Article

Food and Nutrition Bulletin
2015, Vol. 36(2) 167-195

DOI: 10.1177/0379572115587274
fnb.sagepub.com
SAGE

Measuring the Food Access Dimension of Food Security: A Critical Review and Mapping of Indicators

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Abstract

Background: With food security now a top priority for many governments and for the global development community, there is heightened awareness of the need to improve our understanding and measurement of food security.

Objective: To bring clarity in the assessment of the food access dimension of food security at the household and individual level.

Methods: For the most commonly used indicators, we reviewed their original purpose and construction, at what levels (household or individual) they were designed to be used, what components (quality, quantity, safety, and cultural acceptability) they were intended to reflect, and whether or not they have been tested for validity and comparability across contexts.

Results: We identified nine indicators and grouped them in three broad categories: experience-based, coping strategies, and dietary diversity. The indicators only capture the quantity and quality components of food access; none of the indicators capture information on safety or cultural acceptability of food access. Household Dietary Diversity (HDDS) and Food Consumption Score (FCS) are often considered indicators of both quantity and quality, but they have not been validated for the latter.

Conclusions: We recommend the use of experience-based indicators, HDDS, or FCS to assess household access to energy; experience-based indicators to assess household access to diet quality (defined qualitatively as not having to adopt practices that favor acquiring cheaper, less appealing, and less micronutrient-dense foods); and individual dietary diversity scores for women or children to assess individual access to diet quality, defined as micronutrient adequacy.

Keywords

food security, food access, review, indicators, measurement

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Abbreviations

CSI, Coping Strategy Index; ELCSA, Escala Latinoamericana y Caribeña de Seguridad Alimentaria (Latin American and Caribbean Food Security Scale); DD, Dietary Diversity; FANTA, Food and Nutrition Technical Assistance; FCS, Food Consumption Score; HDDS, Household Dietary Diversity Score; HFIAS, Household Food Insecurity Access Scale; HFSSM, Household Food Security Survey Module; HHS, Household Hunger Scale; IDDS, Individual Dietary Diversity Score; IYCDDS, Infant and Young Child Dietary Diversity Score; WDDS, Women's and Individual Dietary Diversity Score

Introduction

A succession of alarming events—including excessive food price volatility, financial crises, and climate change and related weather shocks threatening food production—has elevated food security to a top priority for governments and the global development community. Along with high-level discussions focused on how to feed the growing population in the next decades has come heightened awareness of the need to improve our understanding and measurement of food security. International forums on food security advocate for stronger partnerships and greater coordination among actors and for the harmonization of food security measurement to monitor trends globally, nationally, and at the household and individual levels.[1] This paper is one step in this direction and focuses on indicators to measure the *access* dimension of food security.

Although a variety of individual or composite indicators of food security have been developed and are widely used, there is general confusion regarding which dimensions (availability, access, utilization, or stability), levels (from global to individual), or components (quantity, quality, safety, cultural acceptability and preferences) of food security these indicators are meant to reflect. This paper aims to bring clarity on indicators for the *access* dimension of food security at the *individual* and *household* levels, recognizing that food security can be measured at several other levels, including at the community, national, regional, and global levels. Our focus is on indicators that have low respondent burden and are suitable for use in large surveys. We therefore exclude indicators such as those based on household income or expenditure, food consumption, home production of food, or market distance.[2,3]

We focus on food *access* at the individual and household levels, rather than other dimensions and levels of food security, because there are several ongoing initiatives that currently focus on strengthening the measurement of the *availability* dimension of food security at the national, regional, and global levels. Such initiatives include discussions and work undertaken to strengthen the Food and Agriculture Organization (FAO) measure of undernourishment[4,5], the FAO composite index under development, and the Global Food Security Index.[6] Recent reviews have provided broad overviews of different sets of indicators covering a range of dimensions and levels of measurement of food security.[5,7-12] Our review more narrowly focuses on commonly used, low-respondent-burden indicators of the access dimension of food security at the individual and household levels.

Our contributions to the literature are threefold. First, we provide a conceptual framework that lays out the multiple dimensions, levels, and components of food security. Second, for each of the identified indicators of access to food, we systematically review their original purpose and construction, what underlying construct(s) they were intended to reflect, how they have been used, and whether or not they have been tested for validity, i.e. whether they reliably and accurately reflect the underlying phenomenon they were intended to reflect. We also review evidence on each indicator's equivalence, i.e. the extent to which the indicators can be used to make valid comparisons across contexts. Third, we map each indicator according to the level of measurement and the component(s) of food security access it captures and highlight the strengths and weaknesses of the evidence. Based on the findings, we provide specific guidance on which indicators are best suited for measuring the different

components of food security access and make recommendations for future research.

Methods

Food Security: Definition and Conceptual Framework

The most commonly accepted definition of food security is that it exists "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life."[13] This definition covers many of the dimensions and components of food security, including temporality and shocks; physical (i.e., availability), social, and economic access to food; sufficient quantity and quality of food to meet nutritional requirements; the safety of food; and the ability of individuals to make choices and consume culturally acceptable and preferred foods; as well as linking the definition of food security to key health and productivity outcomes.

The National Research Council (2006) incorporates experience and perceptions in its description of food insecurity and states that food *in*security is experienced by households and individuals when there is uncertainty about future food availability and access, insufficiency of the amount and kinds of foods (quality) required for a healthy lifestyle, or the need to use socially unacceptable ways to acquire food.[14] This definition integrates the notion of perceptions of food insecurity and of "feelings of deprivation" in individuals[15], which may trigger response behaviors that can deepen current poverty or lead to the transmission of poverty to the next generation in the longer term.[16] Some of these behaviors carry important nutritional risks, thus undermining health and productivity, especially for the most nutritionally vulnerable household members, such as pregnant and lactating women and young children, who have high nutrient requirements.

Figure 1 illustrates the key dimensions (availability, access, utilization, and stability), levels (from global to individual), and components (quantity, quality, safety, cultural acceptability and preferences) of food security as usually delineated.[17,18] Availability and access can be measured at all levels from the global to the individual, whereas utilization refers to the ability of individuals to absorb and effectively use the nutrients ingested for normal body functions. Availability and access include several components: quantity (i.e., enough food and energy), quality (i.e., foods that provide all essential nutrients), safety (i.e., food that is free of contaminants and does not pose health risks), and cultural acceptability and preferences (i.e., foods that people like and that fit into traditional or preferred diets). Stability is a cross-cutting dimension that refers to food being available and accessible and utilization being adequate at all times, so that people do not have to worry about the risk of being food insecure during certain seasons or due to external events.

When assessing food security, it is important to differentiate the level at which data are collected and the level at which food security statements are made. In this paper, we focus on measurement of the *access* dimension of food security at the level of *households* and *individuals*. These measures can be used to make food security statements for groups of individuals and households, as well as at higher levels of aggregation, such as community, national, or global levels, depending on the representativeness of the samples used in the measurements. For each indicator reviewed, we assess which components of the access dimension of food security are captured and review evidence for the indicator's validity and equivalence.

Indicators, Validity, and Equivalence

An *indicator* is used to reflect an aspect of a given characteristic (in this case some dimension or component of food security). Indicators are typically constructed by classifying values of a single measure, or an index or scale calculated from multiple measures, on the basis of degree or specific meaning.[19] Deriving an indicator usually implies that there is an understanding of what value of a measure, index, or scale is considered adequate or not (e.g., high vs. normal body temperature).

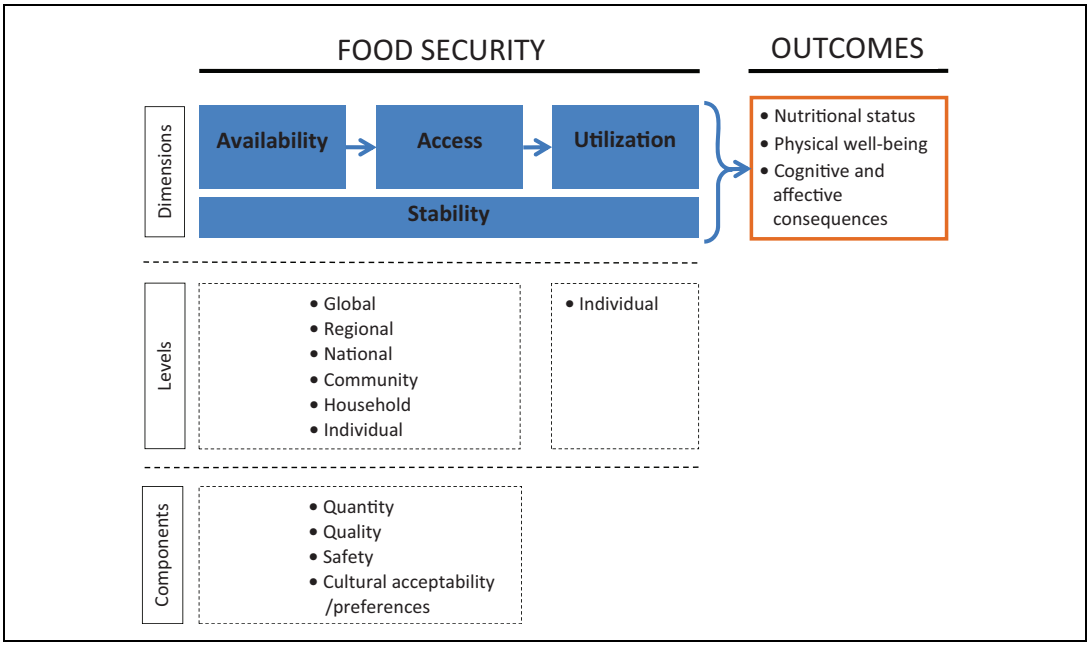

Figure 1. The complex nature of food security: Food security dimensions, levels, and components.

Validity. To be useful, indicators should be *valid*, i.e., suitable for providing useful analytical measurement for a given purpose and context. In turn, to be valid, indicators must be *well-constructed*, *reliable*, and *accurate*.[20]

Well-constructed indicators are grounded in an understanding of the underlying phenomenon being measured, and for which the indicator's performance is consistent with that understanding.

Reliable indicators yield the same value upon repetition of the measurement when the phenomenon does not differ (e.g., weight being measured three times within 10 minutes), and for which differences in the measurement consistently reflect differences in the phenomenon being measured. Often, internal consistency is used to estimate the reliability of scales derived from questionnaire items; internal inconsistency reflects error both in representation of the content by the items and in administration of the questionnaire or instrument.[21]

Accuracy is the extent to which an indicator provides unbiased assessment of the phenomenon. Accuracy is ideally assessed by comparison with another measure of the phenomenon that is known to be highly accurate (i.e., a definitive or "gold standard" measure), but sometimes it must be assessed by comparison with measures of determinants or consequences of the phenomenon if a gold standard is not available.

For food security indicators, ensuring validity is challenging because of the complexity of the construct and the absence of a gold standard measure that is universally accepted as reflecting all food security dimensions and components. Thus, validation exercises should specify first which dimension or component of food security is being assessed and identify the relevant gold standard. For example, if one is interested in measuring household access to sufficient energy to meet the requirements of all its members (i.e., the access dimension and quantity component of food security at the household level), the gold standard would be the total energy consumed by the household members, measured as accurately as possible by either direct weighing, detailed 24-hour dietary recall, or household food consumption measures.

Equivalence. To make comparisons across contexts, population groups, and countries, indicators must also perform well (i.e., have *equivalence*) across different contexts.[22] Equivalence means

Table 1. Types of Equivalence.

Type	Definition	Importance for comparison across contexts
Construct	Same construct is measured across contexts, even if the measures used are not identical	Constructs measured are comparable
Item	Same construct is measured across contexts and the content of each item used is perceived and interpreted in the same way across contexts	Items have same meaning and are comparably interpretable
Measurement	Constructs, items, and units are the same across contexts (i.e., the interval between two scores is the same)	Households and/or individuals can be comparably ordered
Scalar	Same as measurement equivalence, but in addition the definition of zero is the same across contexts	Average scores and prevalence are comparable

that the indicator is invariant (consistent) across contexts.[22,23] There are four types of equivalence: construct, item, measurement, and scalar (Table 1). Ideally, for comparisons across contexts, scalar equivalence is desired, so that the average scores of a given measure and prevalence estimates across contexts are directly comparable. Scalar equivalence, however, is difficult to achieve. Measurement equivalence (defined as constructs, items, and units being the same across contexts) is easier to achieve and allows for meaningful comparisons across contexts for most purposes.

Review Strategy

The first step was to list the most commonly used indicators of food access at the household and individual levels. Based on the list, we searched bibliographic databases and the Internet to identify published papers or documents that describe the design of the indicators; the purpose(s) for which they were developed; whether or not their validity and equivalence had been evaluated, and if so, using which methods; and how (and for what purposes, see Table 2) the indicators have been used. For each identified indicator, we first used a data matrix[24] to tabulate information on the source, definition, computation involved in deriving the indicator, intended uses (i.e., purposes and contexts), assessments of validity, equivalence, and other relevant features. Using the data matrix, we mapped each indicator according to level and component of food access.

Results

We identified 10 indicators that have been used to assess the access dimension of food security at the household and individual levels. We dropped one indicator, ''months of adequate food provisioning,''[25] because there was insufficient information on its validity and equivalence to determine its potential usefulness. The indicators selected are described below and in Tables 3, 4, and 5, along with a summary of information available about validity (i.e., construction, reliability, and accuracy) and equivalence. The indicators are grouped into three categories that differ in terms of both conceptual content and mode of construction: experience-based (Table 3), coping strategies (Table 4), and dietary diversity (Table 5).

Experience-based Indicators

In the early 1990s, the US government led the development of an indicator of food security based on an assessment of the experiences of adults and children in households, as reported by an adult respondent for the household.[14] This measurement approach arose from reviewing results from qualitative research and observations with food-insecure households in the United States, which revealed that people in food-insecure households had experiences that fell into four domains: concerns about quality of food, quantity of food, feelings of uncertainty and deprivation, and social unacceptability of food acquisition.[14] Subsequently, this approach was

Table 2. Possible Purposes of Measuring Food Security.[20]

Level	Possible purposes
Groups of households or people	Estimation of prevalence (What is the magnitude of the problem?)
	Determination of causes and consequences (Why are they affected and what are the effects?)
	Early warning (When is action needed?)
	Targeting (Who will receive a program?)
	Monitoring (How is the situation changing?)
	Impact evaluation of programs (Has the program made a difference?)
Individual households or people	Screening (Is the household or individual at risk?)
	Targeting (Who will receive a program?)
	Diagnosis (Does the household or individual have the problem?)
	Monitoring (How is the situation changing?)

taken as potentially valuable for measuring food insecurity in other countries, including developing countries.

Indicators. The US Household Food Security Survey Module (HFSSM) was developed to measure whether households had enough food or money to meet basic food needs, and what their behavioral and subjective responses to that condition were. It was created by bringing together and adapting items from the indicators developed by Radimer and team[26] and the Community Childhood Hunger Identification Project.[27] The US HFSSM module consists of a set of 18 items, 8 of which are specific to households with children (Table 3).[28] The items reflect a range of severity of food insecurity experiences covering the quantity and quality of food and feelings of uncertainty; feelings of deprivation and social unacceptability are not covered. The recall period is 12 months, but 30 days has also been used. A shortened six-item version of the module has also been developed[29], and an adapted HFSSM was tested in several developing countries, including Bolivia, the Philippines, and Burkina Faso.[30]

Another adaptation of the US HFSSM, also informed by scales used and trialed in Venezuela, Brazil, and Colombia, is the Latin American and Caribbean Food Security Scale (Escala Latinoamericana y Caribeña de Seguridad Alimentaria, ELCSA).[31] The ELCSA was derived from the Brazilian Food Insecurity Scale, which was adapted from the HFSSM through focus group research[31]; it was also informed by a food security survey instrument used in Colombia. In 2010, a workshop was held to harmonize the different versions of the ELCSA in use across Latin America and the Caribbean for use in Mexico and Central America.[32] The harmonized version has been adopted in other Spanish-speaking countries as well as in other regions of the world. The ELCSA asks households whether they worry about procuring food, have to compromise on the quality and diversity of the food eaten, sacrifice quantity by cutting portions or skipping meals, and actually experience hunger because of economic constraints. The scale consists of 15 items, 7 of which are specific to households with children. The recall period is 3 months.[32]

Given the success of the US HFSSM, the US Agency for International Development (USAID)-funded Food and Nutrition Technical Assistance Project (FANTA) commissioned work to develop a Household Food Insecurity Access Scale (HFIAS) to assist development organizations in evaluating their food security programs in developing countries. The construction of the HFIAS was based on an extensive review examining commonalities in the experience and expression of food insecurity (defined as lack of access) across cultures. The review identified four domains and several subdomains of food insecurity that appear to be universal across different countries and cultures.[33] The four domains (and subdomains) were: uncertainty (in the long term) and worry (in the short term) about food; inadequate quality (unhealthy foods and diets, limited variety); insufficient quantity (running out of

Table 3. Experience-based Indicators.

Indicator (reference)	Indicator definition and calculation	(Intended) use	Validity and equivalence[a]
HFSSM Household Food Security Scale Module[28]	**Description** Indicator focuses on whether the household has enough food or money to meet its basic food needs and on the behavioral and subjective responses to that condition **Item list** 18 items (8 of which are specific to households with minors) reflect a range of severity of food insecurity experiences **Recall period** 12 mo (30 days has also been used) **Calculation** Both a continuous household food security scale and a categorical food security indicator can be calculated: sum of affirmative responses (range, 0–10 for households without minors; 0–18 with minors) is compared with a reference table that provides the scale value and the status-level classification **Range** 0–9.3 (continuous scale) **Cutoffs/classification** 0–2.2: food secure; 2.4–4.4: food insecure without hunger; 4.7–6.4: food insecure with hunger, moderate; 6.6–9.3: food insecure with hunger, severe (continuous scale)	**Original purpose** • Estimate prevalence of food insecurity in the US • Monitor food insecurity among groups of US households **Other uses** • Targeting • Impact evaluation • Substantial use and influence on research to determine causes and consequences	**Validity** Extensive evidence, much of it on the subset of the HFSSM items derived from the Radimer-Cornell measure. Detailed review carried out by the US National Research Council (2006) • **Well-grounded construction:** Based on qualitative research to assess experiences of food security; performs in a manner consistent with its construction • **Reliability:** Reliable based on internal consistency (Cronbach alpha) • **Accuracy:** Demonstrated by association with other measures understood to be determinants or consequences of food security. Comparison with a definitive classification of the access dimension of household food security developed from qualitative interviews showed good sensitivity (84%–89%) and specificity (63%–71%), meaning that the HFSSM classified separate households on food security accurately An adapted HFSSM was tested in 3 countries other than the US. The adapted HFSSM was negatively associated with expenditures reflecting both quantity and quality of food A shortened 6-item version of the module has been developed and validated in special populations (Hawaii and Latinos) **Equivalence** Scalar equivalence demonstrated across various groups in the United States. Construct and item equivalence has been demonstrated across 3 countries
ELCSA Latin American and Caribbean Food Security Scale[32]	**Description** Indicator includes questions asked to households about the quality and quantity of household food availability and about coping strategies to manage food shortages. Indicator is based on scales used and trialed in Venezuela, Brazil, and Colombia, and stemming from the US HFSSM. Intended for use in Latin America and the Caribbean	**Original purpose** • Estimate prevalence of food insecurity • Determine causes and consequences of food insecurity • Targeting • Monitoring • Impact evaluation	**Validity** • **Well-grounded construction:** Adapted from the HFSSM through a series of focus groups to ensure good construction; performs in a manner consistent with its construction • **Reliability:** Reliable based on internal consistency, but one study in Colombia found it had poor test–retest reliability

(continued)

Table 3. (continued)

Indicator (reference)	Indicator definition and calculation	(Intended) use	Validity and equivalence[a]
	Item list Set of 15 items, 7 of which are specific to households with minors. Items reflect a range of severity of food insecurity experiences **Recall period** 3 mo **Calculation** Sum of the number of affirmative responses **Range** 0–8 (adult-only households); 0–15 (households with minors) **Cutoffs/classification** 0: food secure; 1–3 (no minors)/1–5 (minors): mildly food insecure; 4–6/6–10: moderately food insecure; 7–8/11–15: severely food insecure		• **Accuracy:** Demonstrated for households by association with other measures understood to be determinants or consequences of food security, including quantity and quality of food One study found that the ELCSA had poor sensitivity and specificity for differentiating individual households as to food security when compared with the usual consumption of energy for all household members **Equivalence** Scalar equivalence demonstrated across various groups within countries; measurement equivalence across Spanish-speaking countries in Latin America
HFIAS Household Food Insecurity Access Scale[34]	**Description** Indicator uses a set of questions that represents universal domains and subdomains of experiencing household food insecurity and more specifically lack of access to food **Item list** Asks for the occurrence of increasingly severe experiences of food shortage In case of an affirmative response to any of the 9 questions, the frequency of occurrence in past 4 weeks (30 days) is asked: 1 = rarely (once or twice); 2 = sometimes (3–10 times); 3 = often (> 10 times) **Recall period** 4 weeks/30 days **Calculation** No occurrence is assigned a value of 0, rarely a value of 1, sometimes a value of 2, and often a value of 3. Values are summed for the 9 questions	**Original purpose** • Assist development organizations in tracking progress (monitoring) and evaluating their food security programs **Other uses** • Estimate prevalence of food insecurity • Targeting	**Validity** • **Well-grounded construction:** Extensive review examining commonalities in the experience and expression of food insecurity (i.e., lack of access) across cultures identified 4 domains and several subdomains that appear to be universal across different countries and cultures and recommended that items reflecting these domains be used as the basis of future food insecurity scale measures • **Reliability and accuracy:** Initial demonstration based on implementation of items in Costa Rica; accuracy tested by association with other measures understood to be determinants or consequences of food security. Subsequently, reliability and accuracy demonstrated in Mozambique **Equivalence** 8-country study found that the first 6 items of the scale were construct equivalent, but not measurement or scalar equivalent across countries

(continued)

Table 3. (continued)

Indicator (reference)	Indicator definition and calculation	(Intended) use	Validity and equivalence[a]
	Range 0–27 **Cutoffs/classification** Complex tabulation plan classifies households as food secure, mildly food insecure, moderately food insecure, or severely food insecure		
HHS Household Hunger Scale[35]	**Description** The HHS was developed from the HFIAS to include a set of questions that were valid for cross-context comparisons. It focuses on the quantity dimension of food access. Uses the last 3 items (the occurrence of severe experiences of food shortage) of the HFIAS **Item list** Asks for the occurrence of increasingly severe experiences of food shortage In case of an affirmative response to any of the 3 questions, the frequency of occurrence in past 4 weeks (30 days) is asked: 1 = rarely (once or twice); 2 = sometimes (3–10 times); 3 = often (> 10 times) **Recall period** 4 weeks/30 days **Calculation** No occurrence is assigned a value of 0, rarely or sometimes a value of 1, and often a value of 2. Values are summed for the 3 questions **Range** 0–6 **Cutoffs/classification** 0–1: little to no hunger; 2–3: moderate hunger; 4–6: severe hunger	**Original purpose** • Estimate prevalence of severe food insecurity across contexts (with scalar equivalence)	**Validity** • Well-grounded construction: see HFIAS • Reliability and accuracy: see HFIAS **Equivalence** Scalar equivalent across countries

[a]References to studies on the validity and equivalence of the indicators are provided in the text.

Table 4. Indicators Reflecting Coping Strategies.

Indicator (reference)	Indicator definition and calculation	(Intended) use	Validity and equivalence[a]
CSI Coping Strategy Index[56]	**Description** Assesses the frequency of occurrence of increasingly severe coping strategies, i.e. the behaviors people engage in when they cannot access enough food **Item list** Locally relevant coping strategies (total of no more than 12 to 15) to be identified through focus groups. The strategies should fall into 4 basic categories: • Dietary change • Short-term measures to increase household food availability • Short-term measures to decrease numbers of people to feed • Rationing, or managing the shortfall Once the coping strategies have been identified, a new series of focus groups is held to assign a weight (1 to 4) to each strategy based on its severity **Recall period** 7 days **Calculation** Sum of the frequency of each coping strategy (days/week) multiplied by its severity weight. The higher the composite score, the more coping reported, and therefore the more food insecure the household is **Range** Depends on the number of strategies identified **Cutoffs/classification** None defined. Notes that a range should not be reduced to a "cutoff" point, and any range is probably situation-specific	**Original purpose** • Understand causes and consequences of food insecurity • Early warning • Monitoring • Impact evaluation	**Validity** • **Well-grounded construction:** Construction of the CSI depends on focus groups in each context • **Reliability:** Not demonstrated • **Accuracy:** Demonstrated for groups of households by association with other alternative measures of food insecurity Calculation of sensitivity and specificity in comparison with those alternative measures found poor accuracy for separate households **Equivalence** By design, the CSI does not have construct, item, measurement, or scalar equivalence
Reduced CSI[56]	**Description** A comparative (reduced) CSI using a smaller set of preweighted strategies **Item list** Five preweighted strategies • Eating less-preferred foods (weight = 1.0) • Borrowing food or money from friends and relatives (weight = 2.0) • Limiting portions at mealtime (weight = 1.0) • Limiting adult intake (weight = 3.0) • Reducing the number of meals per day (weight = 1.0) **Recall period** 7 days **Calculation** Sum of the frequency of each coping strategy (days/week) multiplied by its severity weight **Range** 0–56 **Cutoffs/classification** None defined	**Original purpose** • Monitoring ("comparing across crises") • Geographic targeting	**Validity** • **Well-grounded construction:** Review of surveys using CSI supposedly revealed core set of behaviors that are used in the reduced CSI; methodology for its construction unavailable, however • **Reliability:** Not demonstrated • **Accuracy:** Not demonstrated **Equivalence** Not demonstrated

[a]References to studies on the validity and equivalence of the indicators are provided in the text.

Table 5. Dietary Diversity Indicators.

Indicator (reference)	Indicator definition and calculation	(Intended) use	Validity and equivalence[a]
HDDS Household Dietary Diversity Score[58,59]	**Description** Initially developed as an indicator of the food access component of household food security, and more specifically the quantity and quality of food access at the household level. Food access was defined as the ability to acquire sufficient *quantity* and *quality* of food to meet all household members' nutritional requirements for a productive life **Item list** FANTA: 12 food groups. 2 food groups capture consumption of staple foods (cereals; roots and tubers); 8 food groups consumption of micronutrient-rich foods (vegetables; fruits; meat; eggs; fish; legumes, nuts and seeds; dairy); 3 food groups consumption of energy-rich foods (oils and fats; sweets; spices, condiments, and beverages) FAO: uses a list of 16 food groups, which are then aggregated into the 12 food groups of the FANTA indicator (cereals; white roots and tubers; vitamin A–rich vegetables and tubers; dark-green leafy vegetables; other vegetables; vitamin A–rich fruits; other fruits; organ meat; flesh meat; eggs; fish and seafood; legumes, nuts, and seeds; milk and milk products; oils and fats; sweets; spices, condiments, and beverages) **Recall period** 24 h **Calculation** Simple count of number of food groups consumed **Range** 0–12 **Cutoffs/classification** None provided	**Original purpose** • Monitoring • Impact evaluation	**Validity** • **Well-grounded construction:** Dietary diversity has long been recognized as a key element of diet *quality* because it helps ensure adequate intake of essential nutrients and promotes good health • **Reliability:** Not demonstrated • **Accuracy:** Indicator was tested for its association with per capita expenditures (a proxy for income), total household energy availability, and energy availability from staples and nonstaples, using data from 10 diverse, low-income countries **Equivalence** Construct and item equivalence by design; measurement and scalar equivalence not demonstrated
IYCDDS Infant and Young Child Dietary Diversity Score[61,62]	**Description** Indicator was designed to assess dietary diversity in complementary foods for children 6–23 mo (as a measure of micronutrient density of complementary foods). It is 1 of the 8 WHO-recommended indicators to measure infant and young child feeding practices. It measures the quality of food access at the individual level **Item list** 7 food groups (grains, roots, and tubers; legumes and nuts; dairy products; flesh foods; eggs; vitamin A–rich fruits and vegetables; other fruits and vegetables)	**Original purpose** • Estimate prevalence of low dietary diversity • Monitoring • Impact evaluation	**Validity** • **Well-grounded construction:** Dietary diversity has long been recognized as a key element of diet *quality*. Development done through a multicountry study using a standard methodology applied to 10 datasets from countries in Africa, Asia, and Latin America • **Reliability:** Not demonstrated • **Accuracy:** 4 dietary diversity indicators (7 or 8 food groups, each with minimum amount consumed of 1 or 10 g) were tested through multicountry analysis using standard methodology applied to 10 datasets; analysis

(continued)

Table 5. (continued)

Indicator (reference)	Indicator definition and calculation	(Intended) use	Validity and equivalence[a]
	Recall period 24 h **Calculation** Simple count of food groups consumed **Range** 0–7 **Cutoffs/classification** WHO guidelines on indicators for assessing infant and young child feeding practices uses $\geq$ 4 food groups to define minimum dietary diversity, based on findings from multicountry study and extensive stakeholder consultation		tested association between dietary diversity indicators and mean micronutrient density adequacy (MMDA) of the diet for 9 nutrients (breastfed children) or 10 nutrients (nonbreastfed children). All dietary diversity indicators were positively and statistically significantly associated with MMDA at all ages, in all countries and for both breastfed and nonbreastfed children. The 7-food-group indicator with a 1-g minimum performed best Sensitivity and specificity analyses failed to identify a cutoff point that performed best across all contexts; the cutoff point of 4 was selected based on extensive stakeholder consultations and discussions **Equivalence** Construct and item equivalence by design; measurement and scalar equivalence not demonstrated
WDDS[b] and IDDS Women's and Individual Dietary Diversity Score[59]	**Description** Indicator was designed to assess an individual's access to a variety of foods, a key dimension of dietary quality (meant to reflect micronutrient adequacy of the diet). Originally developed for use in women of reproductive age (WDDS) to reflect the mean probability of micronutrient adequacy; now also used for individuals > 2 yr (IDDS). It is a measure of the quality of food access at the individual level **Item list** 16 food groups (cereals; vitamin A–rich vegetables and tubers; white roots and tubers; dark-green leafy vegetables; other vegetables; vitamin A–rich fruits; other fruits; organ meat; flesh meat; eggs; fish; legumes, nuts, and seeds; dairy; oils and fats; sweets; and condiments), which are then aggregated into 9 food groups (starchy staples; dark-green leafy vegetables; other vitamin A–rich fruits and vegetables; other fruits and vegetables; organ meat; meat and fish; eggs; legumes, nuts, and seeds; and milk and milk products) Disaggregated version used to look at specific foods or nutrients of interest (iron, vitamin A, animal-source foods, etc.) **Recall period** 24 h **Calculation** Simple count of number of food groups consumed	**Original purpose** • Assess mean dietary diversity in populations • Estimate prevalence of low dietary diversity • Monitoring • Impact evaluation	**Validity** • **Well-grounded construction:** dietary diversity long recognized as a key element of diet *quality*. Indicators developed and tested through multicountry studies and other individual studies; designed to reflect micronutrient adequacy of the diet in adult women • **Reliability:** Not demonstrated • **Accuracy:** 8 dietary diversity indicators (6, 9, 13, or 21 food groups each with minimum intake of 1 or 15 g) tested using standard methodology applied to 5 datasets of women of reproductive age from developing countries; dietary diversity measures were tested for associations with the mean probability of adequacy (MPA) for 11 micronutrients. All measures were associated with MPA in all countries, and associations remained after controlling for energy intake. None of the 8 indicators performed best in all countries, but the 9-food-group indicator, which generally performed well across countries, was adopted by FAO in its guidance document Sensitivity and specificity analyses failed to identify a universal cutoff point to classify individuals into low vs. adequate dietary diversity categories The IDDS has not been validated

(continued)

Table 5. (continued)

Indicator (reference)	Indicator definition and calculation	(Intended) use	Validity and equivalence[a]
	Range 0 to maximum number of food groups used (9 or 16) **Cutoffs/classification** No universal cutoff point available from results of multicountry study on women's dietary diversity (see 4th column and text) Recommendation is to use mean value or distribution (as above) or carry out analyses to identify locally meaningful cutoff points		**Equivalence** Construct and item equivalence by design; measurement and scalar equivalence not demonstrated
FCS Food Consumption Score[63]	**Description** Composite score based on household dietary diversity, frequency of household food group consumption, and relative nutritional importance of different food groups. It is thus meant to reflect the quality and quantity of food access at the household level **Item list** Country-specific foods grouped into 8 standard food groups each with food group-specific weight (w): staples (w = 2.0), pulses (w = 3.0), vegetables (w = 1.0), fruit (w = 1.0), meat and fish (w = 4 .0), milk (w = 4.0), sugar (w = 0.5), and oil (w = 0.5) **Recall period** 7 days **Calculation** $FCS = w_{staple} \cdot f_{staple} + w_{pulse} \cdot f_{pulse} + w_{vegetable} \cdot f_{vegetable} + w_{fruit} \cdot f_{fruit} + w_{meat\ and\ fish} \cdot f_{meat\ and\ fish} + w_{milk} \cdot f_{milk} + w_{sugar} \cdot f_{sugar} + w_{oil} \cdot f_{oil}$ where w_i is the weight of each food group and f_i is the frequency of consumption (number of days, out of 7) **Range** 0–112 **Cutoffs/classification** Typical cutoffs: 0–21: poor food consumption; 21.5–35: borderline food consumption; > 35: acceptable food consumption Cutoffs are higher in locations where oil and sugar are eaten daily (0–28; 28.5–42; > 42).	**Original purpose** • Estimate prevalence of different levels of food insecurity (poor, borderline, acceptable food consumption) • Monitoring • Population-level targeting	**Validity** • **Well-grounded construction:** During development, validated against indicators of food consumption and food security using data from different settings; high correlations were found, but no details on the indicators or the analyses were presented; the food group weights were selected by a team of analysts to reflect "nutrient density," a subjective description of "a food group's quality in terms of caloric density, macro and micro nutrient content, and actual quantities typically eaten" • **Reliability:** Not demonstrated • **Accuracy:** Indicator was only tested for its association with per capita household energy consumption and not for its association with measures of dietary quality. Using data from 3 countries, FCS was positively and significantly associated with energy consumption per capita, particularly when small quantities (< 15 g) were excluded from food frequencies Current cutoffs led to a consistent underestimation of energy deficiency. Receiver operating characteristic analyses found areas under the curve (AUC) of about 0.80 (considered very good) in Haiti and about 0.70 in Burundi and Sri Lanka (good) when small quantities (< 15 g) were excluded. When small quantities were not excluded, the AUC was just acceptable and not acceptable for Burundi and Sri Lanka, respectively. Raising the cutoffs also improved the sensitivity and specificity of the FCS **Equivalence** Universally applicable cutoffs were not found. The need for different cut points in different contexts indicates the lack of measurement and scalar equivalence

[a]References to studies on the validity and equivalence of the indicators are provided in the text.
[b]A new indicator, the Minimum Dietary Diversity-Women (MDD-W), was introduced by FANTA and FAO in 2014. The new indicator uses 10 food groups and a cutoff of 5 food groups. Women consuming foods from at least 5 food groups have a greater probability of meeting their micronutrient needs than women consuming foods from fewer food groups. See http://www.fantaproject.org/monitoring-and-evaluation/minimum-dietary-diversity-women-indicator-mddw. The indicator guide for this new indicator will be available in 2015.

food, not consuming enough, eating less, disrupted eating patterns); and social unacceptability (unacceptable means of acquiring food, eating foods that cause shame or embarrassment). The review recommended that items reflecting these domains be used in the future for the construction and adaptation of food insecurity access scales. The HFIAS includes nine items that measure both occurrence and frequency and represent the universal domains associated with household food insecurity access, using a recall period of 30 days.[34] After a validation of the HFIAS had been carried out, a new scale, the Household Hunger Scale (HHS) was developed, which captures universal experiences of the quantity dimension of food access and uses the last three items of the HFIAS on the occurrence of severe experiences of food shortage and actual experiences with hunger. The standard recall period for this scale is also 30 days.[35] For each of the experience-based indicators, both a continuous scale and a categorical (i.e., ordinal) indicator can be calculated using the guidelines provided.

Intended uses. The HFSSM was developed by the US Department of Agriculture to estimate the prevalence of food insecurity and monitor changes over time among groups of households in the United States. It has also been used for targeting interventions and for impact evaluations[27,36,37], and it has been used widely for—and has influenced—research to document the causes and consequences of food insecurity.[14,38] The ELCSA had similar intended uses. The HFIAS was originally developed for program monitoring and impact evaluation.[34] The HHS was developed for similar purposes, but with the additional goal of producing comparable results across contexts.[39]

Validity and equivalence. There is extensive evidence of the validity of the HFSSM, much of it on the subset of the HFSSM items that were derived from the Radimer-Cornell scale. A detailed review of the HFSSM was carried out by the US National Research Council.[14] The results confirm that the HFSSM is well constructed, as a result of the use of qualitative research to assess experiences of food insecurity; it performs in a manner consistent with its construction; and it is reliable (according to tests of internal consistency, with Cronbach $\alpha \geq 0.85$). The accuracy of the indicator (defined as an indicator that accurately reflects the underlying phenomenon) has been demonstrated by studies that tested the association between the HFSSM and other measures understood to be determinants or consequences of food security, such as poverty status, education, program participation, and quantity and quality of dietary intake in groups of households.[20] For example, across four categories of food insecurity from food secure to severely food insecure, the percentages of households with income < $10,000 per year were 11.2%, 31.7%, 36.2%, and 50.9%, respectively[40], and the frequencies (times/week) of consumption of fruits and vegetables (as a measure of diet quality) were 27.6, 22.2, 20.7, and 15.5, respectively.[41] Two studies in individual households demonstrated the accuracy of the HFSSM by comparing it with a definitive classification of the access dimension of food security derived from in-depth qualitative interviews, including aspects of food anxiety and use of food- and diet-related coping strategies.[42,43] In these two studies, good sensitivity (71% and 92%) and specificity (84% and 75%) were found, indicating that the HFSSM accurately classified households that were truly food secure as food secure and those that were truly food insecure as food insecure. The shortened six-item HFSSM has been validated in special populations (Hawaii and Latinos)[29] and the adapted HFSSM in countries other than the United States, such as Bolivia, the Philippines, and Burkina Faso.[30] In this study, the HFSSM was negatively associated with expenditures reflecting both quantity and quality of food; for example, daily per capita expenditures on animal-source foods were correlated with food insecurity scores of 0.38, 0.26, and 0.31 in Bolivia, the Philippines, and Burkina Faso, respectively. Scalar equivalence has been demonstrated across various groups in the United States based on the pattern of responses for items across groups.[20] This means that the indicator can be used to compare estimates of prevalence among groups and populations from different contexts within the United States but may not yield comparable prevalence

estimates between countries. Construct and item equivalence, however, have been demonstrated across three countries from cognitive interviewing.[30]

The ELCSA was adapted from the HFSSM through a series of focus groups to ensure good construction and performs in a manner consistent with its construction. The ELCSA is reliable, based on internal consistency (Cronbach α = 0.91–0.95).[31,44,45] However, one study in Colombia found that the indicator had poor test–retest reliability (0.56).[46] Accuracy has been demonstrated for households by studies testing the association between the ELCSA and other measures understood to be determinants or consequences of food security, including quantity and quality of food.[31,47-49] For example, across multiple samples, 13.5% to 31.9% of severely food-insecure households consumed fruits, vegetables other than roots and tubers, and meat, compared with 71.4% to 91.0% of food-secure households. One study found that the ELCSA had poor sensitivity (63%) and specificity (62%) for differentiating food-secure and food-insecure households when compared with the gold standard measure used (the usual total energy consumption of all household members).[46] Scalar equivalence has been demonstrated across various groups within countries, and measurement equivalence across Spanish-speaking countries in Latin America.[50]

The HFIAS is well constructed, based on an extensive review examining commonalities in the experience and expression of food insecurity (i.e., the access component) across cultures. Initial demonstration of reliability and accuracy for the HFIAS was based on implementation of items in Costa Rica, with accuracy tested by association with other measures understood to be determinants or consequences of food security (poverty, education, income, and health insurance coverage).[51] For example, the percentages of food-secure households were 71.4%, 22.9%, and 5.7% for nonpoor, poor, and extremely poor households, respectively. Subsequently, accuracy was demonstrated in Mozambique.[52] In households of low socioeconomic status, 44% were food insecure, compared with 26% of households of middle or high socioeconomic status. Food-insecure households had lower fish consumption than food-secure households at both pre- and postharvest times, and had a 66% reduction in fish consumption in the postharvest time, compared with a 36% reduction in food-secure households. An eight-country study found that the first six items of the scale, which reflect less severe forms of food insecurity (e.g., worry, changes in diet quality or reductions in quantity), although construct equivalent, were not measurement or scalar equivalent (and therefore not comparable) across countries because the pattern of responses for items was not the same across countries.[53] The three least frequently reported items that constitute the HHS and reflect the severest forms of food insecurity, however, were found to be scalar equivalent across countries, based on the pattern of responses for items across countries; this means that prevalence estimates obtained using these three items are comparable across countries.

Conclusions. Experience-based indicators have proved useful in monitoring changes among groups of households in the United States and some other countries and have generated information regarding the consequences of household food insecurity among adults and children. Experience-based indicators reflect poor access to both quantity and quality of food, with quality defined as not having to adopt practices that favor acquiring cheaper, less appealing, and less micronutrient-dense food and not as micronutrient adequacy. The commonly used scales (HFSSM, ELCSA, and HFIAS) are composed of similar sets of items that cover the same components of food insecurity. Evidence for validity and construct equivalence of these indicators in differentiating groups of households and separating households with varying levels of food insecurity is strong. The available evidence about these indicators suggests, however, that the responses to items depend on cultural and social contexts in ways that may not allow comparison of prevalence from these indicators across countries. The HHS, with three items indicating severe food insecurity (i.e., hunger), has been shown to generate equivalent comparisons of prevalence across countries, but this scale is limited because it measures only the most severe food insecurity experiences and focuses only on the quantity (and

not the quality) of food access; it is appropriate for situations in which a large number of households are expected to be severely food insecure.

Coping Strategies

Coping strategies refer to the responses that people make when facing hardships such as household food insecurity and the measures they take to attenuate or mitigate their consequences. The Coping Strategy Index (CSI) assesses the frequency of occurrence of increasingly severe coping strategies, i.e., the behaviors people engage in when they cannot access enough food.[54,55] There is no universal CSI, but rather a methodology is proposed to derive locally relevant CSIs (Table 4). The methodology involves identifying through focus group discussions a set of coping strategies (for a total of no more than 12 to 15) that are used in a given context when households and individuals are faced with limited access to food.[56] The coping strategies are organized in four basic categories: dietary change, short-term measures to increase household food availability, short-term measures to decrease the number of people to be fed, and approaches to rationing or managing the shortfall. Once the coping strategies have been identified, a new series of focus groups is held to assign a weight (1 to 4) to each strategy based on its severity. A continuous score is calculated by summing the frequency (number of days) each coping strategy is used multiplied by its severity weight. The higher the score, the more coping reported, and therefore the more food insecure is the household. A reduced CSI also has been developed using a smaller set of five preweighted strategies. The recall period for both indicators is 7 days.[54,56]

Intended uses. The CSI was intended to be used for determining the causes and consequences of food insecurity, early warning (by identifying coping strategies that reflect early onset, rather than very severe forms of food insecurity), and identifying households with food insecurity.[54]

Validity and equivalence. The construction of the CSI relies on focus group discussions carried out in each context. Its reliability has not been demonstrated. Accuracy was demonstrated in a study in Ghana where the CSI was found to be correlated with per capita energy availability (correlation coefficients ranged from –0.082 to –0.138) and positively correlated with food budget share (correlation coefficients ranged from 0.122 to 0.195). Calculation of sensitivity and specificity in comparison with these measures, however, found poor accuracy for differentiating individual households in terms of food insecurity (sensitivity ranged from 0.32 to 0.46, specificity from 0.64 to 0.76).[54] The reliability and accuracy of the reduced CSI have not been demonstrated. By design, the CSI does not have construct, item, measurement, or scalar equivalence.

Conclusions. Assessing coping strategies is useful for understanding behavioral responses when a household cannot access enough food, but not necessarily for assessing the access dimension of food insecurity per se. Whether or not a household adopts certain coping strategies depends upon the availability of those strategies as well as the perceived need and/or desire to adopt them.

Dietary Diversity

Dietary diversity has long been recognized as a key element of diet *quality*, because eating a variety of foods helps ensure adequate intakes of essential nutrients and promotes good health.[57] Simple scores have therefore been developed to measure dietary diversity at the household or individual level in contexts where resource constraints prevent the use of detailed dietary assessment methods, such as direct weighing or 24-hour dietary recall. Dietary diversity scores are constructed using a simple count of foods or food groups consumed over a reference period, usually 24 hours. Some dietary diversity indicators have been developed specifically to measure food security.

A variation of the dietary diversity score is the Food Consumption Score (FCS), which was developed by the World Food Programme (WFP). The FCS is a composite score that includes information not only on dietary diversity, but also on the frequency of food group consumption and on the nutritional value of the food

groups (by assigning weights to the different food groups).

Indicators. The Household Dietary Diversity Score (HDDS), initially developed as an indicator of the food access dimension of household food security[58], is defined as the ability to acquire sufficient quantity and quality of food to meet all household members' nutritional requirements for a productive life. Thus, although the indicator is called household "dietary diversity," it was originally designed as a measure of both the *quantity* and the *quality* of food access, and the 12 food groups (for the origin of the set of food groups, see the indicator guide[58]) included in the HHDS reflect a combination of both (Table 5). Two food groups capture consumption of staple cereals, roots, and tubers (mostly quantity); eight food groups capture consumption of micronutrient-rich fruits, vegetables, meat, dairy products, nuts, and seeds (quality and quantity); and three food groups capture consumption of energy-rich (and largely nutrient-poor) foods (sweets, oils and fats, and condiments and beverages) (quantity). The recall period is 24 hours.[58] The FAO further developed a methodology to derive the indicator by first gathering information on consumption of 16 food groups, then aggregating the information into the 12 HHDS food group indicators.[59] No cutoff point has been defined to classify households with low or adequate household diversity.

The Infant and Young Child Dietary Diversity Score (IYCDDS) was developed as part of a process to generate international guidance for optimal Infant And Young Child Feeding (IYCF) practices[60] and to identify simple indicators for assessing IYCF practices. It measures the quality of food intake (which we consider a proxy for the quality component of food access in this paper) at the individual level and was designed to reflect the mean nutrient density adequacy (quality) of complementary foods in children 6 to 23 months of age. The indicator, a seven-food-group score based on a recall period of 24 hours, is part of the World Health Organization (WHO)-recommended set of indicators to assess IYCF practices.[61] A cutoff point of ≥ 4 is used to identify children with minimum dietary diversity.[62]

The Women's Dietary Diversity Score (WDDS) was developed using a similar methodology as that used to derive the dietary diversity indicator in children. The WDDS was originally developed to reflect the mean probability of adequacy of micronutrients in the diet of women of reproductive age, but it has also been used with other age groups (referred to as the Individual Dietary Diversity Score [IDDS]).[59] Similar to the child dietary diversity score, the WDDS and IDDS are measures of the quality of food intake at the individual level and are used here as proxies for the quality component of food access at the individual level. Until recently, the FAO recommended the collection of data from a questionnaire containing 16 food groups, which were then regrouped into 9 food groups.[59] A new indicator, the Minimum Dietary Diversity-Women (MDD-W), was introduced by FANTA and FAO in 2014 (see http://www.fantaproject.org/monitoring-and-evaluation/minimum-dietary-diversity-women-indicator-mddw). The new indicator uses 10 food groups and a cutoff of 5 food groups. Women consuming foods from at least five food groups have a greater probability of meeting their micronutrient needs than women consuming foods from fewer food groups.

The Food Consumption Score (FCS) was developed by the WFP as a food consumption and food security indicator that could be easily collected and adapted to different contexts while maintaining a standard approach for data analysis.[63] The FCS is a composite score that includes information on three aspects: household dietary diversity using information on food group consumption in the past 7 days, frequency of food group consumption (number of days in the past week), and nutritional value using weights. It is thus meant to reflect the quality and quantity of food access at the household level. The indicator uses eight food groups, which are different from those used in the HDDS or individual dietary diversity scores (see Table 5). The food-group weights were selected based on an interpretation by a team of analysts of "nutrient density," which is defined as "a term used to subjectively describe a food group's quality in terms of caloric density,

macro- and micro-nutrient content, and actual quantities typically eaten" (WFP Vulnerability Analysis and Mapping[63], page 19, footnote 14). Higher weights were thus given to foods containing relatively high energy, good-quality protein, and a range of bioavailable micronutrients (e.g., animal-source foods and dairy; weights = 4), and lower weights were given to oil and sugar (0.5), which are high in energy but low in protein and micronutrients. The score is computed by summing up the weighted frequencies for the different food groups consumed by the household and ranges from 0 to 112. According to preestablished thresholds (cutoff points), households are then categorized as having poor (0–21), borderline (21.5–35) or acceptable (> 35) food consumption.[63] These cutoff points were selected by setting a somewhat arbitrary minimum score (21) below which households are not expected to consume at least staple foods and vegetables on a daily basis and are therefore considered to have poor food consumption. The same logic was used to select the other thresholds: the minimum acceptable score of 35 assumes a daily consumption of staple foods and vegetables and a frequent (4 days/week) consumption of oil and pulses, a diet still likely to have a low content of bioavailable micronutrients.

Intended uses. The HDDS was originally developed to monitor changes in access to adequate quantity and quality of food at the household level and to evaluate the impact of programs. Similarly, the child and women dietary diversity indicators were developed to assess the diet quality (micronutrient density or adequacy of the diet) of groups of children or women and to monitor and evaluate the impact of programs. The FCS was designed for use by the WFP and other agencies to assess food insecurity and food aid needs, as well as for population-level targeting and monitoring.

Validity and equivalence. HDDS: The FANTA HDDS indicator was originally tested for accuracy by its association with household per capita energy consumption (used as a measure of access to adequate quantities of food and energy) and per capita energy consumption from staples and nonstaples, respectively.[64] The HDDS was generally found to be positively and statistically significantly associated with all these measures; a 1% increase in dietary diversity was associated with a 0.7% increase in per capita *energy consumption*, a 1.4% increase in per capita *energy consumption from nonstaple* foods, and a 0.5% increase in per capita *energy consumption from staple foods*. In general, the associations held in rural and urban contexts and across seasons and data collection methods, indicating that the HDDS is a robust indicator of the access component of food security. No analyses were done, however, to define a cutoff point that could accurately classify households as food secure or food insecure based on its performance at predicting either per capita household energy consumption or consumption of nonstaple or staple foods.

The HDDS was not tested for accuracy in reflecting the *quality* of food access. Although the indicator was found to be strongly associated with energy from nonstaple foods, which in turn is likely associated with micronutrient adequacy, the score includes three food groups that do not contribute to micronutrient intake—sweets, oils and fats (unless fortified), and condiments and beverages; inclusion of these groups in the score likely weakens its association with micronutrient adequacy and diet quality.

The HDDS has construct and item equivalence, but measurement or scalar equivalence has not been demonstrated. It is unlikely that measurement equivalence (meaning that a one-point change in the scale would reflect the same change in food group intake across contexts) could be achieved for this type of food group-based indicator.

IYCDDS: The development of the infant and young child dietary diversity indicator was done through a multicountry study using a standard methodology applied to 10 datasets from countries in Africa, Asia, and Latin America to assess how accurately dietary diversity indicators predicted the mean micronutrient density adequacy (MMDA, an indicator of diet quality) of the diet in children 6 to 24 months of age following WHO guidance on micronutrient adequacy of complementary foods for breastfed children.[60,65,66] Four different dietary diversity indicators were

compared, two with seven food groups and two with eight food groups, and each was tested with minimum intake quantities (the minimum quantity required for a food to be considered) of 1 and 10 g. The MMDA was computed by averaging the micronutrient density adequacy for 9 key micronutrients for breastfed children and 10 for nonbreastfed children.[65] Dietary diversity indicators were positively and significantly associated with MMDA in all datasets, in all age groups, and for both breastfed (all correlation coefficients were > 0.5) and nonbreastfed (correlation coefficients were slightly lower) children. The seven-food-group indicators generally performed better than the eight-food-group indicators; i.e. they were more likely to correctly identify children with low MMDA (receiver operating characteristic curves analysis showed that all area under the curve (AUC) values except one differed significantly from the null value of 0.5, and most values were > 0.7). There was no added benefit of imposing a 10-g minimum intake quantity. Although the multicountry analysis did not identify a cutoff point that performed best across all contexts, the cutoff point of four was selected based on extensive stakeholder consultations and discussions of the study results; across contexts, the study showed that children who consumed foods from four groups were more likely than those who consumed foods from a smaller number of groups to have consumed at least one animal-source food and one fruit or vegetable in addition to a staple food (grain, root, or tuber).[61] For this reason, a minimum of four groups was set as minimum dietary diversity for children 6 to 24 months of age. A few additional validation studies were carried out in nonbreastfed children in South Africa and the Philippines. The findings (reviewed in Ruel et al.[57]) confirm that overall, dietary diversity indicators can accurately predict micronutrient adequacy or intake (diet quality) in both breastfed and nonbreastfed children from developing countries.

WDDS and IDDS: The women's dietary diversity indicator was developed using datasets with quantitative 24-hour recall of women's dietary intake from five countries. A total of eight dietary diversity indicators were tested, using 6, 9, 13, or 21 food groups with minimum intakes of 1 or 15 g.[67] The indicators were validated against micronutrient adequacy of the diet (rather than micronutrient density adequacy, as in the children's study) using a methodology based on deriving the probability of nutrient adequacy for each of 11 micronutrients and averaging the results to derive a mean probability of adequacy (MPA) of micronutrient intake. As found in the children's study, there were strong, statistically significant positive associations between all eight dietary diversity indicators and MPA in all datasets and for women who were pregnant, lactating, or neither pregnant nor lactating (correlation coefficients ranged from 0.21 to 0.53).[67] None of the eight indicators performed best in all countries, but the nine-food group indicator, which generally performed well across countries, was adopted in the FAO guide.[59] Other studies using different indicators and approaches also confirm the strong correlation between dietary diversity indicators and measures of diet quality (reviewed in Ruel et al.[57]), supporting the accuracy of the indicators for assessing micronutrient adequacy of the diet. Also similar to the child study, sensitivity and specificity analysis failed to generate a universal best cutoff point across study contexts for identifying women with low versus higher (adequate) micronutrient adequacy. A recently completed new analysis of these and new datasets[68], followed by a multistakeholder consultation, identified a cutoff point of ≥ 5 as an acceptable cutoff point to define minimum dietary diversity for women of reproductive age, using a newly defined 10-food-group score (Jef L. Leroy, Marie Ruel, and Terri J. Ballard participated in the consultation; see http://www.fantaproject.org/monitoring-and-evaluation/minimum-dietary-diversity-women-indicator-mddw). The indicator guide for this new indicator will be available in 2015.

The IDDS indicator, which is sometimes used for men or women outside the reproductive age period, has not been validated. As noted for the HDDS, measurement or scalar equivalence of the child, women's, or individual dietary diversity score has not been assessed, but it is unlikely to be achievable with this type of indicator.

FCS: As part of its development, the WFP reports having validated the FCS against

indicators of food consumption and food security using data from different settings. The FCS was found to be highly correlated with these indicators, but no details on the indicators or the analyses are presented.[63] A separate study validated the FCS against per capita household food and energy consumption using data from three countries (Haiti, Burundi, and Sri Lanka).[69] The FCS was found to be positively and significantly associated with energy consumption per capita in Burundi (correlation coefficient, 0.27) and Haiti (correlation coefficient, 0.44), but not in Sri Lanka. When foods consumed in small quantities (< 5, 15, or 45 g) were excluded, correlations between the FCS and energy consumption per capita were markedly higher in all three countries (0.30 to 0.38 in Burundi, 0.46 to 0.62 in Haiti, 0.25 to 0.43 in Sri Lanka; in all three countries, correlation coefficients increased with increasing restriction from 5 to 15 to 45 g). Dropping the weights slightly improved the correlation coefficients. The study also assessed to what extent the FCS classification into poor, borderline, and acceptable food consumption categories matched the hypothesized underlying energy consumption levels (poor FCS, < 1,470; borderline, ≥ 1,470 to < 2,100; and acceptable, ≥ 2,100 kcal/capita/day). The FCS cutoff points were found to consistently underestimate the prevalence of inadequate energy consumption. Raising the cutoffs and excluding small quantities from the FCS considerably improved the sensitivity and specificity of the FCS, meaning that the indicator more accurately differentiated households with low from those with higher per capita energy consumption. Finally, the study found no evidence for the existence of universally valid cutoff points, even when small quantities were excluded from the calculation of the FCS. Similar findings were obtained in a study that used a comparable methodology with data from seven countries from Latin America, South Asia, and Africa.[70] As in the previous study, the results show that the FCS is significantly associated with per capita energy consumption (correlation coefficients range from 0.20 to 0.36) and that higher correlations are obtained when the indicator's food groups are unweighted and foods consumed in small amounts are excluded. No suitable cutoff point was identified that maximized sensitivity and specificity of the indicator and led to an acceptable level of misclassification (< 30%) across contexts. The need for different cut points in different contexts indicates that the indicator lacks measurement and scalar equivalence.

A recent study also validated the FCS against per capita energy consumption and the per capita monetary value of food consumption; the latter was used in this study as an indicator meant to reflect both *quantity* and *quality* of food at the household level. FCS was found to be more strongly associated with per capita food value than with energy (Astrid Mathiassen, personal communication). Note that the indicator used in this study to reflect both quantity and quality of food access, the per capita food value, does not meet the criteria we use in this review, micronutrient adequacy or density of the diet, to define dietary quality quantitatively.

Another study compared the FCS with the HDDS using data from three countries (Burkina Faso, Lao People's Democratic Republic, and Uganda).[71] Correlation coefficients (range from 0.53 to 0.73) and prevalence-adjusted kappa coefficients (range from 65% to 85%) showed strong agreement between the two measures, and both indicators were moderately correlated with indicators of household socioeconomic status and food security, such as an asset index, household total (or food) expenditures, and the number of meals consumed the previous day, across all three countries.

Conclusions. Overall, individual dietary diversity indicators, which were designed specifically to reflect micronutrient adequacy or density of the diet in women and children, respectively, perform well for this purpose and are accurate measures of the quality of food intake (used in this paper as proxy for access) at the individual level. The HDDS, in contrast, was designed as an indicator of household access to both quantity and variety (presumed to be a proxy for quality) of food, and thus combines information on access to both energy- and micronutrient-rich foods. The HDDS accurately reflects household food quantity and energy consumed, but its accuracy in predicting household micronutrient consumption has not been tested.

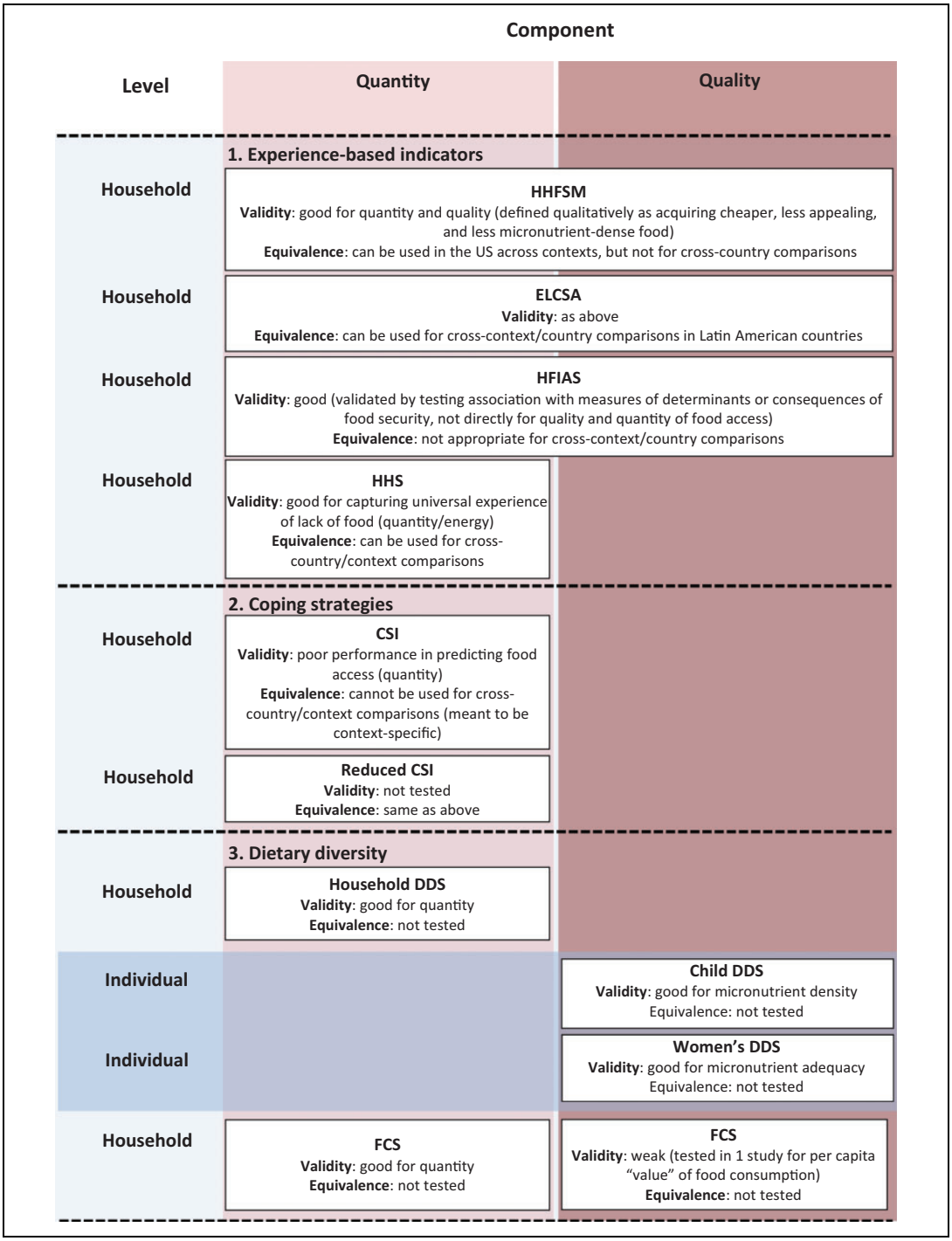

Figure 2. Mapping of indicators of the food access dimension of food security by level and component they were validated for. CSI, Coping Strategy Index; DDS, Dietary Diversity Score; ELCSA, Latin American and Caribbean Food Security Scale (Escala Latinoamericana y Caribeña de Seguridad Alimentaria); FCS, Food Consumption Score; HFIAS, Household Food Insecurity Access Scale; HFSSM, Household Food Security Survey Module; HHS, Household Hunger Scale. Note that none of the reviewed indicators reflects food safety or acceptability and preference.

Similarly, in spite of being widely used as an indicator of both the quantity and the quality of food access, the FCS has not been validated quantitatively as a measure of the quality component of food access. Validation studies have shown that the FCS reflects household socioeconomic factors, per capita food value, and the quantity component of food access.

Discussion

We reviewed nine commonly used indicators of the food access dimension of food security at the household and individual levels. The indicators are mapped in Figure 2 according to the component(s) of food access laid out in our conceptual framework and the level (household or individual) at which measurements are made.

Our first key finding is that the nine indicators reviewed capture only two components of food security access—quantity (energy) and quality (micronutrients); none of the indicators capture information on the other components of the access dimension of food security, namely, the safety and cultural acceptability of food and whether the foods accessed correspond to personal preferences. Figure 2 also shows that most of the indicators reviewed were designed to reflect the quantity component of food access, with the exception of individual dietary diversity scores, which were specifically designed to reflect diet quality measured by micronutrient adequacy or density. Experience-based indicators also reflect poor access to both quantity and quality of food, although quality in this case is not defined as micronutrient adequacy, but rather as not having to adopt practices that favor acquiring cheaper, less appealing, and less micronutrient-dense food.

A second key finding is that there are large differences in the rigor and quality of the research done to develop, test, and validate indicators of food access. For example, extensive research was carried out to develop and validate experience-based indicators of food access such as the HFSSM, which was first developed for the United States and adapted for use in several developing countries, including in Latin America (ELCSA) and other regions of the developing world (HFIAS and HHS). The validity of these indicators was carefully assessed and found to be good. Similarly, dietary diversity indicators were developed and validated through multicountry analyses using a standard methodology to compare the indicators' performance at predicting household per capita energy consumption and other measures of household socioeconomic status for HDDS, and micronutrient density or adequacy of the diet for the individual dietary diversity indicators. The HDDS has good validity in measuring food quantity, and individual dietary diversity scores have good validity in measuring micronutrient adequacy (in adult women) and density (in children). For the women's and children's dietary diversity scores, thorough analyses complemented by extensive expert consultation were conducted to identify and reach consensus on the best cutoff to accurately classify individuals into those with low versus minimum dietary diversity. By contrast, Coping Strategy Indicators (CSI) have not been formally validated against a "gold standard" measure to test how well they reflect the underlying construct they were originally designed to measure. These indicators are therefore classified as having unknown validity. The Food Consumption Score (FCS) stands somewhere in between (with limited information on validity), based on a few published studies that show associations between the indicator and per capita food and energy intake, per capita food value, and HDDS.

A third key finding is that many publications lack clarity regarding which components of access to food the different indicators are meant to reflect, even regarding food quantity or quality. The HDDS and FCS, for example, are often referred to as indicators that reflect both quantity and quality of food access, but neither indicator has been tested for its ability to predict dietary quality, defined as micronutrient adequacy or other valid indicators of access to diets of adequate quality. Both indicators rely on information on dietary *diversity*, but diversity is not synonymous with quality; greater dietary diversity is known to be associated with a higher probability of nutrient adequacy, but diversity is also associated with greater energy intake.[57] Moreover, given that both indicators include not

only food groups that contribute nutrient-rich foods but also some that contribute mostly energy (e.g., oils, sugars), it is likely that, as currently designed, the HDDS and FCS are stronger indicators of food quantity (energy) than of quality (micronutrient adequacy). The same is true for experience-based indicators, which in developing countries were primarily validated against a broad range of measures of causes or consequences of food security, including aspects such as poverty, education, and food quantity, but not against micronutrient adequacy. The CSI is another indicator that lacks clarity in terms of underlying construct and purpose. Coping strategies can be the direct consequence of food insecurity (or of perceived food insecurity or risk of losing food security), but they can also further precipitate food insecurity in the short or long term. Thus, the CSI should be used not as a descriptive measure of food insecurity per se, but as a measure of the severity of adopted compensation strategies. CSI might also be useful for screening households and targeting food security interventions, or as an early warning indicator. Validation of the indicator for these purposes should not rely on tests of associations with indicators of food security, but rather should assess how well the CSI performs in identifying households either before food insecurity sets in or at an early stage of food deprivation. To our knowledge, such validations have not been done.

The purpose of indicators—e.g., for targeting, screening, early warning, diagnosis, estimating prevalence, and monitoring or evaluation—is another aspect of the literature on food security access indicators that remains poorly delineated. The publications describing the design, testing, and validation of the indicators reviewed are generally vague about the purpose(s) for which the indicators were developed and/or validated, and some completely fail to describe the purpose(s). Most validation studies we reviewed assessed how well the indicators reflected the underlying constructs (as compared with a gold standard or other type of measure). Similarly, the studies that included a sensitivity and specificity analysis (e.g., the individual dietary diversity indicators) aimed to identify best cutoff points for deriving prevalence estimates. The FCS was also tested for its performance at estimating prevalence and classifying households into those with poor, borderline, or acceptable food consumption based on hypothesized energy consumption cutoff points. In addition to providing prevalence estimates, however, the purpose of this classification was to use the indicator to target food assistance and other services to households found to have scores below a preestablished cutoff point that defines poor food consumption (low access to food). The FCS, as currently computed, was found to consistently underestimate the prevalence of low energy consumption; thus, if used for targeting, the indicator will result in a significant proportion of food-insecure households being left out of the intervention (false negatives). With respect to monitoring and evaluation purposes, none of the reviewed indicators have been assessed for their performance in capturing changes over time. Evidence from Burkina Faso shows that an individual dietary diversity score[72] and an experience-based scale[73] were responsive to seasonal changes.

Finally, with respect to indicator equivalence—or consistency across contexts—Figure 2 shows that only the experience-based food security indicators have been tested for construct, measurement, and scalar equivalence. Scalar equivalence was achieved for the HFSSM across contexts within the United States and for the ELCSA within countries in Latin America; the ELCSA also has measurement equivalence across at least some countries in Latin America. The HFIAS, which was developed for widespread use in developing countries, showed good construct equivalence but poor measurement and scalar equivalence. This led to the development of the HHS, a scale that has scalar equivalence across contexts and countries but focuses only on the most severe forms of food insecurity experiences and on the quantity aspect of food access. Scalar equivalence is likely to be difficult to achieve for many food security indicators, especially those that rely on highly context- and culture-specific questions. The experience with the HFIAS and the HHS highlights the tradeoffs between achieving scalar equivalence with a focused and narrower set of questions, which

in this case applies only to the most severe forms of food insecurity, versus not achieving comparability across contexts and countries, but covering a broader range of food insecurity experiences. Scalar equivalence is also likely to be difficult to achieve with dietary diversity indicators based on questions related to consumption of food groups, which are also highly context specific. For example, it is difficult to imagine that moving from five to six food groups for an individual dietary diversity score in women will reflect a similar change in micronutrient adequacy of the diet for populations in India (where diversity is relatively high) and Ethiopia (where diversity is generally much lower). Careful assessment of the need for local adaptation of indicators to measure food security should always be conducted in order to accurately capture the often subtle differences between contexts that may have large implications for the food security situation and experiences of different populations.[59] It is critically important to ensure the right balance between reaching equivalence and maintaining local relevance.

Recommendations and Research Agenda

Based on the review, we cautiously recommend the use of the following indicators to assess the food access dimension of food security:

- The use of the reviewed experience-based indicators, and of the HDDS or FCS, to assess household access to sufficient food *quantity*;
- The use of the reviewed experience-based indicators (with the exception of the HHS) to assess household access to diet *quality* (defined qualitatively as not having to adopt practices that favor acquiring cheaper, less appealing, and less micronutrient-dense foods);
- The use of individual dietary diversity scores for women or children as a proxy to assess individual access to diet *quality* (defined as micronutrient adequacy or density of the diet, respectively).

We further recommend research on:

- The validation of the HDDS and FCS to assess their performance at predicting household access to diet quality (defined as micronutrient adequacy) and their redesign for use for this purpose, if appropriate;
- The validation of the CSI for its potential use for early warning and for targeting interventions to prevent deterioration in food access.

Regarding a research agenda, more attention should be paid to indicator validation, starting with assessment of whether or not the indicator reflects what it is intended to reflect. For indicators that are based on scales, validation research should include determining optimal weights for scale items (e.g., equally weighted items may be optimal) and establishing cutoff points and examining their accuracy, ideally by comparison with an indicator of known high accuracy using sensitivity and specificity analysis.[42] Demonstration of reliability through test–retest should also be done, while being careful to avoid testing bias; so far, reliability has been assessed mostly as internal consistency rather than test–retest, the latter being superior to demonstrate reliability. The performance of indicators should also be tested for different purposes (e.g., diagnosis and assessment of prevalence, early warning, screening and targeting, monitoring and evaluation, i.e. capturing changes over time) so that in the future we can map indicators based not only on which component(s) of food security they reflect, but also for which purpose(s) they perform best. Furthermore, more attention should be paid to clarifying and establishing the different forms of equivalence. In particular, it is important to develop and apply standardized qualitative methods to adapt and cognitively test measurement items in particular contexts[19], and statistical methods to compare (i.e., test for equivalence) measures and indicators across cultures, particularly when standardized measurement- or scalar-equivalent indicators are needed.[74] For example, the FAO is conducting research on the cross-cultural validity and equivalence of the Food Insecurity

Experience Scale (FIES)[75], a shortened form of the ELCSA to be included in public opinion polls across the world on an annual basis, using careful linguistic adaptation of the questionnaire in local languages and statistical treatment of the data to adjust scores in order to achieve comparability in the classification of food insecurity severity in different contexts.[76] As part of this initiative, data will be collected in more than 150 countries annually using the FIES. This information will be invaluable, as it will provide the first nationally representative data on the food access dimension of food security at the individual level on an annual basis and for a large number of countries. Indicators to track global changes and measure progress will be invaluable, for example, in the context of the Scaling Up Nutrition (SUN) movement and the monitoring of sustainable development goals.

New indicators need to be developed to measure the food safety and cultural acceptability (e.g., whether people are able to consume foods that they enjoy and are culturally acceptable as often as they like) components of food access. This development should include a careful analysis of what the indicators are intended to reflect and for what purpose they are to be used, and should lay out a plan for the careful validation and assessment of equivalence of the proposed indicators.

Assessment of food insecurity may differ depending on the characteristics of the respondent (e.g., men vs. women, adults vs. children).[77-82] Further research on how the choice and characteristics of respondents affect measurement is needed.

Finally, research should continue on developing and testing different approaches for the comprehensive assessment of multiple food security dimensions and components, including the use of composite indices and suites of indicators.

All these efforts will need to be complemented by major investments in setting up large-scale, regular data collection exercises in a large number of countries, starting with those with the highest burden of food security.

Conclusions

Our study supports the conclusions from several recent reviews of food security measurement that no single indicator can or should be used to capture the complex reality of food security, and that a suite of indicators might be useful for this purpose.[1,7,8,10,12,83] It also reemphasizes the need to harmonize indicators, use a common framework and terminology, and develop and validate indicators that have a stated purpose. A substantial body of research and methodological work has been done over the past decades to identify, test, and validate simple indicators of food security access. Future research should build upon this work and focus on filling the critical research gaps, harmonizing indicators, setting up a global data collection system to monitor and track progress, and ensuring coordination among actors at all levels, including in research, practice, and policy.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was funded in part by the Food and Agriculture Organization European Union Programme "Improved Global Governance for Hunger Reduction" and the CGIAR Agriculture for Nutrition and Health (A4NH) program led by the International Food Policy Research Institute (IFPRI).

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