buy food?
Hungry	Were your children/adolescents ever hungry but you just could not buy more food?
Did not eat all day	Did your children ever go without food for a whole day because there was not enough money to buy food?

^aAll items except for 'Lose weight' were followed by a frequency question. 'How often did this happen: almost every day, on just a few days, on only one or two days, doesn't know or refuses to answer.' An affirmative response to 'Lose weight' was followed by "How much weight did you lose: little, some, a lot, doesn't know or refuses to answer."

^bOnly asked in households with children under 18 years of age.

Each item referred to conditions experienced during a 3-months period previous to the survey application.

The research was exempt from IRB review at the Ohio State University because the dataset does not contain identifiers and is public domain. The expanded EBIA consisted of 10 adult specific items and 6 child specific items asked only in households with children under 18 years of age (Table 1). Items in the survey capture a range of experiences from adaptations in diet quality to reductions in dietary intake and experiences of hunger. All items had a yes/no response format and a time frame referring to the three months previous to the interview. In addition, all items except for Lose weight were followed by a frequency question with the following response options: (i) almost every day; (ii) on just a few days; (iii) on only one or two days; (iv) does not know or refuses to answer. The item Lose weight was followed by the follow-up question: how much weight did you lose? which had following response options: (i) little; (ii) some; (iii) a lot; (iv) does not know or refuses to answer.

Rasch model

Rasch Model has been proposed as a means of assessing the internal validity of household food security tools by establishing their psychometric characteristics.²⁹ This one-parameter logistic item response model provides a mathematical framework against which dichotomous data can be compared, and is used to determine the fitness and internal validity of household food security surveys.^{29,30} Rasch Model analysis allows for the following assumptions. (i) The more food secures an individual, the more likely he or she will respond negatively to dietary quality items. (ii) Dietary quality items are more likely to be answered affirmatively than the items regarding food intake reduction. Among Rasch Model outcomes, researchers assessing the performance of household food security surveys typically rely on two statistics: Relative items severities and infit values. The results of Rasch Modelling alert survey designers to potential

problems with the items and their order within the questionnaire.

Rasch Model assumes that the items within the questionnaire are one-dimensional, measure the same construct and are independent of one another.³⁰ The first two assumptions are assessed by FIT statistics, which measure the difference in the expected and the actual responses. These OUTFIT and INFIT values are estimated by squaring the difference between actual and modelled responses, summing the squared differences of all items, averaging the sum and then standardizing the results to approximate a unit normal(z) distribution. For our study, weighted item INFIT values were assessed which are sensitive to unexpected behaviour that affects responses to items near the person's ability level and are less sensitive to extreme responses.³⁰ In addition, INFIT values are most commonly used in food insecurity scale assessment.¹⁴ OUTFIT values were not assessed because values are heavily influenced by extreme responses. In the event that the item fits the model perfectly, the resulting infit value equals one. As a general rule, infit values within a range of 0.8–1.2 are considered good, and 0.7–1.3 may be acceptable.³¹

Relative item severities quantify the severity of each item and demonstrate independence of items. These values are based on the Rasch Model assumption that the higher the severity of the item, the less likely it will be answered affirmatively; and the more food insecure the household, the more likely the respondent will answer affirmatively to each question. These values are useful in determining the ability of respondents to distinguish between items in the EBIA.¹⁵ Any large gaps along the relative item severity continuum indicate that additional items are needed to distinguish within that particular range of severity.

In order to compare individual relative item severity by gender of the respondent, male relative item severity were adjusted by the corresponding female relative item severity. This was done to remove differences in item dispersion from the responses of both populations. (Male item relative severity – Male relative severity mean)/[(Male relative severity standard deviation × Female relative severity standard deviation) + Female relative severity mean]. We assume that horizontal differences in relative item severities between females and males should not be larger than 0.5 logit units.

Once the conditions of the Rasch Model have been met, differences among population groups regarding the meaning of each item in a scale can be assessed using Differential Item Functioning (DIF).³² DIF allows each item calibration to be compared between two groups in order to assess whether group membership affects responses to food security items.³³ DIF CONTRAST is the resulting estimate of subtracting each item DIF item calibrations by gender. A DIF CONTRAST equal or larger than 0.5 logit units was treated as substantial, demonstrating that response

probabilities are not fully explained by the latent trait. Given the large sample sizes of male and female respondents, a trivial DIF CONTRAST may be identified as statistically significant.³³

Statistical analysis

Demographic characteristics of males and females were elucidated using STATA SVY commands that take into consideration the weights associated with each sample cluster and the effect of the sample design (STATA for Windows, version 8.2; StataCorp, College Station, TX). Wald and simple *t*-tests were used to determine differences between female and male demographic characteristics. To perform Rasch analysis, responses to the items were coded as 'yes' = 1 and 'no' = 0. To maintain the one-parameter nature of Rasch, the follow-up frequency items were incorporated into the original questions as follows: if the individual responded 'yes' to the first question and responded 'almost every day' or 'on just a few days' to the frequency question, they remained classified as 1. On the other hand, if the respondent answered 'yes' to the first answer and 'on only one or two days' to the frequency question, they were reclassified as 0. The item, how much weight did you lose, remained classified as 1 with an initial affirmative response to Lose weight if the individual lost 'some' or 'a lot' of weight. Individuals who only reported losing a little weight were reclassified as 0. The recoding of frequency items follows methods previously used.²² The original database was separated into female and male respondents' datasets to run Rasch modelling analysis with Winsteps 3.6 (Winsteps, Chicago, IL). Adult and child items were analysed separately to eliminate the influence of child item's performance on adult items in households with no children. DIF CONTRAST estimates were computed in Winsteps by subtracting the DIF item calibrations for the two groups and then converting the differences to standard normal variates using a pooled standard error.³⁴ Additionally, 95% confidence intervals were calculated for each DIF CONTRAST estimate.

Results

A larger percentage of males were literate and reported socio-economic status in the two wealthiest quartiles (Table 2). Slightly more females lived in urban areas and more men lived in apartments and one-room facilities. There were small differences in the race or colour of females and males. Males were slightly older and females belonged to larger households. For all EBIA items, the percentage of affirmative responses was higher in female respondents than males (Table 3).

Female and male respondent adult infit values were within 0.06 of each other and followed the same pattern, with female respondent infit values slightly

Table 2 Characteristics of female and male respondent households that responded to the Brazilian Household Food Security Scale (Escala Brasileira de Segurança Alimentar—EBIA). 2004 National Household Sample Survey (Pesquisa Nacional por Amostra de Domicílios—PNAD; $n = 108\,606$)

	Female% (CI) ($n = 72\,986$)	Male% (CI) ($n = 35\,620$)	P-value
Socioeconomic status			
1st quartile (lowest)	28.14 (26.95–29.37)	19.28 (18.22–20.39)	0.0001
2nd quartile	27.72 (27.25–28.2)	25.04 (24.41–25.68)	
3rd quartile	23.54 (22.88–24.22)	26.08 (25.35–26.82)	
4th quartile (highest)	20.59 (19.8–21.4)	29.60 (28.59–30.64)	
Location			
Urban	86.05 (84.77–87.23)	81.25 (79.72–82.68)	0.0001
Rural	13.95 (17.32–20.28)	18.75 (12.77–15.23)	
Race or color			
White	52.88 (0.51–0.54)	53.82 (0.52–0.55)	0.0094
Mullato	39.90 (38.38–41.44)	38.50 (36.91–40.12)	
Black	6.50 (6.22–6.82)	6.90 (6.58–7.28)	
Yellow/Pale	0.50 (0.42–0.58)	0.52 (0.43–0.64)	
Indigenous	0.19 (0.16–0.24)	0.22 (0.16–0.30)	
	Estimate (CI)	Estimate (CI)	
Household size	3.70 (3.67–3.73)	3.24 (3.21–3.27)	0.0000
Age	41.71 (41.50–41.93)	44.11 (43.85–44.36)	0.0000

Wald and simple t -tests were used to estimate differences.

Table 3 Percentage of affirmative responses to the Brazilian Household Food Security Scale (Escala Brasileira de Segurança Alimentar—EBIA) included in the 2004 National Household Sample Survey (Pesquisa Nacional por Amostra de Domicílios—PNAD; $n = 108\,606$) and differences in item severity estimates (DIF CONTRAST) by gender

Item	Female %(n)	Male %(n)	DIF CONTRAST logit units (95% CI)
Adult items	$n = 65\,535$	$n = 35\,620$	$n = 108\,606$
Worried	33.23 (21 778)	23.75 (8460)	0.09 (0.02 to 0.16)
Ran out of food	22.26 (14 585)	15.21 (5417)	0.11 (0.04 to 0.18)
Not healthy/varied	30.07 (19 708)	21.64 (7707)	−0.02 (−0.09 to 0.05)
Few foods	26.82 (17 579)	19.01 (6771)	0.01 (−0.06 to 0.08)
Reduced meal size	21.00 (13 765)	14.67 (5226)	−0.05 (−0.12 to 0.02)
Skipped meal	8.97 (5877)	6.17 (2197)	−0.02 (−0.09 to 0.07)
Ate less	18.39 (12 052)	12.55 (4471)	0.00 (−0.07 to 0.07)
Hungry	7.45 (4883)	5.05 (1799)	0.03 (−0.05 to 0.11)
Lose weight	3.80 (2490)	2.67 (951)	−0.05 (−0.16 to 0.06)
Ate one meal or less/day	5.24 (3432)	3.93 (1400)	−0.21 (−0.31 to −0.11)
Children items	$n = 20\,696$	$n = 6752$	$n = 27\,448$
Not healthy/varied	54.66 (11 312)	51.10 (3450)	−0.02 (−0.10 to 0.06)
Not enough	30.32 (6274)	26.85 (1813)	−0.04 (−0.12 to 0.04)
Reduced meal size	32.17 (6658)	28.24 (1907)	−0.01 (−0.09 to 0.07)
Skipped meal	13.10 (2712)	11.15 (753)	−0.05 (−0.17 to 0.07)
Hungry	12.22 (2529)	10.00 (675)	0.05 (−0.07 to 0.17)
Did not eat all day	4.50 (931)	3.87 (261)	−0.07 (−0.24 to 0.10)

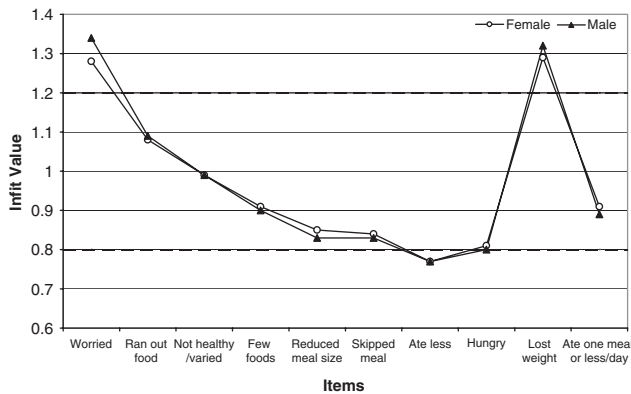


Figure 1 Comparison of adult items' infit values from the Brazilian Household Food Security Scale (EBIA) by gender of respondent (Male $n = 35\,620$; Female $n = 72\,986$). National Household Sample Survey 2004 (PNAD)

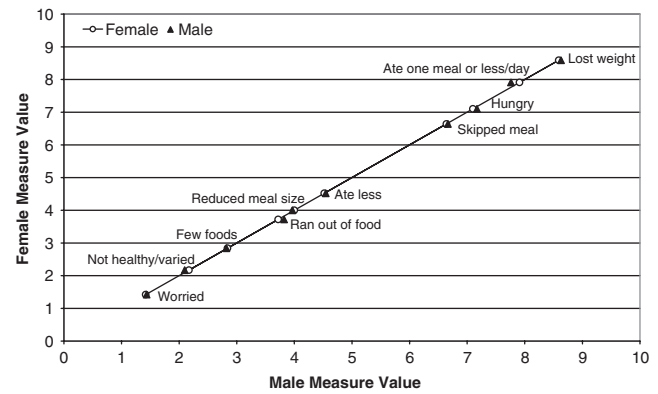


Figure 3 Comparison of adult items' relative item severities from the Brazilian Household Food Security Scale (EBIA) by gender of respondent (Male $n = 35\,620$; Female $n = 72\,986$). National Household Sample Survey 2004 (PNAD)

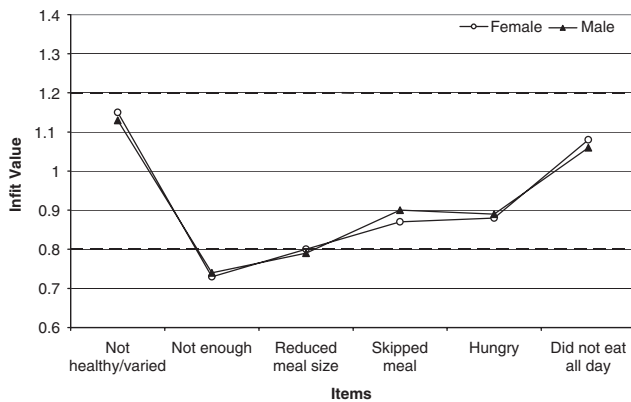


Figure 2 Comparison of children items' infit values from the Brazilian Household Food Security Scale (EBIA) by gender of respondent (Male $n = 6752$; Female $n = 22\,589$). National Household Sample Survey 2004 (PNAD)



Figure 4 Comparison of children items' relative item severities from the Brazilian Household Food Security Scale (EBIA) by gender of respondent (Male $n = 6752$; Female $n = 22\,589$). National Household Sample Survey 2004 (PNAD)

more centered around the value of one than their male counterparts. Adult item infit values outside of the good range (0.8–1.2) included: worried, ate less and lost weight for female and male respondents (Figure 1). Ate less was captured within the broader and acceptable range of (0.7–1.3), as was worried and lost weight for female respondents. Female and male items child infit values were within 0.03 of each other and followed the same pattern. Although outside the 0.8–1.2 range, infit values of child items not enough and reduced meal size, were still within the acceptable range of 0.7–1.3 (Figure 2).

Adult items were spread out along the relative item severity line allowing the households to be distinguished along an increasing continuum of food insecurity (Figure 3). Female- and male-adjusted relative item severity comparison of adult items differed by 0.01–0.14 logit units with a mean standard deviation higher than 2.2 for both genders. Relative item severity of child items compared between

female- and male-adjusted items had differences between 0.01 and 0.13 logit units with a mean standard deviation of 2.7 for both genders (Figure 4). As shown in Table 3, adult and child item DIF analyses resulted in all DIF CONTRASTS between genders < 0.3 logit units (Table 3).

Discussion

The purpose of this study was to test the adapted EBIA for appropriateness in measuring household food insecurity in Brazil regardless of respondent gender. This research adds an important new dimension to a growing pool of research on the performance of household food security surveys and has the strength of using a national dataset to explore gender variations. Although there were gender differences in demographics and percentages of affirmative

responses in the EBIA, we propose that these variations are likely due to the large sample size. The key strength of this research is that it represents the first analysis of the psychometric characteristics of a nationally applied household food security survey by female and male respondents.

Infit values for adult and child items were within a range of 0.8 and 1.2 for all items except for the adult item hungry, as opposed to this study where three adult and two child items were outside of this range. These items were still within the larger range of 0.7–1.3 except for adult items worried and Lose weight for male respondents. A potential confounding factor for the item Lose weight is that the respondents have no record of previous or current weight. Performances of the specific adult items worried and lost weight with infit values outside of the wider acceptable range will need further discussion by researchers, governments and food and nutrition agencies regarding the appropriateness of inclusion in a regional Latin American household food security survey.

None of the items in the EBIA presented substantial DIF indicating unidimensionality of the scale. These items were understood to ‘mean’ the same thing by female and male respondents.³² Thus comparisons between results from the EBIA can be compared regardless of respondent gender with no bias from the tool. Although we found no difference by gender, there may be other subgroups that would present DIF that need further investigation. Rasch analysis of food security in the US by subgroups of race/ethnicity, household composition, metropolitan status and region of country revealed consistent patterns in relative item calibrations.³⁵

The spread of adult items relative item severities demonstrate the wide range of food insecurity situations that the tool measures with a better spread than the food security surveys used in the Caribbean and Colombia.^{17,19} Analyses of tools in Colombia, the United States and Trinidad and Tobago showed a similar generally increasing value as the severity of the question increased as the Brazilian items did.^{12,17,19}

Future work

Questionnaire development is an ongoing process and there are several things that can be done with this database to improve the fitness of the EBIA to the Rasch Model. We suggest that adult items worried and lost weight be reworded to improve fitness within the survey. The rewording of these items must be based on discussions between researchers, governments and members of the target population. In addition, certain items with repeat item severities might be eliminated to reduce interviewee question load. If the results from this new modelling do not indicate any loss of data, the shortened questionnaire

can then be applied to the appropriate population and then analysed.

Supplementary research is needed to explore differences in household food insecurity experiences of females and males while controlling for potential covariates, comparisons of females and males from the same household and variations resulting from gender of the head of household. Previous research in Bangladesh using a different locally developed food security tool with 120 households reported that responses of females and males in the same household agreed 81% of the time, with the most divergence found in food secure households.²⁴ Although they found differences in how female and male respondents answered to the household food insecurity tool used in Bangladesh, the proposed instrument was developed locally and differs from the adapted US-HFSSM used in many regions of the world. Additional analyses in larger populations to compare female and male responses within the same household and the resulting survey psychometric characteristics are needed.

Gender of head of household also may affect response patterns and household food security scale psychometrics and requires additional analysis. In South African households headed by dominate males there were more concerns about food than in households with partner relationships of females and males or those headed by females.³⁶ In male dominated households, there were slightly less reports of hunger experiences than female headed households, but there were more occurrences of not enough food for children than in female headed households or households run by a partner relationship.³⁶ These results would indicate that dissemination of food and resulting food insecurity experiences are a function of gender of head of household in this culture.

Conclusions

Our research demonstrates that the psychometric properties of the EBIA are not affected by respondent gender, suggesting that the scale will provide accurate information for governments, researchers and agencies concerned with reducing epidemic levels of food insecurity and the resulting health disparities. This research is especially timely because agencies worldwide are currently developing and applying similar household food security measures for use at national and regional levels.^{37–45} In addition to providing a tool that accurately quantifies the experience of household food security irrespective of respondent gender, this article also describes the methods necessary to analyse the psychometric characteristics of survey items by population group and interpret the results. Within the broader application of the household food security surveys, Rasch modelling analyses are necessary to compare diverse populations (e.g. male/female respondent, rural/urban residency, poverty level, race

or ethnicity, households with and without children) in order to ensure a comprehensive assessment of the proposed tool. The next step in household food security survey validation is the analysis of gender response variations and psychometric properties of the scale based on head of household gender and gender relations within the household.

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