Rasch Analysis of US Household Food Security Survey Module in Latino Migrant Farmworkers

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Abstract

This secondary analysis evaluated the validation of the short version of the US Department of Agriculture's Household Food Security Survey Module (HFSSM) in a Latino migrant population. The Rasch model assessed the HFSSM's structure, item severity levels, and fitness of the sample population. Differential item functioning (DIF) analysis explored the invariance of HFSSM response patterns between less/more acculturated households. Item infit scores were within an adequate range (0.7–1.3). Item severity scores and unidimensionality structure supported the HFSSM's theoretical framework. Analysis showed statistically nonsignificant DIF contrast between acculturation levels. The adapted HFSSM performed in agreement with the theoretical framework of food insecurity as a managed process in this Latino migrant population.

Keywords

Food security; Rasch model; acculturation; Latinos; migrants

Latinos/Hispanics in the United States are the fastest growing ethnic group, comprising 16% of the population and one half of the nation's population growth.[1] Latino/Hispanic immigrants in the United States, comprise 11% of the population, but the children of these immigrants are 22% of the total population of children under 6 years of age.[2] Seventy-five percent of all migrant farmworkers (MFWs) are born in Mexico.[3] Population estimates of MFWs range from 2 to 4 million, with over 2 million traveling dependents.[3] In Spanish-speaking, low-income Latino households; there is a prevalence of low levels of food security.[4,5] Past research has shown that MFW families experience low to very low levels of food security compared to the majority population[6,7] and have low levels of acculturation.[7]

This secondary analysis using the Rasch model explored how an adapted short version of the US Department of Agriculture's Household Food Security Survey Module (HFSSM) performed in a unique MFW population and examined its invariance between acculturation levels, which was measured by an established tool: the Short Acculturation Scale for Hispanics (SASH).[8,9]

The association of acculturation and food security has been studied in Latino/Hispanic families in Texas in elementary schools.[10] Acculturation was measured by asking participants to identify the main language spoken at home, and food security was assessed by asking whether participants worried about running out of food and whether they did run out of food before the end of each month. The focus of the study was on the association of parental acculturation and food security with children's fruit and vegetable intake. The

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results showed significant negative correlations of low food security and acculturation ($r = -0.13$).[10] Food insecurity in Latino immigrant families was measured in North Carolina using the HFFSM.[11] Here, within 4 subsamples, low food security levels ranged from 36% to 42%. Another research study administered the HFFSM to Mexican immigrant families ($n = 1310$) and compared the results to non-Latinos. The Mexican families and their children had higher rates of low household food security and child hunger compared to non-Latinos (53% vs 16% and 7% vs 0.5%, respectively).[12] These survey results are consistent with studies of Californian Mexican American preschoolers that showed that parents with lower English language proficiency had a higher likelihood of low food security.[13] However, these study findings challenge work done earlier in the National Health and Nutrition Examination Survey (NHANES) analysis that suggested that higher levels of acculturation were associated with low levels of household food security.[14] This secondary data analysis of the third NHANES ($n = 2985$ Hispanic youth aged 4–16 years) showed that when other factors were controlled, less acculturation (as measured by parents' language usage and income) was associated with differences in energy, sodium, fat, and saturated fat intake. Food security was measured by 3 questions (not enough food, cut meal size for adult, and cut meal size for child). In those households where parents spoke only English there was an increased risk for cutting adult meal size. In addition, a key finding was that low acculturation somewhat compensated for the negative associations of low family income and dietary intake. In families where parents spoke Spanish at home there was an association of less food insecurity. A binational study examining Mexican ($n = 301$) and American ($n = 301$) household food security and quality of dietary intake measured acculturation by a proxy of mother's length of residence in the United States.[15] The results showed that food insecurity was not associated with the acculturation proxy in the California sample.

METHODS

Approved in expedited reviews by the university's Institutional Review Board, the original cross-sectional pilot study was intended to gain knowledge on the unique characteristics of Midwest Latino MFW families and children (Dietary Intake and Nutrition Education [DINE] Phase 1), followed by a quasi-experimental intervention study on teaching health eating to migrant mothers in the migrant camps (DINE Phase 3). This study focuses on levels of acculturation and household food security in a homogeneous MFW sample from 2 study years.

All survey instruments used had a Flesch-Kincaid Grade Level less than 4.2 and were available in English and Spanish.[16] All participants chose audio-enhanced personal digital assistants (APDAs) to respond to the study surveys uploaded using the administrative design module, SEDCAadmin, an iteration of the Surveyor software package (Don't Pa…panic Software, SEDCA_Sound Enhanced Data Collection Application, Cleveland, Ohio).[17] The handheld APDAs had attached voice files that read the surveys to the participants. Participants were compensated with gift cards and kept their used portable headphones.

Acculturation

Acculturation is defined as the psychological and social changes occurring when individuals from different cultures come into continuous contact with each other.[18] The SASH was used, which is a reliable method to identify Hispanics with low or high acculturation.[19] The SASH 12-item version responses are averaged, and an average score of 2.99 is used to differentiate the less acculturated from the more acculturated. The Cronbach's alpha for the 12 items in this scale ranges from .78 to .92. The instrument showed significant correlations with length of stay in the United States and US nativity generational level (.70 and .65,

respectively).[18] In this study for years 2008 and 2010, Cronbach's alpha for the SASH was .893 and .902.

Food Security

Food security is defined as the ability of individuals to obtain sufficient food for an active, healthy life in socially acceptable ways.[20] The HFSSM distinguishes various levels of food insecurity.[20] A 5-question short form is used in non-interview data collections, with alternative language formats decreasing test burden without sacrificing reliability.[21] The short form for households with children is sensitive and specific to determine overall food security (85.9% and 99.5%).[22] Completed surveys are given scale scores and classified into food security levels based on standard values in total number of affirmatives: 0–1 = *high or marginal food security*, 2–4 = *low food security*, and 5–6 = *very low food security*. The accuracy of the HFSSM has been well established.[23] In this study for years 2008 and 2010, Cronbach's alpha for the HFSSM was .808 and .818.

Sample

In 2 years of data collection, convenience samples of 112 parents, 97% mothers, were obtained from 6 Midwest MFW camps in 2 states: 57 (51%) in Ohio and 55 (49%) in Michigan. Participants were recruited with the use of flyers and approached the research table to participate in the study. All study participants were adult parents residing in MFW camps with children aged 2 to 13 years. Results from the combined data showed that 56% were married or living with a partner, 61% worked full time, 74% had less than a high school graduates, and 82% self-reported a monthly family income of $1000 or less. Written consent was secured in the participant's choice of language. The study participants were part of the Midwest migrant stream who characteristically resided in Texas, Florida, or Mexico. In this sample, 23% were classified as having very low household food security, 36% were classified as having low food security, and 41% had high or marginal food security based on the tool recommendation. One hundred three (92%) out of 112 parents were classified as less acculturated using the cutoff point of 2.99. Acculturation was not significantly correlated with food security score ($r = -0.10$, $p = .307$).

Data Analysis

The Rasch model was used in this study to examine the fitness and internal validity of household food security surveys in this specific population.[8,24] Responses to the food security items applied were fit into the Rasch model for partial credit scoring, which was run using Winsteps software (Rasch Measurement 3.72, Winsteps, Chicago, Ill). Measures were reported in logits. Fit statistics were reported as mean-square residuals, which have approximate chi-square and *t*-standardized distributions.[25] HFSSM item responses were coded as 4 dichotomous variables and one ordinal variable (for question 3) according to the tool recommendation. HFSSM response pattern differences among acculturation levels were checked by differential item functioning (DIF) analysis.

Rasch Model

The Rasch model is part of item response theory that examines the fit of questionnaire items measuring identical underlying constructs along a logit continuum.[8,25] The theory is that the probability of endorsing an individual item is decided by the difference between the item severity (difficulty) and a person's position (ability). Therefore, if item severity is lower than the person's position, the item has more chance to be endorsed.

Researchers assessing the performance of household food security surveys mainly rely on fit statistics: infit and outfit mean square statistics. *Outfit* is the conventional averaged sum of

squared standardized residuals. *Infit* is a weighted sum that gives more value to on-target observation. When the responses fit the model perfectly, the resulting infit score is 1.0, with a recommended range of 0.8 to 1.2 and a wider acceptable range of 0.7 to 1.3.[26] Item fit is an index of whether items function logically and provide a continuum useful for all respondents. Item misfit may result from items that are too complex and confusing to the respondent or measure a different construct.[25] Person fit to the Rasch model is an index of whether individuals are responding to items in a consistent manner or responses are idiosyncratic or erratic.[27] Responses may fail to be consistent when people are bored and inattentive to the task, when they are confused, or when an item evokes an unusually different response from an individual.[27]

Items' and persons' estimates can be overfit or underfit. Overfit is indicated by a fit score lower than 1.0 or a negative standardized fit.[27] Overfit is interpreted as too little variation in the response pattern, perhaps indicating the presence of redundant items.[27] Underfit is indicated by a fit score >1.2 or standardized fit >2.0, which suggests unusual or inappropriate response patterns.[27] These indices can be used to identify and sometimes correct a measurement disturbance.[27]

Person and item separation assess instrument spread across the trait continuum in standard error units.[27] For an instrument to be useful, the items and persons should be able to be separated, so the separation should exceed 1.0, with higher values of separation representing greater spread of items and persons along a continuum.[27] Lower values of separation indicate redundancy among the items or less variability of persons on the trait. Each item should contain a different amount of the trait.[27] Person reliability is conceptually equivalent to Cronbach's alpha with different formulas.[27]

Relative item severities and person position estimates were calculated by the Rasch model. These scores allowed us to check whether this tool was valid and all of the items were performed in theoretically expected severity order, as well as whether the specific sample was well targeted. They are useful in determining the ability of respondents to distinguish between items in the food security questionnaire.[25] With the Rasch model, users can also assess differences between groups of less or more acculturated households to evaluate the differences in response patterns to the HFSSM.

The Rasch model generates the DIF *contrast*, which allows comparisons across groups while holding the level of psychological disturbances constant.[28] DIF contrast represents the difference in relative severity scores between the groups being compared and is computed in Winsteps by subtracting the measure values for 2 groups and then converting the differences to standard normal variates using a pooled standard error.[29,30] A substantial DIF contrast demonstrates that response probabilities are not fully explained by the latent trait, which means that other variables are influencing the response, making comparisons between groups problematic. The statistical significance of the DIF contrast is assessed using the Welch *t*-test. In addition, DIF contrast scores larger than 1.0 logit unit might require attention because they are probably showing a difference in response patterns among groups being compared. Nevertheless, some researchers consider scores under 2.0 not substantial.[31,32]

RESULTS

The analysis reports how well HFSSM performed in relation to the unidimensional model. In the tables and figure, the labels represent the HFSSM questions: (1) foodlast1: The food we bought just didn't last and we didn't have money to get more; (2) affbalm1: We couldn't afford to eat a balanced meal; (3) cutmeal1: Did you cut the size of your meals or skip meals

because there wasn't enough money for food?; (4) lessmeal1: Did you ever eat less than you felt you should because there wasn't enough money to buy food?; (5) hungry1: Were you ever hungry but didn't eat because you couldn't afford enough food?

The Rasch model converged with relatively little iteration of four using the normal approximation algorithm (Prox) estimation method and ten using joint maximum-likelihood estimation (JMLE). This suggests that the data showed a balanced spread and cohesive order.[33] The item infit statistics revealed that there was no substantial deviation from expectations for all the items. The mean item infit score was 0.97 with a standardized score of −0.2, which were close to a perfect fit of 1 and 0, confirming a highly unidimensional construct. On average, the items overfit slightly, which means that the data fit the model better than we would expect, which may signal some possible redundant items. Table 1 displays the items in order of worst to best fitting. The item infit scores were within the considered adequate range of 0.6 to 1.4 for all items in the Food Security scale. When looking at the last 3 questions, the severity score fell into a range considered very good (0.8–1.2). The item separate score was 5.79, which suggested that we measured items on a continuum. Person reliability was 0.65 and the separation score was 1.37, which are acceptable but not very high. This may due to few items and small categories in the items.

The item–person map in Figure 1 illustrates person position (ability) and item severity (difficulty) on the same logit scale. The HFSSM items and study subjects were sorted by food security severity, with the most severe items or people on the top. Conceptually less severe items had lower relative severity scores than those items representing the more severe underlying conditions. Items were as expected, where the first question was the less severe and the last question the most severe, and were ordered exactly the same as in the tool from 1 to 5. Questions 4 and 5 have similar severity levels, which may suggest some redundancy information. To fill the gap between question 2 and 3, a potential improvement to the tool for this population is to add one item severity level in between. For the person distribution, there are few outliers who had high food security levels. Generally, the width of the test is sufficient to cover the whole range of person positions. The person and item distributions coincide with each other in term of centers and dispersions. This correspondence suggested that the measure is well targeted by the items and that the person estimate measures will be accurate.[25]

When examining differences by acculturation, the problem was that the vast majority of the sample could be considered as less acculturated: only 9 participants could be classified as not less acculturated. We then ran a comparison analysis using the median of the acculturation score of 1.42 as a cutoff for classifying acculturation levels. In this analysis, questions 1, 3, 4, and 5 showed differences (DIF contrast) below 0.5. This means that both groups of more or less acculturation responded in the same manner to these 3 questions. However, for questions 2 the difference was above 0.5, indicating that there were differences in how questions were answered for the less and more acculturated groups. Though not a large difference, the DIF contrast does reflect a difference between the acculturation groups (see Table 2). We also ran the Rasch analysis using only the 103 cases classified as low acculturation using 2.99 as a cutoff and the results were similar to using the median as a cutoff for acculturation, except that question 1 showed some differences in terms of HFSSM response pattern instead of question 2; see Table 3.

DISCUSSION

The sample size of 112 is adequate for stable item calibrations within ±½ logit with 95% confidence interval. This sample size is above the recommended sample size of 100 for most purposes.[34] Limitations of the study include a small number of items in the HFSSM that

made the person estimates less reliable. Another limitation is the imbalanced sample sizes between those with low and high acculturation as indicated by the majority of the participants' scored low levels of acculturation. Despite this imbalance, when dividing the sample into 2 more equally sized categories of acculturation using the median of the acculturation score as the cutoff point, no significant differences were found when comparing the responses by less and more acculturated individuals.

The severity levels of the items fit the assumption that dietary quality food insecurity items are more likely to be answered affirmatively than the food insecurity items regarding quantity adaptations. The last item showed the highest relative severity score for both groups, which is in agreement with the theoretical framework of food insecurity as a managed process[35,36] where families acquire strategies that initially compromise the diet quality with cuts to food quantity until hunger emerges at severe food insecurity levels.

A good tool is expected to contain items of various severities, more or less equally spaced along the whole range of positions of the targeting sample. These results support the use of the HFSSM in this unique population of Latino MFW mothers and show that food security levels of more or less acculturated migrant families are similar.

IMPLICATIONS FOR RESEARCH AND PRACTICE

The presence of low levels of food security in Latino MFW represents significant challenges for health care professionals who strive to improve the diets of children and families. These studies demonstrated that the US Department of Agriculture HFSSM performed well in a unique MFW population and that levels of acculturation did not impact its performance. The HFSSM can be used with confidence in research and in practice in this vulnerable population.

Acknowledgments

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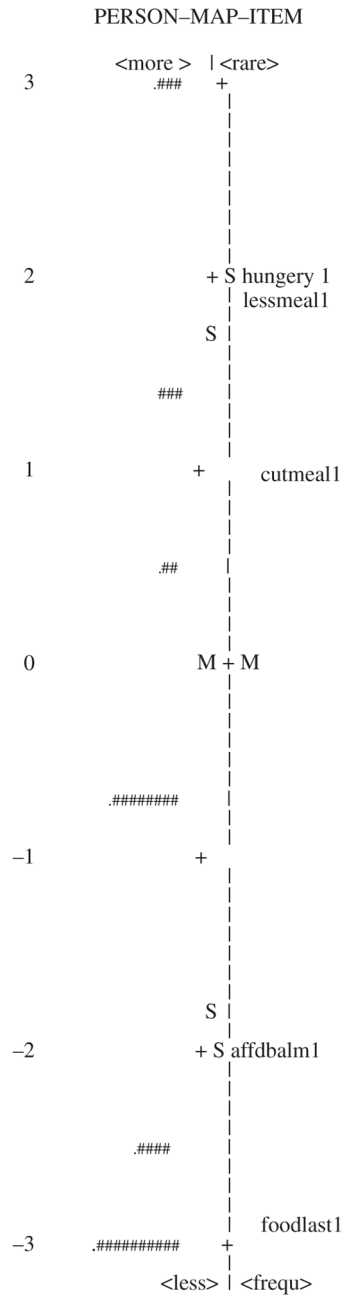
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FIGURE 1.
Map of HFSSM items (5 items) and persons (*n* = 112). M = mean; S = one standard deviation from the mean. Each "#" represents 3 persons and each "." represents one to 2 persons. Positive scores indicate low food security. Items from the scale are shown on the right side of the figure, and person measures are highlighted by "#" or "."

TABLE 1

Item Fit Statistics in Misfit Order Comparing HFSSM and SASH Using the Rasch Model

Entry no.[a]	Total score[b]	Measure[c]	Rasch SE[d]	Infit MNSQ[e]	Infit ZSTD[f]	Correlation[g]
1	71	−2.85	0.40	1.23	2.2	.73
4	26	1.92	0.35	0.95	1.3	.68
3	69	.92	0.23	0.96	−0.4	.81
5	25	2.04	0.35	0.93	−0.3	.69
2	65	−2.04	0.34	0.77	−0.6	.81
Mean	51.2	0	0.33	0.97	0.4	
SD[h]	21.1	2.05	0.06	0.15	1.1	

[a]Entry no. = sequence number of the item in the data.

[b]Total score = total raw score of an item by the persons.

[c]Measure = item severity estimate in logit.

[d]Rasch SE = standard error of the estimate.

[e]Infit MNSQ = information-weighted mean square statistic with expectation 1.

[f]Infit ZSTD = t-standardized information-weighted mean square statistic with expectation 0.

[g]Correlation = point-measure correlation between the item with the unidimensionality structure

[h]SD = standard deviation.

TABLE 2

Differential Item Analysis for Acculturation Levels Using 2.99 as a Cut-Point

Person class[a]	DIF measure[b]	DIF SE[c]	Person class	DIF measure	DIF SE	DIF contrast[d]	Joint SE[e]	Welch *f*	Welch *df*	*P*-value[g]	Item no.
Low	−2.77	0.69	High	−2.91	0.49	0.14	0.85	0.17	63	.8674	1
Low	−2.77	0.69	High	−1.73	0.41	−1.03	0.80	−1.2	60	.2040	2
Low	0.95	0.31	High	0.89	0.33	0.06	0.45	80.12	67	.9019	3
Low	2.12	0.46	High	1.67	0.51	0.44	0.69	0.64	67	.5239	4
Low	2.12	0.46	High	1.95	0.54	0.16	0.71	0.23	67	.8165	5

[a] Person class = low/high acculturation.

[b] DIF measure = difficulty of this item for this class.

[c] DIF SE = standard error of the DIF measure.

[d] DIF contrast = difference between the DIF measures.

[e] Joint SE = standard error of the DIF contrast.

[f] Welch *t* = Welch *t* statistics for DIF contrast.

[g] *P*-value = *P*-value of the Welch *t*-test.

TABLE 3

Differential Item Analysis for Acculturation Levels Using Median of 1.42 as a Cut-Point

Person class[a]	DIF measure[b]	DIF SE[c]	Person class	DIF measure	DIF SE	DIF contrast[d]	Joint SE[e]	Welch t[f]	Welch df[g]	P-value[h]	Item no.
Low	−2.75	0.41	High	−3.82	1.97	1.06	2.01	0.53	2	.6509	1
Low	−2.04	0.36	High	−2.13	1.34	0.10	1.38	0.07	3	.9486	2
Low	0.90	0.23	High	1.26	1.75	−0.36	1.76	−0.20	2	.8577	3
Low	1.92	0.35	High	1.92	2.75	0	2.77	0	2	1	4
Low	2.04	0.35	High	2.04	2.90	0	2.92	0	2	1	5

[a] Person class = low/high acculturation.

[b] DIF measure = difficulty of this item for this class.

[c] DIF SE = standard error of the DIF measure.

[d] DIF contrast = difference between the DIF measures.

[e] Joint SE = standard error of the DIF contrast.

[f] Welch t = Welch t statistics for DIF contrast.

[g] df = joint degrees of freedom.

[h] P-value = P-value of the Welch t-test.