Validity of the Food Insecurity Experience Scale (FIES) for Use in League of Arab States (LAS) and Characteristics of Food Insecure Individuals by the Human Development Index (HDI)

Olfat B Sheikomar,[1] Wesley Dean,[2] Hala Ghattas,[3] and Nadine R Sahyoun[1]

[1]Department of Nutrition and Food Science, University of Maryland, College Park, MD, USA; [2]Department of Food and Resource Economics, University of Copenhagen, Copenhagen, Denmark; and [3]Center for Research on Population and Health, American University of Beirut, Beirut, Lebanon

ABSTRACT

Background: The Food Insecurity Experience Scale (FIES) is a UN FAO Voices of the Hungry (FAO-VoH) experiential metric of food insecurity (FI). It was pilot tested in some countries but not in Arab speaking ones and validated using global data. Yet, its psychometric properties may vary in the League of Arab States (LAS) due to cultural and linguistic differences.

Objectives: *1*) assess the validity of FIES for use in the LAS region, *2*) determine the prevalence of FI, by gender, age group, and the human development index (HDI), and *3*) examine sociodemographic characteristics of severe FI individuals.

Methods: To assess the psychometric properties of FIES, Rasch modeling was applied to the 2014–2015 Gallop World Poll (GWP) in the LAS. Prevalence and characteristics of severely FI individuals were assessed using the 2014–2017 GWP data of 62,261 respondents.

Results: Overall, FIES met the Rasch model assumptions of equal discrimination and conditional independence. Infit statistics for FIES items, in most LAS countries, were <1.3, indicating good internal validity. In Syria and Sudan, the item "worried about not having enough food to eat" had infits >1.3. Outfit statistics >2.0, indicating erratic responses, were noted in 26% of the LAS countries. Significant correlations were found ($\geq$0.4) between items in Algeria, Tunisia, and Lebanon. The overall prevalence of severe FI was 15.7%. At highest risk were those aged $\geq$50 y compared with younger adults (16.5% versus 15.5%, respectively, P <0.02), women compared with men (17.6% versus 14.1%, respectively, P <0.0001), and those in countries with low HDI compared with high HDI (24.9% versus 8.3%, respectively, P <0.0001).

Conclusions: Overall, FIES is valid for measuring FI in the LAS. Cognitive testing of items with high outfit statistics and omission of correlated ones may improve the scale. Populations vulnerable to severe FI include older adults and women. These populations should be examined further.   *Curr Dev Nutr* 2021;5:nzab017.

Introduction

The League of Arab States (LAS) is a large geographic area consisting of 22 Arabic-speaking countries in the Middle East and Africa (1). These countries share common environmental challenges such as limited agricultural resources, growing water scarcity, and climate change, but vary by levels of economic development (2). In addition, many of these countries face rapid population growth, urbanization, high unemployment rates, food price volatility, violent conflict, and political turmoil, all of which exacerbate the risk of food insecurity (FI) (2), hence the need to monitor it in this region.

Assessing FI is challenging, therefore, several tools have been developed to assess its experiences (3). These tools contain a series of questions that focus on a household's or individual's experience in reducing the quantity and/or quality of food intake over a specific period of time as a result of limited access to food or resources to obtain food. These tools vary from simple indicators that can be quickly and easily administered, to more complex measures that require more details and sophisticated analytics (4). Several studies have examined FI in countries of the LAS region, including Yemen (5), Palestinian Territories (6), Jordan (7), Syria (8), and Lebanon (9–11). However, different measures were used in these studies, limiting the comparability of the results. One

study measured income and food consumption (6) to report on food security, whereas the others used select questions from the US Household Food Security Survey Module (12). To our knowledge, the only tool that has been validated for use in the LAS is the Arab Family Food Security Scale (AFFSS) (13), but its use has been limited. Also, except for Yemen, which was a national survey, the other surveys were administered to select populations such as women in Northern Jordan (7) or Iraqi refugees in Jordan and Syria (8). Other assessments of FI in this region used different geographical classifications, such as Near East and North Africa (NENA), which includes Iran but excludes Somalia, South Sudan, Palestine, Comoros, and Djibouti, (14) and Western Asia and North Africa (WANA), which includes Armenia, Azerbaijan, Cyprus, Georgia, Israel, and Western Sahara but excludes Mauritania, Somalia, and South Sudan (15). The prevalence of FI at the regional level in other geographical classifications such as the Middle East and North Africa (MENA) or the LAS has not been reported previously. The prevalence of FI increased in the NENA region and doubled from 1990–1992 to 2014–2016 (16).

To meet the need for a simple, flexible, broadly applicable, and crossculturally comparable tool on a global scale, the FAO Voices of the Hungry project (FAO-VoH) developed the Food Insecurity Experience Scale (FIES) in 2013 (17, 18). It is the first tool developed to measure FI at the individual level, globally (19). FIES was validated using the 2014 Gallup World Poll (GWP) data from >150 countries (20, 21). However, since a global standard was used to validate the measure, there is a need for regional psychometric analysis of the tool to determine its applicability. This tool has also been validated for sub-Saharan Africa and its applicability to that region of the world was determined but with several caveats (22). The overall goal of this study was to define a standard metric for the LAS that can be used to identify common determinants of FI in its countries.

We, therefore, focused on Arabic-speaking countries to minimize the variation in the language of the translated FIES. In addition, we used national indicators of the Human Development Index (HDI) and the Political Stability and the Absence of Violence and Terrorism (PSAVT) to control for the variability in the socioeconomic status and political unrest in the region. The specific objectives of this study were to: *1*) assess the internal validity of FIES for use in the LAS region, *2*) assess the prevalence of FI, by age and gender, stratified by the HDI, and *3*) determine the sociodemographic and economic characteristics of individuals with severe FI in that region.

Methods

Study design

Data for this analysis were obtained from the GWP surveys conducted in 19 LAS countries, areas, or territories. GWP is a series of complex cross-sectional surveys conducted annually in >150 countries. The target population from each country is a nationally representative civilian, noninstitutionalized population of individuals aged 15 y and older. Data were collected through 1-h, face-to-face interviews, or 30-min telephone calls with typically 1000 respondents from each country per survey year using multistage probability sampling (23). The difference in time allocated to the interviews is due to the additional questions administered to individuals during the face-to-face interviews compared with those on the telephone calls. The 2014 and 2015 GWP data of

35,064 individuals, after excluding those aged <19 y and those with missing age or missing responses to any questions of FIES, were used in the psychometric analysis of FIES. The 2014–2017 GWP data were used to examine the prevalence of FI in the LAS countries and characteristics of the sample population in those 19 countries. The final analytical sample was composed of 62,261 individuals. Gallup works with global partners in data collection. The ethical approval for the survey was obtained from the GWP Ethics Office.

FI assessment using FIES

Beginning in 2014, GWP started collecting food security information using the FIES developed by FAO-VoH. FIES is composed of 8 questions with simple dichotomous responses of "Yes" or "No" (**Table 1**). Respondents were asked if they at any time during the previous 12 mo experienced different severity levels of FI. These questions range from "being worried about not having enough food to eat" to "going hungry for a whole day," due to lack of money or other resources. Responses to these FIES questions are aggregated, the total scores ranging from 0 to 8. For these analyses, the scores were classified into 3 categories based on the global standard; *1*) food secure (0–3), *2*) moderately FI (4–6), and *3*) severely FI (7, 8). The development of a regional and individual country's FI threshold is discussed below.

Demographic and socioeconomic variables

Demographic and socioeconomic variables included in this analysis were: age, household size, and number of children aged under 15 y residing in the household, and these were examined as dichotomous and continuous variables. Whereas the variables: gender, marital status (married and domestic partner compared with never married, divorced, separated, or widowed), area of residence (living in a rural area or on a farm, a small town or village, compared with a large city, and a suburb of a large city), and employment status (employed or self-employed full time, employed part-time do not want/want full-time work, compared with unemployed, out of workforce) were examined as dichotomous variables. After accounting for the diverse national classifications of education across countries and making them comparable, educational attainment was categorized as: *1*) 8 y of primary education, *2*) secondary or high school completion, and *3*) 1 or more years of a college education.

To calculate income, the survey inquired about monthly household income from all sources, including wages and salaries, and remittances in local currency from all family members. If respondents had difficulty answering this question, they were asked to select from an income range, and the midpoint of that range was used for analysis. Household income in local currency was converted to international dollars (ID) using the World Bank's purchasing power parity conversion factor to make income comparable across countries. The income per capita was then derived by dividing income in ID by household headcount (23, 24). In this analysis, household income per capita was examined as income quintiles.

Country-level variables
HDI.

Economic and human development vary widely between LAS countries. These analyses were stratified by HDI, which is a statistic composite of 3 dimensions related to human development: *1*) a long and healthy life, measured by life expectancy at birth, *2*) education, assessed by average

TABLE 1 Questions of the Food Insecurity Experience Scale (FIES)

	During the last 12 mo, was there any time when …:			
	Questions	Label	Domains of FI construct	Assumed severity of FI
Q1	You were worried you would not have enough food to eat because of a lack of money or other resources?[1]	WORRIED	Uncertainty and worry about food	Mild
Q2	You were unable to eat healthy and nutritious food because of a lack of money or other resources?	HEALTHY	Inadequate food quality	Mild
Q3	You ate only a few kinds of foods because of a lack of money or other resources?	FEWFOOD	Inadequate food quality	Mild
Q4	You had to skip a meal because there was not enough money or other resources to get food?	SKIPPED	Insufficient food quantity	Moderate
Q5	You ate less than you thought you should because of a lack of money or other resources?	ATELESS	Insufficient food quantity	Moderate
Q6	Your household ran out of food because of a lack of money or other resources?	RUNOUT	Insufficient food quantity	Moderate
Q7	You were hungry but did not eat because there was not enough money or other resources for food?	HUNGRY	Insufficient food quantity	Severe
Q8	You went without eating for a whole day because of a lack of money or other resources?	WHLDAY	Insufficient food quantity	Severe

[1] "Other resources" is used in all the questions to make it suitable for respondents who usually acquire food in ways other than purchasing it with money. Interviewers are trained to emphasize the expression "because of a lack of money or other resources" to avoid receiving affirmative responses due to other reasons such as dieting or fasting (25).

years of schooling for adults aged 25 and over, and expected years of schooling for children, and *3)* having a decent standard of living, measured by gross national income per capita (26). In 2017, countries were classified by the United Nations Development Program as: *1)* very high HDI (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates [UAE]), *2)* high HDI (Algeria, Jordan, Lebanon, Libya, Tunisia), *3)* medium HDI (Egypt, Iraq, Morocco, Palestinian Territories), and *4)* low HDI (Comoros, Djibouti, Mauritania, Somalia, Sudan, South Sudan, Syria, Yemen) (26, 27). Data from very high and high HDI countries and those from low and very low were combined.

PSAVT.
Considering the political unrest in some countries of the LAS, it was controlled for in these analyses using 1 of the World Bank's country-level indicators, PSAVT (28). This measure captures the likelihood that the government will be destabilized under violence and the frequency of politically motivated violence and terrorism. Generally, the performance score ranges from −2.5 to 2.5 and the highest score reflects the best situation (29). In these analyses, the LAS countries were stratified into 3 categories based on tertiles of the PSAVT 2017 score: *1)* high politically stable countries (Jordan, Kuwait, Mauritania, Morocco, UAE, *2)* medium politically stable countries (Algeria, Bahrain, Egypt, Saudi Arabia, Tunisia), and *3)* low politically stable countries (Iraq, Lebanon, Libya, Palestinian Territories, Somalia, South Sudan, Sudan, Syria, Yemen) (29).

Statistical analysis
Rasch modeling.
Rasch modeling, which is a single-parameter logistic measurement model based on the Item Response Theory, was used to assess the psychometric properties of the FIES. Rasch is a statistical technique used to develop and validate survey instruments by evaluating individual

items and their functioning (30). Rasch modeling was used to provide a theoretical basis to link the FIES responses to the measure of severity of FI and place responses to the items and the level of FI measured by the items on the same continuum scale (17, 31, 32). The responses to the items are a logistic function of the difference between the severity of a respondent's FI status and the severity of FI measured by each item (33). For example, if the respondent's level of severity of FI is lower than the severity of FI measured by the item, the probability of affirming that item is low. Individuals with missing responses to any of the 8 FIES items were excluded from the Rasch analysis and in the computation of the prevalence rates. A high proportion of missing responses can indicate questions that are not easy to understand. The total score of the FIES ranges from 0 to 8. For these analyses, extreme scores of 0 and 8 were excluded to avoid potential bias due to the large proportion of these extreme values (17, 34).

We assessed adherence of the data from each country to the assumptions of the Rasch model of: *1)* equal discrimination, meaning that the performance of all items included in the scale is consistently and equally related to food security, and *2)* conditional independence and unidimensionality, which means that responses to the items are independent and only measure 1 latent trait, that is, FI. Also, the correlations between items are entirely due to their common association with this latent trait; thus, they should be uncorrelated after controlling for the latent trait (17). Meeting the assumptions is a precondition to the FIES's validity and reliability to measure the severity of FI and make the raw scores a meaningful indicator of the severity level of FI (17, 34).

We assessed the assumption of equal discrimination using fit statistics (infit and outfit statistics) and overall model fit (reliability). Fit statistics are chi-square-type statistics that compare observed and expected responses of each item (35). Infit is mainly used to assess the assumption by checking the performance of the items in the scale, and outfits identify items that need improvement and those with erratic re-

sponses (25). The ideal value of all item-infit is 1.0, but values in the range of 0.7 to 1.3 are considered acceptable. An Item-infit value higher than 1.3 indicates higher proportions of unexpected responses (misfit), implying weaker discrimination, which should be identified for further investigation (35, 25). An elevated outfit value can occur if there are a few highly unexpected observations (denials of the least severe items but affirm the most severe ones), or if an item is highly discriminative, misunderstood, or miscoded. However, outfits are profoundly affected by a few random or erratic responses (outliers). Therefore, if the infit statistics are within the acceptable range, high outfits (≥2), are not usually criteria for eliminating items. These items need reasonable clarification to determine if there is an issue with the items (35). In contrast, lower infits may indicate the presence of redundant items that measure the same level of FI (34, 25), which may undervalue the item in its contribution to the overall measure. To provide a more comparable measure of model fit across countries, the overall model fit of the FIES items was assessed through a modified Rasch reliability test, a measure of whether the scale produces similar results under consistent conditions (36). The acceptable level of reliability is ≥0.7, which means that the order of the items is consistent, and the responses to the items reflect the person's level of food security (37).

Conditional independence and unidimensionality of the items were assessed by calculating the residual correlation matrix of each pair of items. Responses to items were considered not independent of each other if the items were correlated with ≥0.40, with lower correlations (≥0.25 to <0.40) between 3 or more adjacent items indicating the presence of multidimensionality in the data (25, 36). The order of item severity was also assessed in this study. Once raw scores were calculated, they were transformed into continuous data with equal interval units (logits) and their relative order examined. These intervals indicate the severity of FI measured by the total raw scores (33, 36). It is expected that less severe items have more affirmative responses than more severe ones (25). As the severity of the FIES items increase, the proportion of affirmative responses should decrease. Respondents with a lower level of FI would affirm items with lower severity parameters than items with higher severity parameters (33, 25). If not, this could imply a misunderstanding of the item due to languages, cultures, and livelihood arrangements and, in turn, the related experience, which could be problematic for crosscountry comparisons (17, 37).

Developing the FIES LAS-regional standard scale.
We developed a scale for each country of the LAS and a standard metric for the region using aggregated LAS data. Item severity scales for each country were calibrated against the item severities of the LAS standard metric by equating their means and SDs and adjusting them to a common metric. The intention is to represent a similar FI experience across the LAS countries, which would allow for the comparison between and within the countries. However, during the adjustment procedure, we identified "unique" items that are not comparable with the LAS standard. Unique items can be identified by comparing the relative positions of item severity parameters of each country to the regional standard metric. We allowed a maximum of 3 unique items to deviate in their severity parameters from the standard metric (31, 33). All scales, except for Syria, had ≤3 unique items. Due to the higher number of unique items, and the small size of nonextreme responses from Syria, we excluded Syrian data in the construction of the final LAS standard metric.

However, we computed the prevalence rates of FI in Syria using the overall FI thresholds estimated for the LAS. Raw score parameters for each country were then adjusted using the means and SDs of the adjusted item severity parameters after excluding unique items (37). Finally, we specified the regional thresholds for moderate and severe FI following the FAO-VoH thresholds as food secure (raw score = 0–3), moderate FI (raw score = 4–6), and severe FI (raw score = 7–8). We then plotted raw score parameter estimates of each country against the regional one to determine moderate FI and severe FI thresholds for each country.

Data were analyzed using the statistical software package R (version 3.2.3; R Foundation), Excel 2010, and SAS (version 9.4; SAS Institute Inc.). Descriptive characteristics were weighted to adjust for complex survey design. To assess for differences in characteristics between the food secure and FI individuals by the country's HDI levels , the t-test for continuous variables and chi-square for categorical variables were used and considered statistically significant at $P < 0.05$. We used logistic regression analysis to examine associations between FI and demographic and socioeconomic characteristics, accounting for the complex survey design, and controlling for country and survey year as fixed effects.

Results

Characteristics of the study population
Of the 62,261 respondents in this study, 19.1% were aged 50 y and older. Most survey respondents were men (54.3%), married or partnered (65.1%), urban residents (58.1%), had 8 y of education or less (40.9%), and about half of the respondents (48.8%) were unemployed. More than half of the population lived in very high/high HDI (55.4%) countries (**Supplemental Table 1**). Mean household size consisted of 5.8 members and 2.2 children (data not shown).

Fit statistics and overall reliability of FIES
The infit statistics of FIES items for all countries, except for Sudan and Syria, were within the acceptable range of 0.7 to 1.3 (**Table 2**). This indicates that the items met the model assumption of equal discrimination and that FIES measures the same underlying construct of FI, across the LAS. Sudan had the highest infit (1.48) for the item "worried," and Syria had the highest infits for the items "healthy" and "whlday" (1.51 and 1.44, respectively). Infit statistics in the range of 1.3 to 1.5 are not high enough to omit from a scale but indicate that the questions need improvement (17). The lowest infit values were for the items "worried" and "runout" in Syria (0.61 and 0.63, respectively).

On the other hand, high or low outfit values indicate items that are consistently misunderstood by some respondents but may also reflect careless responses or error recordings by the interviewers or data managers, such as affirming a severe item but denying 1 or more of the less severe items. Items with unusually high outfit statistics may present a cognition problem and/or may need improvement in translation (25). Results showed high outfit values (≥2.0) for the item "worried" in Jordan and Sudan, and for the item "healthy" in Syria, Palestinian Territories, and Yemen. For the most severe item "whlday," Palestinian Territories showed the highest outfit value (4.34), followed by Yemen (3.19). In contrast, low outfit values (<0.7) were found for the item "worried" in Syria, the item "fewfood" in South Sudan, the item "ateless" in Palestinian Territories, Somalia, South Sudan, Sudan, and Tunisia, the item

TABLE 2 Item fit statistics[1,2] by countries of the League of Arab States (LAS), Gallop World Poll (GWP) surveys 2014 and 2015

	WORRIED		HEALTHY		FEWFOOD		SKIPPED		ATELESS		RUNOUT		HUNGRY		WHLDAY	
	Infit	Outfit	Infit	Outfit	Infit	Outfit	Infit	Outfit	Infit	Outfit	Infit	Outfit	Infit	Outfit	Infit	Outfit
LAS	1.13	1.37	1.06	1.10	0.95	1.01	1.00	1.03	0.85	0.78	0.95	0.95	0.82	0.77	1.15	1.68
Algeria	0.82	0.78	1.26	1.33	0.95	0.95	0.87	0.82	1.03	0.97	0.81	0.66	0.88	0.74	1.25	2.51**
Bahrain	1.19	1.11	1.21	1.25	0.87	0.78	0.95	0.92	0.84	0.84	0.90	0.84	0.78	0.53	1.30	2.53**
Egypt	1.02	1.02	1.09	1.42	0.97	1.21	0.97	0.98	0.93	0.89	0.99	1.22	0.90	0.90	0.99	1.01
Iraq	1.19	1.37	1.07	1.02	1.01	1.13	0.99	0.92	0.80	0.72	0.87	0.77	0.86	0.78	1.20	1.68
Jordan	1.03	2.79**	1.01	0.80	0.92	0.93	1.01	1.04	0.87	0.83	0.93	1.23	0.83	0.75	1.20	0.90
Kuwait	1.16	1.28	1.15	1.23	0.96	1.02	0.95	0.96	0.83	0.78	1.06	1.15	0.88	0.85	0.93	0.79
Lebanon	1.12	1.35	1.00	1.11	1.06	1.01	1.02	1.02	1.03	1.01	0.99	0.91	0.80	0.82	0.84	0.57
Libya	1.13	1.17	1.04	1.11	0.97	1.01	0.93	0.91	0.98	0.96	1.00	1.02	0.87	0.78	1.10	1.05
Mauritania	0.93	0.85	1.08	1.18	1.21	1.44	1.06	1.01	0.91	0.83	0.77	0.75	0.91	0.79	1.13	1.01
Morocco	1.21	1.29	0.96	0.95	0.92	1.97	1.01	1.00	0.91	0.79	0.95	0.87	0.83	0.70	1.09	0.77
Palestinian Territories	1.04	0.84	1.03	2.85**	0.94	0.71	0.96	0.86	0.87	0.66	1.07	0.93	0.80	1.21	1.12	4.34**
Saudi Arabia	1.18	1.18	1.06	0.98	0.89	0.88	0.92	0.89	0.92	0.95	0.88	0.79	0.89	0.95	1.26	1.82
Somalia	1.03	1.03	1.14	1.23	1.01	0.95	0.95	0.90	0.79	0.68	0.97	0.95	0.88	0.79	1.23	1.61
South Sudan	1.21	1.33	0.97	0.81	0.77	0.52	1.17	1.34	0.78	0.69	1.00	1.01	0.92	0.88	1.07	1.16
Sudan	1.48*	2.08**	1.15	1.72	0.90	0.98	0.89	0.70	0.70	0.51	0.92	0.89	0.79	0.63	1.05	1.05
Syria	0.61	0.48	1.51*	2.22**	0.96	0.87	1.03	1.12	1.08	1.21	0.63	0.53	0.71	0.56	1.44*	1.65
Tunisia	1.21	1.61	1.04	1.20	0.84	0.75	0.90	0.92	0.73	0.64	0.97	1.10	0.88	0.67	1.33	2.23**
UAE[2]	1.06	1.14	1.02	0.94	0.88	0.91	1.01	0.96	0.80	0.71	1.07	1.15	0.92	0.76	1.29	1.86
Yemen	0.97	1.72	1.03	2.01**	0.96	0.72	1.09	1.21	0.92	0.80	0.98	0.79	0.79	0.61	1.09	3.19**

[1] *Infit* item-infit mean square statistic, *infit >1.4; [2] *Outfit* item-outfit mean square statistic, **outfit >2.0.
[2] UAE, United Arab Emirates.

"runout" in Algeria, the item "hungry" in Bahrain, and for the item "whlday" in Lebanon (Table 2).

Finally, the overall model fit using the Rasch reliability assessment was 0.71 for the LAS region (**Supplemental Table 2**). Countries had reliability values within an acceptable range of 0.70 to 0.80. The lowest Rasch reliability was 0.69 in Saudi Arabia, Somalia, South Sudan, and Syria, and the highest was 0.77 in Palestinian Territories and Yemen. These levels of reliability for a scale comprised of 8 items reflect a reasonably good model fit (25).

Conditional independence of the items
Overall, there were no significant correlations between the items in the combined LAS data. However, at the country level, high correlations (≥0.4) were found for the items "runout" and "hungry" in Algeria and Tunisia, and for the items "hungry" and "whlday" in Lebanon. There was, however, no indication of multidimensionality of the FIES, since there were no significant correlations between any 3 adjacent items of between 0.25 and 0.40.

Severity order of FIES items
The severity level of FI measured by the items was assessed through the proportions of respondents affirming each item, and by examining the relative order of the severity parameters of the items in logit scale. The overall LAS item severity parameters ranged from –0.83 to 1.90 (2.73 logits), and a similar range was found in most countries with few exceptions (**Table 3** and **Figure 1**). The observed severity level of FI measured by items 1–5 was different from the level of FI they were designed to measure, which indicates disordering of the items in most of the countries and in the aggregated LAS data. Items measuring more severe FI; "hungry" and "whlday," performed as expected in most cases. Since the relative disordering of the item severity was reasonably similar across the LAS countries, this indicates that severe FI was experienced similarly in the LAS.

Nevertheless, the proportion of respondents affirming items measuring more severe FI, items 6–8, were lower than the proportion of affirmative responses to items measuring less severe FI, except for Syria and Somalia (**Supplemental Figure 1**). As the severity of the item increased, the proportion of affirmative responses decreased. For instance, ~63% of the population reported being worried about having enough food, with 16% of the population reporting going hungry for the whole day (**Supplemental Figure 2**). However, among the items measuring less severe FI, the item "fewfood" had the highest affirmative responses in most of the countries. Also, the order of severity of FI measured by the items "skipped" and "ateless" were reversed in some countries (Supplemental Figure 2).

It is worth mentioning that the proportions of missing responses to any of the 8 FIES questions were <5% for all countries except for Syria. No single item stood out as having consistently higher proportions of missing responses. Having higher percentages of missing responses to any of the FIES items compared with others may indicate difficulty in understanding the question. Syria had the highest number of missing 1 or more of the FIES items.

Regional and country threshold
The robust calibration procedure of Rasch modeling indicated the raw scores to be meaningful measures of severity of FI in each country

TABLE 3 The overall proportion of affirmative responses to Food Insecurity Experimental Scale (FIES) items, item severity parameters, and item fit statistics of the League of Arab States (LAS), Gallop World Poll (GWP) surveys 2014 to 2017

Item	Affirmative responses (weighted%)	Severity ± SE[1]	Infit[2]	Outfit[3]
WORRIED	63.0	− 0.83 ± 0.08	1.13	1.37
HEALTHY	62.1	− 0.82 ± 0.08	1.06	1.10
FEWFOOD	65.7	− 0.97 ± 0.08	0.95	1.01
SKIPPED	48.7	− 0.09 ± 0.08	1.00	1.03
ATELESS	53.5	− 0.34 ± 0.08	0.85	0.78
RANOUT	42.0	0.30 ± 0.08	0.95	0.95
HUNGRY	32.4	0.83 ± 0.10	0.82	0.77
WHLDAY	15.9	1.90 ± 0.14	1.15	1.68

[1]Severity parameter of the FIES items. The calibrations were estimated on a logit scale (with equal discrimination = 1), mean set to 0, and SD of 1.
[2]Infit, item-infit mean square statistic.
[3]Outfit, item-outfit mean square statistic.

(**Supplemental Figure 3**). Subsequently, the raw scores were stratified into 3 categories: food secure (0–3), moderately FI (4–6), and severely FI (7, 8). The thresholds of moderate and severe FI for each country are shown in **Supplemental Figure 4** where each country's adjusted raw score parameter is plotted against the regional one. In most countries examined, the threshold for moderate FI was 4, but the threshold for severe FI was 7 except for Sudan, Syria, and Yemen, where the severe FI threshold was 8.

### Prevalence and characteristics of severe FI individuals by HDI

Overall, 30.4% of respondents experienced moderate and severe FI, and 15.7% experienced severe FI. There was a wide variation in the prevalence of severe FI across the LAS countries, ranging from 1.8% in Lebanon to 83.1% in South Sudan (**Figure 2**). Countries with politi-

cal unrest had the highest prevalence of severe FI; including South Sudan, Somalia, Iraq, Sudan, and Palestinian Territories (Figure 2). Adults aged 50 y and older were at significantly higher risk of severe FI compared with younger adults (16.5% and 15.5% respectively, $P <0.02$) and women higher than men (17.6% and 14.1%, respectively, $P <0.0001$) (**Table 4**). Analyses stratified by HDI showed that countries with low HDI and low political score (PSAVT score) had the highest prevalence of severe FI (24.9% and 32.2%, respectively, $P <0.0001$) compared to countries with high HDI and high political score (8.3% and 6.8%, respectively, $P <0.0001$).

Overall, severe FI was significantly more prevalent among married individuals, rural residents, those with lower educational attainment, unemployed, live in lower income quintile, larger households with more children, and in low PSAVT countries (Table 4). These patterns were similar by HDI categories although the magnitudes of risks were higher
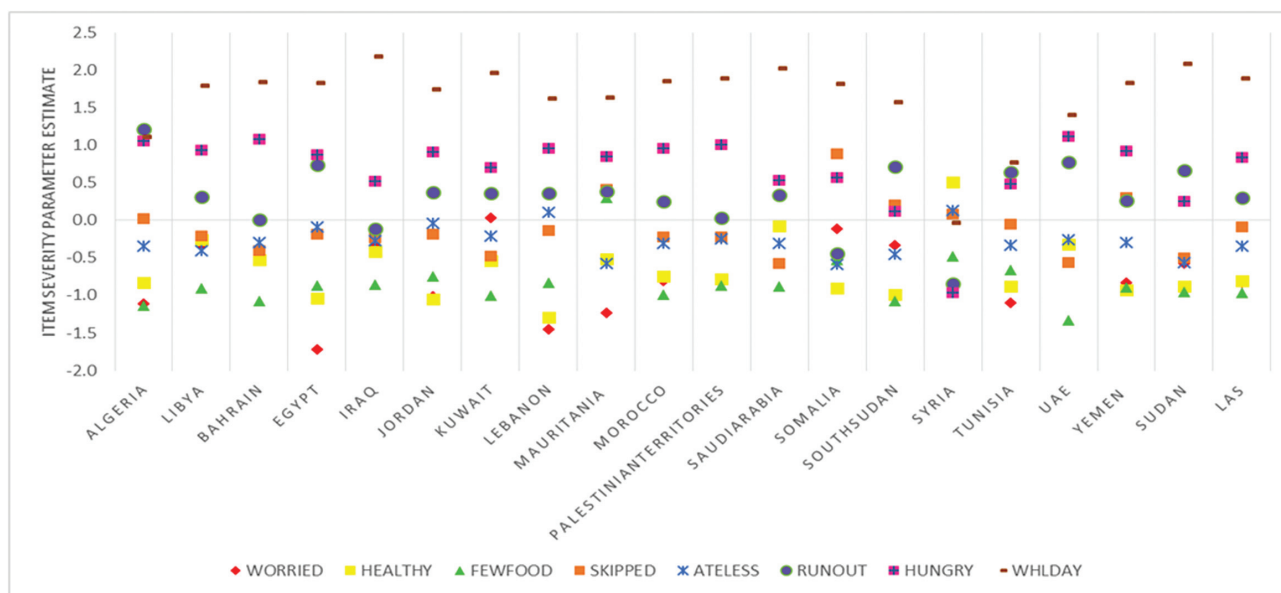
FIGURE 1 Relative severity order of the Food Insecurity Experimental Scale (FIES) items in the League of Arab States (LAS) and individual countries, Gallop World Poll (GWP) surveys 2014 and 2015.
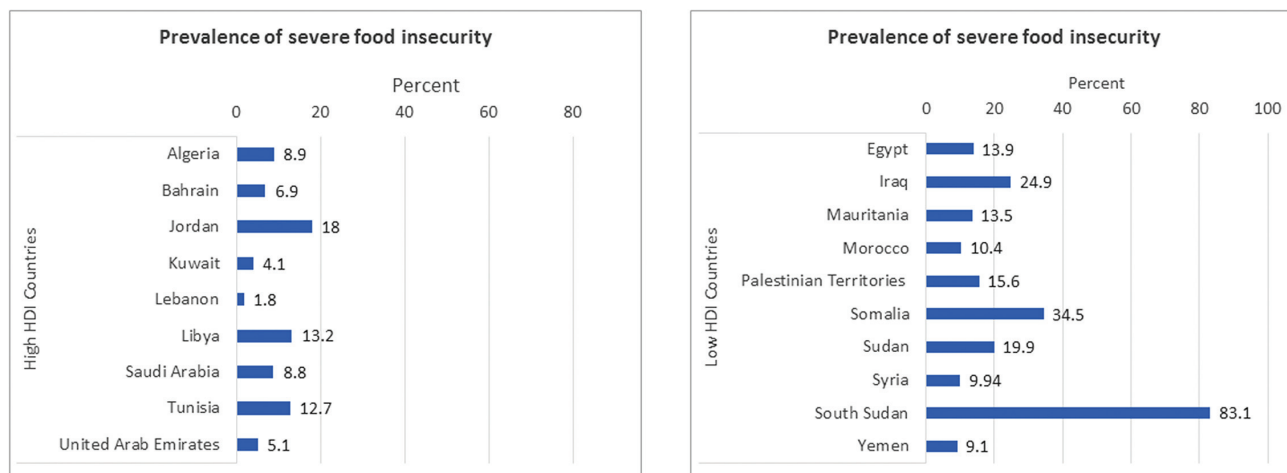
FIGURE 2 Country-based prevalence of severe food insecurity (FI) by the Human Development Index (HDI), Gallop World Poll (GWP) surveys 2014 to 2017.

in low HDI countries. Also, there were no significant differences in the prevalence of FI, by employment status, for individuals in countries with low HDI or marital status in countries with high HDI. The results of the logistic regression analysis showed that lower educational attainment, lower income, lower PSAVT score, large household size, and greater numbers of children were most significantly associated with severe FI in countries in both HDI levels. However, living in rural areas (compared with urban ones) was associated with severe FI in countries with high HDI only, whereas employment was associated with severe FI in low HDI countries (results not shown).

Discussion

This study used Rasch modeling to assess the internal validity of FIES in measuring FI in the LAS. Overall, based on the reliability scores, the fit statistics, and the correlations of item residuals, the FIES met the assumption of equal discrimination and conditional independence; hence has satisfactory psychometric properties and is thus valid for use in the LAS region but with some caveats.

The high infits for the items "worried," in Sudan and the items "healthy" and "whlday" in Syria suggest that these items are weakly associated with FI in these countries. In contrast, the low infit for the items "worried" and "runout" in Syria highly indicate possible redundancy of one of these items, that is, they may be measuring the same level of FI. Nevertheless, the high and low infits in Sudan and Syria may be attributed to the small nonextreme sample sizes, which provide less precise estimates due to the potential to inflate margins of error of the infit statistic (25). Thus, for these 2 countries, further testing is recommended in larger samples. Larger samples may decrease the effect of the erratic responses or measurement errors and improve infit values for the specific problematic items (17, 30, 33). Infit statistics in the range of 1.3 to 1.5, such as in Sudan, indicate that the item can still be used, but improvements are recommended (2). Improvements can be made through

cognitive testing to ensure that respondents understand the questions as intended.

High outfit values were observed for the item "whlday" in several countries. Similar results of high outfits for the item "whlday" were reported in the validation study for the FIES in Sub-Saharan Africa (22) and by FAO-VoH in the global 2014 GWP data (17). This high outfit for the item "whlday" in these countries may have resulted from the high proportion of affirmed responses to going without food for the whole day, resulting in subsequent exclusion of these responses from the Rasch analysis, leading to less precise estimates (22). These results suggest that some respondents gave unlikely responses for this item based on their answers to other items, meaning that they may not have been their real experiences. The item "whlday" may require cognitive testing in LAS. This is also true for the items "worried" and "healthy" in some countries, to ensure that the questions are understood as intended, and to improve the wording of the questions, if necessary. Nevertheless, since high item outfits may be due to a small proportion of erratic responses, and given the observed good infit statistics for these items, these high outfits may not be indicative of any violation of the Rasch assumptions or cause a threat to the validity of the FIES.

Our results also show that the FIES is unidimensional, measuring the one construct of FI. The correlations between residuals of some items in Algeria, Tunisia, and Lebanon may be explained by the fact that these countries were highly food secure, with a large number of extreme values (zeros) and so the data were excluded from the Rasch analysis. Further testing should be done when more data become available, and cognitive testing may be required for these items to ensure that they do not measure the same experience.

Our results indicate that there are some inconsistencies in the conceptual order of the severity of FI measured by some items. In particular, a shift in the order of the 3 items measuring the less severe levels of FI. The item "fewfood" was found to measure the least severe level of FI instead of the item "worried" as conceptualized in FIES. A possible explanation for this finding may be related to religious and fatalistic beliefs of people in the LAS region that God will provide and so there

TABLE 4 Sociodemographic and economic characteristics of severe food insecure (FI) respondents, by the Human Development Index (HDI) and within-group comparisons,[1] Gallop World Poll (GWP) surveys 2014 to 2017

Characteristics	Overall		High HDI[2]		Low HDI[3]	
	n	Weighted %	n	Weighted %	n	Weighted %
Food insecurity	9015	15.7	2508	8.3***	6507	24.9***
Age group						
Younger adult (19 y to 49)	7167	15.5*	1971	8.1*	5196	25.1
Older adult (50+)	1848	16.5	537	9.3	1311	24.1
Gender						
Men	4320	14.1***	1330	7.6***	2990	23.8**
Women	4695	17.6	1178	9.4	3517	25.9
Education						
<9 y of education	5811	26.9***	906	14.9***	4905	32.1***
High school education	2146	10.9	984	8.8	1162	14.8
≥ 1 y of college	1034	4.8	614	4.3	420	6.8
Marital status						
Married or with a domestic partner	6331	16.9***	1582	8.3	4749	26.6***
Single (never married, divorced, separated, widowed)	2677	13.6	922	8.4	1755	21.2
Employment						
Employed	3976	13.2***	1156	6.7***	2820	24.9
Unemployed	5039	18.3	1352	8.7	3687	24.8
Residence						
Urban (live in a large city or suburb of a large city)	3620	10.8***	1564	7.2***	2056	18.4***
Rural (live in a rural area, on a farm, or in a small town or village)	5348	22.9	901	11.6	4447	29.4
Household composition						
Households with ≤6 members	5317	12.5***	1744	7.1***	3573	22.0***
Households with >6 members	3698	22.0	764	12.3	2934	28.2
Household with 0–3 children	6145	12.6***	2071	7.7***	3870	20.5***
Household with ≥4 children	3074	28.5	437	13.8	2637	35.0
Income quintile						
Lowest	2786	26.8***	962	17.8***	1824	38.0***
Second	2078	18.8	614	10.5	1824	29.1
Middle	1693	14.4	449	6.9	1244	23.7
Fourth	1375	11.1	283	4.1	1092	19.7
Highest	1083	7.8	200	2.6	883	14.2
Political score (PSAVT)[4]						
Low	5547	25.2***	352	6.8***	5195	32.2***
Medium	1648	10.2	1163	9.3	485	13.9
High	1820	9.3	993	8.0	827	11.8

[1]Chi-square tests were used to evaluate the distributions
[2]High HDI includes Lebanon, Saudi Arabia, Jordan, Algeria, Bahrain, Kuwait, Libya, Tunisia, and United Arab Emirates.
[3]Low HDI includes Egypt, Morocco, Syria, Palestine Territories, Mauritania, Iraq, Somalia, Sudan, Yemen, and South Sudan.
[4]Political Stability and the Absence of Violence and Terrorism:
1) Low: Syria, Lebanon, Palestine Territories, Iraq, Somalia, Sudan, Libya, Yemen, and South Sudan.
2) Medium: Egypt, Saudi Arabia, Algeria, Bahrain, and Tunisia.
3) High: Morocco, Jordan, Mauritania, Kuwait, and the United Arab Emirates.
*Significantly different at $P \leq 0.05$.
**Significantly different at $P \leq 0.01$.
***Significantly different at $P \leq 0.0001$.

is no need to worry. Similarly, the high response to the item eat "few-food" may also represent cultural eating patterns in some countries of this region and may not necessarily be an indication of FI. Nevertheless, since all the LAS countries showed the same disordering of these items, it indicates consistency of FIES in measuring FI in this region. This disordering did not affect the overall measurement of FI in this study since the least 3 items were categorized similarly as food secure. To overcome the limitation of the disordering of the items we examined the FI as a dichotomous variable as food secure and moderate FI versus severe FI. Nevertheless, these items may also need to be cognitively tested.

In this study we found a higher prevalence of severe FI in the LAS (15.7%) than in other geographical classifications of the region. For example, using FIES, the FAO report of the NENA region, showed a severe FI prevalence of 9.5% in 2014–2015 (14) and 10.3% in the WANA region in 2014–2015 (38). This difference in prevalence may be due to the different countries that are included in these regional surveys. Our study found that the aggregated prevalence of severe FI from 2014 to 2017 is quite varied in individual countries of the LAS region. Additionally, the overall prevalence of FI in this region should be considered provisional and explained with caution since a wide variation in economic status characterizes the LAS region and also due to small samples in

some countries. Different patterns of FI emerged when countries were grouped by economic level. Our study showed that as the level of income, HDI, or political score falls, the prevalence of severe FI increases. The same pattern was also reported in the 2018 and 2020 FAO reports (15, 39).

The country-level prevalence of severe FI also varied by political stability, indicating a need for an in-depth assessment of the determinants of severe FI, tailored interventions, and continued monitoring of FI in this region. The politically unstable countries of Iraq, South Sudan, Somalia, and Syria had the highest prevalence of severe FI. Although assessing FI in real-time is difficult, such surveys may provide the best possible snapshot at the time of conflict; however, it might change in the course of new conflict dynamics. In this study, Yemen had a lower level of severe FI, which might be the result of a sampling error due to active conflict in the country; however, the prevalence of combined moderate and severe FI was quite high. These results may also be quite different in the current circumstances due to the ongoing war and pandemic. Similarly, the prevalence of combined moderate and severe FI was 46.7% and severe FI was 20% in Sudan. Therefore, the high prevalence of FI in this country might be due to the prolonged conflict, with resultant environmental degradation, and poverty that increases the risk of FI (40). Sudan is one of the wealthiest countries in Africa in terms of natural resources, but the majority (80%) of the population depend on agricultural activity for their livelihood (41). In conflict situations, many factors may exacerbate FI and malnutrition and their consequences. Conflict impacts access to and utilization of food, water, and health care, leading to malnutrition.

Individuals with severe FI were characterized by lower educational attainment, lower incomes, unemployment, rural residence, and having >3 children in the household. These findings were not surprising since these characteristics are associated with resource access and have been reported in previous studies conducted in different countries of the LAS region (5, 7–10, 13, 14, 16, 42). FI was more prevalent in women than men, irrespective of HDI. However, women in high HDI countries had a lower risk of severe FI compared with those living in low HDI countries, which might be due to better educational and employment opportunities, and potentially due to social services available in high HDI countries. Estimates of FI in other regions of the world, by gender, also point to a gender gap according to the FAO report, and the prevalence of FI is higher among women in every continent (15). Given the primary role women play in the households as caretakers, producing and preparing food, FI may hinder them from having time for jobs outside of the home, leading to a vicious cycle of poverty and FI. Future studies of women and older adults of that region may inform policies targeted to these vulnerable groups.

The strengths of our study include the use of large nationally representative samples from 19 countries of the LAS, which allow for the generalizability of the results to that region. Also, using the same instrument to assess food security in this study allows for comparison across countries and populations and within countries over time. FIES is an easy tool to use which allows for real-time monitoring and generation of food security information that may guide actions and interventions. Limitations of this study are related to the cross-sectional study design which does not allow for inference of causality of FI and responses may be biased due to self-reported data. Qualitative studies can pro-

vide additional information to better understand the causes of FI in that region.

In LAS, a common threshold of severe FI exists for adults using FIES. These results indicate that FI is experienced similarly across the LAS with few exceptions, and it is comparable across countries and populations of that region. Cognitive testing is recommended for certain questions of the FIES tool to possibly guide the improvement of items that are correlated and those with high outfit statistics. Additionally, a closer examination of the order of FIES items for LAS is warranted. The disordering of the severity level of FI measured by some items observed in this study, indicates that the items may need to be reordered to better measure the least severe category of FI. At a regional level, FIES is recommended for use especially for comparative purposes to other regions of the world. However, country-based surveys may be better served by using locally developed and tested instruments.

Data Availability

Data obtained through a license from FAO-VoH; part of the data is not available for public access, data used for this analysis will be furnished upon request.

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