Food and Agriculture Organization
of the United Nations

Methods for estimating comparable prevalence rates of food insecurity experienced by adults throughout the world

Technical
Report

Voices of the Hungry

The Voices of the Hungry project has developed
the **Food Insecurity Experience Scale,**
a new metric for household and individual food insecurity.
It brings us a step closer to hearing the voices of the people
who struggle every day to have access to safe and nutritious food.

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VOICES

of the

HUNGRY

Methods for estimating comparable prevalence rates of food insecurity experienced by adults throughout the world.

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Note to the reader:

In this version of the report, statistics for Mexico have been revised due to a processing error for Mexico national survey data in the earlier release. Minor typos have also been corrected, but the only changes in statistical results are those for Mexico prevalence rates.

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A formidable challenge

How to estimate national prevalence rates of food insecurity that are comparable across countries and population groups.

"Food security exists when all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." (FAO, 2009).

A key objective of the Voices of the Hungry project (VoH) is to estimate comparable prevalence rates of food insecurity in national populations for more than 140 countries every year. These estimates are based on conditions and behaviors reported by adults through the **Food Insecurity Experience Scale** survey module (FIES-SM). The data collected in nationally representative surveys of the adult population in each country are used to compute a measure of severity of the food insecurity status for each respondent, focusing on conditions reflecting limited access to food. Individual measures are then calibrated against a common global reference scale of severity, thus allowing classifications and estimates of prevalence rates that are comparable across countries and population groups.

Defining the global reference scale and appropriate methods for calibration is a **formidable challenge**, given the differences in languages, cultures, and livelihood arrangements that exist across countries. Though statistical theory and methods for latent trait analysis based on **Item Response Theory** (IRT) provide a general approach and many of the statistical tools needed to accomplish this task, some adaptation and extension of those methods is required. This report describes the adaptations and extensions of IRT methods developed by VoH, providing details of the process from data collection to the production of comparable national statistics. It then presents the results of the analyses of data collected through the **Gallup® World Poll** (GWP) in 146 different countries, areas or territories in 2014, leading to preliminary estimates of the prevalence of moderate and severe food insecurity.

The main purpose of the report is to allow food security analysts to evaluate the statistical soundness and adequacy of the methods described. Descriptions assume that the reader has a basic understanding of statistical measurement methods based on Item Response Theory, and in particular on the Rasch measurement model. Readers lacking this background may want to consult Nord (2014) as an introduction to those methods.

Sections are as follows:

1. Overview of the concepts of food security and food insecurity and the role of experience-based measures within the field of food security assessment.
2. Description of the questionnaire module, the FIES-SM.
3. Data collection: sampling, interviewing, editing and weighting.
4. Analysis of each country's food security data: Measurement model estimation—calculation of the FIES, assessment of each item and of the scale for each country.
5. Development of the VoH global reference scale—the bridge by which prevalence rates in countries will be compared.
6. Adjusting each country's scale to the global reference scale and calculating prevalence rates of food insecurity at two levels of severity.
7. Results to date: measures of item and model fit, assessment of conditional independence of items, parameters and robustness of the global reference scale, summary of consistency of country-level scales to the global reference scale
8. Results to date: preliminary analysis of correlations between estimated prevalence rates and other indicators of development at country level.

1. The concept: food insecurity seen through the lens of people's experiences

Overview of the concepts of food security and food insecurity, and the use of experience-based measures for food security assessments.

Combined scientific and political efforts have converged on a growing consensus regarding conceptual frameworks and measures of food security. Because no single indicator can account for the **multiple dimensions** of food security, the discussion has focused on defining a suite of indicators based on measures of aspects ranging from food production and availability, to dietary quality and the prevalence of nutrition-related outcomes in the population (FAO, 2012a; Coates, 2013; Jones et al, 2013; FAO, IFAD & WFP, 2014).

The Food Insecurity Experience Scale (FIES) is expected to make an important contribution in the area of food security assessment by better capturing the **access dimension** of food security. It does so by providing the set of tools needed to compute valid and reliable indicators of the prevalence of food insecurity, at different levels of severity, in a population reached by a representative survey. By gauging the scope and depth of limited access to food, such indicators will be a valuable addition to the suite of existing food security indicators at country level, (Ballard et al., 2013).

The FIES establishes an **experience-based metric** for the severity of the food insecurity condition of individuals or households. The metric is calculated from data on people's direct responses to questions regarding their access to food of adequate quality and quantity. The construct it measures is thus fully consistent with a view that the key defining characteristic of food security is "secure access at all times to sufficient food" (Maxwell & Frankenberger, 1992, p. 8).

Ethnographic research carried out in the USA to understand the lived experience of hunger revealed it to be a process characterized initially by anxiety about having enough food, followed by dietary changes to make limited food resources last, and finally, decreased consumption of food in the household (Radimer, Olson & Campbell, 1990; Radimer et al, 1992). Although the original ethnographic study was based on a small number of households in a wealthy country, a review conducted years later of studies derived from many countries in different regions of the world concluded that these dimensions of the experience of hunger appear to be **common across cultures** (Coates et al., 2006).

This theoretical construct of food insecurity formed the basis for the U.S. Household Food Security Survey Module (US HFSSM), which has been applied annually in the United States since 1995 and has served as a model for the FIES. Numerous other experience-based food insecurity scales emerged from the same theoretical basis in diverse countries around the world.[1] Two measures in particular, the Household Food Insecurity Access Scale (HFIAS) (Coates, Swindale & Bilinsky, 2007) and the *Escala Latinoamericana y Caribena de Seguridad Alimentaria* (ELCSA) (Pérez-Escamilla et al., 2007; FAO, 2012b) included analytic methods to make the measures comparable across countries. The FIES builds heavily on the ELCSA as well as other scales by providing an analytic framework to improve the precision of comparability across countries and to extend comparability to all countries.

[1] The first one was the *Escala Brasileira de Insegurança Alimentar* (EBIA) used in Brazil since 2004 (Segall-Corrêa et al., 2004), fo-llowed by the *Escala Mexicana de Seguridad Alimentaria* (EMSA) adapted for use in Mexico (Pérez-Escamilla).

Figure 1-1

Food insecurity experiences and associated severity levels

The measurement theory behind the FIES

Research has revealed how different experiential domains are typically associated with different levels of food insecurity, with possible associations shown in Figure 1-1. This observation paved the way towards identifying potential questions to be included in a questionnaire to form a proper basis for measurement scales of food insecurity, such as the FIES.

The fundamental assumption behind the FIES and similar food security scales is that the severity of the food insecurity condition of a household or an individual can be **analysed as a *latent trait*.** Latent traits cannot be observed directly, but their measure can be inferred from observable evidence through application of measurement models based on **Item Response Theory (IRT)**, a set of methods rooted in statistics with broad application to measurement problems in the human and social science domains.

In applying IRT models to the measurement of food insecurity, we postulate that: (a) the severity of the food insecurity condition of the respondent and that associated with each of the experiences can be located on the same one-dimensional scale, and that: (b) higher severity of the food insecurity condition of a respondent will increase the probability of reporting occurrence of experiences associated with food insecurity.

By defining a probabilistic model that links the (unknown) measure of food insecurity to the (observable) responses to experience-based questionnaires, it is possible to obtain estimates of the former using data collected on any sample of individuals.

The simplest of such models that preserves all desirable qualities of a proper measurement model is the **Rasch model**, named for the Danish mathematician Georg Rasch, who first proposed it, which is also referred to as the one-parameter logistic (1PL) model. (Rasch, 1960; Fischer & Molenaar, 1995).

In this model, the probability that a respondent will report a given experience is a logistic function of the distance between the respondent's and the item's positions on the severity scale:

$$\text{Prob}(x_{h,i} = 1 | \theta_h, \beta_i) = \frac{e^{\theta_h - \beta_i}}{1 + e^{\theta_h - \beta_i}},$$

where $x_{h,i}$ is the response given by respondent h to item i, coded as 1 for "yes" and 0 for "no".

The relative severity associated with each of the experiences (the parameters β_i in the formula above) can be inferred from the frequency with which they are reported by a large sample of respondents, assuming that, all else being equal, more severe experiences are reported by fewer respondents. Once the severity of each experience is estimated, the severity of a respondent's condition (the θ_h parameter) can be computed by noting how many of the items have been affirmed. The rationale for this is that, on average, it is expected that a respondent will answer affirmatively to all questions that refer to experiences that are less severe of their food insecurity situation, and negatively to questions that refer to situations that are more severe.[2]

[2] Notice that, as in any estimation model based on empirical data, this is deemed true only in a probabilistic sense, meaning that deviations from the expected patterns of response are admitted. The frequency and magnitude of such deviations are the elements against which the validity of the model is tested with any specific dataset (see section 4 below).

The mathematics of the model imply that a proper statistical measure of the respondent's food insecurity level can be based only on the raw score (number of affirmative answers), irrespective of which specific experiences were affirmed.[3] Raw score-based classifications are typically used with the US HFFSM, the ELCSA and other similar scales to monitor the food security situation in a given population over time. However, they may be problematic for cross-country comparisons, as nothing ensures that the same raw score would correspond to the same severity level in different countries, even when using the same questionnaire. This is because differences across countries in languages, cultures, and livelihood arrangements almost certainly affect the way in which any given question is understood and the related condition is experienced.

Owing to the analytic protocol developed by FAO and detailed in this report, **the FIES is the first experience-based food insecurity measurement system that generates formally comparable measures** with desirable measurement properties across such a large number of countries.

Use of FIES-based indicators

As no single measure can account for the complex nature and multiple dimensions of food security at country level, FIES-based indicators should be seen as a key addition to a suite of complementary measures. Most existing indicators of food insecurity focus on its likely determinants or potential consequences. The FIES fills a gap in global food security monitoring by directly measuring **the access dimension of food insecurity** at the individual and household levels. Other direct measures, such as those based on food consumption data, require considerably higher investments in terms of financial resources, time and level of professional training.

Prevalence estimates of food insecurity at different levels of severity can be analyzed together with indicators of determinants and consequences of food insecurity at the population level. Such analyses will contribute to a more comprehensive understanding of food insecurity and inform more effective policies and interventions to address it.

In summary, compared to other indicators of food security, experience-based indicators stand out because of their **analytic soundness, ease of administration, comparatively low cost and timeliness of reporting**. Indicators derived from the FIES in particular have the distinctive advantage of being more precisely comparable across countries.

In addition to allowing the computation of prevalence rates in a population, the FIES will also produce measures of food insecurity severity for each respondent in a survey. Expected measurement errors, reflecting the extent of uncertainty around individual measures of severity, are typically too large to make them useful for programme purposes, for example targeting individuals to receive benefits. However, these measures can be used to conduct micro level analyses of association of food insecurity status with other individual or household characteristics. For such uses, individual or household level food insecurity measures are best defined either as **categorical indicators or as (continuous) probabilities of belonging to a given food security class** (e.g. food secure, moderately food insecure, severely food insecure) in appropriate regression models with limited (discrete or truncated) dependent variables. (See Voices of the Hungry, 2015 for further details.)

[3] The fact that the simple raw score is a proper ordinal measure, (irrespective of which items are affirmed) seems surprising at first. However, it is readily demonstrated mathematically under assumptions of the measurement model that raw score is a sufficient statistic for the measure on the latent trait. This becomes more intuitively credible when we consider that the raw score takes into account not only what is affirmed, but also what is denied, and that there is information on the food security condition of a respondent both in reporting an experience and in denying it. For example, a respondent who affirmed only one item, but a rather severe one, will have denied several less severe items. Those denials also inform our estimate of the respondent's true food insecurity.


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2. The Food Insecurity Experience Scale Survey Module (FIES-SM)

A description of the questionnaire.

The FIES Survey Module (FIES-SM) is composed of eight questions[4] with simple dichotomous responses ("yes"/"no"). Respondents are asked whether anytime during a certain reference period they have worried about their ability to obtain enough food, their household has run out of food, or if they have been forced to compromise the quality or quantity of the food they ate due to limited availability of money or other resources to obtain food.[5] (See Ballard et al., 2013 for a description of the development of the FIES module).

The FIES-SM is flexible with regard to recall period ("during the previous one month", "…three months", or "…12 months") and unit of reference (individual, e.g. "you were…" or household, e.g. "you, or others in your household, were…").

In the version that has been applied globally through the GWP, questions are framed with **reference to individuals** and have a reference period of **12 months** (Table 2-1). This is because the GWP is conducted in different months in different countries and a shorter recall period might result in lack of comparability across surveyed countries due to the possible interaction of seasonality of food insecurity and season of data collection.

Table 2-1

Questions in the Food Insecurity Experience Scale Survey Module for Individuals (FIES SM-I) as fielded in the 2014 GWP

	Now I would like to ask you some questions about food. During the last 12 MONTHS, was there a time when… :	(label)
(Q1)	… you were worried you would not have enough food to eat because of a lack of money or other resources?	(WORRIED)
(Q2)	… you were unable to eat healthy and nutritious food because of a lack of money or other resources?	(HEALTHY)
(Q3)	… you ate only a few kinds of foods because of a lack of money or other resources?	(FEWFOODS)
(Q4)	… you had to skip a meal because there was not enough money or other resources to get food?	(SKIPPED)
(Q5)	… you ate less than you thought you should because of a lack of money or other resources?	(ATELESS)
(Q6)	… your household ran out of food because of a lack of money or other resources?	(RANOUT)
(Q7)	… you were hungry but did not eat because there was not enough money or other resources for food?	(HUNGRY)
(Q8)	… you went without eating for a whole day because of a lack of money or other resources?	(WHLDAY)

[4] The eight FIES questions are derived directly from the eight questions referring to adults in the ELCSA.
[5] It is essential to include a resource constraint in the questions as it contributes to define the construct of food insecurity as limited access to food. Enumerators are trained to emphasize the expression "because of a lack of money or other resources" to avoid receiving positive responses due to fasting for religious reasons or dieting for health reasons. The "other resources" notion has been tested in several contexts, to make it appropriate for respondents who normally acquire food in ways other than purchasing it with money.

In general, shorter recall periods may be expected to provide more reliable data, as recall errors are reduced. Periods as short as the previous 30 days may be more appropriate, depending on the objectives of the specific survey, especially if the survey can be repeated during the year. VoH is planning **additional research** to explore formally the link between results obtained using a 12 month FIES and those obtained using shorter reference periods.

Within the context of the GWP, which is a survey of adult individuals weighted to represent the national populations aged 15 or more,[6] the questions in the FIES are - with one exception[7] - referenced to the individual respondent.[8]

For surveys that are sampled and weighted to represent households, a **modified version of the FIES-SM** referenced to the respondent's household is available.

The aim of the Voices of the Hungry project is to promote **inclusion of the FIES-SM in national-level large scale surveys** such as Household Income and Expenditure Surveys, Household Budget Surveys, Living Standard Measurement Surveys and health and nutrition surveys.

[6] In the context of the GWP, adults are defined as 15 years of age and older.

[7] The insertion of one question referring to a household situation is consistent with an individually framed questionnaire. As the experience of running out of food in the house may be thought of as affecting all of the household members it is also an individual experience.

[8] The 2014 GWP included, as an adjunct to the FIES, two questions about the food security of children under age 5. Scales that included these questions were explored, but the questions added little to the reliability of the FIES. Since many households do not have children, two scales would have been required in each country to incorporate the child items. It was not considered worthwhile to incur this additional complexity for relatively little gain in reliability, so the VoH assessment was limited to the eight item, adult-referenced FIES. In addition, since the GWP is a survey of adults and weighted to represent adults, it was not possible to aggregate information from the child questions to provide meaningful statistics on children's food security. The child questions will be omitted from the 2015 GWP surveys.

3. Data collection through the Gallup World Poll

Sampling, interviewing, editing, and weighting.

The Gallup® World Poll (GWP), created in 2005, is a survey of individuals 15 years of age and older **conducted annually in over 150 countries, areas or territories**. The survey is administered to a representative sample of individuals in each country, area or territory to collect information on people's opinions, experiences and aspirations. Among the topics covered are law and order, food and shelter, institutions and infrastructure, job climate, and financial, social, physical and self-reported well-being. The GWP includes a set of core questions applied in most countries throughout the world with additional region-specific questions applied where relevant. The majority of items are framed as questions requiring dichotomous (yes/no) responses, although some feature a wider response set. Beginning in 2014, the FIES Survey Module (FIES-SM) has been included in the GWP.[9]

In 2013, VoH conducted **linguistic adaptations** of the FIES-SM in national languages of Angola, Ethiopia, Malawi and Niger, using a methodology that included consultations with country-level specialists and officials and focus group discussions (Gallup, 2013; Manyamba, 2013; Massaoud and Nicoló, 2013). These experiences provided valuable information and corroborated studies conducted in other countries regarding phrases and concepts that require more careful adaptation. FAO used this information to prepare a document to guide GWP's country-level partners who carry out the standard questionnaire translation procedure.[10] Gallup employs multiple independent professional translators to develop versions of the questionnaire in the major conversational languages and dialects of each country. Translations are checked by independent back-translation to the source language. This same approach is used by Gallup for translation of the FIES-SM. In a few cases where VoH had contact with local experts fluent in a language, translations were assessed by those experts and the GWP generally included their suggested improvements in the final questionnaire.[11]

The GWP samples are intended to be nationally representative of the male and female resident population aged **15 years and older** in each country. Sample sizes of 1,000 are most common, although larger samples are taken for some countries such as India (3,000 individuals) and China (5,000 individuals). Samples are probability based, and coverage includes both rural and urban areas. The entire country is included except in exceptional cases where safety is a concern or travel to a remote area is exceedingly difficult. [12]

Surveys in much of Latin America, Africa, Asia, Eastern and Central Europe and the former Soviet Republics are administered through face-to-face interviews. Only in medium and high-income countries with at least 80 percent telephone coverage are surveys conducted by telephone.[13]

[9] The GWP is not an ideal vehicle for our purpose, but at present, there is no better option. The project is also promoting and providing technical support for inclusion of the FIES in national Governmental surveys. As data from those surveys become available, reliance on the GWP will decline. Moreover, the purpose of the VoH project is to estimate national level prevalence rates of food insecurity. For this goal, the sample size may be adequate. However, caution is needed when disaggregating at subnational level.

[10] See: http://www.fao.org/3/a-be898e.pdf.

[11] Translations of the FIES-SM in all languages used by the GWP are available through the VoH website.

[12] The GWP methodology documentation can be found at: http://www.gallup.com/poll/105226/world-poll-methodology.aspx.

[13] The threshold of 80 percent for telephone coverage may not be adequate for some countries, and would need to be higher to ensure adequate representativeness of the adult population. Unfortunately, VoH project is a minor part of the GWP and has no ability to set this parameter differently. Its effect is partially mitigated by the post-stratification weighting of the sample to national control totals, which typically include educational attainment as well as age, sex and other standard demographic information.

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For face-to-face interview countries, the first stage of **sampling** involves the identification of 100-135 sampling units (clusters of households). These clusters are stratified by population size or geographic units. The second stage of sampling involves the selection of households through a random route procedure. Samples for telephone survey countries are selected using random digit dialing or a nationally representative list of phone numbers, and a dual sampling frame is used where cell phone use is high.

The **final stage** of sampling for both types of surveys is the **selection of an individual member of the household to interview**. This is done by collecting each person's birthday and using a Kish grid to identify the eligible individual to be interviewed. In certain cultural contexts where gender matching of interviewer and respondent is necessary, the person to interview is selected from among the eligible men or women of the household. Usually three attempts are made to interview the selected individual in the selected household. If the interview cannot be completed, a formal substitution method is followed to identify another household (but not a different adult within the originally selected household, because of concern that this would bias results by under-representing working adults).

Interviewers complete extensive training sessions with qualified trainers using Gallup's standardized manual. They are trained to follow the sample selection protocol and rules for conducting interviews. Following data collection, the data are reviewed for quality and consistency. Household size and oversamples are accounted for by base **sampling weights**. Post-stratification weights are provided to allow projection of results to the national population. Where adequate population statistics are available, post-stratification weights are adjusted so that survey sample totals match as close as possible national totals for gender, age, education and socioeconomic status.

4. Analyzing FIES data with the Rasch model

The protocol for the analysis of each country dataset.

As described in section 1 above, the Rasch model provides the theoretical basis to link the data obtained through the FIES survey module to a proper measure of food insecurity severity. Close adherence of the data to the assumptions of the Rasch model is a precondition for establishing **validity and reliability** of the measures obtained with the FIES.[14] The first phase in the analytic protocol is thus aimed at assessing the quality of each country's data (particularly in terms of how closely they reflect the assumptions for valid measurement of a **unidimensional latent trait** embedded in the single parameter logistic model) while at the same time, estimating item and respondent parameters for that country. This process is carried out separately for each country based on that country's data only, and consists of the steps described below.

Dealing with missing responses

Cases with any missing responses are excluded from the analysis. The proportion of cases with missing responses to any of the eight items is calculated along with the proportion of missing responses to each item (for respondents with any valid responses). A disproportionately high number of missing responses can indicate questions that are difficult to understand or answer or that are too sensitive.

Estimating item severity parameters

Using the single-parameter logistic IRT (Rasch) model, item severity parameters are estimated from the responses to the eight dichotomous FIES items using conditional maximum likelihood (CML) methods implemented in R[15], an open-source statistical software. The alternative estimation methods based on marginal maximum likelihood (MML) produces essentially identical item parameter estimates in all countries, as do joint maximum likelihood (JML) methods if the JML estimates are adjusted for their known bias toward over-dispersion of item parameters.

Open-access software is used to facilitate transfer of the basic scale assessment technology to national statistical agencies that may lack resources for commercial software or are legally required to use open-access software.

The model-fitting program was written expressly for this particular application because existing R functions for this purpose have limitations (such as not accepting sampling weights, not assessing conditional independence of items and not producing some of the needed fit statistics). The **VoH R program** for weighted Rasch model estimation was tested on simulated Rasch-consistent data and the output compared with that of other commercial and open source available software to ensure integrity. [16]

The sample used to estimate the parameters of the measurement model is limited to the cases where the eight responses are not all "yes" or all "no". Obviously, all complete responses (including those with raw score 0 and raw score 8) are used to estimate prevalence rates.

Estimating respondent parameters

Given estimated item parameters, respondent (person) parameters and associated errors (i.e. the extent of uncertainty around the parameter estimate) are obtained for each raw score as the

[14] The processes described in this section are essential for establishing the internal validity of an experience-based measure when it is first introduced into a language or culture. Once validity has been established in a sufficiently large and diverse sample, further administrations of the same module in that population will not generally require such extensive validation and can use parameters calculated from the original validation survey.
[15] See http://www.r-project.org/
[16] The VoH R software is freely available from VoH upon request by writing to Voices-of-the-Hungry@fao.org.

maximum likelihood estimates.[17] The CML procedure cannot yield an estimate for extreme raw scores of 0 or 8.[18] To classify cases with such **extreme values of the raw score**, an ad hoc procedure is required.[19] For the VoH global assessment, respondents with **raw score zero are assumed to be food secure** with no measurement error. This assumption is unlikely to introduce any bias in the published classifications since any reasonable severity parameter associated with raw score zero is far below the threshold set for moderate food insecurity. The probability that a case reporting raw score zero might belong to that class is negligible.

The treatment of cases with the maximum raw score of 8 is more problematic. This is important because an appropriate threshold for estimating the national prevalence rates of severe food insecurity will be set at quite a high level. This means that a substantial proportion of cases with raw score 8 are likely to be less severe than that threshold under any reasonable assumption regarding the distribution of the latent trait in the population. To avoid overestimating the prevalence of severe food insecurity, as would be the case if all respondent with raw score 8 were assigned to that class, **we assign to raw score 8 a parameter based on pseudo raw scores** between 7.5 and 7.7. The exact value used for each country is higher the higher the proportion of cases with raw score 8, implying that the distribution of true severity of respondents with raw score 8 is assumed to be located more towards the severe end of the scale when there is a larger proportion of cases with that extreme raw score.[20]

Testing Rasch model assumptions

The Rasch model assumption of equal discrimination is assessed by examining standardized item *infit* statistics. These statistics have quite large sampling errors for sample sizes typical in the GWP data. These errors are taken into account and *infit* statistics in the range of 0.8 to 1.2 are considered excellent. Those in the range of 0.7 to 1.3 are considered to be acceptable. Those higher than 1.3 are flagged for investigation to assess the need for improved translation, especially if the high *infit* is observed again in the following year. To date, **no *infit* values have been observed so high as to justify omitting the item from the scale in any country**.[21] (See Table 7-2). Item *outfit* statistics are also examined to identify items with unusual occurrence of highly erratic responses (see Box 1 and Nord 2014 for further specifics). No specific criteria are set, but items

[17] Under the Rasch model's assumptions, the raw score is a sufficient statistic for respondents' parameters (see the discussion in section 1 above). The respondent parameter for each raw score can be easily computed from the so-called test characteristic curve, which is the function expressing the expected raw score as a function of the respondent severity level, and which depends only on the item severity parameters. The severity associated with each raw score is then simply the value of severity corresponding to the point where the test characteristic curve crosses the integer values from 1 to 7. The measurement error is the square root of the inverse of the derivative of the test characteristic curve at that point. (That derivative is the Fischer information function.)

[18] The reason why no severity level can be associated with extreme raw scores of 0 or 8 can be intuitively appreciated by considering that any respondent with low enough severity would be expected to deny all items, and any respondent with high enough severity would affirm all of them. Given a finite number of items, a scale can only measure severity over a certain range, defined by the severity associated with the items included in the scale.

[19] The issue of estimating parameters and margins of errors for zero and maximum raw scores has not been explored much in previous statistical work on experience-based food security measurement. All countries that regularly use these methods categorize the severity of food insecurity discretely based on raw score. Cases with raw score zero are usually classified as "food secure", while those with maximum row score as "severely food insecure".

[20] This method is based on reasonable assumptions but not on strong statistical theory. When the survey module for use with the 2014 GWP was defined, the occurrence of large proportions of cases in raw score 8 was not anticipated, assuming that the more severe item would capture a severe enough situation to be rare in most countries. Instead, frequencies of raw score 8 over 40 percent have been observed in a few countries, which calls for the need to carefully consider the possible distribution of severity for these cases (the reader should note however that this high proportion reflects the reference period of 12 months). Methods to enable the FIES-SM to more adequately represent the severe end of the severity scales are being explored, either by adding more severe questions (or follow-up questions about how often the more severe conditions occurred) to the module or by using marginal maximum likelihood methods to estimate the measurement model. So far, limited application of each of these alternative methods has resulted in estimates of severe food insecurity that do not differ greatly from those based on the interim method using pseudo raw scores. Follow-ups to the two most severe questions, asking how often the condition occurred were included in surveys in several countries in 2014 and will be added in all low-income countries in 2015.

[21] As a further check on the Rasch-model assumption of equal discrimination, a 2-parameter logistic model (allowing for differing discrimination of items) was estimated for several countries using marginal maximum likelihood methods implemented in R. Differences due to violation of the assumption of equal discrimination were not substantial.

Box 1

***Infit* and *outfit* statistics**

The *infit* and *outfit* statistics assess the "performance" of the items included in the scale; that is, the strength and consistency of the association of each item with the underlying latent trait. These are obtained by comparing the way in which the observed patterns of responses compare to the ones that would be expected under the truth of the measurement model.

One of the Rasch model assumptions is that all items discriminate equally, which means that, ideally, all *infit* statistics would be 1.0. *Infit* values in the range of 0.7-1.3 are generally considered to meet the model assumption of equal discrimination to an acceptable degree. *Infit* statistics in the range 1.3 to 1.5 identify items that can still be used for measurement, but attention to possible improvement of such item may be worthwhile. Values larger than 1.5 indicate items that should not be used for scoring, as they may induce considerable biases in the measure.

On the opposite side, items with *infit* statistics lower than 0.8 can still be used for measurement, although such low values of residuals will imply that the particular item will be somewhat undervalued in its contribution to the overall measure. Similar standards may be applied to item *outfit* statistics, but in practice, *outfit* statistics are very sensitive to a few highly unexpected observations. As few as two or three highly unexpected responses (i.e. denials of the least severe items by households that affirm the most severe ones) among several thousand households can elevate the outfit for that item to 10 or 20. Carefully interpreted, outfit statistics may help identify items that present cognitive problems or have idiosyncratic meanings for small subpopulations.

with unusually high *outfit* statistics are flagged for possible improvement of translation.

To check whether subsets of items measure additional latent phenomena other than food insecurity, the assumption of conditional independence of the items is assessed by calculating conditional correlations[22] among each pair of items and submitting the correlation matrix to principal components factor analysis. The correlation matrix is examined to identify any strong correlations among pairs of items. Factor eigenvalues and item loadings from the factor analysis of conditional correlations are examined to identify the presence of any strong second dimensions in the data.

Finally, **overall model fit** is assessed by Rasch reliability statistics—the proportion of total variation in true severity in the sample that is accounted for by the model.[23] Two Rasch reliability statistics are calculated. The standard Rasch reliability statistic weights components in each raw score by the number of cases with that raw score, and it is therefore sensitive to the distribution of cases across raw scores. For this reason, also a "Flat" Rasch reliability is calculated, based on the assumption of an equal number of cases in each non-extreme raw score class. This statistic provides a more comparable measure of model fit across countries with sizable differences in prevalence rates of food insecurity.

[22] Expected correlations among items are calculated under Rasch model assumptions given the item parameters, probabilities of each response pattern within each raw score and the distribution of cases across raw scores. Residual correlations are then calculated as partial correlations given the observed and expected correlations.

[23] Model variation is the sum of squares of difference of each raw score parameter from the average. Error variation is the sum of squared measurement error across raw scores. Total variation is the sum of model variation and error variation. Rasch reliability is not technically a measure of model fit, but for scales comprising the same items it is highly correlated with model fit across data sets and provides a readily accessible statistic for comparing model fit.

5. Developing the FIES global standard scale

The bridge by which prevalence rates are compared across countries.

Application of the Rasch model on a single country dataset produces estimates of parameters on a scale that is, to some extent, arbitrary and idiosyncratic to that country.[24] Before comparing measures obtained in two different countries, it will be necessary to calibrate the two scales on a **common metric**. The calibration of two scales on the same metric is obtained formally by equating the mean and the standard deviation of the set of items that are common to the two scales, allowing for the possibility that each scale may also have a number of additional items contributing to the measure that are unique to that scale.

To obtain prevalence rates that are comparable across the large number of countries covered by the VoH project, we define the **FIES global standard** scale as a set of item parameters based on the results from application of the FIES-SM in all countries covered by the GWP survey in 2014. By calibrating each country's scale against the FIES global standard, the respondent severity parameters obtained in each country are effectively adjusted to a common metric, thus allowing the production of **comparable measures of severity** for respondents in all countries as well as **comparable national prevalence rates** at specified thresholds of severity.

One challenge in defining the global scale and in adjusting each country's scale to the global standard is that in any given country, one or more items may differ in severity from the severity level associated with the same item in most other countries. In other words, even if in principle each single item is intended to represent the same experience of food insecurity everywhere, the **severity of that item relative to that of the others may differ** in a country for several reasons. Translation may not be accurate, so that the question is understood by respondents to refer to a somewhat different set of objective conditions in one country compared to another. In other cases, the relationships between specific objective conditions and the latent trait of food insecurity may differ somewhat in one country compared with others due to differences in culture, livelihood arrangements or management of food scarcity.

Identifying **items that are "unique"** to a country (that is, whose relative position in the scale differs from what it has on the global standard) is important, as they should neither be used to define the FIES global standard nor to adjust the country's scale to it. Unique items remain in the scale for that country, however, contributing to the measure of person parameters.

We have taken into account differences in item severity across countries both in the development of the global standard and in the process of adjusting each country's scale to the standard. The FIES global standard is developed through an iterative process, programmed in R, with the following steps.[25]

[24] Recall that with N items in a scale, only N-1 item parameters can be separately identified. Our Rasch model-fitting software estimates the scale for each country on a logistic metric with mean item parameter arbitrarily set at zero. Moreover, average discrimination of the items will differ across countries, reflecting primarily differences in statistical noise in the scales, with the consequence that items may be spaced differently around zero on the severity scale in different countries.

[25] One reviewer suggested an alternative procedure to define the global reference scale consisting of estimating the Rasch model on the pooled sample of data from all countries. That procedure produces a global standard that is nearly equivalent to the one we obtain with the algorithm described in this report. The small differences between the results of the two methods are due to the specification in the VoH method of some items in some countries as unique and the omission of those items from the calculation of the global standard. This process is statistically superior to the simple pooled estimation.

1. Item parameters are estimated separately in each country using CML, as described in section 4 above.
2. Each item parameter is multiplied by the inverse of the standard deviation of the item parameters estimated for that country. This results in normalized parameters with mean of zero and a standard deviation of one for each country.[26]
3. An interim global standard parameter for each item is calculated as the median normalized parameter for that item across all countries.
4. For each country, items differing from the interim global standard by more than a specified critical value are declared unique to that country.[27]
5. Each country's parameters are readjusted to the interim global standard by equating the mean and standard deviation of common (i.e. non-unique) items in the country scale to the mean and standard deviation of the corresponding items in the interim global standard.
6. The interim global standard parameter for each item is recalculated as the median across countries of the adjusted parameter for that item, omitting the parameter for items identified as unique.
7. The critical value for identifying items as unique is reduced by a small increment, and iteration continues with steps 3-6 until a specified minimum critical value is reached. The minimum critical value currently specified is 0.3, which corresponds to about 0.5 logistic units on the average scale.
8. The final global standard is then adjusted by a linear transformation in order that item parameters have a mean of zero and standard deviation of one.

Although this procedure worked satisfactorily in most cases, a few situations required special handling:

- If an item parameter in a country is based on fewer than 10 affirmative responses, that item is always identified as unique and is not used to calculate the global standard. This occurs for severe items in countries that are highly food secure. The reason for excluding items with very few affirmative responses is the concern that, due to lack of statistical consistency, the parameter estimate may be unstable.
- If more than three items are identified as unique in a country, data from that country are not used to calculate the global standard. This occurs in relatively few countries, as detailed in Section 7 of this report.
- If data from a country appear to be problematic in the assessments described in Section 4 or are based on a very small sample of non-extreme cases (as may occur in some very food secure countries), data from that country may be omitted entirely from calculation of the global standard.

[26] We chose a standard deviation of one for convenience. Notice that rescaling is only done at this stage to identify items that are unique in a country and to define the global standard. The differences in discrimination across countries are taken into account later when respondent parameters are adjusted to the global standard, to preserve the actual discrimination of the scale in each country.

[27] The critical value is set at a rather large value initially, and reduced in successive iterations as described in step 6, until reaching a minimum critical value.

6. Computing comparable prevalence rates

Adjusting each country's scale to the global standard and calculating prevalence rates of food insecurity at two levels of severity with comparable thresholds.

The scale for each country is adjusted to the global standard metric (described in Section 5) in order to derive comparable food insecurity prevalence rates. The same adjustment for each country, calculated from item parameters, is then applied to all measures of severity (including respondent parameters and measurement errors). This allows setting thresholds and obtaining estimates of **prevalence rates and margins of errors that are comparable across countries**. The adjustment consists of a simple linear transformation, calculated so that the mean and standard deviation of the parameters of items identified as "common" for a country (i.e. omitting items identified as unique to that country) equal the mean and standard deviation of the parameters for the corresponding items in the global standard. For most countries, the set of items considered to be common is identical to the set identified as common in the development of the global standard (see Section 5).

This process of **equating scales**, that is, of making their adjusted severity parameters comparable, does not require items identified as common to have exactly the same severity as their corresponding items on the global standard scale. Rather, it constrains only the mean and standard deviation of the set of common items to be equal to their counterparts on the global standard while preserving the *relative* severity of all items, common and unique, as seen in the original scale for the country. The multiplicative constant in the linear transformation is also applied to the measurement error (see below) for each raw score, so that differences across countries in average discrimination of items (i.e. overall model fit) are taken into account in calculation of prevalence rates.

Approximate comparability of prevalence rates across countries could be achieved by **assigning food security status discretely** based on raw score. In this case, the specific **raw-score thresholds** defining each range would differ as necessary from country to country to more closely represent the same level of severity of the adjusted respondent parameters for each raw score. As a result, for example, in one country respondents with raw score 4 and higher might be classified as having moderate or severe food insecurity while in another country, those with raw scores 3 and higher might be so classified. Such comparisons would be inevitably biased one way or another between most pairs of countries, because discrete raw-score-based thresholds are rarely exactly equivalent across countries.[28]

To overcome this problem, the VoH project uses a **more precise method** to calculate comparable food insecurity prevalence rates that takes into account estimated measurement error (i.e. the extent of uncertainty) around the parameter estimate associated with each raw score. (See chapter 5 of Nord, 2012 for a detailed description of this methodology.) The procedure entails the steps described below.

1. For each country, the distribution of true severity of respondents at each raw score is assumed to be normal (Gaussian) with a mean

[28] Within countries, however, discrete assignment of food security status by raw score is the norm. This method is used in all countries with established periodic assessment of food security using experience-based measurement scales. Even within countries, the mapping of raw scores to respondent parameters may differ among some subpopulations. In most cases, however, probabilistic assignment of food security status as described here may be used to assess the extent of possible biases in prevalence comparisons among subpopulations. The advantages of discrete raw score-based assignment of food security status in terms of transparency and ease of explanation to the public and to policy officials have made it the preferred method for within-country classification.

equal to the adjusted respondent parameter for that raw score and standard deviation equal to the adjusted measurement error for that raw score (see Figure 6-1). These distributions are used to compute the probability that respondents in each class of raw score are beyond a certain level of severity.

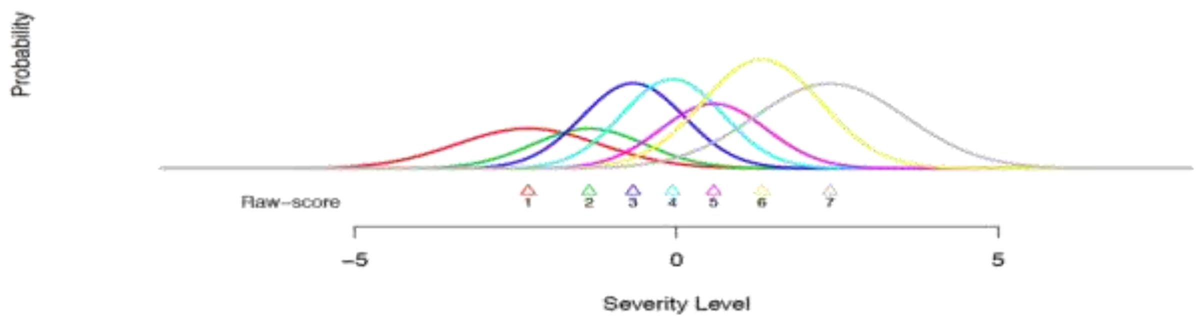
2. The proportion of the adult population (15 years and older) with severity beyond any specified threshold can then be calculated as the weighted sum across raw scores of the proportion of the distribution for each raw score that exceeds the specified threshold. The weights for this summation are the estimated population shares in each raw score.

In principle, a prevalence rate can be calculated for any specified threshold. The VoH project sets thresholds to estimate two prevalence rates: the *Prevalence of Experienced Food Insecurity at moderate or severe levels* (**$FI_{mod+sev}$**) and *Prevalence of Experienced Food Insecurity at severe levels* (**FI_{sev}**), using two appropriately selected thresholds.

The lower threshold is specified at the level of severity associated with the item "Ate less than should" in the global reference scale (at about -0.3 units), while the higher threshold is specified at the severity level of the item "Did not eat for a whole day" (a value of about 2.0 on the global reference scale).[29] These, like any other specific thresholds, are somewhat arbitrary. They were specified by VoH with the objective of providing **useful and meaningful** prevalence statistics for monitoring food security over time in countries ranging from highly food secure to highly food insecure.[30]

Figure 6-1

Estimated distributions of true severity among respondents with each raw score



Note. In this example, the total area under each raw-score curve is proportional to the population share represented by that raw score.

[29] The "moderate" category by itself is not very useful for comparing across countries or over time in the same country because, for example, a smaller or reduced prevalence could indicate either improved food security (if the change was to a larger proportion food secure) or worse food security (if the change was to a larger proportion of severely food insecure). Moreover, the use of the category "moderate-or-severe" is standard practice for other global indicators. For example, with anthropometry, the two main indicators of malnutrition are "moderate-severe malnutrition (wasting, stunting, or underweight) and "severe malnutrition". Another example is overnutrition: overweight plus obesity corresponds to a BMI of 25 or above and obesity corresponds to a BMI of 30 or above.

[30] Thresholds to define food insecurity have been set to reflect the very broad definition of food security cited at the beginning of the

Countries that use experience-based measurement scales in national surveys for monitoring food security are encouraged to specify thresholds appropriately linked to descriptive labels that are meaningful within the public dialogue of the country. If those thresholds differ from the VoH thresholds, however, it is then important to keep those differences in mind when comparing to VoH prevalence rates. National classification systems may also be applied to the country-specific GWP data for comparison and research purposes.

$FI_{mod+sev}$ and FI_{sev} as estimated from GWP data are representative of the national population because sampling weights are included in their calculation. Confidence intervals around these mean estimates are calculated taking into account sampling and measurement error. The **sampling error** is obtained using the complex survey design information. The procedure varies depending on the type of interview and entails Taylor series linearization estimation. In face-to-face interviews, the geographical stratification variable and population clusters within strata (primary sampling units or PSUs) are included. In the case of telephone interviews, only the stratification variable is used, as there are no PSUs.

The extent of **uncertainty** around the measure (i.e. measurement error) is calculated considering that within each raw score, the variance in the proportion with true severity beyond a set threshold is given by $p(1-p)/n$, where p is the proportion estimated by the method used to estimate prevalence and n is the number of unweighted cases in the considered raw score. These variances are then summed across raw scores and weighted by the square of the respective share, i.e. the proportion of weighted cases in the raw score.[31]

Because sampling and measurement errors are considered independent, they are combined to obtain the **global prevalence standard error** as follows:

$$SE_{tot}=\sqrt{(\text{Sampling Error})^2+(\text{Measurement Error})^2}$$

As future years of data collection become available, the VoH project's tentative plan is to estimate item parameters and adjustment-to-global-standard parameters based on the first three years of data collection and then fix those parameters for subsequent years. This will require revising the first two years' prevalence estimates when data from a third year will be in hand, but will result in reasonably stable inter-country comparability and, more importantly, good **time-trend comparability** within countries.

paper (food security at all times, for all people). Consequently, food insecurity prevalence rates may look particularly high for some counties. In interpreting these thresholds it may be worth recalling that they are based on items that ask whether the experiences have occurred even just once over the reference period.

[31] The intuitive explanation for multiplying by the square of the share is that multiplying by share converts variance as a ratio to proportion of sample in the raw score, into variance as a ratio to the total sample; multiplying by share again provides weights for the weighted sum across raw scores.

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7. Results to date: data quality

Consistency of the data collected through the 2014 round of the GWP in 146 countries, areas or territories with assumptions of the Rasch measurement model.

This section summarizes findings on data quality and consistency with assumptions of the Rasch measurement model and presents the results obtained from the 146 datasets collected in the 2014 round of the GWP.

Missing Responses

Table 7-1 summarizes the data on missing responses. Missing responses were relatively rare in most cases: 127 datasets had 5 percent or fewer cases with missing responses to any of the eight FIES-SM questions and among those, 48 had fewer than 1 percent such cases. The mean frequency of missing responses across all countries was 2.7 percent (data not shown). In only six datasets, more than 10 percent of cases had one or more missing responses: the highest frequency was 17.7 percent.[32]

No single item stood out as having consistently higher proportions of missing responses and this was true even in the four countries with the highest share of missing responses (analysis not shown). All cases with any missing responses were omitted from the computation of prevalence rates.[33]

Item *Infit* Statistics

In spite of the wide range of cultures and languages in which the FIES-SM was administered and the attendant challenges of translation, the **fit of all the items to the measurement model was remarkably good**. *Infit* statistics for each item were between 0.8 and 1.2 in a large majority of countries (80 percent), and between 0.7 and 1.3 in 93 percent of countries for all items. (Table 7-2). The highest mean *infit* (1.15) was for the

Table 7-1

Summary of missing responses to food security questions in the first 146 datasets for which 2014 GWP data were available

Characteristic and range	Number of datasets	Percent of datasets
Cases with any missing responses:		
<1%	48	33
1% to 5%	79	54
>5%	19	13
Cases with no valid responses:		
0	78	53
>0 to 1%	61	42
>1%	7	5

32 Possible causes of the relatively high proportion of missing responses in these datasets will be explored separately.

33 Cases with any missing response could not have raw score 8 and those with two or more missing responses could not have raw score 7. It is almost certain, therefore, that including cases with missing responses in the prevalence estimates would bias the estimated prevalence of severe food insecurity downward, unless an appropriate treatment is made of missing responses. The distribution across raw scores of cases with missing responses indicated that they were somewhat more likely to have raw scores 1 to 3 and less likely to have raw score 0 than cases with no missing responses.

Table 7-2

Summary of item *infit* statistics for 136 datasets in the 2014 GWP[1]					
Item[2]	*Infit* 0.8 to 1.2 (% of cases)	*Infit* 0.7 to 1.3 (% of cases)[3]	Mean *infit*	Minimum *infit*	Maximum *infit*
WORRIED	80	93	1.11	0.82	1.49
HEALTHY	89	96	1.02	0.67	1.53
FEWFOODS	88	98	0.96	0.63	1.55
SKIPPED	85	96	0.92	0.61	1.58
ATELESS	79	95	0.89	0.53	1.29
RANOUT	80	98	0.91	0.59	1.34
HUNGRY	66	91	0.87	0.47	1.40
WHLDAY	73	87	1.15	0.75	1.90

Notes:
1 Data were available for an additional 10 datasets for which samples with complete and non-extreme responses included less than 100 cases, too small to provide reliable fit statistics.
2 See Table 2-1 in this report for the complete wording of the questions, which referred to a 12-month recall period and specified that the behavior or experience occurred because of a lack of money or other resources.
3 Includes those with *infit* between 0.8 and 1.2.

item *Did not eat whole day*. The highest *infits* for five of the eight items exceeded 1.4. However, only seven countries had any item with an *infit* higher than 1.4, and with one exception, those were countries with small number of non-extreme cases. We see no reason for particular concern at this point. If high *infits* are observed for the same items in the same countries in data collected the following year, larger combined samples will enable further exploration of possible causes. The lowest mean *infits* were for *Hungry but did not eat* (0.87) and *Ate less than should* (0.89). Those items also had the largest proportions of *infits* lower than 0.7 (6 percent in each case, results not shown). These low *infit* statistics imply

Table 7-3

Summary of item *outfit* statistics for 136 datasets in the 2014 GWP[1]				
Item[2]	*Outfit* < 2.0 (%. of cases)	Mean *outfit*	Minimum *outfit*	Maximum *outfit*
WORRIED	82%	1.52	0.70	4.81
HEALTHY	84%	1.46	0.48	12.02
FEWFOODS	87%	1.23	0.36	5.07
SKIPPED	92%	0.91	0.24	3.22
ATELESS	92%	0.86	0.23	3.94
RANOUT	91%	0.90	0.14	2.25
HUNGRY	90%	0.86	0.07	3.70
WHLDAY	69%	2.22	0.02	16.25

Notes:
1 Data were available for an additional 10 datasets for which samples with complete and non-extreme responses included less than 100 cases, too small to provide reliable fit statistics.
2 See Table 2-1 in this report for the complete wording of the questions, which referred to a 12-month recall period and specified that the behavior or experience occurred because of a lack of money or other resources.

Table 7-4

Mean residual correlations between items (136 datasets from the 2014 GWP)[1]							
Item[2]	HEALTHY	FEWFOODS	SKIPPED	ATELESS	RANOUT	HUNGRY	WHLDAY
WORRIED	0.04	-0.01	-0.08	-0.03	-0.04	-0.08	-0.16
HEALTHY	-	0.16	-0.06	-0.03	-0.06	-0.08	-0.16
FEWFOODS	-	-	-0.02	0.07	-0.03	-0.06	-0.16
SKIPPED	-	-	-	0.15	0.08	0.15	-0.03
ATELESS	-	-	-	-	0.09	0.10	-0.08
RANOUT	-	-	-	-	-	0.17	0.00
HUNGRY	-	-	-	-	-	-	0.10

Notes:
[1] Data were available for an additional 10 datasets, but samples with complete and non-extreme responses were too small for reliable correlation calculations (N<100).
[2] The complete wording of the questions specified a 12-month recall period and specified that the behavior or experience occurred because of a lack of money or other resources (see Section 2 of this report)

that the **items were most consistently associated with the latent trait** measured by all of the items. Although these items may be slightly undervalued in the equally weighted Rasch measure, their higher discrimination is not so great as to be substantially distorting, and it may be considered encouraging, given their cognitive content, that they are indeed the items most strongly associated with the latent trait of food insecurity.

Item *Outfit* Statistics

Outfit statistics are sensitive to even a few cases with highly improbable response patterns. They are useful primarily for identifying items that may be inconsistently understood by a small proportion of respondents, but may also reflect just one or two careless responses or recordings by the interviewer.

The most severe item, *Did not eat whole day*, had the highest mean *outfit* (2.22), the highest proportion of countries with *outfit* greater than 2.0 (31 percent) and the highest single *outfit* (16.25). (Table 7-3). A high *outfit* for this most severe item reflects affirmation of the item by a few respondents who denied many or most other less severe items. The highest *outfit* of 16.25 was one of only four *outfits* higher than 5.0 for any country (analysis not shown). The causes of the high *outfits* in these countries bear investigation in the 2014 data and follow-up observation in the 2015 data. Overall, the ***outfit* statistics** computed for the 2014 application of the FIES with the GWP **do not indicate substantial model misfit** or distortion of severity estimates for respondents to warrant any change in the estimation procedure.

Model Fit—Rasch Reliability

Mean Rasch reliability[34] was 0.740 (analysis not shown). Reliability was between 0.70 and 0.80 for 79 percent of countries. These levels of reliability for a scale comprising just eight items reflect reasonably **good model fit**. Simulation analyses (not shown) suggest that measurement error implied by these levels of reliability introduce errors in national prevalence estimates that are substantially smaller than sampling errors.

[34] These statistics are for "flat" Rasch reliability, that is, calculated giving equal weight to each non-extreme raw score rather than weighting by the proportion of cases in each raw score as in the standard statistic.
The "flat" statistic is more comparable across countries because it is not sensitive to the distribution of cases across raw scores, which may differ from country to country. See section 4 above.

The lowest Rasch reliability was 0.676 and the highest was 0.847.[35]

Conditional Independence of Items

Residual correlations were not found to be excessive for any pairs of items in countries with sufficient sample size of non-extreme cases to produce reliable assessments. (Table 7-4) There was an initial concern that the two diet quality items (*Unable to eat healthy nutritious food* and *Ate only a few kids of foods*) might be somehow redundant, tapping into the same behavior. However, the residual correlations for this pair of items were not unusually high in general (Table 7-4). The mean residual correlation for the pair was small (0.16) and the highest was 0.5 (not shown).

In a number of datasets, **factor analysis of the residual correlation matrix** suggested a weak second dimension in the response data characterized by the diet quality versus food intake quantity items. These sets of items represent theoretically distinct domains. This pattern is also seen in the mean residual correlations, which tend to be negative among items in different domains and positive among items in the same domain. However, the pattern in the mean correlations is quite weak, and the scree plots in the factor analyses and eigenvalues of the first factor also indicate that the second dimension in the data is not strong enough to substantially distort measurement in any country. Although the domains may represent distinct dimensions, they are, apparently very nearly collinear.

Three dataset-item pairs had residual correlations larger than 0.50, but none exceeded 0.60 (analysis not shown). The largest residual correlations were seen between *Unable to eat healthy nutritious food* and *Ate only a few kinds of foods* (0.54) and between *Skipped meal* and *Hungry but didn't eat* (0.57). Almost all of these are from countries with small non-extreme samples (i.e. highly food secure) and are, therefore, not very reliable. For these countries, additional years of data will be needed to verify whether any conditional correlations are high enough to require re-examination of translations.

Results of the equating procedure

Based on the procedure described in section 5, standardized measures of severity associated with each item have been obtained for 146 countries. These values are distributed as in Figure 7-1. Using the median value of the distribution of standardized severity for each item, VoH defined the provisional FIES global standard represented in Figure 7-2.

Items are considered common when their severity in a country differs from the one on the global standard by less than 0.35 units on the global reference scale. In 93 percent of the countries, **a set of at least 5 common items** was identified, thus allowing a robust equating procedure to be carried out. For the few cases for which it was not possible to identify at least 5 common items, the analysis was conducted on a case-by-case basis. We compared the rates of prevalence that would be obtained with alternative sets of items for equating, even if one or two of the items considered in the equating differed from the global standard by more than the set tolerance. For these countries, prevalence rates were considered valid only if the choice of alternative possible combinations of items for equating generated essentially the same prevalence rates.

No acceptable solution to the equating problem was found for only 3 datasets (from Azerbaijan, China mainland, and Bhutan). In those cases, prevalence rates were computed by associating to each of the items the severity they have in the FIES global standard. These estimates should thus be considered provisional, pending revision once additional data from these countries will become available and research will reveal possible ways to improve adaptation of the questionnaire.

[35] For cases with the lowest reliabilities, possible causes, such as differential item function across language groups or other identifiable subpopulations (such as rural-urban or by educational attainment), will be investigated. Improvements might be obtained by increasing the attention to accuracy and nuances of translation.

Figure 7-1

Distributions of standardized values of item severity across 146 datasets.

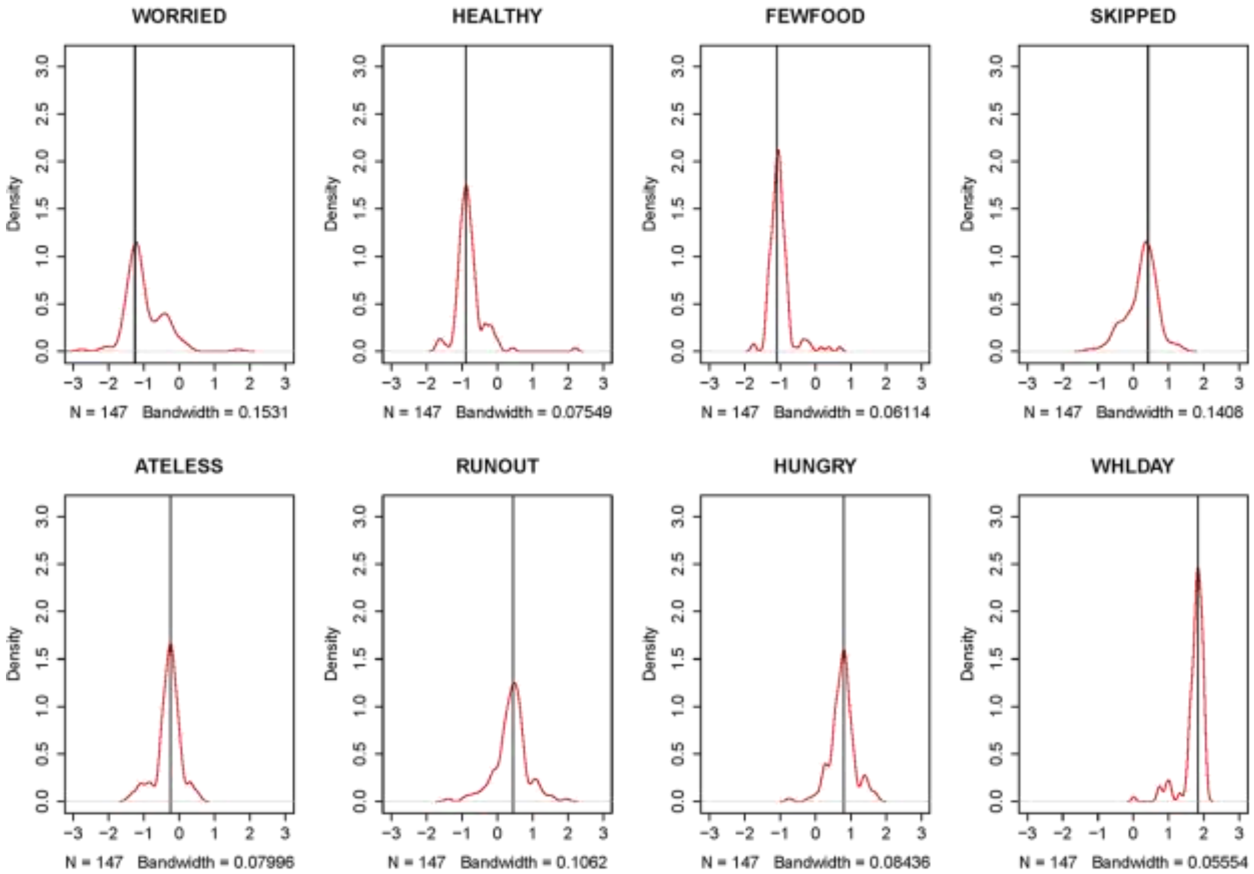
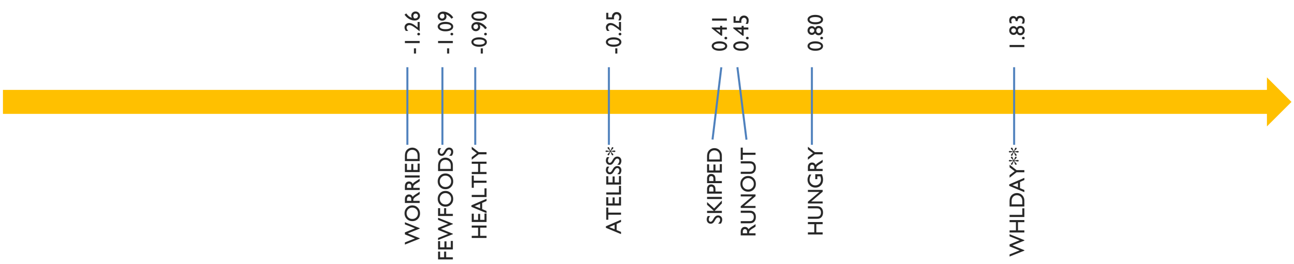


Figure 7-2

The FIES global standard



* Provisionally set as the threshold for moderate or severe food insecurity

** Provisionally set as the threshold for severe food insecurity

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8. Results to date: prevalence rates

Estimated prevalence of food insecurity in the adult populations.

Given the overall positive results on adherence of the data collected to the conditions for valid measurement through the Rasch model, the percentages of individuals that have experienced moderate-or-severe food insecurity ($FI_{mod+sev}$) and that have experienced severe food insecurity (FI_{sev}) in 2014 was estimated following the procedure described in section 6 above in each of the datasets analyzed. Table A-I in the Appendix presents the results for the 146 countries, areas or territories covered by the GWP in 2014.[36]

Before experience-based measures of food insecurity could be properly tested across different countries, languages, cultures and livelihood conditions, the fear arose that they would capture people's subjective perceptions of their condition relative to the food security situation of those around them. This led to a concern that these measures might not yield comparable results, as they would reveal similar prevalence rates of food insecurity irrespective of the actual situation.

Table 8 - 1 shows, instead, the very **broad variation of estimated food insecurity** across the populations covered by 143 datasets, with values of $FI_{mod+sev}$ varying from a minimum of 2.97 percent to a maximum of 92.25 percent, and those for FI_{sev} from values less than 0.5 percent[37] to 76.24 percent. Median values across the datasets are 19.66 percent for $FI_{mod+sev}$ and 5.67 percent for FI_{sev}.

The data in Table 8-2 show how countries and territories are distributed across classes of food insecurity prevalence. Twenty-eight of the 146 datasets analyzed (19 percent), reveal that more than half the represented population likely experienced moderate or severe food insecurity in 2014, a disturbing result. The incidence of food insecurity was found to be quite small ($FI_{mod+sev} < 5$ percent) for the populations represented by 10 of the 146 datasets. In terms of the most severe condition, prevalence rates are quite high in 30 countries, areas or territories ($FI_{sev} > 20$ percent) and very small in 22 others ($FI_{sev} < 1$ percent).

Preliminary analysis of correlations between estimated prevalence rates and other indicators.

One way to validate the results presented thus far would be to situate the estimated values of $FI_{mod+sev}$ and FI_{sev} in the broader context of the assessment of **human development**. Toward this end, preliminary values of VoH indicators for 143 countries have been analyzed in comparison with a number of major development indicators.[38]

Table 8-1

Descriptive statistics of the food insecurity prevalence rates (143 datasets in 2014)[1]

Food insecurity class	Minimum	Median	Maximum
Moderate or severe ($FI_{mod+sev}$)	2.97%	19.66%	92.25%
Severe (FI_{sev})	< 0.5%	5.67%	76.24%

[1] For three datasets no acceptable solution to the equating problem was found.

[36] For countries for which recent national data from comparable food security scales where available, prevalence rates are based on national data. This includes Brazil, Guatemala, Mexico and the United States of America. See the discussion in Annex I for a comparison of these results with national assessments conducted with the same data.

[37] Half a percentage point is the lowest prevalence rate VoH reports. For sample sizes typical of the GWP, this is about the lowest level that can be meaningfully detected with tools like the FIES.

[38] The three datasets for which no acceptable equating procedure was possible have been excluded from the analysis.

Table 8-2

Distribution of countries, areas or territories for different classes of $FI_{mod+sev}$ and FI_{sev}.					
Moderate or severe ($FI_{mod+sev}$)			Severe (FI_{sev})		
Range (%)	N. of cases	% of cases	Range (%)	N. of cases	% of cases
< 5	11	7.5	< 1	22	15.1
5-14.99	50	34.2	1-4.99	48	32.9
15-24.99	24	16.4	5-9.99	22	15.1
25-50	33	22.6	10-20	24	16.4
> 50	28	19.2	> 20	30	20.5
Total	146	100.0		146	100.0

Table 8-3

Spearman's rank correlation between food insecurity indicators[1] and selected indicators of development at national level.

Indicator	Period	N	$FI_{mod+sev}$	FI_{sev}
Under-5 mortality rate	2013	137	0.833**	0.775**
Sanitation facilities (% with access)	2012	130	-0.829**	-0.757**
Human Development Index	2013	136	-0.818**	-0.737**
Adolescent fertility rate (women ages 15-19)	2012	139	0.798**	0.728**
Fertility rate	2012	140	0.795**	0.782**
Water source (% with access)	2012	133	-0.777**	-0.703**
Gross National Income per capita	2011-2013	137	-0.783**	-0.690**
Poverty headcount ratio at $1.25 a day	2010-2013	76	0.755**	0.738**
Life expectancy at birth	2013	136	-0.754**	-0.666**
Prevalence of undernourishment	2014	135	0.757**	0.695**
Youth (15-24 years) literacy rate (%)	2015	113	-0.749**	-0.728**
Adult literacy rate (%) projection	2015	113	-0.697**	-0.721**
Multidimensional Poverty Index	2009-2013	42	0.642**	0.598**
Children aged 0-59 months Stunting	2009-2013	102	0.666**	0.645**
Gender-related development index (GDI)	2013	124	-0.599**	-0.641**
Rural population (%)	2011-2013	139	0.595**	0.515**
Children aged 0-59 months Underweight	2009-2013	102	0.596**	0.600**
GINI index	2009-2013	91	0.482**	0.479**
Children aged 0-59 months Wasting	2009-2013	101	0.345**	0.377**
Children aged 0-59 months Overweight	2009-2013	90	-0.354**	-0.363**

Notes
[1] See Table A-2 in the Appendix for a description of the indicators and sources of data.
* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).
N = number of valid cases.
Periods 2009 to 2013: last value available.

Table 8-4

Regression analysis of food security and poverty indicators on child mortality rates

Response variable: Logarithm of Child Mortality Rate[1]				
	Model 1	Model 2	Model 3	Model 4
	Standardized regression coefficient (P-value H_o: coefficient = 0)			
Log-odds(PoU[2])	0.420 (< 0.001)	0.509 (< 0.001)	0.260 (< 0.001)	0.284 (< 0.001)
Log-odds($FI_{mod+sev}$)	0.499 (< 0.001)	-	0.312 (< 0.001)	-
Log-odds(FI_{sev})	-	0.409 (< 0.001)	-	0.264 (< 0.001)
Log-odds (Extreme poverty[3])	-	-	0.351 (<0.001)	0.373 (< 0.001)
Adjusted R-squared	0.741	0.716	0.769	0.759
N	135	135	103	103

Notes

(1) Child Mortality: Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age five. Last value available. Source: UNICEF, 2013

(2) PoU: Prevalence of Undernourishment. 2012-14. Source: SOFI 2014

(3) Extreme Poverty: Poverty headcount ratio at $1.25 a day (PPP) (% of population) from the World Bank (last value available in 2010-2013). When missing, it has been imputed using POVCALNET, the poverty rate calculator available from the World Bank.

Table 8-3 presents the values of Spearman's rank correlation between the two indicators of prevalence of food insecurity and a number of internationally recognized indicators of development. The data reveal that $FI_{mod+sev}$ and FI_{sev} show **significant and high correlation in the expected direction with most accepted indicators of development**.

Although informative, the pairwise comparisons in Table 8-3 may be revealing possible spurious correlations. Various indicators that are related to access to food (prevalence of food insecurity, extreme poverty, and prevalence of undernourishment) may be capturing the same fundamental information and therefore be somehow redundant in predicting, for example, child mortality rates.

To verify whether this is the case, multiple regression analyses were conducted with **child mortality rate** as the dependent variable and poverty, undernourishment and food insecurity as independent variables. Even though results are to be interpreted with caution, given the provisional nature of $FI_{mod+sev}$ and FI_{sev} and the fact that the various indicators do not refer to the same time period, they reveal interesting patterns (Table 8-4).

Four different models have been estimated, using either $FI_{mod+sev}$ or FI_{sev}, with and without controlling for extreme poverty. Models 1 and 2 show that both the PoU and either $FI_{mod+sev}$ or FI_{sev} reveal strong predictive power for child mortality rates across countries.

What is more interesting, as shown in Model 3 and 4, is that both food security indicators maintain significant predictive power even when controlling for extreme poverty. This suggests that **experience-based food insecurity measures capture aspects related to difficulties in access to food beyond what can be explained in terms of monetary poverty**, evidence that income alone is insufficient to capture many factors that determine food security, and in particular food access, at the household level.

Expansion of this type of analysis to other potential outcomes of food insecurity and addition of carefully selected covariates may shed light on differences in the aspects of food insecurity captured by the FIES and the PoU, as well as the mechanisms that link food insecurity to various outcomes.


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Filling a gap in our ability to measure food insecurity

FIES based procedures produces valid measures of experienced food insecurity (access to food) that are formally comparable across applications over populations that differ greatly by language, culture and livelihood conditions

This report describes the analytic developments and presents the preliminary results of the Voices of the Hungry project – the latest FAO initiative in the field of food security measurement. The project aims to fill an important gap in our collective ability to measure household or individual food insecurity, by developing and applying a cost effective method to estimate the prevalence of food insecurity at different levels of severity in a population, on a global scale.

The methodology described here is shown to produce estimates of the prevalence of food insecurity at various levels of severity that are **valid, reliable and properly comparable across populations**. The simplicity of the questionnaire and the availability of the necessary software for data analysis allows obtaining results much more quickly and at a fraction of the costs needed to obtain analogous measures using other approaches. Measures based on the FIES are thus particularly attractive for monitoring food insecurity in a timely manner, with great potential for improving food security governance, even on a global scale. Innovations presented in this report have led to the definition of **two indicators** – the percentages of individuals in the population aged 15 years or more, experiencing moderate-or-severe (**$FI_{mod+sev}$**) and severe levels of food insecurity (**FI_{sev}**). The indicators have been computed using the data collected by FAO with the FIES through the GWP or, when available, national data from recent applications of experience-based food security scales such as the HFSSM, the EMSA, the EBIA and the ELCSA, which can be analyzed with the FIES analytic methods presented in this report.

The discussion highlights several advantages of this approach. First, the theoretical foundation of the method on IRT permits statistical testing of the empirical validity and the goodness of fit of the data collected. This implies that the data collection process can be validated and the data evaluated in terms of their **statistical reliability** before computing the indicators. Moreover, confidence intervals reflecting both measurement and sampling errors can be computed, a feature that is rather uncommon among existing food security measures. Analyses performed on the data from 146 different datasets have shown how – with the exception of only three cases – the FIES-based methods have yielded reliable results that **can be used with confidence to compare the extent of food insecurity across populations**. Even with samples of only about 1000 individuals, confidence intervals are sufficiently narrow to be able to detect relevant differences between populations.

As an additional indication of the validity of the method, national prevalence rates of moderate and severe food insecurity obtained through the FIES are significantly and highly **correlated, in the expected direction, with various other measures of economic and human development at country level.** Furthermore, the national rates of food insecurity prevalence reveal statistically significant coefficients when used in regression analyses of child mortality rates across countries, even after controlling for the prevalence of undernourishment or of extreme poverty. This is a particularly relevant result, as it suggests that these measures of food insecurity capture specific aspects related to difficulties in access to food beyond what can be explained in terms of monetary poverty.

Due to the ease of FIES data collection and analysis, assessments can be produced in a very limited time span, **allowing real time monitoring**. Broad use of the FIES will thus bring undeniable advantages in generating food security information in time to guide actions.

All of these aspects make $FI_{mod+sev}$ and FI_{sev} particularly apt as indicators to monitor food insecurity on a global scale, even when obtained from relatively small samples like those used in the GWP survey, and thus at **very low cost compared to other indicators** that might provide a comparable level of detail and reliability.

The positive implications of all this for any global monitoring initiative are clear. Ideal indicators in such contexts are policy relevant; appropriate for global monitoring (i.e., cross-country comparable); based on sound methodology; easy to interpret and communicate; sustainable and of high quality; and can be disaggregated by sub-national geographic area, gender, income class, etc. **The indicators based on the FIES meets all of these criteria, and therefore they may play an important role in monitoring the Sus-**

tainable Development Goals (SDGs) and the post-2015 development agenda, in particular Goal 2 on eradicating hunger and all forms of malnutrition. Moreover, analyses such as those conducted within the framework of the Integrated Food Security Phase Classification (IPC), implemented by a consortium of international organizations, would certainly greatly benefit from the availability of analytically sound, properly comparable indicators of food insecurity like the ones obtained with the FIES, which can be produced at subnational level when a suitable data collection vehicle is used.

Benefits from the Voices of the Hungry project are not limited to global monitoring of food insecurity by FAO and its partners. Through its advocacy and capacity development activities, VoH will promote the inclusion of the FIES-SM in national censuses and in demographic, health and agricultural surveys and provide the needed technical support. The FIES-SM is already **available in more than 200 different languages or dialects** and dedicated open source software is freely available for data analysis. Countries and institutions can choose and apply the version of the FIES-SM appropriate for their needs. The inclusion of the module in national surveys will enable comparison of the food insecurity condition among sub-groups of the populations, i.e. according to gender, age, income, education level, employment or geographic area. Until now, such comparisons have been largely based on meta analyses of information derived from different indicators, using data collected in a non-integrated fashion, typically in different periods, with validity of the results dependent on unverifiable hypotheses regarding the possibility of proper ex-post integration. The capacity to detect differences in the prevalence of food insecurity among men and women using the FIES individual survey module is a particularly relevant innovation in the area of food security assessment. Separate assessments of the prevalence of food insecurity among men and among women in the same population had been hindered so far by the lack of suitable data at the individual level. The ability to detect and understand **gender related differences in food insecurity** will likely have important implications for food security policies and programmes worldwide.

The results presented in this report allow us to conclude with confidence that **the FIES produces valid measures of experienced food insecurity (access to food) that are formally comparable across applications over populations that differ greatly by language, culture and livelihood conditions**. The VoH project looks forward to working with international, national and non-governmental institutions to promote adoption of the FIES methodology to inform food security policy and programme design, to target resources and to monitor progress over time.

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Appendix

Table A-1

Prevalence rates of food insecurity in 146 countries, areas or territories in 2014§									
Countries, areas or territories		FI mod+sev				FI sev			
		Prev.*	MoE**	N_1*** (thousands)	N_2**** (thousands)	Prev.*	MoE**	N_1*** (thousands)	N_2**** (thousands)
1	Afghanistan	45.1%	(±3.92%)	7,248	14,468	20.3%	(±3.35%)	3,267	6,587
2	Albania	36.2%	(±3.06%)	889	1,204	9.8%	(±2.06%)	242	338
3	Algeria	6.3%	(±1.58%)	1,829	2,547	1.3%	(±0.65%)	383	541
4	Angola	62.4%	(±4.26%)	7,211	14,357	19.7%	(±3.86%)	2,278	4,761
5	Argentina	13.3%	(±2.82%)	4,181	5,867	4.7%	(±1.52%)	1,465	1,914
6	Armenia	15.5%	(±2.58%)	367	470	2.0%	(±1.03%)	48	60
7	Australia	10.6%	(±2.36%)	2,032	2,803	2.6%	(±1.15%)	493	698
8	Austria	6.6%	(±2.30%)	482	587	2.2%	(±1.32%)	159	190
9	Azerbaijan†	7.8%	(±1.27%)	571	705	< 0.5%	(±0.18%)	29	31
10	Bahrain	18.5%	(±6.72%)	199	250	7.3%	(±4.72%)	79	101
11	Bangladesh	33.5%	(±4.49%)	36,262	55,734	10.8%	(±2.29%)	11,678	18,661
12	Belarus	8.3%	(±1.95%)	661	722	< 0.5%	(±0.36%)	35	36
13	Belgium	7.8%	(±2.57%)	723	876	2.8%	(±1.56%)	261	319
14	Belize	27.7%	(±4.19%)	61	106	9.3%	(±2.60%)	20	36
15	Benin	49.7%	(±4.63%)	2,982	5,074	21.6%	(±3.35%)	1,293	2,171
16	Bhutan†	2.8%	(±0.98%)	15	19	< 0.5%	(±0.04%)	1	1
17	Bolivia (Plurinational State of)	29.7%	(±3.12%)	2,061	3,428	16.3%	(±2.35%)	1,134	1,911
18	Bosnia and Herzegovina	8.0%	(±1.86%)	252	278	0.9%	(±0.54%)	29	32
19	Botswana	52.1%	(±4.27%)	699	*n.a.*	31.6%	(±4.12%)	424	*n.a.*
20	Brazil♣	8.3%	(±0.20%)	12,561	19,556	< 0.5%	(±0.03%)	579	948
21	Bulgaria	12.9%	(±2.58%)	803	989	1.1%	(±0.69%)	65	94
22	Burkina Faso	36.3%	(±4.56%)	3,419	6,622	13.2%	(±3.25%)	1,246	2,434
23	Burundi	79.0%	(±3.71%)	4,644	8,383	40.3%	(±4.19%)	2,371	4,448
24	Cambodia	53.3%	(±3.34%)	5,601	8,298	24.7%	(±2.80%)	2,589	3,871
25	Cameroon	50.8%	(±4.13%)	6,554	11,946	26.5%	(±3.29%)	3,422	6,193
26	Canada	8.0%	(±1.90%)	2,368	3,022	2.0%	(±0.98%)	587	788
27	Chad	61.9%	(±3.97%)	4,182	8,101	20.1%	(±3.27%)	1,362	2,554
28	Chile	12.0%	(±2.45%)	1,661	2,622	3.7%	(±1.22%)	514	731
29	China†,¥	2.1%	(±0.42%)	23,536	30,639	< 0.5%	(±0.07%)	832	1,611
30	China, Hong Kong, S.A.R.	8.6%	(±1.78%)	546	632	1.1%	(±0.68%)	71	83

NOTES TO TABLE A-1

§ **All prevalence rate estimates presented in this table must be considered provisional, pending further consolidation of the global FIES reference scale and an analysis of the stability of the FIES performance in all countries based on the data that will be collected in the next two years.**

* Prevalence is the estimated percentage of individuals aged 15 or more in the national population who are food insecure.

** MoE is the margin of error at 90% confidence.

*** N_1 is the estimated number of individuals aged 15 or more in the national population who are food insecure. It is obtained by multiplying the prevalence by the total number of individuals aged 15 or more in the national population (UNSD – Population Division data, as downloaded in May 2015).

**** N_2 is an estimate of the number of individuals in the total population living in households where at least one individual aged 15 or more is classified as food insecure. See Annex II for details.

† Estimates for Azerbaijan, Bhutan and China are subject to revision, as no satisfactory solution to the equating procedure was found. Item severity has been imputed for all items, based on the FIES global standard.

¥ Data for China excludes Hong Kong, S.A.R and Taiwan, province of China, listed separately.

♣ Estimates for Brazil are based on data collected by the *Instituto Brasileiro de Geografia y Estadistica* (IBGE) in the 2013 *Pesquisa Nacional por Amostra de Domicilios* (PNAD) using the *Escala Brasileira de Insegurança Alimentar* (EBIA). $FI_{mod+sev}$ and FI_{sev} are computed by calibrating the severity associated with the eight adult items of the EBIA on the FIES global reference scale and using the threshold defined by FAO for global assessment. These prevalence rates are therefore different from the rates published by IBGE, being based on different thresholds of severity. See Annex I for details.

Table A-1

Prevalence rates of food insecurity in 146 countries, areas or territories in 2014§

	Countries, areas or territories	$FI_{mod+sev}$				FI_{sev}			
		Prev.*	MoE**	N_1*** (thousands)	N_2**** (thousands)	Prev.*	MoE**	N_1*** (thousands)	N_2**** (thousands)
31	Colombia	25.3%	(±3.15%)	8,835	12,629	8.6%	(±1.79%)	2,991	4,372
32	The Dem. Rep. of the Congo	73.3%	(±3.88%)	27,726	52,768	40.2%	(±4.90%)	15,202	29,244
33	The Congo	63.4%	(±3.67%)	1,669	3,032	38.8%	(±3.54%)	1,021	1,714
34	Costa Rica	19.9%	(±2.41%)	738	1,049	4.4%	(±1.07%)	163	236
35	Croatia	7.0%	(±1.91%)	255	521	1.2%	(±0.75%)	45	169
36	Cyprus	15.3%	(±3.12%)	145	167	5.0%	(±1.99%)	48	55
37	The Czech Republic	6.8%	(±2.31%)	625	712	1.5%	(±0.99%)	141	168
38	Denmark‡	4.9%	(±1.88%)	229	294	0.6%	(±0.68%)	30	39
39	The Dominican Republic	53.3%	(±3.59%)	3,861	5,387	18.6%	(±2.18%)	1,349	1,938
40	Ecuador	22.2%	(±3.79%)	2,448	3,590	8.7%	(±2.50%)	956	1,447
41	Egypt	29.9%	(±2.86%)	17,096	26,300	12.1%	(±2.04%)	6,883	10,399
42	El Salvador	37.7%	(±2.92%)	1,635	2,437	9.6%	(±1.62%)	414	695
43	Estonia	8.4%	(±1.71%)	91	110	1.3%	(±0.60%)	14	16
44	Ethiopia	48.4%	(±3.68%)	25,962	48,880	12.1%	(±2.23%)	6,496	12,561
45	Finland	9.4%	(±2.01%)	426	469	3.2%	(±1.25%)	143	149
46	France	6.9%	(±2.35%)	3,660	4,181	1.7%	(±1.21%)	909	1,091
47	Gabon	56.3%	(±4.28%)	591	925	35.4%	(±4.01%)	372	591
48	Georgia	23.5%	(±3.17%)	842	1,048	2.4%	(±0.95%)	85	112
49	Germany‡	4.3%	(±1.44%)	3,064	3,527	0.7%	(±0.54%)	504	570
50	Ghana	48.9%	(±4.41%)	7,899	13,620	22.6%	(±3.78%)	3,640	6,411
51	Greece	17.2%	(±2.71%)	1,632	1,942	2.1%	(±0.87%)	203	244
52	Guatemala♦	44.7%	(±0.70%)	4,151	7,117	10.9%	(±0.50%)	1,011	1,735
53	Guinea	73.6%	(±3.98%)	5,065	9,051	36.1%	(±4.50%)	2,482	4,514
54	Haiti	82.0%	(±4.32%)	5,474	8,121	70.8%	(±4.74%)	4,729	6,841
55	Honduras	56.0%	(±3.53%)	2,926	4,644	23.2%	(±2.71%)	1,210	1,988
56	Hungary	9.7%	(±2.11%)	819	947	1.1%	(±0.62%)	94	110
57	India	24.8%	(±3.33%)	219,369	337,943	12.4%	(±2.43%)	109,831	172,513
58	Indonesia	13.1%	(±3.12%)	23,218	38,219	3.3%	(±1.86%)	5,812	8,283
59	Iran (Islamic Republic of)	39.9%	(±3.34%)	23,918	30,854	8.5%	(±1.77%)	5,106	6,690
60	Iraq	40.4%	(±3.10%)	8,255	14,355	17.6%	(±2.49%)	3,595	6,215
61	Ireland	10.9%	(±2.63%)	401	504	4.3%	(±1.97%)	157	203
62	Israel	5.7%	(±1.88%)	324	406	< 0.5%	(±0.33%)	18	26
63	Italy	8.2%	(±3.01%)	4,323	5,191	1.0%	(±0.88%)	540	630
64	Côte d'Ivoire	53.5%	(±4.87%)	6,474	10,778	18.4%	(±3.26%)	2,224	3,664
65	Jamaica	43.1%	(±4.44%)	857	1,141	22.9%	(±3.74%)	455	608
66	Japan‡	3.0%	(±1.21%)	3,268	3,560	0.6%	(±0.57%)	612	659
67	Jordan	28.5%	(±3.21%)	1,386	2,278	13.7%	(±2.27%)	666	1,095
68	Kazakhstan	10.2%	(±1.87%)	1,272	1,804	0.7%	(±0.53%)	91	97
69	Kenya	57.9%	(±3.67%)	15,152	27,407	31.7%	(±3.34%)	8,281	15,320
70	Kosovo§	17.3%	(±2.55%)	267	316	4.5%	(±1.35%)	70	84
71	Kuwait	13.6%	(±2.49%)	355	448	4.9%	(±1.52%)	127	156

‡ For Denmark, Germany, Japan, Netherlands, Norway, Singapore, Sweden and Switzerland there were too few (less than 100) cases with non-extreme response patterns to allow robust estimation of item parameters, which have therefore been imputed using the global FIES reference scale. These estimates are subject to revision, when more valid cases from these countries will be available.

♦ Estimates for Guatemala are based on data collected by the *Instituto Nacional de Estadistica* (INE) in the 2011 *Encuesta Nacional de Condición de Vida* (ENCOVI) using the ELCSA. $FI_{mod+sev}$ and FI_{sev} are computed by calibrating the severity associated with the nine adult items of the ELCSA on the corresponding items in the FIES global reference scale, and using the threshold defined by FAO for global assessment. These prevalence rates are different from rates published by INE, being based on different severity thresholds. See Annex I for details.

§ References to Kosovo shall be understood to be in the context of the U.N. Security Council resolution 1244 (1999).

Table A-1

		FI mod+sev				FI sev			
Countries, areas or territories		Prev.*	MoE**	N_1*** (thousands)	N_2**** (thousands)	Prev.*	MoE**	N_1*** (thousands)	N_2**** (thousands)
72	Kyrgyzstan	20.5%	(±3.71%)	807	1,239	5.9%	(±2.24%)	234	395
73	Latvia	10.4%	(±1.86%)	182	219	1.8%	(±0.69%)	32	38
74	Lebanon	7.8%	(±2.43%)	295	426	2.0%	(±1.17%)	76	116
75	Liberia	84.8%	(±2.92%)	2,112	3,727	63.9%	(±3.70%)	1,593	2,817
76	Lithuania	19.6%	(±3.69%)	500	601	3.3%	(±1.24%)	84	98
77	Luxembourg	6.3%	(±1.97%)	28	31	2.4%	(±1.20%)	11	12
78	The former Yugoslav Republic of Macedonia	15.9%	(±3.11%)	278	360	5.3%	(±1.73%)	92	117
79	Madagascar◊	53.9%	(±4.38%)	7,184	13,227	12.3%	(±2.50%)	1,643	3,185
80	Malawi	86.6%	(±2.18%)	7,899	14,364	56.1%	(±3.19%)	5,114	9,317
81	Malaysia	19.8%	(±2.91%)	4,314	5,779	10.0%	(±2.17%)	2,194	3,006
82	Mali◊	17.9%	(±3.44%)	1,506	2,879	2.6%	(±1.22%)	219	372
83	Malta	5.9%	(±1.39%)	22	31	1.5%	(±0.73%)	6	8
84	Mauritania	19.7%	(±3.64%)	467	815	7.0%	(±2.09%)	166	284
85	Mauritius	9.3%	(±2.04%)	91	134	3.6%	(±1.23%)	36	58
86	Mexico♥	26.9%	(±1.07%)	24,736	36,099	3.9%	(±0.41%)	3,586	5,510
87	Republic of Moldova	11.9%	(±1.82%)	342	409	1.1%	(±0.58%)	33	38
88	Mongolia	13.8%	(±2.88%)	290	409	1.0%	(±0.60%)	21	32
89	Montenegro	14.2%	(±2.42%)	71	91	1.7%	(±0.85%)	9	11
90	Morocco	25.6%	(±3.16%)	6,157	8,673	8.1%	(±1.80%)	1,958	2,732
91	Myanmar◊	11.1%	(±2.35%)	4,426	6,349	1.0%	(±0.65%)	403	558
92	Namibia	61.3%	(±3.70%)	897	1,502	42.2%	(±3.51%)	617	1,049
93	Nepal	21.2%	(±2.78%)	3,747	6,566	8.3%	(±1.85%)	1,476	2,551
94	The Netherlands‡	5.5%	(±1.86%)	758	921	0.8%	(±0.82%)	108	135
95	New Zealand	9.3%	(±2.00%)	335	465	2.9%	(±1.24%)	106	140
96	Nicaragua	42.3%	(±2.90%)	1,711	2,733	15.6%	(±2.01%)	631	1,020
97	Niger	57.6%	(±4.25%)	5,355	11,049	18.4%	(±3.22%)	1,710	3,480
98	Nigeria	52.7%	(±5.06%)	52,623	92,246	26.8%	(±4.42%)	26,814	45,203
99	Norway‡	3.9%	(±0.45%)	161	215	0.6%	(±0.23%)	25	40
100	Pakistan	44.2%	(±3.57%)	52,856	89,260	16.8%	(±2.89%)	20,128	35,835
101	Palestine	27.6%	(±3.73%)	709	1,303	10.0%	(±2.46%)	258	495
102	Panama	28.7%	(±3.72%)	798	1,201	10.9%	(±2.34%)	302	470
103	Paraguay	32.8%	(±3.98%)	1,509	2,373	4.5%	(±1.49%)	209	346
104	Peru	27.5%	(±3.02%)	5,927	9,292	8.5%	(±1.83%)	1,831	2,646
105	The Philippines	45.7%	(±3.59%)	29,610	48,366	12.0%	(±2.11%)	7,793	13,271
106	Poland	12.1%	(±1.98%)	3,919	5,348	2.8%	(±0.99%)	912	1,679
107	Portugal	14.0%	(±2.78%)	1,262	1,483	4.3%	(±1.73%)	387	461
108	Puerto Rico	18.1%	(±4.14%)	530	675	7.5%	(±2.50%)	221	275
109	Romania	18.9%	(±2.66%)	3,476	4,591	6.3%	(±1.50%)	1,156	1,480
110	The Russian Federation	6.5%	(±1.32%)	7,862	8,649	0.7%	(±0.39%)	792	924

Caption: Prevalence rates of food insecurity in 146 countries, areas or territories in 2014§

◊ Due to limited coverage of the 2014 GWP samples, estimates for Madagascar, Mali, Myanmar, Somalia, South Sudan, The Sudan and Viet Nam may not be representative of the entire national population.

♥ Estimates for Mexico are based on data collected by the *Instituto Nacional de Estatística y Geografia* (INEGI) in the 2012 *Encuesta Nacional de Ingresos y Gastos de Hogares* (ENIGH) using the EMSA. $FI_{mod+sev}$ and FI_{sev} are computed by calibrating the severity associated with the eight adult items of the EMSA on the corresponding items in the FIES global reference scale and using the threshold defined by FAO for global assessment. These prevalence rates are different from the rates published by INEGI, being based on different severity thresholds. See Annex I for details.

‡ For Denmark, Germany, Japan, Netherlands, Norway, Singapore, Sweden and Switzerland there were too few (less than 100) cases with non-extreme response patterns to allow robust estimation of item parameters, which have therefore been imputed using the global FIES reference scale. These estimates are subject to revision, when more valid cases from these countries will be available.

Table A-1

Prevalence rates of food insecurity in 146 countries, areas or territories in 2014§									
Countries, areas or territories		FImod+sev				FIsev			
		Prev.*	MoE**	N_1***	N_2****	Prev.*	MoE**	N_1***	N_2****
				(thousands)				(thousands)	
111	Rwanda	34.7%	(±4.85%)	2,325	4,608	10.6%	(±2.86%)	708	1,388
112	Saudi Arabia	23.6%	(±2.89%)	4,795	6,877	10.0%	(±2.10%)	2,040	3,231
113	Senegal	22.5%	(±3.07%)	1,845	3,365	5.4%	(±1.77%)	441	765
114	Serbia	10.0%	(±2.22%)	787	1,047	0.9%	(±0.60%)	74	78
115	Sierra Leone	67.7%	(±3.96%)	2,431	4,248	46.4%	(±4.45%)	1,665	2,933
116	Singapore‡	4.3%	(±1.17%)	197	204	1.1%	(±0.59%)	51	53
117	Slovakia	6.0%	(±1.99%)	278	369	0.8%	(±0.55%)	39	55
118	Slovenia	12.2%	(±2.33%)	218	254	1.5%	(±0.88%)	27	33
119	Somalia◊	46.2%	(±3.61%)	2,612	5,287	28.0%	(±3.09%)	1,584	3,305
120	South Africa	41.2%	(±3.43%)	15,398	22,574	21.0%	(±2.79%)	7,846	11,494
121	Republic of Korea	7.9%	(±2.47%)	3,263	4,234	0.9%	(±0.82%)	362	460
122	South Sudan◊	92.3%	(±1.90%)	6,191	10,854	76.2%	(±3.24%)	5,116	8,936
123	Spain	7.1%	(±2.14%)	2,850	3,715	1.5%	(±1.12%)	584	849
124	Sri Lanka	17.7%	(±2.10%)	2,847	4,137	7.1%	(±1.97%)	1,135	1,711
125	The Sudan◊	44.1%	(±4.59%)	9,911	20,662	20.5%	(±4.11%)	4,605	9,238
126	Sweden‡	3.1%	(±1.01%)	253	305	0.5%	(±0.42%)	37	44
127	Switzerland‡	3.0%	(±1.03%)	209	296	< 0.5%	(±0.28%)	18	20
128	Taiwan Province of China	3.6%	(±1.21%)	744	876	0.8%	(±0.62%)	158	186
129	Tajikistan	14.6%	(±2.84%)	785	1,172	4.3%	(±1.81%)	230	343
130	United Republic of Tanzania	49.9%	(±4.70%)	13,964	26,407	23.9%	(±3.65%)	6,683	12,556
131	Thailand	4.8%	(±1.82%)	2,629	3,084	< 0.5%	(±0.33%)	201	234
132	Togo	65.5%	(±4.44%)	2,653	4,632	34.4%	(±4.33%)	1,394	2,452
133	Tunisia	17.5%	(±4.36%)	1,488	2,016	10.3%	(±3.67%)	873	1,197
134	Turkey	31.3%	(±3.15%)	17,426	n.a.	5.4%	(±1.40%)	3,002	n.a.
135	Uganda	69.8%	(±4.42%)	13,859	28,325	36.1%	(±4.22%)	7,181	15,435
136	Ukraine	12.3%	(±3.04%)	4,751	5,064	1.0%	(±0.74%)	384	401
137	The United Arab Emirates	10.8%	(±2.62%)	880	967	3.5%	(±1.93%)	286	315
138	The United Kingdom	10.1%	(±2.88%)	5,315	8,399	4.5%	(±2.11%)	2,357	4,660
139	United States of America♠	10.2%	(±0.27%)	25,755	33,252	1.2%	(±0.08%)	2,849	3,488
140	Uruguay	15.9%	(±2.47%)	422	610	5.1%	(±1.39%)	135	201
141	Uzbekistan	11.1%	(±1.95%)	2,288	3,340	2.2%	(±0.82%)	457	689
142	Venezuela (Bolivarian Rep. of)	27.6%	(±5.53%)	6,012	8,686	11.9%	(±3.73%)	2,596	3,888
143	Viet Nam◊	16.8%	(±2.42%)	11,921	15,331	1.1%	(±0.49%)	775	1,018
144	Yemen	34.4%	(±3.30%)	4,982	9,114	7.9%	(±1.77%)	1,147	2,067
145	Zambia	73.1%	(±3.73%)	5,827	11,164	43.2%	(±4.04%)	3,441	6,694
146	Zimbabwe	57.9%	(±4.09%)	4,966	8,559	32.1%	(±3.66%)	2,750	4,887

‡ For Denmark, Germany, Japan, Netherlands, Norway, Singapore, Sweden and Switzerland there were too few (less than 100) cases with non-extreme response patterns to allow robust estimation of item parameters, which have therefore been imputed using the global FIES reference scale. The estimates presented here are therefore subject to possible revision in the future, when more valid cases from these countries will be available.

◊ Due to limited coverage of the 2014 GWP samples, estimates for Madagascar, Mali, Myanmar, Somalia, South Sudan, The Sudan and Viet Nam may not be representative of the entire national population.

♠ Estimates for the United States of America are based on data collected by the US Census Bureau in the Decemebr 2013 Current Population Survey Food Security Supplemental using the US Household Food Security Survey Module. FImod+sev and FIsev are computed by calibrating the severity associated with the eight adult items of the US HFSSM on the FIES global reference scale and using the threshold defined by FAO for global assessment. These prevalence rates are therefore different from the rates published by USDA based on different severity thresholds.

Table A-2

Selected Indicators of Development used in the correlation analysis		
Name	Source	Description
Poverty headcount ratio at $1.25 a day	World Bank	Poverty headcount ratio at $1.25 a day (PPP) (% of population, projection to 2013 using PovCalNet)
Human Development Index	UNDP	Human Development Index (HDI) 2013
Multidimensional Poverty Index	UNDP	Multidimensional Poverty Index 2009-2013
GINI index	World Bank	GINI index (World Bank estimate)
Gross National Income per capita	World Bank	Gross National Income per capita, PPP (current international $)
Under-5 mortality rate	UNICEF	Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age five
Children aged 0-59 months Underweight	UNICEF	Underweight 2009-2013– Moderate and severe: Percentage of children aged 0–59 months who are below minus two standard deviations from median weight-for-age of the World Health Organization (WHO) Child Growth Standards
Children aged 0-59 months Stunting	UNICEF	Stunting 2009-2013 – Moderate and severe: Percentage of children aged 0–59 months who are below minus two standard deviations from median height-for-age of the WHO Child Growth Standards.
Children aged 0-59 months Wasting	UNICEF	Wasting 2009-2013 – Moderate and severe: Percentage of children aged 0–59 months who are below minus two standard deviations from median weight-for-height of the WHO Child Growth Standards.
Children aged 0-59 months Overweight	UNICEF	Overweight 2009-2013 – Moderate and severe: Percentage of children aged 0–59 months who are above two standard deviations from median weight-for-height of the WHO Child Growth Standards.
Rural population	World Bank	Rural population (% of total population)
Adult literacy rate (%) projection	UNESCO	Adult literacy rate, population 15+ years, both sexes (%) with UIS Estimation to 2015
Youth (15-24 years) literacy rate	UNESCO	Youth literacy rate, population 15-24 years, both sexes (%) with UIS Estimation to 2015
Life expectancy at birth	UNDP	Life expectancy at birth, total (years)
Fertility rate	UN	Fertility rate, total (births per woman)
Adolescent fertility rate (women ages 15-19)	UN	Adolescent fertility rate (births per 1,000 women ages 15-19)
Sanitation facilities (% with access)	WHO/UNICEF	Improved sanitation facilities (% of population with access)
Water source (% with access)	WHO/UNICEF	Improved water source (% of population with access)
Gender-related development index (GDI)	UNDP	Gender-related development index (GDI)

Annex I - Prevalence Rates Based on National Government Survey Data

A.1 General remarks

The Voices of the Hungry (VoH) Project encourages, and provides technical support for, collection of food insecurity experience data in nationally representative surveys conducted by government statistical agencies. Prevalence rates published in this report are based on national government survey data rather than GWP data for countries in which such data have been collected within the last three years, provided that the data can be made reasonably comparable with the data collected on the FIES administered in the GWP. In the present report, this includes Brazil, Mexico, Guatemala and the United States.

It should be noted that prevalence rates in this report for the four countries differ from those published in the official reports of the respective national statistical agencies, mainly due to the difference in the threshold used for classification. National statistical agencies use thresholds based on raw score, with no attention given to the possibility of equating them to thresholds used in other countries. In order for prevalence rates for these countries to be comparable with rates estimated for other countries using the GWP data, they must be based on the same methodology and thresholds of severity as are used for the GWP data. This annex provides the official statistics for each country and describes the differences in methodology and thresholds that account for the difference between the prevalence rates published here and the official rates published for each country. The most important differences are described below.

- Different thresholds of severity.

Population prevalence rates of food insecurity are based on categories, or ranges of severity of food insecurity defined against thresholds of severity. However, the underlying measure of severity of food insecurity is essentially a continuous measure and the specification of thresholds is statistically arbitrary. Each country specifies thresholds of severity to demarcate ranges of severity of food insecurity that are judged to have policy relevance, and gives labels to those ranges so as to facilitate understanding by policy officials and the general public of the severity represented by each prevalence rate. However, the ranges of severity that are relevant in a high-income or middle-income country may be quite different from ranges of severity that are informative in very low-income countries. The thresholds specified on the VoH Global Standard scale, especially the threshold for severe food insecurity, are more severe than those of any of the countries for which national government data are currently available. This is consistent with the purpose of these statistics, which is to provide information on countries with more severe conditions of food insecurity. For example, the threshold for severe food insecurity (labeled “very low food security” in the United States) is at the level of severity where individuals have reduced food intake below usual levels what they consider appropriate. On the VoH Global Standard, the threshold for severe food insecurity is at the level of severity where individuals have, at times, gone a whole day without eating. Similarly, in most countries with established food security monitoring, the threshold for moderate food insecurity (labeled “low food security” in the United States) represents primarily reductions in quality, variety, and desirability of meals, whereas on the VoH Global

standard, the threshold with that same label represents at least some reduction in quantity of food intake below levels considered appropriate. As such, prevalence rates in table A-I of this report — especially the rates of severe food insecurity — are generally lower than the officially reported prevalence rates, with differences in thresholds accounting for most of the differences in prevalence rates. [An analogy: The percentage of a population who are elderly is smaller if elderly is defined as "70 or older" than if elderly is defined as "55 or older"].[39]

- <u>Difference in reference period.</u>

The GWP asks each question in the FIES with reference to "the last 12 months." The 12-month reference period is essential in order to avoid possible biases due to seasonality, since the survey is conducted during a few weeks and at different times of the year across a large number of countries. Official food insecurity prevalence rates for the U.S. and Canada are also based on a 12-month reference period, but those for Brazil, Guatemala, and Mexico are based on a 3-month reference period. (Respondent recall for a shorter reference period is considered to be more accurate and the 3-month reference may be preferable to a 12-month reference provided seasonality is not considered substantial enough to bias results.) Prevalence rates over a three-month period will be lower than those over a 12-month period since not all food insecurity is chronic or continuous. The extent of the difference depends on the volatility of food insecurity and may differ from country to country. Based on information available from the U.S. where a second nationally representative survey uses a 30-day reference period, the difference between a 3-month and 12-month reference period are not expected to be substantial, but it should be kept in mind that prevalence rates for Brazil, Guatemala, and Mexico in table A-1 may be biased slightly downward compared with those of other countries due to the different reference periods employed.

- <u>Difference in reporting unit.</u>

The GWP is a survey of individual adults (aged 15 and older), and food insecurity prevalence rates are expressed as percentages of adults. The FIES questions (with one exception) ask only about the food insecurity experiences of the sampled adult. In contrast, most national government surveys are household-referenced and the most commonly cited official prevalence rates are expressed percentages of households. The food security questions in those surveys ask about 'you or other adults in the household' and 'any child in the household' and the household is considered food insecure if anyone is food insecure. Some countries also report the percentages of adults (usually ages 18 and older) by the food security status of their household, but it is not known if all adults in the household were food insecure. Statistics in table A-3 are calculated from microdata and represent individuals ages 15 and older, but the reported food security status is that of their household. It is likely that this biases prevalence rates for these countries upward somewhat vis-a-vis prevalence rates based on the GWP, since food security status may differ between adults in the same household.

[39] Brazil, Guatemala and Mexico also report prevalence of "mild" food insecurity, and this category is sometimes included in statistics on overall food insecurity. Canada and the US specify a category of "marginal food security" in their data products, but do not generally report statistics for this less severe range of food insecurity and do not include the category in the totals reported as food insecure.

A.2 National Government Survey Data Comparisons

Brazil

Data were collected in the *Pesquisa Nacional de Amostra de Domicílios* – PNAD (National Household Survey) conducted by the *Instituto Nacional de Geografia e Estatística* (IBGE) in 2013. The sample used by VoH to calculate prevalence estimates included 280,107 individuals ages 15 and older in 116,540 households. The Brazilian food insecurity scale, or *Escala Brasileira de Insegurança Alimentar* (EBIA) which was included as a supplement in the survey, includes eight adult and household referenced questions and six child-referenced questions. The EBIA is referenced to the household and to the three months prior to the survey. In the official Brazilian statistics, the food security status of households with children is based on responses to all 14 items, while that of households with no children is based on responses to the eight adult/household items.

To be as consistent as possible with the methodology used in the GWP, to measure the food security status of households the scale based only on the adult and household questions was used. Responses to those items were fit to the Rasch model, household weighted with one record for each household and the scale was adjusted to the VoH Global Standard metric based on the item parameters. The complete and non-extreme sample used to estimate the Rasch model included 25,450 households, giving very precise item parameter estimates. Two items, RANOUT and WHLDAY, were considered unique (not comparable with the VoH Global Standard) a priori because their cognitive content differs between the EBIA and the FIES. The remaining six items matched very well to the Global Standard. The largest deviation was .26 units on the Global Standard, or about .35 logits and the correlation among common items was .973, giving confidence that prevalence results calculated against the VoH Global Standard thresholds were comparable with those of countries in the GWP. Standard VoH methodology was then used to estimate prevalence rates of food insecurity using person-weighted data and attributing the raw score for a household to all individuals aged 15 and older in the household.

According to the official statistics for Brazil, 22.6 percent of households experienced some level of food insecurity (including mild food insecurity) in 2013 (table A-3). This total included 7.8 percent with either moderate or severe food insecurity and 3.2 percent with severe food insecurity. Published statistics for individuals by age give similar results for adults ages 18 and older; 7.8 percent either moderately or severely food insecure and 3.1 percent with severe food insecurity. Including older children (ages 15 and older) along with adults increased prevalence rates only slightly. Classifying those same individuals using only the eight adult/household items resulted in somewhat higher prevalence rates (10.6 percent moderate or severe, including 4.2 percent severe).[40] Finally, classifying those same individuals probabilistically (i.e. based on raw score, but taking measurement error into account) gives the VoH prevalence rates published in table A-1 and repeated in the far right column of table A-3: 8.3 percent moderate or severe, including 0.4 percent severely food insecure. The difference between the final two columns is entirely due to the greater severity of the VoH thresholds.

[40] The higher prevalence rate based only on adult and household items is because the raw score-based thresholds for moderate food insecurity and severe food insecurity in the EBIA classification system are higher on the 15-item scale applied to households with children compared to the 8-item scale applied to households with no children, used for this report to be more comparable with classifications based on the FIES.

Guatemala

Data were collected in the *Encuesta Nacional de Condiciones de Vida* (ENCOVI) conducted by the I*nstituto Nacional de Estadística* (INE) in 2011. The sample used by VoH to calculate prevalence estimates included 12,667 households, with 40,509 individuals ages 15 and older. The Latin American and Caribbean Food Security Scale, or *Escala Latinoamericana y Caribeña de Seguridad Alimentaria* (ELCSA), included as a supplement in the survey, includes eight adult and household referenced questions and seven child-referenced questions. The ELCSA is referenced to the household and to the three months prior to the survey. In the official statistics, the food security status of households with children is based on responses to all 15 items, while that of households with no children is based on responses to the eight adult/household items.

Here a scale based only on the adult and household questions was used to measure the food security status of households to be as consistent as possible with the methodology used in the GWP. Responses to those items were fit to the Rasch model, household weighted with one record for each household and the scale was adjusted to the VoH Global Standard metric based on the item parameters. The complete and non-extreme sample used to estimate the Rasch model included 9,476 households. Two items, WORRIED and SKIPPED, were considered unique (not comparable with the VoH Global Standard). The remaining six items matched well to the Global Standard. The largest deviation was .36 units on the Global Standard metric, or about .45 logits, and the correlation among common items was .989, giving confidence that prevalence results calculated against the VoH Global Standard thresholds were comparable with those of countries in the GWP. Standard VoH methodology was then used to estimate prevalence rates of food insecurity using person-weighted data and attributing the raw score for a household to all individuals aged 15 and older in the household.

According to the published statistics for Guatemala based on official thresholds, 80.8 percent of households experienced some level of food insecurity (including mild food insecurity) in 2011 (table A-3). This total included 41.5 percent with either moderate or severe food insecurity and 14.4 percent with severe food insecurity. Calculated statistics for individuals by age give slightly higher results for adults ages 18 and older: 42.8 percent either moderately or severely food insecure and 16.8 percent with severe food insecurity. Including older children (ages 15 and older) along with adults increased prevalence rates only slightly. Classifying those same individuals using only the eight adult/household items resulted in somewhat lower prevalence rates (45.9 percent moderate or severe, including 15.6 percent severe). Finally, classifying those same individuals probabilistically (i.e. based on raw score, but taking measurement error into account) gives the VoH prevalence rates published in table A-1 and repeated in the far right column of table A-3: 44.7 percent moderate or severe, including 10.9 percent severely food insecure. The difference between the final two columns is entirely due to the greater severity of the VoH thresholds.

Mexico

Data were collected in the *Encuesta Nacional de Ingresos y Gastos de los Hogares* (ENIGH) conducted by the *Instituto Nacional de Geografia e Estatística* in 2012. The sample used by VoH to calculate prevalence estimates included 9,000 households, with 23,920 individuals ages 15 and older. The Mexican food security scale, or *Escala Mexicana de Seguridad Alimentaria* (EMSA), included as a supplement in the survey, includes nine adult and

household referenced questions and seven child-referenced questions. The EMSA is referenced to the household and to the three months prior to the survey. In the official Mexican statistics, the food security status of households with children is based on responses to all 16 items, while that of households with no children is based on responses to the nine adult/household items.

Again, a scale based only on the adult and household questions was used to measure the food security status of households to be as consistent as possible with the methodology used in the GWP. Responses to those items were fit to the Rasch model, household weighted with one record for each household, and the scale was adjusted to the VoH Global Standard metric based on the item parameters. The complete and non-extreme sample used to estimate the Rasch model included 4,834 households. Two items, RUNOUT and WHLDAY, resulted to be unique when compared to the severities on the Global Standard, while the item *"Mendigar por comida"* was considered unique a priori because conceptually not comparable with any of the FIES questions. The remaining six items matched reasonably well to the Global Standard. The largest deviation was .47 units for the WORRIED item on the Global Standard metric, or about .56 logits, and the correlation among common items was .956, giving confidence that prevalence results calculated against the VoH Global Standard thresholds were comparable with those of countries in the GWP. Standard VoH methodology was then used to estimate prevalence rates of food insecurity using person-weighted data and attributing the raw score for a household to all individuals aged 15 and older in the household.

According to the calculated statistics for Mexico based on official thresholds, 21.8 percent of households experienced either moderate or severe food insecurity in 2012 (table A-3), 9.5 percent with severe food insecurity. Calculated statistics for individuals by age give similar results for adults ages 18 and older: 21.3 percent either moderately or severely food insecure and 8.9 percent with severe food insecurity. Including older children (ages 15 and older) along with adults increased prevalence rates only slightly. Classifying those same individuals using only the adult/household items resulted in approximately the same moderate and severe prevalence rate (21.7 percent), and severe prevalence rate (9.0 percent). Finally, classifying those same individuals probabilistically (i.e. based on raw score, but taking measurement error into account) gives the VoH prevalence rates published in table A-I and repeated in the far right column of table A-3: 26.9 percent moderate or severe, including 3.9 percent severely food insecure. The difference between the final two columns is entirely due to the different severity of the VoH thresholds.

United States

Data were collected in the Current Population Survey Food Security Supplement (CPS-FSS) by the U.S. Census Bureau in December 2013 and analyzed and reported by the Economic Research Service (ERS) of the U.S. Department of Agriculture (Coleman-Jensen et al., 2014). The sample included 83,303 individuals ages 15 and older in 42,014 households with valid food security data. The U.S. Household Food Security Scale (USHFSS) includes 10 adult and household referenced questions and eight child-referenced questions if there are children in the household.[41] The USHFSS is referenced to

[41] More precisely, the US-HFSSM comprises eight adult and household items and seven child reference items if the household includes children. Two of the adult-referenced items and one child-referenced item include follow up questions to affirmative responses asking, "how many times did this happen?" The base (yes/no) question and follow-up question in each case are analyze as a single item with three categories, using a Rasch partial credit measurement model.

the household (i.e. questions ask about "you or other adults in the household" and about "any child in the household") and to the 12 months prior to the survey. In the official U.S. household statistics, the food security status of households with children is based on responses to all 18 items, while that of households with no children is based on responses to the 10 adult and household items. However, ERS also publishes prevalence rates for adults (18 and older) based only on the 10 adult and household items.

Once again, in order to be consistent with the methodology used in the GWP, a scale based only on the adult and household questions was used to measure the food security status of households. Responses to those items were fit to the Rasch model, household weighted, with one record for each household, and the scale was adjusted to the VoH Global Standard metric based on the item parameters. The complete and non-extreme sample used to estimate the Rasch model included 8,693 households, which provides very precise item parameter estimates. Two items, RANOUT and SKIPPED, were considered unique (not comparable with the VoH Global Standard) a priori because their cognitive content differs between the USHFSS and the FIES. The lower Rasch-Thurstone threshold for the two items with "how often did this happen?" follow-up questions was considered equivalent to the corresponding yes/no item in the FIES. The BALANCED MEALS question in the USHFSS was considered equivalent to both HEALTHY and FEWFOODS in the FIES, resulting in six items considered equivalent between the scales. The severity parameters of these six items matched well to the Global Standard. The largest deviation was .30 units on the Global Standard, or about .45 logits and the correlation among common items was .984, giving confidence that prevalence results calculated against the VoH Global Standard thresholds were comparable with those of countries in the GWP. Standard VoH methodology was then used to estimate prevalence rates of food insecurity, using person-weighted data and attributing the raw score for a household to all individuals ages 15 and older in the household.

According to the official statistics for the United States, 14.3 percent of households were food insecure (i.e. with low or very low food security) in 2013, including 5.6 percent with severe food insecurity (i.e. very low food security; table A-3). Published statistics for adults ages 18 and older are slightly lower, 14.0 and 5.1 percent. Including older children (ages 15 and older) along with adults lowers the prevalence of food insecurity to 13.4 percent, but increases the prevalence of severe food insecurity (very low food security) to 5.4 percent. Column 4 does not differ from column 3 in the U.S. since both are based only on adult and household items. Finally, classifying those same individuals probabilistically (i.e. based on raw score, but taking measurement error into account) gives the VoH prevalence rates published in table A-1 and repeated in the rightmost column of table A-3: 10.2 percent moderate or severe, including 1.2 percent severely food insecure. The difference between the final two columns is entirely due to the greater severity of the VoH thresholds.

Table A-3

Prevalence rates calculated from national government survey data and from FAO- GWP data*					
Country and range of severity	(A)				(B)
	(A1)	(A2)[1]	(A3)[2]	(A4)	(B1)[3]
Brazil (2013)[4]					
Mild, moderate, or severe food insecurity	22.6				
Moderate or severe food insecurity	7.8	7.8	7.9	10.6	8.3 (0.2)
Severe food insecurity	3.2	3.1	3.2	4.2	0.4 (0.03)
Guatemala (2011)[4]					
Mild, moderate, or severe food insecurity	80.8	80.8	82.0	83.2	
Moderate or severe food insecurity	41.5	42.8	44.5	45.9	44.7 (0.7)
Severe food insecurity	14.4	16.8	19.5	15.6	10.9 (0.5)
Mexico (2012) [4]					
Moderate or severe food insecurity	21.8**	21.3	21.7	19.2	26.9 (1.07)
Severe food insecurity	9.5**	8.9	9.0	9.3	3.9 (0.41)
United States (2013)					
Moderate or severe food insecurity (Low or very low food security)	14.3	14.0	13.4	13.4	10.2 (0.27)
Severe food insecurity (Very low food security)	5.6	5.1	5.4	5.4	1.2 (0.08)

(A) – Based on discrete assignment of food security status by raw score, and national thresholds for food security status
(A1) – Published (Household)
(A2) – Published adults (18+) by food security status of household
(A3) – Adults (15+) by food security status of household; classification based on national classification system
(A4) – Adults (15+) by food security status of household; classification based on adult items only

(B) – Based on probabilistic food security status assignment, and VoH global thresholds
(B1) - Adults (15+) by food security status of household based on adult items. Margins of Error (MoE) at 90% confidence in parentheses.

Notes:

* The prevalence rate calculated from national government survey data are compared with rates for the same countries, using the same data, calculated to be comparable with rates for other countries based on the Food Insecurity Experience Scale administered in the Gallup World Poll.

** These prevalence rates are not, in fact, the official published rates for Mexico, because they are based on households rather than persons, and because the Mexico official rate omits households for which other measures of poverty are not available.
[1] Published percentages, or calculated from published statistics by age.
[2] Calculated from national government survey microdata.
[3] These are the statistics most directly comparable with statistics for other countries published in table A-I.
[4] All Brazil, Guatemala and Mexico national government statistics based on a 3-month reference period

Annex II - Number of food insecure adults and number of individuals in the total population affected by food insecurity

This Annex explains how the figures included in Table A-1, columns labeled "N_1" and "N_2" for both moderate or severe and severe food insecurity are computed.

VoH main outputs are prevalence rates (percentages) of moderate and severe food insecurity ($\%_{MOD+SEV}$) and of severe food insecurity ($\%_{SEV}$) among adults, defined as individuals older than 15, which compose the reference population of the GWP.

The corresponding numbers of food insecure adults (15 or older) in the national population are therefore easily obtained as

$$N_{1,MOD+SEV} = \%_{MOD+SEV} \times Pop_{15+}$$

and

$$N_{1,SEV} = \%_{SEV} \times Pop_{15+}$$

where Pop_{15+} is the national population of individuals aged 15 or more, obtained from United Nations Department of Economic and Social Affairs, Population Division, 2015 revision.

When analyzing the numbers reported in the columns labeled "N_1" against other closely related indicators – such as the number of individuals in extreme poverty (published by the World Bank) and the number of people undernourished (published by FAO) – care should be taken in recognizing that these other indicators usually refer to individuals of all ages.

To estimate the number of individuals of all ages who are food insecure or live in food insecure household at the two levels of severity, we therefore need to compute also an estimate of the number of children (i.e. individuals aged 14 or less) who live in households where an adult is found to be food insecure. Let us call these numbers N_3.

The procedure to obtain an estimate of N_3 is as follows:

Step 1: Estimate an approximate "children weight" for each sampled adult as:

$$\text{children weight} = \frac{w_t}{N_{\text{adults}}} \times N_{\text{children}}$$

where w_t is the GWP post-stratification adult weight.

As only one adult is sampled in each household reached by the GWP, dividing the post-stratification weight by the number of eligible adults in that household creates an approximate household sampling weight. Multiplying it by the number of children living in the same household gives an estimate of the number of children represented by the sampled adult.[42]

Step 2: Calculate a weighted distribution of children across raw scores, using the children weights and the corresponding adult raw scores.

Step 3: Multiply the probability of belonging to a food insecurity class, conditional on a given raw score, by the weighted proportion of children associated with that raw score.

[42] Gallup reports both the number of eligible adults and the number of children in each sampled household.

(Recall that the probability of being food insecure conditional on Raw score zero is assumed to be zero.)

Step 4: Sum the products obtained in Step 3 across raw scores to obtain an estimate of the prevalence of food insecurity in each severity class among children (14 and younger), that is $\%^{child}_{MOD+SEV}$ and $\%^{child}_{SEV}$

Step 5: Multiply the prevalence rates obtained in Step 4 by the national population of individuals aged 14 or less (Pop_{14-}), again from UNDESA Population Division Data.

Rates (moderate or more and severe) calculated in step 3 are multiplied by the total census population for children to get total number of food insecure children, therefore

$$N_{3,MOD+SEV} = \%^{child}_{MOD+SEV} \times Pop_{14-}$$

and

$$N_{3,SEV} = \%^{child}_{SEV} \times Pop_{14-}$$

The values reported under columns N_2 are the sum of N_1 and N_3.

Obviously, even if referring to the same reference populations, these values will differ from closely related indicators such as the number of individuals in extreme poverty, because they represent somewhat different conditions and different levels of severity.

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