INTERNATIONAL FOOD
POLICY RESEARCH INSTITUTE
sustainable solutions for ending hunger and poverty

Supported by the CGIAR

IFPRI Discussion Paper 00870

June 2009

Validation of the World Food Programme's Food Consumption Score and Alternative Indicators of Household Food Security

Doris Wiesmann

Lucy Bassett

Todd Benson

John Hoddinott

Poverty, Health, and Nutrition Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI) was established in 1975. IFPRI is one of 15 agricultural research centers that receive principal funding from governments, private foundations, and international and regional organizations, most of which are members of the Consultative Group on International Agricultural Research (CGIAR).

FINANCIAL CONTRIBUTORS AND PARTNERS

IFPRI's research, capacity strengthening, and communications work is made possible by its financial contributors and partners. IFPRI receives its principal funding from governments, private foundations, and international and regional organizations, most of which are members of the Consultative Group on International Agricultural Research (CGIAR). IFPRI gratefully acknowledges the generous unrestricted funding from Australia, Canada, China, Finland, France, Germany, India, Ireland, Italy, Japan, Netherlands, Norway, South Africa, Sweden, Switzerland, United Kingdom, United States, and World Bank.

AUTHORS

Doris Wiesmann*
Independent Consultant

Lucy Bassett*, International Food Policy Research Institute
Research Analyst, Development Strategy and Governance Division

Todd Benson*, International Food Policy Research Institute
Senior Research Fellow, Development Strategy and Governance Division

John Hoddinott, International Food Policy Research Institute
Senior Research Fellow, Poverty, Health, and Nutrition Division

* At the time of writing of this paper, Lucy Bassett, Todd Benson, and Doris Wiesmann were all members of the Poverty, Health, and Nutrition Division.

Notices

[1] Effective January 2007, the Discussion Paper series within each division and the Director General's Office of IFPRI were merged into one IFPRI–wide Discussion Paper series. The new series begins with number 00689, reflecting the prior publication of 688 discussion papers within the dispersed series. The earlier series are available on IFPRI's website at www.ifpri.org/pubs/otherpubs.htm#dp.

[2] IFPRI Discussion Papers contain preliminary material and research results, and have been peer reviewed by at least two reviewers—internal and/or external. They are circulated in order to stimulate discussion and critical comment.

Contents

List of Tables

List of Figures

List of Boxes

ACKNOWLEDGMENTS

This study was supported by a grant to the International Food Policy Research Institute (IFPRI) from the World Food Programme (WFP) as part of WFP's Strengthen Emergency Needs Assessment Capacity project. We thank Jan Delbaere, Agnes Dhur, and Joyce Luma for their helpful comments and suggestions on this study.

We greatly benefited from strong support for our fieldwork by the Vulnerability Analysis and Mapping (VAM) unit in Bujumbura and by staff from the WFP and the Coordination Nationale pour la Sécurité Alimentaire (CNSA) in Port-au-Prince. We offer our sincere thanks to Evaline Diang'a, Jeanne-Françoise Ndayisenga, Melanie Rubavu, and Jean Mahwane from WFP Burundi; Romain Sirois, Raphaël Chuinard, and Jean Carel Norcéide from WFP Haiti; and Gary Mathieu and Pierre Anthony Garraud from CNSA. We quickly developed a good working relationship that made the task of finalizing the comprehensive food consumption module and training the enumerators on its administration a smooth, efficient, and enjoyable process.

We gratefully acknowledge research assistance by Heidi Haugen, VAM officer in Dakar, who spent two weeks in Washington, D.C., to work with us on this study. Her contribution has been extremely helpful, in particular for deriving the Food Consumption Score for Burundi and Sri Lanka and assisting with the calorie conversions for the former country.

We also thank Yisehac Yohannes from IFPRI for his valuable assistance with the calorie conversions for Sri Lanka and Haiti. We are indebted to Manohar Sharma from IFPRI for including a section on food frequency in the questionnaire for his food-versus-cash transfer study in Sri Lanka and for providing helpful information on the survey. We are grateful to Mary Arimond from IFPRI for her advice and comments about this study. Finally, we thank Jay Willis for his assistance with finalizing this document.

Errors and opinions are those of the authors.

ABSTRACT

The objective of this study is to validate the World Food Programme's (WFP) method of establishing the prevalence of food insecurity. WFP's method has two parts: (1) the construction of a Food Consumption Score (FCS) and (2) the classification of food security status based on the FCS. Our validation work has the following components: (1) collecting and analyzing survey data from three countries—Burundi, Haiti, and Sri Lanka—that contain information about calorie consumption at the household level and information needed to construct the FCS; (2) establishing the extent to which an assessment of food security status based on the FCS mimics food security status based on household calorie consumption; and (3) assessing whether changes to the construction of the FCS would improve its predictive power and whether such changes are feasible, given the environment in which these assessments are typically conducted.

To achieve the third objective, alternative dietary diversity and food frequency indicators are constructed by either modifying WFP's calculation method for the FCS or following a different approach, such as that for the Household Dietary Diversity Score developed by the Food and Nutrition Technical Assistance Project. By comparing indicator performance, we can answer the questions of whether the FCS could be simplified by using food group diversity instead of food frequency by food group, if further disaggregation of food groups would improve its validity, and what the merits and demerits of other aspects of WFP's standard method are. Based on our findings about the validity of the FCS and the results for alternative proxy indicators, we then suggest changes to the construction of the FCS.

Our findings on the usefulness of the FCS are encouraging. The same holds true for the alternative indicators of dietary diversity and food frequency we considered. There are positive and statistically significant associations with calorie consumption per capita, particularly when small quantities are excluded from food frequencies. In two out of three study sites, food frequency scores are clearly superior to simpler measures of diet diversity (food or food group count). Higher levels of disaggregation are advantageous, but with diminishing marginal returns. We note, however, that the provision of food aid seems to weaken the association of the FCS with calorie consumption.

All of these observations support the use of WFP's FCS for food security assessments. However, the cutoff points used by WFP to define poor, borderline, and adequate Food Consumption Groups are too low when the FCS classification is compared to estimates of calorie deficiency from our survey data and other sources. As a food security classification device, the FCS could be improved by excluding foods consumed in small quantities from the FCS and, even more important, adjusting the cutoffs used to classify households as having poor, borderline, or acceptable food security. Minor gains in the validity of the FCS could be achieved by making several technical adjustments to the calculation of the FCS, for example, using a 12-group food classification instead of an 8-food group classification.

This study has several limitations. We did not validate the proxy indicators against diet quality, because this would have required the collection of individual 24-hour recall data for all household members, which was beyond the scope of our study. The use of seven-day household recall data is a limitation for our analysis; information on dietary intakes from individual 24-hour recalls is generally considered more accurate. The lack of precise information on the effects of excluding small quantities from food frequencies is another constraint.

Keywords: food security, dietary diversity, food frequency, Food Consumption Score, proxy indicator, validation study, Burundi, Haiti, Sri Lanka

1. INTRODUCTION

Background

Measuring food security is fraught with methodological challenges. While a number of approaches exist, for many of the organizations working in populations that experience food insecurity, complex data collection and analysis are impractical, especially in emergency situations. Data on the dietary diversity and food frequency of households or individuals are easy to collect and have proven reliable proxy indicators of diet quality and quantity across a range of settings (Arimond et al. 2008; see Ruel 2002 and Wiesmann et al. 2006 for an overview of the literature).

Based on earlier work, including Ruel (2002) and Hoddinott and Yohannes (2002), which indicated that diversity and food frequency were correlated with measures of household food security such as calorie availability, the World Food Programme (WFP) developed a proxy measure of food security. Data were collected on a seven-day recall of frequency of consumption of several food groups at the household level. These data were used to construct a Food Consumption Score (FCS) and classify households according to their food consumption. These scores are an integral part of WFP's Comprehensive Food Security and Vulnerability Assessments and its Emergency Food Security Assessments.

Monitoring, assessing food needs, and population-level targeting are the most important uses of the data regularly collected by WFP in Comprehensive Food Security and Vulnerability Assessments and Emergency Food Security Assessments in more than 20 countries. By means of the FCS and complementary indicators, WFP aims to track changes in food security in countries and regions, assess a country's food security status relative to other countries for the purpose of international targeting, identify food-insecure regions and vulnerable groups for within-country targeting, and determine the food needs of a food-insecure population to calculate food rations. For example, WFP's assessment of needs and of food aid requirements in Darfur are based, in part, on the FCS (WFP 2007). It should be noted that the FCS is not intended for household-level targeting.

Against this background, the purpose of this study is to validate the FCS as a proxy indicator of food security and suggest possible improvements to make it a better instrument for the above-mentioned purposes. Thus, this study makes a practical contribution to an ongoing dialogue among researchers and organizations implementing food security assessments. Definitions and dimensions of food security and corresponding indicators, objectives, and organization of the study are detailed in the following.

Definitions, Dimensions, and Proxy Indicators of Food Security

The most commonly used definition of food security highlights its multidimensional nature. At the World Food Summit in 1996, high-level representatives of the international community agreed that "food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996).

Along similar lines, and underscoring the complexity of food security measures, Barrett (2002, 24) describes four essential aspects of food security: (1) the availability of and access to sufficient amounts of food (that is, that people have enough food to meet their energy [calorie] requirements); (2) the availability of and access to different types of food to ensure adequate diet quality (or that people are able to meet their protein and micronutrient requirements); (3) the absence of feelings of deprivation, restricted choice, or anxiety related to the quantity or quality of available food, that is, the psychological dimension; and (4) the social or cultural acceptability of consumption patterns. Popular indicators of food security tend to provide information on only one of these dimensions at a time. Table 1 shows examples of primary indicators and proxy indicators that correspond to each of the four aspects.

Table 1. Dimensions of food security and corresponding indicators

Dimension	Indicator	Proxy indicator
(1) Diet quantity	Dietary energy intake Calorie availability	Food frequency Dietary diversity Meal frequency
(2) Diet quality	NAR, MAR	Food frequency Dietary diversity
(3) Psychological dimensions	Perception of dietary adequacy and acceptability	Coping strategies Food security scales
(4) Social and cultural dimensions	Perception of dietary adequacy and acceptability	Coping strategies Food security scales

Source: Adapted from Wiesmann et al. (2006).
Notes: This table does not attempt to provide a comprehensive list of indicators; it gives examples of commonly used indicators and proxy indicators. Dietary energy intake and calorie availability: calculating dietary energy *intake* requires precise information about the amounts of all foods *eaten* by an individual over a defined time period (usually 24 hours). Calorie availability is derived from household-level data, using food consumption modules common in economics. In the economic sense, consumption is defined as the using up of goods and services by consumer purchasing or in the production of other goods and is often expressed as the monetary value of these goods and services. Food consumption includes food not eaten by household members, such as food given to guests, food given to animals, and waste. Food consumption modules request information on quantities of food consumed and/or expenditure on food. The reference period normally varies from 7 to 30 days. NAR = nutrient adequacy ratio, which is defined as the ratio of intake of a particular nutrient to its recommended dietary intake (Ruel 2002). MAR = mean nutrient adequacy ratio, which is the average of the NARs, computed by summing the NARs and dividing by the number of nutrients. Each NAR is usually truncated at 100 percent of the recommended dietary intakes to avoid high consumption levels of some nutrients' compensating for low levels of others in the resulting MAR (Ruel 2002). Dietary diversity is usually operationalized as follows: respondents are asked the number of different foods or food groups they (and/or their household) have consumed over a predetermined time period, varying from 1 to 30 days. Indicators of food frequency consider the frequency of consumption of foods or food groups over a defined period.

In practice, the most popular dimension of food security is the first one—access to sufficient *quantity* of food. Dietary energy *intake* as a corresponding indicator is obtained mostly by 24-hour recalls, which are meant to assess the amounts of all foods an individual ate in the previous 24 hours (Gibson 2005). Food consumption/expenditure data collection tools are usually designed to gather information at the household level on the consumption of (and expenditures on) foods over a predetermined period of time (often one or two weeks) (Deaton 1997). The information obtained from this type of data is usually referred to as "calorie availability at the household level" (see, also, the definitions in the notes to Table 1).

The second dimension of food security addresses the issue of diet quality, or whether individuals are able to meet all their daily nutrient requirements. Commonly used measures of nutrient adequacy include the individual nutrient adequacy ratio (NAR), which is derived for each nutrient of interest, and the mean nutrient adequacy ratio, which is an average of all the NARs and thus provides an overall assessment of adequacy for a given set of nutrients. Twenty-four-hour recall data are the only type of data considered suitable for properly assessing the diet quality aspect of food security: calculating NARs of micronutrients, for example, requires detailed information on food intake at the individual level and food preparation and processing methods, which influence losses and bioavailability of micronutrients.

The indicators that touch on the third dimension, the psychological aspects of food insecurity, are generally qualitative measures, such as food security scales and measures of coping strategies.[1] These proxies are meant to reflect people's perceptions of their own food security. The fourth dimension, the social and cultural acceptability of consumption patterns, is even more difficult to quantify and thus is

[1] Barrett (2002, 15) describes a coping strategy as the intentional loss of human or nonhuman productive capital to sustain an economic shock and smooth food consumption over time.

lacking specific measurement devices, although the qualitative measures also reflect cultural and social aspects (Barrett 2002).

We deliberately restrict our validation of the FCS to the quantitative aspect of food security, measured as calorie consumption from seven-day household recall data. The main reason is that the scope of this study precludes the collection of 24-hour recall data, which require a particularly high level of technical skill in interview techniques, data processing, and analysis (Ferro-Luzzi 2002; Gibson 2005). Also, since the FCS is a household-level measure and 24-hour recall data are collected at the individual level, lengthy interviews with each household member would be required to match the unit of analysis for the proxy indicator and benchmark variable. While 24-hour recall data on dietary intakes are deemed more precise than seven-day household recall data of food consumption, the latter are considered acceptable for measuring the quantitative aspect of food security at the population level (Smith, Alderman, and Aduayom 2006).

We have to neglect the diet quality aspect of food security in this study, although dietary diversity and food frequency indicators (such as the FCS) are promising proxy indicators of diet quality (Ruel 2002; Working Group on Infant and Young Child Feeding Indicators 2006; Hatløy, Torheim, and Oshaug 1998; Torheim et al. 2004). It is well known that as people diversify from their plant-based staple diets to include animal source foods, fruit and vegetables, and dairy products, they increase their intake of essential micronutrients such as calcium, vitamin A, iron, and zinc (Wiesmann et al. 2006). The use of seven-day household recall data, however, limits our analysis. As explained earlier, information about dietary intakes from individual 24-hour recalls would be needed to validate the FCS against the diet quality dimension of food security. In fact, the FCS was designed to reflect diet quantity *and* diet quality aspects (compare WFP's justification of weights in the Data Sets and Methodology section). For most of WFP's purposes—such as assessing the amount of food aid needed—the diet quantity aspect is more relevant.

The psychological, social, and cultural dimensions of food security are clearly not the focus of our study, given the uses of the FCS for monitoring, targeting, and needs assessments. Dietary diversity and food frequency indicators such as the FCS are not considered proxy indicators for the third and fourth dimension of food security listed in Table 1. Qualitative measures attempting to capture these dimensions are highly context sensitive and require great care in interpretation. In its assessments, WFP collects information about coping strategies that relate to these dimensions, but these data are not used for constructing the FCS.

Objectives of the Study

The objective of this study is to validate WFP's method of establishing the prevalence of food insecurity. WFP's method has two parts: (1) the construction of an FCS and (2) the classification of food security status based on the FCS. Our validation work has the following components:

1. Collecting and analyzing survey data from three countries—Burundi, Haiti, and Sri Lanka—that contain information about calorie consumption at the household level and information needed to construct the FCS.
2. Establishing the extent to which an assessment of food security status based on the FCS mimics food security status based on household calorie consumption.
3. Assessing whether changes to the construction of the FCS would improve its predictive power and whether such changes are feasible given the environment in which these assessments are typically conducted.

To achieve the third objective, we construct alternative dietary diversity and food frequency indicators besides the FCS. We either modify WFP's calculation method for the FCS or follow a different approach, such as for the Household Dietary Diversity Score (HDDS) developed by the Food and Nutrition Technical Assistance Project (FANTA). By comparing indicator performance, we can answer the questions of whether the FCS could be simplified by using food group diversity instead of food frequency by food group, whether further disaggregation of food groups would improve its validity, and what the merits and demerits of other aspects of WFP's standard method are.

Organization of the Study

The study is organized as follows. We begin by describing the data sets and methodology, including the construction of the FCS and alternative proxy indicators. The next section presents the results of the validation of the FCS for each of the three case studies (Burundi, Haiti, and Sri Lanka). Finally, we present a synthesis and discussion of the findings and recommendations on how to improve the FCS for the purpose of food security assessments.

2. DATA SETS AND METHODOLOGY

This analysis aims to identify how accurately WFP's FCS predicts the quantitative dimension of household food security, defined as having adequate food *quantity* or calorie consumption per capita. To assess whether changes to the construction of the FCS would improve its predictive power, we construct alternative dietary diversity and food frequency indicators by varying elements of the FCS calculation. We restrict our analysis to the prediction of the quantitative aspect of food security because validating the proxy indicators against diet quality is beyond the scope of this study. This is a limitation of our study because even under the conditions of scarcity, people value diet quality—to quote one household head from Haiti, "certainly we eat to fill our bellies, but both quality and quantity should be taken into consideration."

The following sections describe the data sets from Burundi, Haiti, and Sri Lanka and the survey tools: WFP's food frequency module to collect data for the FCS and the International Food Policy Research Institute's (IFPRI) comprehensive food consumption module to determine calorie consumption per capita. We continue by presenting the method currently used by WFP for deriving the FCS and the construction of alternative indicators of dietary diversity and food frequency. This section concludes by explaining the measurement of calorie consumption per capita as the benchmark variable in this study and outlining the analytical strategy to validate the proxy indicators against this benchmark. A number of terms are listed in Box 1 with the definitions used by WFP.

Box 1. Definitions

Dietary diversity is defined as the number of different foods or food groups eaten over a reference time period, not regarding the frequency of consumption.

Food frequency, in this context, is defined as the frequency (in terms of days of consumption over a reference period) that a specific food item or food group is eaten at the household level.

Food group is defined as a grouping of food items that have similar caloric and nutrient qualities.

Food item cannot be further split into separate foods. However, generic terms, such as *fish* or *poultry*, are generally considered to be food items for the purpose of this analysis.

Condiment, is this context, refers to a food that is generally eaten in a very small quantity, often just for flavor. An example would be a "pinch" of fish powder, a teaspoon of milk in tea, spices, and so forth.

Source: World Food Programme (2007, 3ff).

Data Sets

Burundi

The data for this study were collected during the 10th round of the Burundi Food Security Monitoring Survey (FSMS) (*Burundi: Étude sur la Sécurité Alimentaire et Vulnérabilité*) in October 2007 as part of WFP's regular Vulnerability Analysis and Mapping activities. The comprehensive food consumption module developed at IFPRI was appended to the normal FSMS questionnaire, which is routinely used to collect information about food frequencies by food group, coping strategies, and other variables related to household food security. The detailed food consumption data are needed to calculate calorie consumption per capita. In addition, a supplementary data collection instrument was applied in local markets to derive conversion factors for common nonmetric local units. The survey was conducted in the sentinel sites established by WFP in 16 rural provinces and comprised 442 households.

Haiti

The data collection in Haiti followed the same approach as in Burundi: the IFPRI team developed a comprehensive food consumption module adapted to the Haitian context. This module was implemented together with the normal FSMS questionnaire in February 2008, during the seventh round of the Haiti FSMS (*Haïti: Suivi de la Sécurité Alimentaire)*. As in Burundi, information needed for the conversion of local units was gathered in local markets by means of a supplementary data collection instrument. The survey took place in eight sentinel sites established by WFP in the North and Northeast departments and comprised 411 households.

Sri Lanka

The data on food consumption and food frequency were collected as part of a study by IFPRI on tsunami-affected households in Sri Lanka. The objective of this research was to compare food and livelihood security outcomes between households that receive food assistance and households that receive an equivalent amount of cash assistance by WFP (see Sharma 2006 for further information). The baseline survey was completed in November 2005; the follow-up survey, in February–March 2006. The questionnaire for both rounds includes full food consumption and expenditure modules and information on crop production, assets, and the participation in government and nongovernmental organization-(NGO) run assistance programs. Prior to the implementation of the follow-up survey, sections on food frequency (by individual food items and by the most important food groups), meal frequency, and coping strategies were added to the questionnaire. These additional questions were tailored to suit the methods and validate the indicators suggested in the *Emergency Food Security Assessment Handbook* (WFP 2005). The survey was implemented in three coastal districts in southern and eastern Sri Lanka, collecting data on 1,391 households. It is important to note that only beneficiaries of food or cash transfers were included (the transfers were targeted to families who had their houses completely or partly destroyed by the tsunami, lost their main livelihoods, or were considered destitute) (Sharma 2006).

The Survey Tools

WFP's Food Frequency Module

WFP's food frequency modules are designed to collect data for calculating the FCS. (In this study, the data are also used to derive some alternative indicators of dietary diversity and food frequency; see the section on Developing Proxy Indicators of Food Security for further explanation.) The food frequency module is usually administered by asking the respondent how many days in the past week the household has eaten a food item/food group. In its Technical Guidance Sheet on the calculation and use of the FCS in food consumption and food security analysis (WFP 2007), WFP states the following guidelines for the design of the food frequency module:

1. The food list should cover 10 to 25 food items/groups from nine main food groups, based on knowledge of the local food habits and considering both economic and nutrition aspects.
2. The recommended recall period is seven days.
3. Frequency of consumption is defined as number of *days* a food item was consumed over seven days, not as the number of *times* consumed.
4. The food items known to be eaten as condiments (i.e., in very small quantities) should be identified and the frequency of their consumption recorded separately during data collection.

The rationale for these decisions, as explained by WFP, and more detailed instructions are described in Box 2. Appendix Table A.1 shows an example of a food frequency module devised along these lines, taken from WFP's Technical Guidance Sheet (for the food frequency module designed at IFPRI for Sri Lanka, see Table A.2). We note that so far, the questionnaires for the routinely applied Burundi and Haiti FSMSs have made no provision for excluding small quantities from food frequencies.

The same holds true for the food frequency module for Sri Lanka that we developed in 2006, based on the *Emergency Food Security Assessment Handbook* (WFP 2005) because the revised guidelines were not yet available in 2006.

Box 2. World Food Programme (WFP) guidance on food lists, recall period, operationalization of frequency, and treatment of condiments

The food items/groups listed in the questionnaire can be categorized into nine main food groups: cereals; starchy tubers and roots; legumes and nuts; meat, fish, poultry, and eggs; vegetables (including green leaves); fruit; oils and fats; milk and dairy products; and sugar/sweets. Vulnerability Analysis and Mapping collects information on some single food items within these groups because there might be interesting economic or well-being information coming from the consumption of certain items compared to the consumption of other ones.

In this sense, the list should be detailed enough to distinguish between items with different economic meaning (besides the nutrition information). On the other hand, too many foods would confuse the respondent, because detailed recall is difficult over a seven-day recall period. Generally, the list of food items/groups surveyed contains between 10 and 25 items. The food item list should be customized, paying particular attention to cereals/grains, cereal-made food like bread or couscous, or other staples that have important different economic meaning. Knowledge of the local food habits as well as nutritional considerations must inform the creation of the list of foods.

WFP's Vulnerability Analysis and Mapping experts advise a recall of seven days to ensure both good time coverage and reliability of the respondent's memory. According to practical data collection experience (of WFP and others), a seven-day recall period seems to be the most appropriate to capture information about a household's habitual diet, taking into account the limits given by possible seasonal consumption. A recall period longer than seven days has proved to be problematic as difficulties in remembering what was prepared appear to increase. A shorter recall period would risk missing foods served habitually but infrequently at the household level, for example, on market days, Fridays (in Muslim areas), or Sundays (in Christian areas), or it would overestimate the consumption if the recall period included those special days.

The dietary diversity and food frequency approach aims to estimate whether the household manages to access items from the basic food groups in its habitual diet. Number of days of consumption out of the reference last seven days (week) is intended to track potential regularities in the consumption habit. The number of *times* would mask or confuse regularities because eating meat three times a week could mean three days, with once-per-day consumption; two days, with once-per-day consumption on one day and twice-per-day consumption on one day; or one day, with three times' consumption. The fact that one unique piece of information collected could result in different possible interpretations is not appropriate for the aim for the module: detecting regularities of consumption. Of course, the fact that households might consume a particular food item just once within a day or more frequently cannot be estimated through this module.

The questionnaire should properly account for food items that are consumed in very small quantities—here referred to as condiments. For instance, if a pinch of fish powder is added to the pot, this should be treated as a condiment rather than as a day's consumption of fish. The same logic would be used for a teaspoon of milk in the tea, a shred of bush meat used for flavor in a stew, and so forth. To address this in data collection, the items known to be eaten as condiments should be identified during questionnaire design. These condiments should be listed as separate food items, for example, "fish eaten as part of a meal" and a separate item, "fish used in small amounts for flavor." The enumerators should then be clearly trained to distinguish between the two. Weight cutoffs to distinguish between use of a food as a condiment and use as a main food are not used during data collection with the interviewees; however, a weight cutoff may be appropriate when providing instructions to enumerators.

Source: WFP (2007, 15ff.).

IFPRI's Comprehensive Food Consumption Module

The comprehensive food consumption module is designed to collect detailed information on the food consumption of survey households. The principal analytical output of the module is household calorie consumption, to serve as a benchmark for assessing the food security classification by means of WFP's FCS. (The module is also the basis for constructing some alternative indicators of dietary diversity and food frequency; see the section on Developing Proxy Indicators of Food Security.) The module is administered by asking the respondent (ideally the individual in the household primarily responsible for food preparation) whether any member of the household of which they are a part consumed any of each item in an extensive list of common items found in local diets over the recall period. If so, the enumerator then asks for information on the total quantity consumed of the food item.[2] Designing the comprehensive food consumption modules entails the following steps:

1. Comprehensive food lists for the study countries have to be developed, including all food items that are common in the local diet (some spices that contribute only minuscule amounts of calories can be neglected).
2. Appropriate units for the quantities of each food item in the food list need to be determined, such as gallons, liters, and milliliters for liquids; grams and kilograms for solid foods; or nonstandardized measures (cups, spoons, metal cans, pieces of fruit, loaves of bread, etc.).
3. It is recommended that a supplemental data collection instrument be developed to overcome some of the problems arising from the use of nonstandard or locality-specific units with particular foods. A worksheet for collecting the weights of quantities of commonly consumed foods that are usually reported in these units should be designed.[3]
4. In monetized food economies where most of the food is purchased, it is worthwhile to ask for the principal mode of acquisition and the estimated market value. The approximate market value can serve as a control variable for data cleaning and help to properly determine quantities given in "other" units.
5. The recall period of the comprehensive food consumption module should be seven days, to match the recall period for WFP's food frequency module.
6. Several rounds of field-testing and revising the survey instruments should be performed to better reflect the characteristics of and variations in local food economies. Testing and revision during the training are also required for the guidelines for interviewers that accompany the module.

This approach is standard for the collection of household data for economic analysis. Appendix Table A.3 shows an excerpt from the comprehensive food consumption module for Haiti that was developed along these lines. If detailed information about the composition of the household by age, sex, and pregnancy and lactation status was not available from other sections of WFP's standard questionnaire, a small section requesting this information was included at the beginning of the comprehensive food consumption module.

Developing Proxy Indicators of Food Security

The FCS and other proxy indicators can be constructed in a number of ways. We begin by explaining how the FCS is calculated before outlining the construction of a number of alternative indicators.

---

[2] It should be noted that directly asking for the quantity *consumed* introduces less noise into the data than another common method in economics, that is, asking for the *frequency* of *purchasing* a food item, the quantity of the last purchase, and the amount of food consumed from own production or received as a donation.

[3] Using this worksheet, the supervisor has to determine the weights of various piles of roots and tubers or heaped containers of cereals or pulses that are found for sale in local markets. With this information, conversion factors into metric units can be developed.

Construction of the FCS

The FCS is a frequency-weighted diet diversity score, also referred to as a "food frequency indicator." The FCS is calculated using the frequency of consumption of eight food groups consumed by a household during the seven days before the survey, according to the following procedure:

1. Using standard seven-day food frequency data, group all the food items into specific food groups (Appendix Tables A.4 and A.5 show these groupings for Burundi and Haiti).
2. Sum the consumption frequencies of food items within the same group, yielding a food group score for each food group.
3. Any food group score greater than seven is recoded as seven. This recoding of values is referred to as "truncation" in the analysis below.[4]
4. Multiply the value obtained for each food group by its weight (see Box 3), thus creating weighted food group scores.
5. Sum the weighed food group scores, thus creating the FCS.
6. Using the appropriate thresholds (see Table 2), recode the variable FCS from a continuous variable to a categorical variable for the Food Consumption Groups (FCGs) (WFP 2007).

In its Technical Guidance Sheet for the FCS from August 31, 2007, WFP explains the rationale for the truncation as follows: The survey instrument gathers, for example, the consumption of maize and manioc separately. Therefore, the frequency of starch consumption will be double counted in cases wherein these foods are eaten in combination. A high number of food items consumed per food group can thus bias the score upward. Besides limiting the number of food items in the questionnaire (see the description of the survey tool in the previous section), the truncation of the sum of food frequencies to seven for each food group serves to control this problem, although imperfectly (WFP 2007). The truncation also helps achieve greater comparability of the FCS across countries and makes the FCS more suitable for targeting countries.[5]

The weights are supposed to make the FCS more capable of capturing two dimensions of food security: diet quality *and* diet quantity. This is evident from the detailed explanation of WFP's weighting scheme and its justification in Box 3. The subjective concept of "nutrient density," which should not be confused with common definitions of (micro-) nutrient density, encompasses quantitative aspects (caloric density, actual quantities typically eaten) as well as qualitative aspects (protein content and quality, content and bioavailability of micronutrients).[6]

---

[4] We note in this context that the number of days and not the number of times a food item was consumed is recorded during data collection. This could already be considered a form of truncation, since number of times consumed is a more common definition of food frequency. The frequency of consumption of each food item is capped at seven (days), because the reference period is seven days. Yet in the following, we refer to truncation exclusively as the capping of the sum of food frequencies of a food group at seven.

[5] Yet the truncation cannot fully compensate for the variation in the number of food items per food group across countries. This variation is inevitable because the list of food items needs to be adapted to the local context. For example, the World Food Programme's (WFP) food frequency module lists 8 main staples for Burundi and 11 main staples for Haiti, but 6 leaves or vegetables for Burundi and vegetables/leaves as 1 item for Haiti. The theoretical maximum of the (nontruncated) food group score for main staples is therefore 56 for Burundi and 77 for Haiti; the maximum for vegetables/leaves is 42 for Burundi and 7 for Haiti. Thus, by design, the food frequency module for Haiti will tend to produce comparatively higher scores for the main staples group and lower scores for the vegetables/leaves group, despite the truncation.

[6] For some food groups, the aim to reflect diet quality *and* diet quantity simultaneously creates a conflict: sugar, for example, which is rightly labeled as "empty calories," should be assigned a weight of 0 from a strict diet quality perspective. From a diet quantity perspective, oil could have a greater weight than 0.5 because of its potential contribution to dietary energy intake (although the quantities consumed are usually low). From a diet quality point of view, fruits and vegetables should be awarded a higher weight than 1 because they are important sources of micronutrients. It appears that their micronutrient content, that is, their good contribution to diet quality, is weighed against their low energy content, that is, their low share in diet quantity.

Box 3. Explanation of the weighting scheme for the Food Consumption Score (FCS)

The determination of the food group weights as described in the calculation of the FCS is based on an interpretation by a team of analysts of "nutrient density."… "Nutrient density" is a term used to subjectively describe a food group's quality in terms of caloric density, macro- and micronutrient content, and actual quantities typically eaten. Although subjective, this weighting attempts to give greater importance to foods such as meat and fish, usually considered to have greater "nutrient density" and lesser importance to foods such as sugar. It is not yet known if these weights are appropriate universally. However, at this time it is recommended that the weights remain constant to provide a more standardized methodology. As research continues, further support may be lent to these weights, or it may be found best to modify them in either a universal or context specific manner.

The guiding principle for determining the weights is the nutrient density of the food groups. The highest weight was attached to foods with relatively high energy, good quality protein, and a wide range of micronutrients that can be easily absorbed. Currently, weights recommended by VAM [Vulnerability Analysis and Mapping] are calculated based on the following logic (World Food Programme 2007, 17ff.).

Aggregate Food Groups and Weights to Calculate the FCS

Food groups	Weight	Justification
Main staples	2	Energy dense, protein content lower and poorer quality than legumes, micronutrients (bound by phytates)
Pulses	3	Energy dense, high amounts of protein but of lower quality than meats, micronutrients (inhibited by phytates), low fat
Vegetables	1	Low energy, low protein, no fat, micronutrients
Fruit	1	Low energy, low protein, no fat, micronutrients
Meat and fish	4	Highest quality protein, easily absorbable micronutrients (no phytates), energy dense, fat. Even when consumed in small quantities, improvements to the quality of diet are large.
Milk	4	Highest quality protein, micronutrients, vitamin A, energy. However, milk could be consumed only in very small amounts and should then be treated as condiment, and therefore reclassification in such cases is needed.
Sugar	0.5	Empty calories. Usually consumed in small quantities.
Oil	0.5	Energy dense but usually no other micronutrients. Usually consumed in small quantities.

Source: World Food Programme (2007, 17ff.).

Since considerations about diet quality *and* diet quantity guide the assignment of weights, it is legitimate to evaluate the usefulness of weights with regard to calorie consumption per capita as an indicator for the quantitative dimension of food security. We are aware that this does not do full justice to the weighting scheme, because we cannot validate the FCS against indicators of diet quality within the scope of this study.

In its most recent guidelines, WFP strongly advocates that the consumption frequency of foods eaten in condiment quantities (such as milk or sugar added to tea) should be recorded separately and not be included in the FCS. We cannot make this distinction in our analysis; as mentioned earlier, the food frequency modules used for data collection make no provision for recording condiments separately.

Table 2. Thresholds for creating food consumption groups

Food Consumption Score	Profile
0–21	Poor
21.5–35	Borderline
>35	Acceptable

Source: World Food Programme (2007).
Note: For populations that consume oil and sugar nearly daily, the thresholds for the three consumption groups can be raised from 21 and 35 to 28 and 42 (World Food Programme 2007).

Construction of Alternative Proxy Indicators

In this study, we examine the performance of alternative dietary diversity and food frequency indicators besides the FCS to predict calorie consumption per capita. We are thereby able to answer questions about how the FCS can be improved or simplified: Does the consideration of consumption frequencies in the score prove advantageous compared to simpler food or food group counts, that is, measures of dietary diversity? Would further disaggregation of food groups improve the validity of the score (for example, the 12-food-group classification for the HDDS developed by FANTA might be a viable alternative to WFP's 8-food-group classification)? What are the effects of truncation and weighting with regard to the association with calorie consumption per capita? and, How important is the exclusion of foods consumed in small quantities for the validity of the proxy indicator?

We therefore construct alternative proxy indicators of household food security by (1) varying the number of food groups that are included; (2) ignoring or including the frequency of food consumption; (3) applying weights or not weighting; (4) truncating or not truncating food frequencies; and (5) including or excluding the consumption of very small quantities of food. Table 3 gives an overview of how the first four alternatives are combined in our analysis; Box 4 describes FANTA's HDDS and its 12-food-group classification; finally, the exclusion of small consumption quantities in constructing all these proxy indicators is explained.

To assess the impact of omitting foods eaten in condiment quantities, the proxy indicators listed in Table 3 are varied by excluding foods consumed in small amounts. As mentioned previously, the data collected give us no information on the true number of days a food was consumed in larger quantities in the past week. We have to resort to an approximation method to mimic the exclusion of small quantities from food frequency and dietary diversity scores.

We therefore divide the quantity of a food item the household consumed over seven days by the number of household members and the number of days the food was consumed. We apply thresholds of 5, 15, and 45 grams to the quantity consumed per person per day to make the food count for the dietary diversity or frequency score. For the proxy indicators based on 8 or 12 food groups, the consumption quantity by food group was the yardstick for inclusion or exclusion. We note that our method is imperfect, because the consumption quantity per person may vary from day to day and between persons. Yet we are confident that the errors of our method will largely cancel each other out.

We acknowledge that implementing quantity cutoffs in simple survey tools poses great challenges. The quantity cutoffs of 5, 15, and 45 grams are imposed after the fact in data sets that allow estimates of quantities in grams. These differ in nature from the data sets generated by simple tools, such as WFP's food frequency module or FANTA's HDDS questionnaire. Especially higher cutoffs, such as less than or greater than 45 grams, are difficult to implement in practice. We therefore regard our quantity cutoffs as experimental: they are meant to identify systematic patterns in the data, for example, trends in the strength of the association between the proxy indicator and the benchmark variable when thresholds are raised. The existence of such patterns could show the right direction to improve the FCS.

Table 3. Overview of the construction of the Food Consumption Score (FCS) and alternative proxy indicators of food security

Type of proxy indicator	Number of foods/food groups	Dietary diversity[a]	Food frequency[b]	Truncation[c]	Weighting[d]	Comments
Alternative dietary diversity scores	8	X		NA	No	The 8 food groups are based on WFP's food group classification for the FCS, using data from the food frequency module.
	12	X		NA	No	The 12 food groups are based on the food group classification for FANTA's HDDS, using data from the food frequency module.
	15–24	X		NA	No	The number of foods is based on the list in the food frequency module.
	141–219	X		NA	No	The number of foods is based on the list in the comprehensive food consumption module.
World Food Programme Food Consumption Score	8		X	Yes	Yes	
Alternative food consumption scores	8		X	Yes	No	The 8 food groups are based on WFP's food group classification for the FCS, using data from the food frequency module.
	12		X	Yes	No	The 12 food groups are based on the food group classification for FANTA's HDDS, using data from the food frequency module.
	15–24		X	No	Yes	The number of foods is based on the list in the food frequency module.
	15–24		X	No	No	The number of foods is based on the list in the food frequency module.
	141–219		X	No	No	The number of foods is based on the list in the comprehensive food consumption module.

Notes: NA = not applicable; WFP = World Food Programme; FANTA = Food and Nutrition Technical Assistance Project; HDDS = Household Dietary Diversity Score.
[a] The dietary diversity indicators are a count of food groups or food items consumed over seven days.
[b] Food frequency indicators are the sum of consumption frequencies of food groups or food items. The consumption frequency is the number of days a food group or food item was consumed over seven days.
[c] Truncation is used to derive food frequency scores for aggregate food groups. After summing up food frequency scores for all food items in the group, values higher than seven are recoded to seven.
[d] The weighting scheme developed by WFP (see Box 3) is used.

Box 4. The Household Dietary Diversity Score (HDDS)

The HDDS was developed by the Food and Nutrition Technical Assistance Project as a proxy indicator of household food access. This dietary diversity indicator is the number of food groups out of 12 groups consumed "during the past day and at night" (see Swindale and Bilinsky 2005, who provide a sample questionnaire). It differs from WFP's Food Consumption Score (FCS) in the following ways: The reference period is one day and not seven days; main staples are disaggregated into two groups (cereals, and roots and tubers); the meat, fish, and eggs group is disaggregated into its three subgroups; and there is a group for "other foods," such as condiments, coffee, or tea. In addition, unlike the FCS, it

Box 4. Continued

does not take into account the frequency of food consumption and is not weighted (Swindale and Bilinsky 2005).

To construct a measure similar to the HDDS from our data, we match the list of 24, 22, or 15 foods in the food frequency modules for Burundi, Haiti, and Sri Lanka, respectively (see Appendix Tables A.2, A.4, and A.5), with the 12-group classification for the HDDS. We note that we thereby only approximate the HDDS as described in Swindale and Bilinsky (2005). One reason is the difference in reference periods; another reason is that the food groupings for the HDDS and the FCS are not perfectly compatible.

For example, the first group of the HDDS contains all cereals and cereal products, whereas the list of cereals and their products used in the WFP food frequency modules is usually not all-encompassing. For Burundi, food frequencies are collected for a list of vegetables by WFP; yet frequently consumed vegetables such as onions are not included, which would be part of the HDDS vegetable group. On the other hand, the HDDS group for meat does not include insects, which are part of the WFP food frequency module for Burundi. Plantains and bananas are not listed separately in the HDDS classification and have therefore been assigned to the fruits group (in the absence of an aggregate group for "main staples" in the HDDS). For the "other foods" group, which is not represented in the WFP food frequency module, we fall back on the detailed food consumption module developed by the International Food Policy Research Institute and take the maximum consumption frequency.

Measuring the Benchmark Variable

The benchmark variable against which the FCS as a proxy indicator of food security will be validated in this study is calorie consumption derived from household-level recall data. The recall period is seven days for all three study countries. Like any other variable, calorie consumption cannot be measured without errors. The fact that respondents have to recall the consumption quantities for each food during the interview is a source of measurement error. In addition, local units used by respondents for measuring quantities (like bowls or calabashes) often vary from one household to the next, but usually, uniform factors are used for conversion to metric quantities. Insofar as these errors are random, they will increase the variance of dietary energy per capita but should not systematically bias the results of the analysis (Wiesmann et al. 2006).

The calorie consumption of the household was calculated from data collected by means of a seven-day household recall, comprehensive food consumption module developed by IFPRI. Quantities were converted into a common metric unit, and volumes converted to weights, using conversion factors from the USDA National Nutrient Database. Particular attention was paid to the proper conversion of nonstandard local units. The food item quantities were then multiplied by the percentage weight of the food deemed edible, and these edible grams of food were converted to kilocalories based on information found in standard food composition tables.[7] Calorie consumption per person per day was obtained by

[7] We used the following sources: for Burundi, food composition tables for Burundi (Centre de Recherches sur la Nutrition 1991), Malawi (Williamson 1975), and East Africa (West et al. 1987); for Haiti, a food composition table for Central America (INCAP/OPS 1996); for Sri Lanka, a food composition table compiled by the Medical Research Institute, Colombo, Sri Lanka, and obtained by Manohar Sharma through personal communication with WFP in 2006. If no information was available from these food composition tables, we used values from Platt (1962) or the USDA National Nutrient Database (http://www.nal.usda.gov/fnic/foodcomp/search). We note that food composition tables vary widely in quality, for example, concerning rigor of sampling and analytic methods. However, data regarding calorie content of foods are usually similar—especially for main staples, which are most relevant for our analysis because they contribute the lion's share of calories. Data regarding micronutrient content vary more greatly across food composition tables because micronutrient content differs for local food varieties and measurement requires sophisticated lab technology.

forming the aggregate of the calories for the various food items. Summing across these food items gives total calorie consumption, which is then divided by the number of household members to obtain per capita consumption. Households with calorie consumption below 500 kilocalories/capita/day or above 5,000 kilocalories/capita/day were considered outliers and excluded from the subsequent analysis.

The food consumption module of the *Emergency Food Security Assessment Handbook* suggests three cutoff points derived from a basic dietary energy requirement of approximately 2,100 kilocalories/capita/day, corresponding to shortfalls of 0, 10, and 30 percent relative to requirements; see Table 4 (WFP 2005). WFP gives no justification for assuming a dietary energy requirement of 2,100 kilocalories per person and day. It appears that WFP uses this requirement as a rule of thumb and that food rations composed by WFP have approximately this dietary energy content.

Table 4. Thresholds for creating calorie consumption groups

Calorie consumption in kilocalories/capita/day	Shortfall, in percentage	Profile
< 1,470	> 30	Poor
≥ 1,470 – < 2,100	≤ 30 – > 0	Borderline
≥ 2,100	0	Acceptable

Source: Food consumption shortfalls described in World Food Programme (2005, 139).

Compared to *average* energy requirements computed for a range of Sub-Saharan African and Asian countries (Smith, Alderman, and Aduayom 2006; Smith and Subandoro 2005), 2,100 kilocalories per person a day seems fairly realistic. The aforementioned studies use average energy requirements for light physical activity by age and sex from FAO/WHO/UNU (1985) and the demographic composition of the population to calculate average energy requirements at the country level. They find that average energy requirements at the country level vary from 2,060 to 2,160 kilocalories per person and day in 7 Asian countries studied (Smith and Subandoro 2005) and from 2,025 to 2,069 kilocalories per person and day in 12 Sub-Saharan African countries examined (Smith, Alderman, and Aduayom 2006). We note that the method used does not consider variation in body size or physical activity across countries.

To estimate the proportion of people who are food insecure, FAO uses *minimum* energy requirements, which are lower: for developing countries, they typically range from 1,720 to 1,950 kilocalories per capita and day (FAO 2006a). For each activity level, the FAO/WHO/UNU (1985) requirements are based on a normatively specified body weight consistent with good health. For a given height, there is a range of body weights consistent with good health. Therefore, there is a range of requirements at each acceptable weight-for-height and physical activity level. FAO uses the lowest acceptable requirement, corresponding to the fifth percentile of the body mass index, and calls it the *minimum* energy requirement.[8] The national dietary energy requirement is a weighted average of the age- and sex-specific minimum requirements with population proportions as weights (Naiken 2003). Smith, Alderman, and Aduayom (2006) note that FAO's use of minimum energy requirements instead of average energy requirements minimizes errors of inclusion in identifying the food insecure. Yet this comes at the expense of higher errors of exclusion (Smith, Alderman, and Aduayom 2006).

For this study, we use the thresholds specified by WFP since our purpose is to validate the FCS classification against the calorie consumption groups WFP defines. Therefore, we constructed a variable for three groups of calorie consumption using the calorie cutoffs shown in Table 4. According to the definition in WFP (2005, 139), these groups should match the FCGs derived from the FCS. In addition, calorie consumption per adult equivalent is calculated to take into account that individual dietary energy needs vary by age and sex and that households differ in their demographic composition. We use the method described in Smith and Subandoro (2007) for this purpose: We first categorize household members by age and sex and assign an adult equivalent factor that compares the energy needs of each

[8] For children under 10 years, the FAO uses the median of the range of weight-for-height and not the lower limit, because a range was not specified for this group.

category with those of a 30- to 60-year-old male according to the energy requirements for moderate activity (2,900 kilocalories according to Table 7 in Smith and Subandoro 2007, 65, based on FAO/WHO/UNU 1985). We then multiply the number of household members in each age-sex category by the corresponding adult equivalent factor and sum the number of adult equivalents to obtain the total of adult equivalents for each household.

The Analytical Strategy

To explore the associations between the proxy indicators and the benchmark variable, we employ a range of analytical techniques, in particular, (1) descriptive analyses, (2) scatter plots, (3) correlation analyses, (4) bivariate analyses, (5) cross-tabulations, and (6) sensitivity-specificity analyses.

We use descriptive analysis to compare estimates of the prevalence of food insecurity from the FCS and calorie consumption per capita based on our surveys, attempting to corroborate our findings with data from other sources. Scatter plots illustrate the relationship between the proxy indicator and the benchmark variable of food security graphically. They give a first impression of the strength, direction, and linearity or nonlinearity of any association found between the two variables. Inserting a line of "best fit," that is, predicted values generated by regression analysis, demonstrates the direction and functional form of the relationship even more clearly.

If the scatter plot shows a linear or mostly linear association between variables, correlation analysis is applied to generate statistical measures that express the strength of the association.[9] Correlation coefficients range from 0 (no correlation) to 1 (perfect correlation), and their *p* values allow us to assess the level of significance. Parametric and nonparametric correlations are used in this study, relying on Pearson's correlation coefficients and Spearman rank correlations, respectively. The latter are based on less strict assumptions regarding the normal distribution of variables and the linearity of their relationship.

We also examine how the food frequency of each food item, each food group score, and the FCS varies across calorie consumption groups, with and without excluding small quantities, truncation, and weighting. This helps us to understand the effects of excluding small quantities, truncation, and weighting on the FCS in more detail and how individual food items and food groups contribute to the ability of the FCS to differentiate by calorie consumption group. We employ a bivariate analysis of food frequencies, food group scores, and different FCS versions by calorie consumption group for this purpose: We calculate mean values by calorie consumption group, assess whether they increase as expected from the lowest to the highest calorie consumption group, and test for significant differences across groups.

The findings from the bivariate analysis will help to answer the following questions: Are some food groups particularly well suited to differentiate across calorie consumption groups? If yes, are these the same food groups for all three study sites? If this is the case, raising the weights of these food groups relative to other food groups could be considered to improve the ability of the FCS to classify households by calorie consumption group.[10] Also, is the ability of certain food group scores to differentiate households by calorie consumption group negatively affected by the truncation? If yes, skipping the truncation or splitting a food group into two or more groups might be an option. Last, are some food groups or food items primary candidates for excluding small quantities because this improves their ability to differentiate markedly? Insights about this issue could help to prioritize foods for exclusion of small quantities. It would be advantageous to apply small quantity exclusions not to all foods in the food frequency module because operationalization in the field can be challenging.

---

[9] When small quantities are excluded from the score, the associations between the variables could be affected by correlated measurement errors. The quantities to which the exclusion thresholds are applied are also the basis for deriving calorie consumption per capita. If a household systematically underestimates the amounts of food consumed, calorie consumption per capita and the proxy indicators excluding small quantities will both be downward biased.

[10] We are aware that modifying the weights to better reflect diet quantity would neglect—or possibly even counteract—their purpose with regard to diet quality. As explained earlier, we cannot examine the diet quality aspect of food security in this study.

Another simple technique for examining the relationship between indicators is cross-tabulation for comparing classifications based on the proxy indicator and the benchmark variable. It requires that continuous variables like the FCS are transformed into categorical variables (see the example in Table 2 for creating the three FCGs for poor, borderline, and adequate consumption). The FCGs are then tabulated against three calorie consumption groups to see how well the classification results for these two indicators match. This approach is recommended in the Technical Guidance Sheet for food consumption analysis (WFP 2007). The multi-shaded Table 5 follows these guidelines and shows the limitations of this method: By design, we obtain a relatively high proportion of close matches, even when the observations are equally distributed across cells and no association of the two variables exists.

Table 5. Sample cross-tabulation of food consumption groups (FCGs) and calorie consumption groups

		Category of calorie consumption			
Percentage of cases		**Poor**	**Borderline**	**Acceptable**	**Total**
FCGs	Poor	11.1	11.1	11.1	33.3
	Borderline	11.1	11.1	11.1	33.3
	Acceptable	11.1	11.1	11.1	33.3
	Total	33.3	33.3	33.3	100.0

Good match	33.3%
Close match	44.4%
Poor match	22.2%

Source: This table was adapted from World Food Programme (2007).
Note: Tables 2 and 4 show the usual thresholds for creating FCGs and calorie consumption groups.

A more sophisticated method to assess the goodness of the classification from the proxy indicator is sensitivity-specificity analysis, which systematically examines errors of exclusion and inclusion with reference to the benchmark variable. This type of analysis employs dichotomous variables: a test variable expressing whether the value of the proxy indicator falls above or below a given cutoff point and a benchmark variable with two possible values (usually 0 and 1) that is also cutoff-based. In this study, households are classified into two groups: the food secure and the food insecure. For example, households can be classified by whether calorie consumption per capita is above or below a certain threshold, such as 2,100 kilocalories/capita/day and can be cross-classified against the number of food groups (being above or below a certain cutoff point). The basis for the analysis is the cross-tabulation shown in Table 6.

Table 6. Cross-tabulation for sensitivity-specificity analysis (showing errors of exclusion and inclusion)

		Benchmark variable classification	
		Food insecure	**Food secure**
Proxy indicator classification	Food insecure	True positives	False positives [a]
	Food secure	False negatives [b]	True negatives

[a] Errors of inclusion.
[b] Errors of exclusion.

There are three numbers of interest derived from this table: *sensitivity,* the proportion of food-insecure households also classified by the proxy indicator as food insecure (number of true positives divided by the number of all food-insecure households; high sensitivity implies low errors of exclusion); *specificity,* the proportion of food-secure households also classified by the proxy indicator as food secure (number of true negatives divided by the number of all food-secure households; high specificity indicates low errors of inclusion); and the positive predictive value of the test (the number of true positives divided by the number of all those classified as food insecure by the proxy indicator). The total percentage of households misclassified is also of interest when testing the performance of a proxy indicator to predict the "true" prevalence of food insecurity ("true" is set in quotation marks because we acknowledge that the benchmark variable has limitations). A proxy indicator strongly associated with calorie consumption will have high specificity, high sensitivity, and a high positive predictive value when a suitable cutoff point is chosen (Hoddinott and Yohannes 2002).

There is always a trade-off between sensitivity and specificity, and the Area under the Curve (AUC) from Receiver Operating Characteristic (ROC) analysis is an important test statistic to assess the general suitability of a proxy indicator. The ROC curve plots sensitivity against 1-specificity for all cutoff points of the test variable (for example, the number of food groups) based on the results of cross-classifications with the dichotomous benchmark variable (see Wiesmann et al. 2006 for a graphical example). Sensitivity increases with higher cutoff points (errors of exclusion decline), while specificity falls (errors of inclusion rise). A proxy indicator with good properties for the classification will produce a ROC curve well above the diagonal of the graph, indicating combinations of high sensitivity and specificity for a range of cutoff points. If the ROC curve coincides with the diagonal, the association between the variables is purely random. The AUC will be 0.50, and no acceptable combinations of sensitivity and specificity can be found. A perfect classification by the proxy indicator would result in an AUC of 1.00. As a general rule of thumb, an AUC below 0.60 is considered not acceptable, above 0.70 is good, higher than 0.80 is very good, and greater than 0.90 is excellent.

A proxy indicator with good properties has at least one suitable cutoff point for classifying food security. The cutoff point can be found by seeking to balance sensitivity and specificity and to minimize the proportion of households misclassified. As a rule of thumb for population-level assessments, both sensitivity and specificity should amount to at least 60 percent, and percentage misclassified should not exceed 30 percent.[11] However, it is not guaranteed that cutoff points chosen with this approach will yield realistic estimates of the prevalence of food insecurity. To obtain an estimate of food insecurity that matches the "true" prevalence of food insecurity as closely as possible, a frequency tabulation of the proxy indicator is performed (showing all its unique values and counting how many times each value occurs). The cutoff point with the cumulative percentage of observations that best matches the prevalence of food insecurity is then selected. This cutoff may or may not have an acceptable balance of sensitivity and specificity, and the method cannot be recommended if no close association between the proxy indicator and the benchmark variable exists (see Box 5 for further explanations).

Box 5. Comparing methods to find cutoff points for proxy indicators of food insecurity

The two methods for selecting a suitable cutoff point for the proxy indicator—trying to match the prevalence of food insecurity versus trying to balance sensitivity and specificity and minimize misclassification—can produce divergent results. The sample cross-classifications for 100 observations (or households) in the table below and resulting statistics help to illustrate the reasons for divergent outcomes.

(continued)

[11] Arimond et al. (2008) state in their study of dietary diversity as a measure of women's diet quality that there are no fixed criteria for determining what levels of sensitivity, specificity, and misclassification are acceptable. There are always trade-offs between sensitivity and specificity; which one should be "favored" depends on the intended uses of the indicator, and sometimes on other factors, such as level of resources available for helping those identified as in need. In general, yardsticks for population-level assessment may have lower requirements—that is, more misclassification could be tolerated—than would indicators used to differentially allocate resources or to trigger action, and indicators used for individual screening may have even higher requirements. For assessing and comparing diet quality for women and tracking change across time in the aforementioned study (purposes similar to the goals of WFP's food security assessments), a balance between sensitivity and specificity was aimed for, and levels of misclassification below 30 percent were considered acceptable (Arimond et al. 2008).

Box 5. Continued

As a starting point, a perfect proxy indicator with a perfect cutoff point is considered for a "true" prevalence of food insecurity of 50 percent ("true" is set in quotation marks because we acknowledge that the benchmark variable has limitations). In this case, the classification is exactly the same as for the benchmark variable; all observations are concentrated in the fields for true positives (upper left field) and true negatives (lower right field). Consequently, sensitivity and specificity are at their maximum values of 100 percent, and the proportion of misclassified amounts to 0 percent (compare the definitions of sensitivity and specificity in the main text). The prevalence of food insecurity from the proxy indicator perfectly matches the "true" prevalence of food insecurity from the benchmark variable.

This picture changes when considering an inadequate proxy indicator for 50 percent prevalence of food insecurity. No systematic association of the proxy indicator and the benchmark variable is evident from the cross-tabulation; the observations are distributed evenly over all four fields. The proxy indicator seems to more or less randomly assign half of the truly food-insecure households to the food-insecure category and the other half to the food-secure category (and likewise for the truly food-secure households). This results in unacceptably low sensitivity and specificity and unacceptably high misclassification. However, the prevalence of food insecurity estimated from the proxy indicator exactly matches the "true" prevalence of food insecurity because in this example, false positives and false negatives cancel each other out.

In effect, it will usually be possible to find a cutoff point of the proxy indicator that produces a prevalence of food insecurity that matches the "true" prevalence. This cutoff point can be picked from a frequency tabulation of the proxy indicator by selecting the value with the cumulative percentage that matches the "true" prevalence of food insecurity best. Yet if the proxy indicator is not meaningfully associated with the benchmark variable (such as in the example just discussed), this approach will be elusive. The reason is that the proxy indicator is unlikely to properly reflect changes in the benchmark variable.

The third example in the table below shows a suitable but not perfect proxy indicator for a prevalence of food insecurity of 50 percent. Given our criteria, sensitivity and specificity are balanced and greater than 60 percent, and the proportion misclassified is acceptable. The prevalence of food insecurity obtained from the benchmark variable and the proxy indicator also match very closely. Both methods for selecting a cutoff point produce virtually identical results in this case.

To modify our scenario, we subsequently consider cross-classifications for a "true" prevalence of food insecurity of 10 percent. Again, we start with the trivial case of a perfect proxy indicator and present an inadequate proxy indicator next. As before, the inadequate indicator evenly splits the truly food-insecure and truly food-secure households. Yet since the proportion of truly food-insecure households is much smaller now, the false positives and false negatives do not cancel each other out. The result is a prevalence of food insecurity estimated from the proxy indicator that is far from the "true" prevalence of food insecurity (50 percent versus 10 percent).

The "true" prevalence of food insecurity determines for which combinations of sensitivity and specificity the proxy indicator produces a realistic estimate of the prevalence of food insecurity. The following examples of a suitable proxy indicator at a prevalence of 10 percent with two different cutoffs illustrate this point. The first cutoff results in acceptable sensitivity, specificity, and misclassification. However, the false positives by far outweigh the false negatives. This imbalance of false positives and false negatives does not affect sensitivity (the ratio of true positives to all truly food-insecure households; compare Table 6) or specificity (the ratio of true negatives to all truly food-secure households). However, the proxy indicator overestimates the prevalence of food insecurity: the estimate is 33 percent instead of 10 percent.

(continued)

Box 5. Continued

Lowering the cutoff point for the proxy indicator can counteract this unsatisfactory result: fewer households are classified as food-insecure by the proxy indicator, and the estimated prevalence of food insecurity moves closer to the “true” prevalence rate (see the cross-tabulation for a suitable proxy indicator at a prevalence of 10 percent with a different cutoff below). At the same time, sensitivity falls in our example because the number of false negatives increases to 5 out of 10 truly food-insecure households and specificity rises because the number of false positives falls to 7 out of 90 truly food-secure households. The second cutoff is preferable to the first one for obtaining a realistic estimate of food insecurity, although sensitivity is low and not in balance with specificity.

The proportion misclassified is also very low in the second example for a suitable proxy indicator at 10 percent food insecurity, yet the lowest level of misclassification does not necessarily coincide with the best cutoff for estimating the prevalence of food insecurity. The last example in the table, showing an alternative proxy indicator with a suitable cutoff, has higher total misclassification (and very low sensitivity), but the prevalence of food insecurity from the proxy indicator exactly matches the “true” prevalence of food insecurity.

We conclude from this exploration that there are various possible scenarios. If the “true” prevalence of food insecurity is around 50 percent, the cutoff of a suitable proxy indicator to match estimated and “true” prevalence will be close to the cutoff balancing sensitivity and specificity. If the “true” prevalence of food insecurity is low, the cutoff of the proxy indicator that best matches the “true” prevalence will be tilted toward lower sensitivity and higher specificity and vice versa if the “true” prevalence of food insecurity is high.

Examples of cross-classifying proxy indicators and the benchmark variable

Proxy indicator classification	Benchmark variable classification: Food insecure	Benchmark variable classification: Food secure	Sensitivity	Specificity	Percentage misclassified	Prevalence of food insecurity: “True”	Prevalence of food insecurity: Proxy
50 percent prevalence, perfect proxy indicator							
Food insecure	50	0	100	100	0	50	50
Food secure	0	50					
50 percent prevalence, inadequate proxy indicator							
Food insecure	25	25	50	50	50	50	50
Food secure	25	25					
50 percent prevalence, suitable proxy indicator							
Food insecure	37	12	74	76	25	50	49
Food secure	13	38					
10 percent prevalence, perfect proxy indicator							
Food insecure	10	0	100	100	0	10	10
Food secure	0	90					
10 percent prevalence, inadequate proxy indicator							
Food insecure	5	45	50	50	50	10	50
Food secure	5	45					
10 percent prevalence, suitable proxy indicator (various cutoff points)							
Food insecure	7	26	70	71	29	10	33
Food secure	3	64					
Food insecure	5	7	50	92	12	10	12
Food secure	5	83					
10 percent prevalence, alternative suitable proxy indicator							
Food insecure	1	9	10	90	18	10	10
Food secure	9	81					

3. RESULTS OF VALIDATION STUDY

Burundi

Country Overview

Burundi is a landlocked, resource-poor, East African country with a predominantly agricultural economy and an underdeveloped manufacturing sector (CIA 2008). The country ranked last out of 118 developing and transition countries on the Global Hunger Index (Wiesmann et al. 2007).[12] Since the beginning of the 1980s, hunger has continuously increased in Burundi, with a mounting proportion of people who are food-energy deficient and rising child malnutrition and child mortality rates (FAO 2006b; WHO 2006; UNICEF 2006). The poverty headcount ratio at a dollar a day climbed from 45 percent in 1992 to 55 percent in 1998 (World Bank 2007).

The deterioration of food security and increase in poverty in Burundi largely result from more than a decade of conflict that was motivated by ethnic tensions, from internal displacement of large population groups, and from a weak economy dependent on subsistence agriculture and coffee and tea exports (Uppsala Conflict Data Program 2006; CIA 2008; Messer and Cohen 2007). The conflict, which exacerbated many of Burundi's problems, ended in September 2006, but peace is still fragile: it is not yet clear if the cease-fire deal signed by Burundi's last rebel group and the government will end the violent tensions between the dominant Tutsi minority and the Hutu majority in the long term. Political stability and the end of the civil war have improved aid flows, and economic growth has resumed, but underlying weaknesses—the high poverty rate, poor education levels, a weak legal system, and low administrative capacity—threaten to undermine planned economic reforms (CIA 2008).

Description Analysis of Food Security Classification

We begin by calculating the proportion of households classified as having poor or borderline food security using the FCS and the data on calorie consumption. As Figure 1 shows, the FCS gives much lower estimates of food insecurity than the benchmark variable. According to the FCS, 10 percent of households are severely food insecure, and 42 percent are food insecure. By contrast, the calorie consumption per capita data show that 46 percent of households are severely food insecure (consuming less than 1,470 kilocalories/capita/day) and 70 percent are food insecure (consuming less than 2,100 kilocalories/capita/day). The use of adult equivalents to adjust for the demographic composition of households produces virtually identical results.

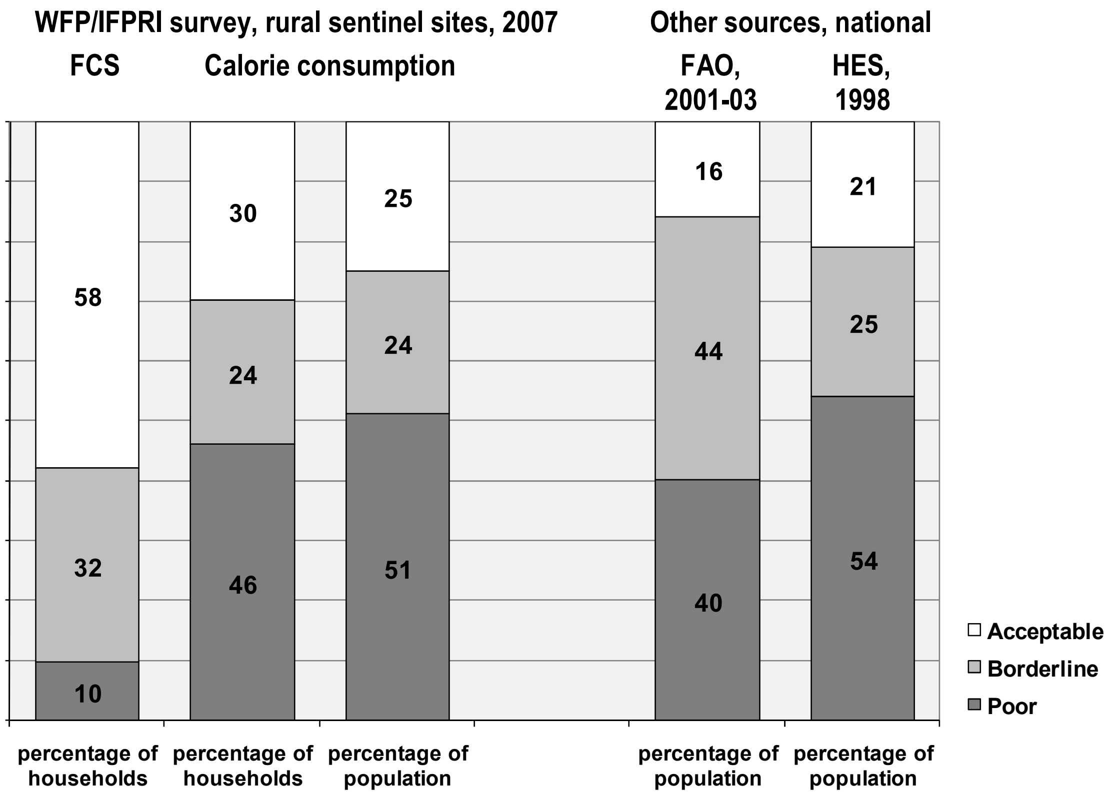
The inevitable "noise" in our calorie data may bias the derived estimates of food insecurity upward, particularly for the 1,470 kilocalories/capita/day cutoff. Reporting errors, imprecision in converting local units, and the fluctuation in calorie consumption over time inflate the variation in calorie consumption per capita from our survey as compared to the true variation. Therefore, we may overestimate the proportion of people below the lowest cutoff to some extent.

Yet the order of magnitude of food insecurity in Burundi that we obtain from our calorie consumption data is corroborated by other sources. We compare the prevalence of calorie deficiency calculated from our survey with estimates from food balance sheets for 2001–2003 and from a household expenditure survey conducted in 1998 (FAO 2006b; Smith, Alderman, and Aduayom 2006). Following FAO (2006b), 67 percent of the population could not meet their *minimum dietary energy requirements,* which were estimated to average 1,790 kilocalories/capita/day for Burundi. The country is third to last among all developing countries with available data, right before the Democratic Republic of Congo and Eritrea (FAO 2006b). Using data from a household expenditure survey, Smith, Alderman, and Aduayom (2006) find that 75 percent of Burundi's population were unable to meet their *average dietary energy*

[12] The index is an aggregate of the Food and Agriculture Organization of the United Nations's estimates of the proportion of people who cannot meet their minimum dietary energy requirements, the prevalence of underweight in children, and the under-five mortality rate (Wiesmann 2006).

requirements for light activity in 1998, which amounted to 2,025 kilocalories/capita/day at the population level.[13] Together with Ethiopia, Burundi trails at the end of a list of 12 Sub-Saharan African countries for which Smith, Alderman, and Aduayom (2006) report estimates of food insecurity. To account for differences in calorie cutoffs, we recalculated the estimates by FAO (2006b) and Smith, Alderman, and Aduayom (2006) for the 1,470 and 2,100 kilocalories/capita/day thresholds used in this study and obtained prevalence rates that are largely consistent with the findings from our calorie consumption data (see Figure 1).

Figure 1. Classification of food security in Burundi, based on the Food Consumption Score (FCS) and caloric consumption per capita



Note: WFP = World Food Programme; IFPRI = International Food Policy Research Institute; FCS = Food Consumption Score; FAO = Food and Agriculture Organization of the United Nations; HES = Household Expenditure Survey.

Further, the fact that our survey was not designed to generate nationally representative data does not invalidate this comparison of food-insecurity estimates. The sentinel sites established by WFP in 16 rural provinces (including all of Burundi's provinces except for urban Bujumbara) are spread over different agroecological zones, and 90 percent of the population lives in rural areas. The sample can thus be considered approximately nationally representative. The results should be comparable to data from FAO (2006b) and Smith, Alderman, and Aduayom (2006) that are nationally representative. However, another limitation arises from the discrepancy in reference years: the estimates of food insecurity from FAO (2006b) and Smith, Alderman, and Aduayom (2006) date from 2001–2003 and 1998, respectively.

[13] The method considers the age and sex composition of each household to determine household-level dietary energy requirements; see Smith, Alderman, and Aduayom (2006) and Smith and Subandoro (2007) for details. The average requirement for light activity of 2,025 kilocalories/capita/day for Burundi is expected to fall below the actual per capita requirement. More than 90 percent of Burundi's population rely on subsistence agriculture (CIA 2008), which requires moderate to high levels of physical activity.

The situation may have improved after the civil war was terminated in September 2006 but is unlikely to have changed dramatically up to October 2007, when our data were collected. Our estimate of food energy deficiency of 70 percent is credible.

High child malnutrition, child mortality, and poverty rates lend further credibility to a grim food security situation in Burundi. In 2000, 39 percent of preschoolers were underweight and 63 percent stunted (WHO 2006). Given available evidence on food insecurity in Burundi, we assume that food scarcity contributes strongly to this outcome, beside other causes of child malnutrition such as frequent infections, lack of access to health care and safe water, inadequate caring and feeding practices, and widespread micronutrient deficiencies (World Bank 2006). Burundi is among the 15 countries with the highest child mortality rate in the world: According to UNICEF (2007), 18 percent of children (181 per 1,000 live births) died before their fifth birthday in 2006. The most recent poverty estimates by the World Bank for 1998 indicate that 55 percent of the population lived on less than one dollar a day and 88 percent on less than 2 dollars a day (World Bank 2007). An income of one dollar a day is frequently not sufficient to ensure decent food consumption. Especially for Sub-Saharan Africa, the proportion of the "ultra hungry" who consume less than 1,600 kilocalories/capita/day tends to exceed the proportion of people living on less than one dollar a day (compare Ahmed et al. 2007, Tables 3.2 and 3.3).

As discussed earlier, a more sophisticated method to assess the goodness of the classification from the proxy indicator is sensitivity-specificity analysis. Cross-tabulating the FCGs based on the FCS with categories of calorie consumption, we find low sensitivity combined with high specificity (that is, large errors of exclusion together with minor errors of inclusion). The majority of households that are classified as having poor food consumption according to the FCS are also severely calorie deficient, but so are large proportions of households that fall in the borderline or adequate FCG according to the FCS.

Table 7 shows this in detail: about 10 percent of households are classified as severely food insecure using the FCS, and 7 percent fall into the category with poor food consumption according to both indicators. Yet for the borderline FCG, only 6 percent of all households have also borderline calorie consumption per capita. The much higher proportion of 19 percent is still in the category with poor calorie consumption per capita.

Table 7. Cross-tabulation of food consumption groups (FCGs), based on the Food Consumption Score and categories of calorie consumption, rural Burundi

Percentage of cases		Categories of calorie consumption per capita: Poor	Borderline	Acceptable	Total
FCGs	Poor ≤ 21	6.8	1.8	1.0	9.7
	Borderline > 21 – ≤ 35	19.2	6.0	7.1	32.3
	Acceptable > 35	20.2	16.0	21.8	58.0
	Total	46.2	23.9	29.9	100.0

Good match	34.6%
Close match	44.1%
Poor match	21.3%

Note: Numbers do not sum exactly because of rounding.

At the same time, 20 percent of households are severely calorie deficient, yet are considered to have acceptable food security following the FCS classification. For the FCS cutoff of 21, for example, sensitivity is 15 percent, which means that only 15 percent of severely calorie-deficient households are captured by the FCS classification (see Appendix Table A.10). Classifying households with acceptable calorie consumption as food-insecure by means of the FCS is not a matter of concern: only 8 percent of households are in the poor or borderline FCG while having acceptable calorie consumption per capita.

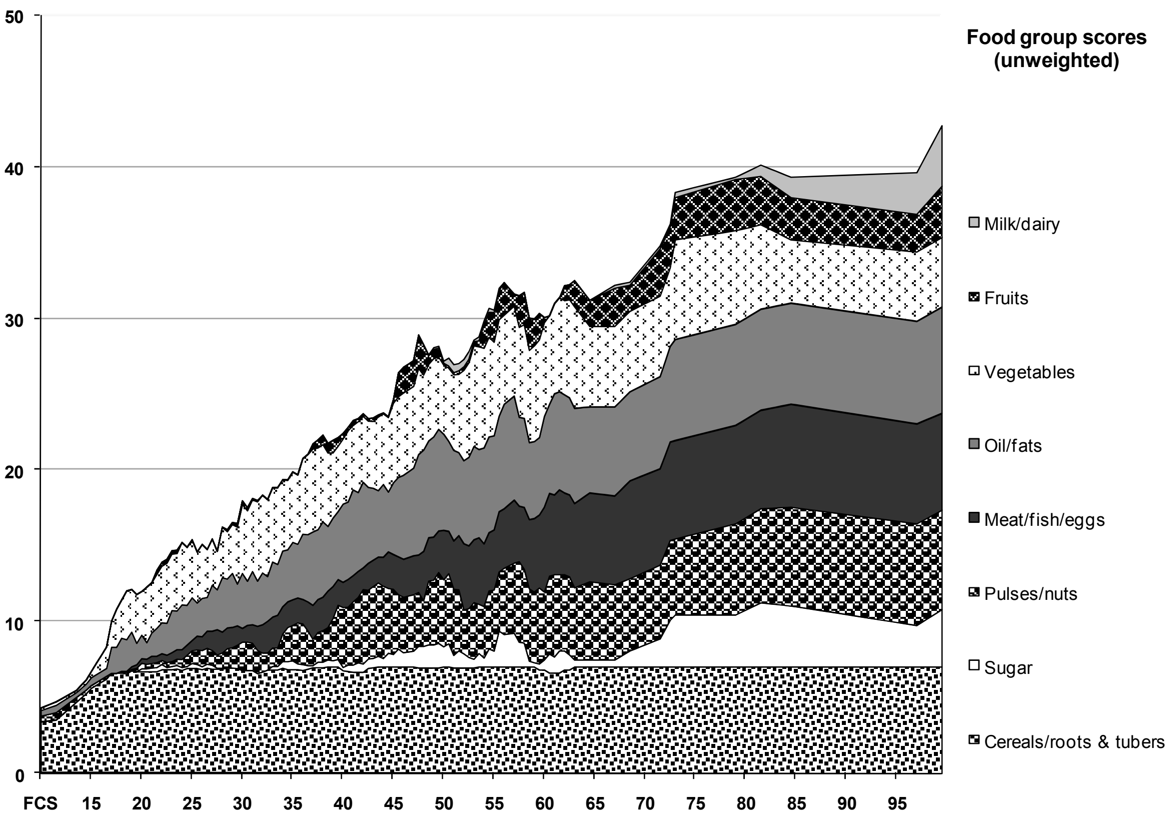
This corresponds to a specificity of 95 percent for the FCS cutoff of 21: 95 percent of food-secure households actually fall into the borderline or acceptable FCG (see Appendix Table A.10).

Given these results, we now turn to analysis that helps us understand these findings and assesses whether alternative indicators would produce better results.

The Association of the Proxy Indicators with the Benchmark Variable

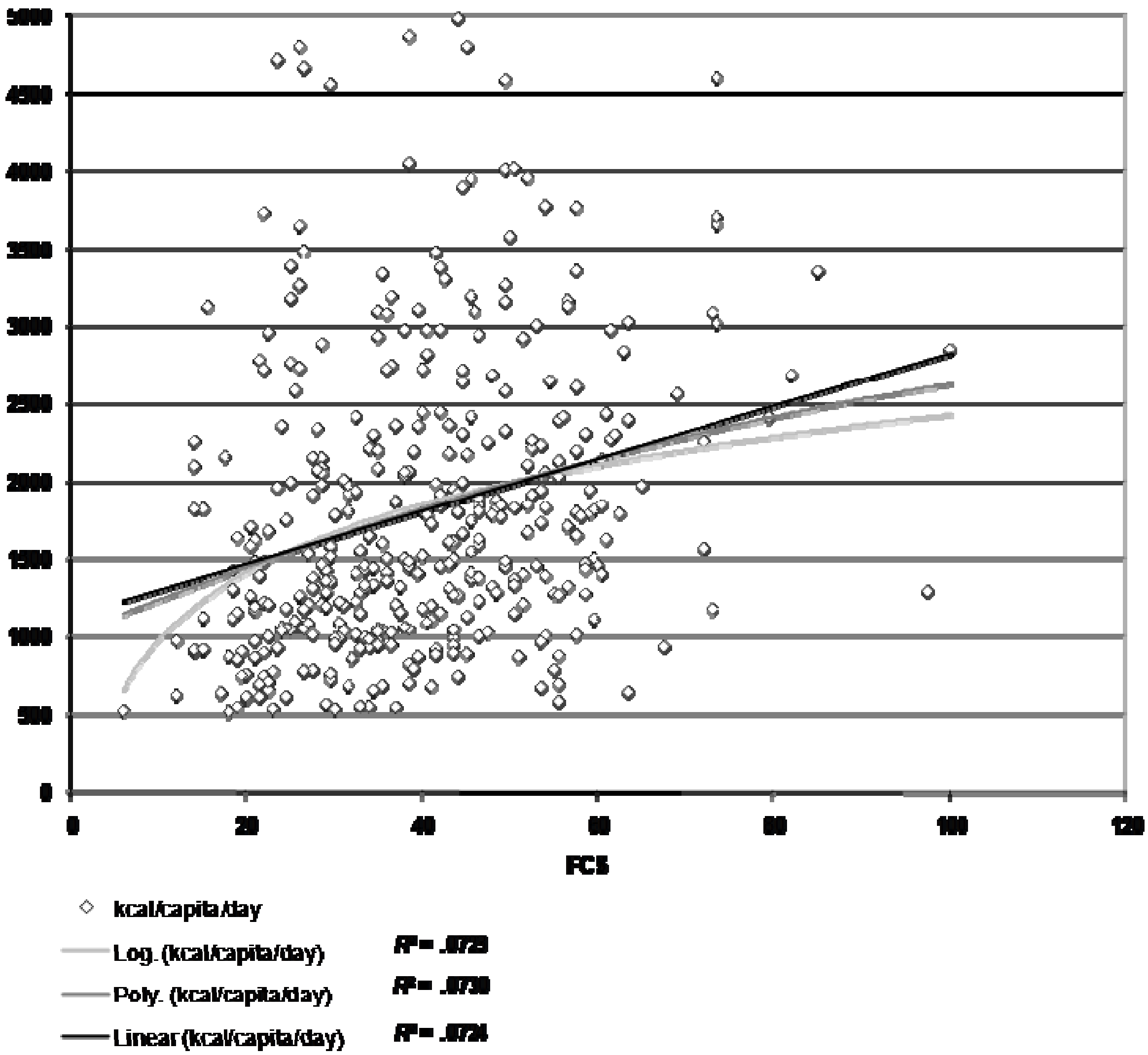
We begin with Figure 2, which shows how the food group scores build up the FCS. Note that the truncation of frequencies at seven is responsible for the straight line obtained for starchy staples (see previous explanation of truncation). With this information in mind, Figure 3 explores the association between the FCS and calories per capita. There is a positive relationship between these but with (the expected) wide dispersion around the lines of best fit. Combining the FCS with its square to predict calories per capita produces the values of the fitted line (dark grey line, polynomial regression) and gives virtually the same *R*-squared as the linear prediction (black line) and the logarithmic prediction (light grey line). If we no longer truncate the food group scores when calculating the FCS, as shown in Figure 4, we see that the strength of the relationship improves for all three specifications. Comparing Figures 3 and 4 suggests that truncation diminishes the predictive power of the FCS by 3 to 4 percentage points. By contrast, omitting the weights from the calculation does not change the pattern notably (results not shown).

Figure 2. Contribution of truncated food group scores to the Food Consumption Score (FCS), rural Burundi



Note: This graph is based on shifting averages.

Figure 3. Caloric consumption per capita plotted against Food Consumption Score (FCS), rural Burundi

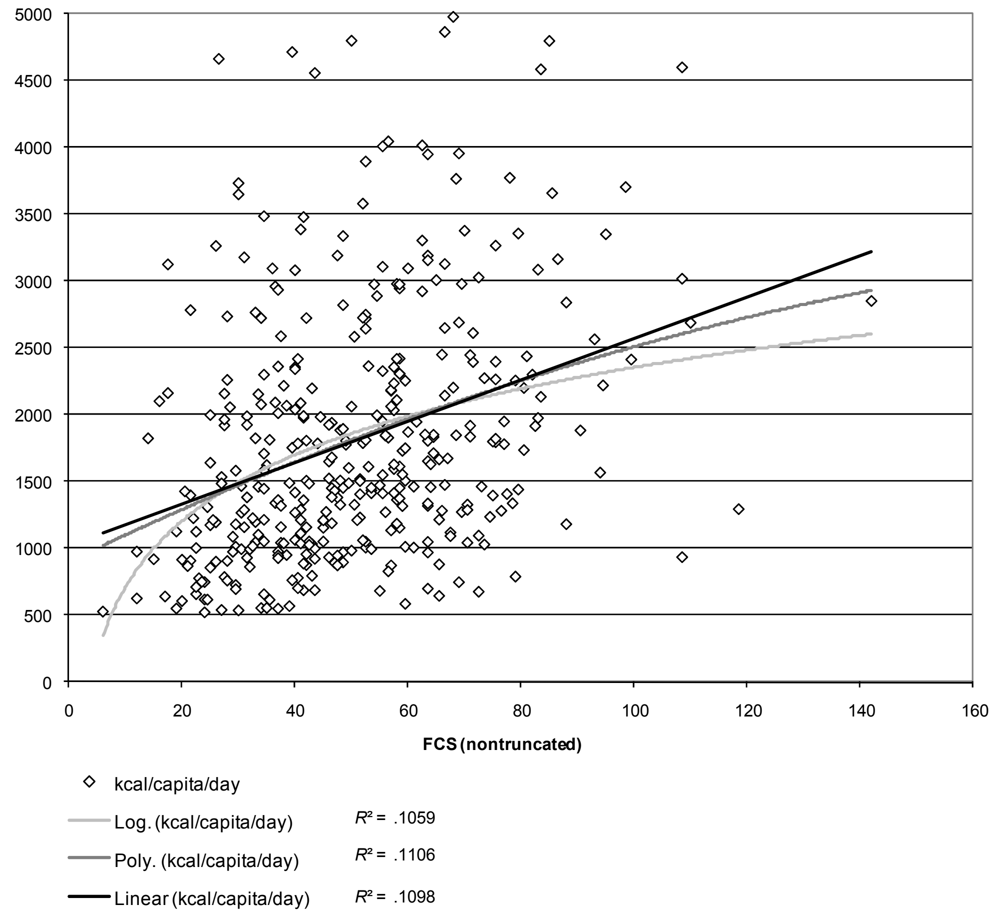


Notes: kcal = kilocalories; Log. = logarithmic; Poly. = polynomial.

Next, Table 8 shows Pearson's correlation coefficients for nine alternative proxy indicators as well as the FCS. Note that using any number of food groups or unique foods without accounting for the frequency of their consumption performs less well than the current FCS. Weighting or not weighting the FCS seems to make little difference to the correlation with calorie consumption. However, using more food groups does increase the magnitude of these correlation coefficients.[14]

[14] We obtain almost identical results for rank correlations and correlations with calorie per adult equivalent, with the latter being marginally higher than the coefficients shown in Table 8 (see Appendix Table A.6).

Figure 4. Calorie consumption per capita plotted against Food Consumption Score (FCS), based on nontruncated food group scores, rural Burundi



Notes: kcal = kilocalories; Log. = logarithmic; Poly. = polynomial.

Table 8. Pearson's correlations of calorie consumption per capita with measures of dietary diversity and food frequency, rural Burundi

Type of proxy indicator	Number of foods/food groups	Dietary diversity	Food frequency	Truncation	Weighting	Correlation Coefficient
Alternative dietary diversity scores	8	X		NA	No	.14***
	12	X		NA	No	.19***
	24	X		NA	No	.20***
	120	X		NA	No	.24***
World Food Programme Food Consumption Score	8		X	Yes	Yes	.27***
Alternative food consumption scores	8		X	Yes	No	.28***
	12		X	Yes	No	.34***
	24		X	No	Yes	.33***
	24		X	No	No	.34***
	120		X	No	No	.40***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 120 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 381. *** = significant at the 1 percent level.

Table 9 shows that the exclusion of foods consumed in small quantities markedly improves the association of these proxy indicators with calories per capita. The correlation coefficients are higher, the larger the threshold for exclusion, at least for the relatively small quantities of 5 to 45 grams that we examined.

Table 9. Pearson's correlations of calorie consumption per capita with measures of dietary diversity and food frequency, with exclusion of small quantities, rural Burundi

Type of proxy indicator	Number of foods/food groups	Dietary diversity	Food frequency	Truncation	Weighting	Correlation Coefficient Limit for exclusion from score 5 grams	15 grams	45 grams
Alternative dietary diversity scores	8	X		NA	No	.23***	.32***	.34***
	12	X		NA	No	.27***	.34***	.35***
	24	X		NA	No	.24***	.30***	.35***
	120	X		NA	No	.27***	.33***	.38***
World Food Programme Food Consumption Score	8		X	Yes	Yes	.30***	.36***	.38***
Alternative food consumption scores	8		X	Yes	No	.31***	.39***	.44***
	12		X	Yes	No	.34***	.40***	.45***
	24		X	No	Yes	.34***	.39***	.43***
	24		X	No	No	.35***	.41***	.47***
	120		X	No	No	.44***	.52***	.57***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 120 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 381. *** significant at the 1 percent level.

To better understand how truncation (as defined in the Data Sets and Methodology section), weighting, and exclusion of small quantities modify the association of the proxy indicators with the benchmark variable, we undertook a bivariate descriptive analysis. Detailed tabular results are found in the Appendix to this report; here we provide a summary of these results.

As one would expect, the average frequency of consumption increases from the poor to the adequate calorie consumption group for most foods; see Appendix Table A.9. After aggregation of the food frequencies to food group scores, five out of eight food groups show highly significant differences across calorie consumption groups: main staples; pulses and nuts; fruits; meat, fish, and eggs; and oil. These food group scores are able to differentiate well between the calorie consumption groups.

Truncation mainly affects the food group score for staples: significant differences across calorie consumption groups are erased. The weighting factors give emphasis to some food groups with high ability to differentiate across calorie consumption groups but not to others. For example, pulses and nuts as well as oils have the best test results for significance of differences. Pulses and nuts also have a relatively high weighting factor of 3, but oil has a low weight of only 0.5. The two next best food groups—fruits as well as meat, fish, and eggs—have weights of 1 and 4, respectively. Milk has a high weight of 4, and its food group score is low and varies inconsistently across calorie consumption groups, with no significant differences. These findings explain why in the Burundi data, dropping these weights has so small an effect on the correlations we observe. By contrast, truncation discards some useful information.

Excluding small quantities improves the ability to differentiate across calorie consumption groups mainly for oils and fats but also for fish, plantains and bananas, sugar, and manioc leaves; see Appendix Table A.9. This translates favorably to the aggregated food group scores: all food groups except for milk (which was rarely consumed) show significant differences across calorie consumption groups after applying the 15-gram restriction. The truncation still has a big impact on the main staples group but leaves the average food group scores with a little more variation and weakly significant differences.

Finally, we note that weighting, truncation, and the exclusion of small quantities shift the mean of the FCS. The application of the weighting factors raises the average of the score. The mean FCS drops when the weights are omitted and rises again when the truncation is not used. Apparently, the nontruncated, weighted FCS will always have the highest values for a given data set. The exclusion of small quantities lowers the mean of the FCS. Mainly oil, fish, and vegetables tend to be consumed in small amounts in Burundi. This results in larger decreases in the mean of these food group scores when the 15-gram restriction is applied.

Revisiting the Cutoffs

Recall from Table 7 that sensitivity was poor—only 15 percent of severely calorie deficient households were captured by the FCG classification. While the construction of the FCS could be one reason for this, the cutoffs used for the FCS classification could be another. We examine this possibility here by considering alternative cutoffs.

The simplest approach is to select cutoffs that balance sensitivity and specificity, seeking to minimize the total proportion of the sample population that is misclassified. This generates much higher cutoffs for the FCS than those of 21 and 35 that are currently recommended. Sensitivity-specificity analysis suggests an FCS cutoff around 38 for identifying poor calorie consumption and 44 for borderline calorie consumption (see Appendix Tables A.10 and A.11). For these cutoffs, both sensitivity and specificity are acceptable, and the proportion of misclassified households is at 37 and 35 percent, respectively.

Calibrating cutoffs to obtain matching estimates on the proportion of food-insecure households from the FCS leads to very similar results. Table 10 shows the cross-classification of calorie consumption categories and FCGs for FCS cutoffs of 37 and 47. We observe that the proportion of households in each category, or the prevalence of food insecurity, now matches almost perfectly for both indicators. False negatives (which represent errors of exclusion) and false positives (which represent errors of inclusion) are still found in the dark grey and medium grey cells, but they mostly cancel each other out for the overall prevalence estimates. The share of households that are on the diagonal of the table—that is, households for which we find a good match—has increased to 48 percent. At the same time, the proportion of households in the "close match" and "poor match" categories has fallen.

Table 10. Cross-tabulation of food consumption groups (FCGs), based on the food consumption score with revised cutoffs (37 and 47) and categories of calorie consumption, rural Burundi

		Categories of calorie consumption per capita			
Percentage of cases		**Poor**	**Borderline**	**Acceptable**	**Total**
FCGs	Poor ≤ 37	28.1	8.7	9.7	46.5
	Borderline > 37 – ≤ 47	9.7	7.6	7.6	24.9
	Acceptable > 47	8.4	7.6	12.6	28.6
	Total	46.2	23.9	29.9	100.0

Good match	48.3%
Close match	33.6%
Poor match	18.1%

Examining cross-tabulations based on the nontruncated FCS or nontruncated and unweighted FCS with calorie consumption per capita, we find only marginal improvements. The proportion of good matches rises to 49 percent for the nontruncated FCS, while the proportion of poor matches remains about the same: 17.8 percent as compared to 18.1 percent previously. For the nontruncated and unweighted FCS, the proportion of good matches is again 48 percent, whereas the proportion of poor matches falls to

16 percent. For both modified versions of the FCS, the cutoffs need to be recalibrated, since the truncation of food group scores and weighting changes the mean and maximum of the indicator.

Excluding small quantities from the FCS is an interesting alternative that improves the classification result. The exclusion of food frequencies with consumption quantities of 15 grams or less from the score leads to more favorable properties of all proxy indicators; compare Appendix Tables A.7 and A.8. Almost all food frequency indicators reach an AUC of 0.70 or higher when the 15-gram restriction is applied.[15] Using the standard FCS with weighting, truncation, and the 15-gram restriction, we see that the proportion of poor matches declines to 15.5 percent while the share of close matches increases. Note too that the existing cutoffs used by WFP are close approximations of those that minimize misclassification. Calibrating the cutoffs to match the prevalence of calorie deficiency, we find that the cutoffs should be set at 27 and 36.5; see Table 11. These new cutoffs are relatively close to the cutoffs of 21 and 35 outlined in WFP (2007).

To summarize, using these Burundi data, an initial assessment of WFP's current method shows scope for improvement. Accounting for the frequency of consumption, which the current FCS does, clearly improves predictive power. Imposing a minimum quantity restriction—such as the exclusion of quantities of 15 grams or less from the score—slightly increasing the number of food groups (from 8 to 12), and dispensing with the weights or retaining the current method of calculating the FCS but adjusting the cutoffs would improve the reliability of WFP's method of assessing food security.

Table 11. Cross-tabulation of food consumption groups (FCGs), based on the food consumption score with exclusion of small quantities (≤ 15 grams) and categories of calorie consumption, rural Burundi

		Categories of calorie consumption per capita			
Percentage of cases		**Poor**	**Borderline**	**Acceptable**	**Total**
FCGs	Poor ≤ 27	27.8	8.4	10.0	46.2
	Borderline > 27 – ≤ 36.5	12.9	5.8	5.2	23.9
	Acceptable > 36.5	5.5	9.7	14.7	29.9
	Total	46.2	23.9	29.9	100.0

Good match	48.3%
Close match	36.2%
Poor match	15.5%

Haiti

Country Overview

Haiti is the poorest country in the Western hemisphere. It ranked 98 out of 118 countries on the Global Hunger Index and last among all countries in the Latin American and Caribbean region (Wiesmann et al. 2007). Three-quarters of all Haitians live on less than the equivalent of US$2 per day, and more than half live on the equivalent of less than US$1 per day (World Bank 2007). In addition to these high rates of poverty, Haiti also has the most unequal income distribution in the region, with a Gini coefficient of 0.65 (Sletten and Egset 2004).

Haiti has been plagued by political violence throughout its history, and the national economy has been deteriorating steadily since the 1980s (WFP 2008). Two-thirds of all Haitians depend on the agricultural sector, mainly small-scale subsistence farming, and remain vulnerable to damage from natural

[15] As stated in the Data Sets and Methodology section, an Area under the Curve below 0.60 is considered not acceptable; 0.70 or above, good; and 0.80 or higher, very good.

disasters, exacerbated by the country's widespread deforestation. Haiti suffers from higher inflation than similar low-income countries, a lack of investment due to insecurity and limited infrastructure, and a severe trade deficit. Remittances are the primary source of foreign exchange, equaling nearly a quarter of gross domestic product (GDP) (CIA 2008).

Political, social, and economic instability, coupled with extreme poverty and recurrent natural disasters, has increased vulnerability to food insecurity for large sectors of the population (WFP 2008). Haiti was particularly hard-hit by the hike in global food prices because the country is heavily dependent on food imports. The country received wide coverage in the international media due to riots and unrest as people protested soaring food prices and rising costs of living.

The proportion of children under five who are underweight fell from 28 percent in the mid-1990s to 17 percent in 2000 but has risen to 22 percent in 2005–2006 along with the deterioration of economic conditions (Cayemittes et al. 2001). The decline in child malnutrition up to 2000 can be related to expanding efforts in the health-care sector by national and international NGOs. The state is largely absent from the life of most citizens, and public service provision remains weak: NGOs and other private, nonprofit organizations provide 60 percent of health services, and about 90 percent of schools are funded and run privately (Cohen et al. 2007).

Descriptive Analysis of Food Security Classification

As we did with our analysis of the data from Burundi, we begin by comparing a classification of food security status based on the FCS with that derived from the calorie consumption data. Based on the FCS, a mere 4.6 percent of households are severely food insecure and a further 18.4 percent are food insecure (see Figure 5).[16] Given the extent of poverty and hunger in Haiti, these numbers seem astonishingly low. By contrast, the calorie consumption data show 22 percent of households to be severely food insecure (consuming less than 1,470 kilocalories/capita/day), and 47 percent food insecure (consuming less than 2,100 kilocalories/capita/day).[17]

The extent of food insecurity we calculate for the North and Northeast using calorie consumption data is consistent with results from other data sources. Our estimate of the prevalence of household food insecurity, 47 percent, matches FAO's national estimate for 2001–2003 from Food Balance Sheet data, which find 47 percent of the Haitian population unable to meet their *minimum dietary energy requirement* of 1,930 kilocalories/day.[18] If we apply FAO's estimation formula, its data regarding calorie supply per capita, and the coefficient of variation of calorie intake with the dietary energy requirements of 1,470 and 2,100 kilocalories per capita per day used in our study, we find that 57 percent of Haitians were food insecure in 2001–2003, slightly more than the 53 percent of the population that was food insecure according to our survey in the North and Northeast in 2008 (see Figure 5).

We initially expected a higher proportion of food-insecure households in our sample because FAO's calorie data show that national dietary energy supply per capita fell from 2001 to 2005 and food insecurity is considered more severe in the northern regions than in other parts of the country (FAO 2007; WFP Haiti, personal communication). In fact, food prices have been spiking across the country. All of the 15 households interviewed in a qualitative survey that complemented our quantitative survey stated that they ate better in the past. The most common explanation for this was that environmental conditions (drought and flood) had ruined gardens and harvests; the next most common reasons were high food prices and higher prices for other goods (see Appendix Box A.1 for a summary of the qualitative findings). Further, the Northeast had the highest poverty rate among all regions of the country in 2001, with 84 percent of the population living below one dollar a day. The poverty rate across the North was 68 percent, which is also considerably above the national average of 56 percent (Sletten and Egset 2004).

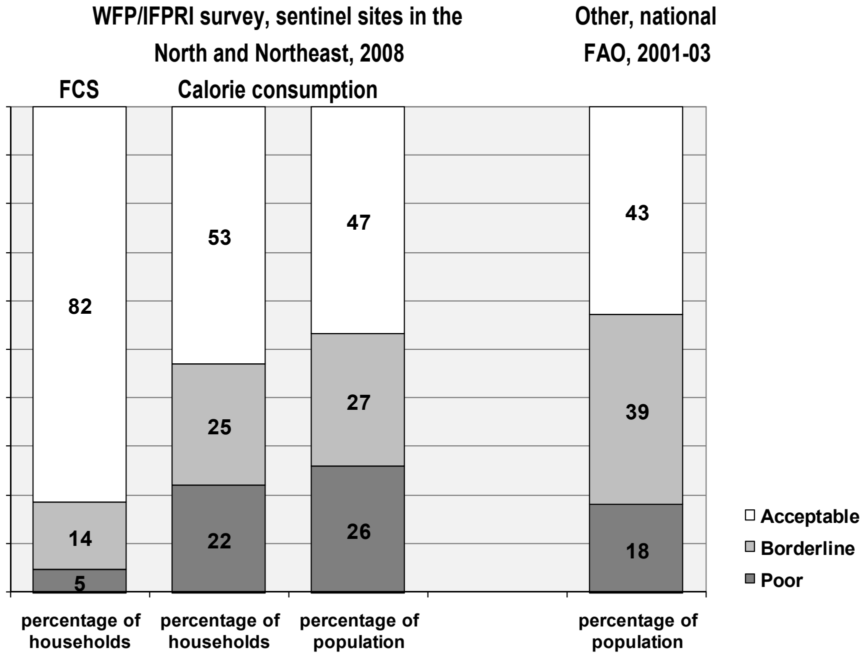
---

[16] The use of adult equivalents to adjust for the demographic composition of households does not change these findings.

[17] Note that the Food Consumption Score was calculated using higher cutoffs for populations with "high sugar and oil consumption" (WFP 2007). On average, households in the survey region consumed sugar on 4.9 days and oil and fats, including coconut, on 6.7 days per week; see Table A.15.

[18] Estimates of food insecurity from household expenditure surveys are not available for Haiti.

Figure 5. Classification of food security in Haiti based on the food consumption score and calorie consumption per capita



Notes: WFP = World Food Programme; IFPRI = International Food Policy Research Institute; FCS = Food Consumption Score; FAO = Food and Agriculture Organization of the United Nations. Numbers do not always sum to 100 percent because of rounding.

Two factors somewhat mitigate these statements on current trends and regional patterns. First, our survey was undertaken in February, well outside the hunger season (June to August) (Mulder-Sibanda 1998). Second, child malnutrition rates in the Northeast are comparable to the national average: in 2005–2006, 21 percent of children under five years of age were underweight in the Northeast, as were 22 percent nationally. In the North, 25 percent of children under five were underweight. For stunting, the differences are a bit larger, with 30 percent in the North, 26 percent in the Northeast, and 24 percent nationally. While health environments, maternal knowledge, and caring capacity are very important determinants of child nutritional status besides household food security, these numbers suggest that food insecurity is not necessarily dramatically worse in the North and Northeast than in other parts of the country. That said, it is not obviously any better.

Given the findings displayed in Figure 5, it is not surprising that a cross-tabulation of the FCGs based on the FCS with categories of calorie consumption shows very low sensitivity (because errors of exclusion are large) and high specificity (because errors of inclusion are relatively small). Thirty-one percent of households are assessed as having acceptable food consumption based on the FCS, while their calorie consumption is poor (13.1 percent) or borderline (18.2 percent); see Table 12.

Sensitivity is 9 percent for the FCS cutoff of 28 that we use for "poor consumption" in Haiti, which means that only 9 percent of severely calorie-deficient households are correctly identified. For the same FCS cutoff, 97 percent of households with adequate calorie consumption fall into the FCG with borderline or acceptable food consumption, which corresponds to a specificity of 97 percent (see Appendix Table A.16).

This imbalance of sensitivity and specificity (reflecting errors of exclusion and inclusion) is in line with the mismatch between estimates of food insecurity from the FCS and the findings based on calorie consumption per capita we discussed earlier with reference to Figure 5. The general pattern in

Table 12 is similar to our results for Burundi, wherein false negatives (that is, errors of exclusion) were also prevalent.

Table 12. Cross-tabulation of food consumption groups (FCGs), based on the food consumption score and categories of calorie consumption, Haiti, North and Northeast regions

Percentage of cases		Categories of calorie consumption per capita			
		Poor	Borderline	Acceptable	Total
FCGs	Poor ≤ 28	2.1	1.8	0.8	4.6
	Borderline > 28 – ≤ 42	6.9	4.9	2.1	13.8
	Acceptable > 42	13.1	18.2	50.3	81.5
	Total	22.1	24.9	53.1	100.0

Good match	57.2%
Close match	29.0%
Poor match	13.8%

Note: Numbers do not sum exactly because of rounding.

Accordingly, our finding that 53 percent of the population in the North and Northeast are calorie deficient may be a slight underestimate, but it is unlikely to be an overestimate. Likewise, while seven-day-recall household food consumption data may tend to upward bias estimates of *severe* food insecurity (see the pertinent discussion in the section about Burundi), our results are plausible when triangulated with data from other sources. This lends credibility to our assertion that the FCS classification leads to underestimating food insecurity in Haiti, as we have already seen for Burundi.

Given these results, we now turn to analysis that helps us understand these findings and assesses whether alternative indicators would produce better results.

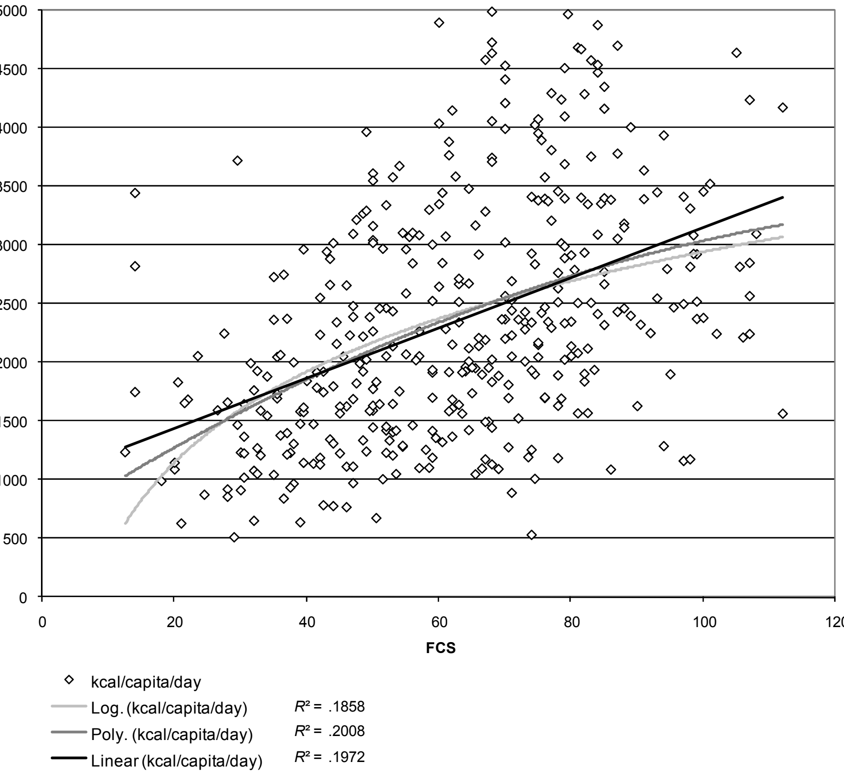
The Association of the Proxy Indicators with the Benchmark Variable

We begin with Figure 6. As with the Burundi data, observations are widely scattered around the lines of best fit.

Using a combination of the FCS and its square to predict calories per capita gives the dark grey line. This polynomial prediction explains 20 percent of the variation in calories per capita. It has a marginally higher *R*-squared than the linear prediction (black line). The logarithmic model, which uses the logarithm of the FCS to predict calories per capita, results in a slightly lower *R*-squared. Thus, there is no strong evidence of a nonlinear relationship between the two variables. The association between the FCS and calories per capita is much stronger for Haiti than for Burundi.

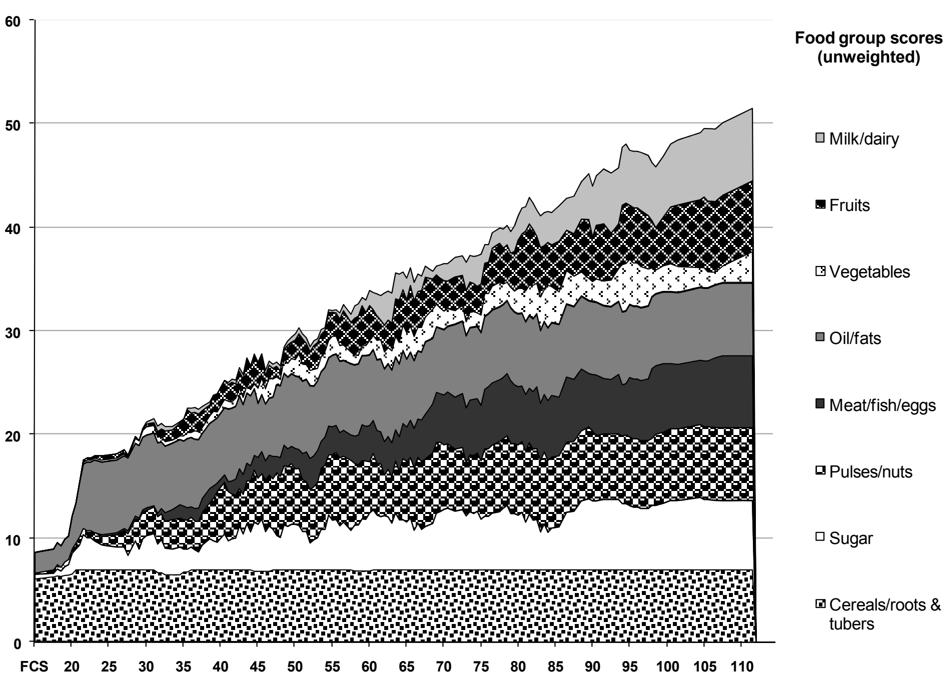
We find once more that the strength of the relationship improves when we use the FCS based on nontruncated food group scores rather than the standard FCS; compare Figures 6 and 8. (Figure 7 shows how the food group scores build up the FCS; again, the truncation of frequencies at seven is responsible for the virtually straight line obtained for starchy staples.) The *R*-squared for all three specifications of the line of best fit increases by 2 to 3 percentage points. The relationship between the variables seems to become less linear when the truncation is skipped. Omitting the weights in addition to the truncation gives a very similar picture to the one we see in Figure 8 (results not shown).

Figure 6. Calorie consumption per capita plotted against food consumption score (FCS), Haiti, North and Northeast regions



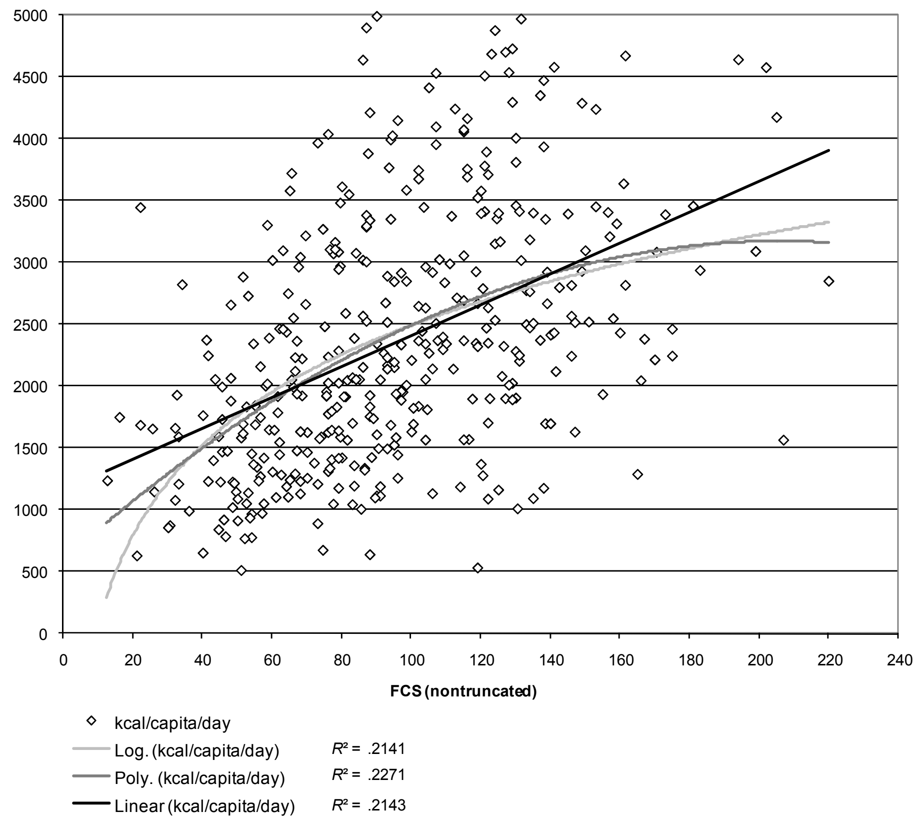
Note: kcal = kilocalories; Log. = logarithmic; Poly. = polynomial.

Figure 7. Contribution of truncated food group scores to the food consumption score (FCS), Haiti, North and Northeast regions



Note: This graph is based on shifting averages.

Figure 8. Calorie consumption per capita plotted against food consumption score (FCS), based on nontruncated food group scores, Haiti, North and Northeast regions



Note: kcal = kilocalories; Log. = logarithmic; Poly. = polynomial.

The pattern of correlation coefficients for Haiti is remarkably similar to that for Burundi. Indicators that account for the frequency of consumption as well as dietary diversity outperform indicators based solely on dietary diversity (compare the correlation coefficients for the number of foods consumed out of the total of 141 foods and the sum of consumption frequencies for 8 food groups). Dropping the weight used by WFP has no adverse effect, and moving to a slightly more disaggregated, 12-food group indicator further improves these correlations. We obtain similar results for rank correlations and correlations with calories per adult equivalent, with the former being slightly higher and the latter marginally lower than the coefficients shown in Table 13 (see Appendix Table A.12).

The exclusion of foods consumed in small quantities from the score further improves the association of all proxy indicators considered with calories per capita; see Table 14. Correlation coefficients increase with larger thresholds for exclusion in the range of 5 to 45 grams. For the food frequency indicators with a 45-gram limit, we obtain high correlation coefficients between .62 and .83. The general tendencies we observed when no quantity restriction was applied (such as higher disaggregation's leading to higher correlations and food frequency indicators' being superior to dietary diversity indicators) remain unchanged.

To better understand how truncation, weighting, and exclusion of small quantities modify the association of the proxy indicators with the benchmark variable, we undertook a bivariate descriptive analysis. Detailed tabular results are found in the Appendix to this report; here we provide a summary of these results.

Table 13. Pearson's correlation coefficients of calorie consumption per capita with measures of dietary diversity and food frequency, Haiti, North and Northeast regions

Type of proxy indicator	Number of foods/food groups	Dietary diversity	Food frequency	Truncation	Weighting	Correlation coefficient
Alternative dietary diversity scores	8	X		NA	No	.33***
	12	X		NA	No	.33***
	22	X		NA	No	.35***
	141	X		NA	No	.41***
World Food Programme Food Consumption Score	8		X	Yes	Yes	.44***
Alternative food consumption scores	8		X	Yes	No	.45***
	12		X	Yes	No	.49***
	22		X	No	Yes	.46***
	22		X	No	No	.47***
	141		X	No	No	.52***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 141 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 390. *** = significant at the 1 percent level.

Table 14. Pearson's correlations of calorie consumption per capita with measures of dietary diversity and food frequency, with exclusion of small quantities, Haiti, North and Northeast regions

Type of proxy indicator	Number of foods/ food groups	Dietary diversity	Food frequency	Truncation	Weighting	Correlation coefficient: Limit for exclusion from score: 5 grams	15 grams	45 grams
Alternative dietary diversity scores	8	X		NA	No	.35***	.42***	.59***
	12	X		NA	No	.36***	.42***	.59***
	22	X		NA	No	.36***	.43***	.61***
	141	X		NA	No	.47***	.53***	.67***
World Food Programme Food Consumption Score	8		X	Yes	Yes	.46***	.50***	.62***
Alternative food consumption scores	8		X	Yes	No	.46***	.54***	.70***
	12		X	Yes	No	.45***	.52***	.70***
	22		X	No	Yes	.50***	.56***	.70***
	22		X	No	No	.50***	.58***	.76***
	141		X	No	No	.61***	.69***	.83***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 141 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 390. ***Significant at the 1 percent level.

Food frequencies show strong and consistent trends of increasing averages across the calorie consumption groups (see Appendix Table A.15). After aggregation of the food frequencies to food group scores, all eight food groups exhibit highly significant differences across calorie consumption groups.

As for Burundi, the truncation levels off the differences across calorie consumption groups for the main staples group. The weighting factors correspond relatively well to the ability of food groups to differentiate across calorie consumption categories for the food consumption pattern in Haiti's North and Northeast. For example, pulses and nuts, as well as meat, fish, and eggs, stand out in this regard, and they also have high weights of 3 and 4, respectively. The food group score for oil shows little variation across calorie consumption groups, which corresponds well to the low weight of 0.5 for this group.

With this background information, we understand better why the unweighted FCS without truncation performs best with regard to differentiating across calorie consumption groups. Omitting the weights and skipping the truncation both have small positive effects.

Approximating the exclusion of small quantities from food frequencies improves the ability to differentiate between calorie consumption groups particularly for oils and fats and to a lesser extent for pulses, vegetables, milk, and meat (see Appendix Table A.15). Regarding the aggregate food group scores, positive effects from excluding small quantities are most notable for the main staples and oil, followed by pulses and nuts. Yet the gains for the main staples group are largely eliminated by the truncation later on, although the differences remain highly significant.

Revisiting the Cutoffs

If we seek to balance sensitivity and specificity and minimize the total proportion misclassified, we again obtain much higher cutoffs for the FCS than are currently employed. Using these criteria in sensitivity-specificity analyses, we find that FCS cutoffs between 54 and 58 would be suitable for identifying poor calorie consumption, and cutoffs ranging from 59 to 64 for borderline calorie consumption (see Appendix Tables A.16 and A.17). For these cutoffs, both sensitivity and specificity are acceptable, and the proportion of misclassified households falls between 30 and 33 percent.

Calibrating cutoffs to obtain matching estimates on the proportion of food-insecure households is a different approach that also suggests higher cutoffs than 28 and 42. The cutoff of 45 we thus get for identifying poor calorie consumption is lower than the results of sensitivity-specificity analysis imply but still considerably higher than the currently recommended cutoff. To distinguish between borderline and acceptable consumption, we arrive at a cutoff of 61 when we use this method, which is well within the range of cutoffs with good combinations of sensitivity and specificity.

Table 15 shows the cross-classification of calorie consumption categories and FCGs for FCS cutoffs of 45 and 61. The proportion of false negatives (errors of exclusion) declines markedly, while the proportion of false negatives (errors of inclusion) increases slightly. The prevalence of food insecurity now matches almost perfectly for both indicators, since this was the criterion for setting the cutoffs. Yet the share of households that are on the diagonal of the table ("good match") has fallen from 57 to 53 percent, while the proportion of close matches has increased considerably and the proportion of poor matches has been reduced.

When we exclude small quantities from the FCS, the classification result improves. The exclusion of food frequencies with consumption quantities of 15 grams or less from the score leads to better properties of all proxy indicators; compare the AUCs in Appendix Tables A.13 and A.14. All food frequency indicators reach an AUC of 0.80 or higher with the 15-gram restriction, which is very good. Using the standard FCS with weighting, truncation, and the 15-gram restriction, as well as adjusted cutoffs, we get the best classification result so far; see Table 16. Fifty-seven percent of households are good matches, and only 8 percent are poor matches.

Regarding the adjusted cutoff points, they are lower for the FCS with a 15-gram restriction than for the FCS without such a quantity restriction. The cutoffs are again calibrated to match the prevalence of calorie deficiency. For the Haiti data, this approach results in adjusted cutoffs of 38.5 and 51.5, which are still considerably higher than the cutoffs of 28 and 42 proposed by WFP for populations with frequent sugar and oil consumption. Excluding small quantities ≤ 15 grams from the FCS would produce better estimates of food insecurity with the current standard cutoff points, but the remedial effect is smaller than for Burundi.

Table 15. Cross-tabulation of food consumption groups (FCGs), based on the food consumption score with revised cutoffs (45 and 61) and categories of calorie consumption, Haiti, North and Northeast regions

		Categories of calorie consumption per capita			
Percentage of cases		**Poor**	**Borderline**	**Acceptable**	**Total**
FCGs	Poor ≤ 45	10.3	7.9	4.4	22.6
	Borderline > 45 – ≤ 61	6.9	5.6	11.3	23.8
	Acceptable > 61	4.9	11.3	37.4	53.6
	Total	22.1	24.9	53.1	100.0

Good match	53.3%
Close match	37.4%
Poor match	9.2%

Note: Numbers do not sum exactly because of rounding.

Table 16. Cross-tabulation of food consumption groups (FCGs), based on the food consumption score with exclusion of small quantities (≤ 15 grams) and categories of calorie consumption, Haiti, North and Northeast regions

		Categories of calorie consumption per capita			
Percentage of cases		**Poor**	**Borderline**	**Acceptable**	**Total**
FCGs	Poor ≤ 38.5	11.5	6.9	3.6	22.1
	Borderline > 38.5 – ≤ 51.5	6.2	7.4	11.0	24.6
	Acceptable > 51.5	4.4	10.5	38.5	53.3
	Total	22.1	24.9	53.1	100.0

Good match	57.4%
Close match	34.6%
Poor match	7.9%

Note: Numbers do not sum exactly because of rounding.

For Haiti, the standard FCS—as well as all other proxy indicators examined here—has very suitable properties for a cross-classification against calorie consumption per capita. To improve the accuracy of food security assessments, raising the cutoff points would be necessary to avoid serious underestimates of food insecurity. Dropping food frequencies from the score if only 15 grams or less were consumed would also be helpful.[19] Unlike Burundi, however, the associated downward shift of the mean of the FCS does not solve the problem that the cutoffs currently recommended by WFP are too high for the North and Northeast regions of Haiti. This would require a higher threshold for the exclusion of small quantities (see also the discussion in the Synthesis and Discussion of Findings section).

[19] The food frequency module used to collect data for this study for Haiti was not developed by IFPRI. It is identical with the food frequency module employed by WFP for the previous six rounds of the Haiti Food Security Monitoring Survey and made no provision for excluding foods consumed in small quantities from the food frequencies.

3.3 Sri Lanka

Country Overview

Sri Lanka is an island nation located off the southern coast of India. It ranked 69 out of 118 on the Global Hunger Index, taking a middle position among Asian countries (Wiesmann et al. 2007). In spite of a long history of ethnic conflict, poverty rates are not very high: in 2002, 42 percent of the population lived on less than two dollars a day, and 6 percent on less than one dollar a day (World Bank 2007).

In 1983, tensions between the Sinhalese majority and Tamil separatists erupted into war. Tens of thousands have died in this ethnic conflict that continues to fester. Despite the civil war, Sri Lanka saw GDP growth average 4.5 percent in the last 10 years, with the exception of a recession in 2001. In late December 2004, a major tsunami hit the eastern and southern coastline of Sri Lanka and took about 31,000 lives, left more than 6,300 missing and 443,000 displaced, and destroyed an estimated $1.5 billion worth of property (CIA 2008). The international community, including WFP, provided assistance in the wake of the disaster (Sharma 2006).

The majority of poor households in Sri Lanka, mostly small-scale farmers and landless laborers, experience seasonal food shortages despite the country's achievement of near self-sufficiency in rice. Their food security is highly dependent on rainfall patterns. Due to irregular rainfall, recurrent drought, and neglect of irrigation infrastructure, agricultural productivity in small-scale farming has been declining since the mid-1990s (FAO 2005).

In 2001, 26 percent of children under five were underweight in Sri Lanka (Wiesmann et al. 2007, based on data from World Health Organization 2006). Child malnutrition and child mortality rates have fallen considerably in past decades. Owing to a highly educated population and noteworthy achievements in the health sector, child malnutrition in Sri Lanka is relatively low compared to other South Asian countries, such as neighboring India and Bangladesh.

Descriptive Analysis of Food Security Classification

As we have already seen for Burundi and Haiti, classifying households in Sri Lanka using the FCS also produces much lower estimates of food insecurity than classifying them by calorie consumption per capita. Just as for Haiti, the FCS was calculated for Sri Lanka by means of higher cutoffs for populations with "high sugar and oil consumption" (see WFP 2007).[20] Figure 9 shows a comparison of the classifications: based on the FCS, there are no severely food-insecure households at all, and merely 2 percent are food insecure. This is in sharp contrast to the classification by calorie consumption per capita, which shows 24 percent of households to be severely food insecure (consuming less than 1,470 kilocalories/capita/day) and 55 percent to be food insecure (consuming less than 2,100 kilocalories/capita/day). Again, the use of adult equivalents to adjust for the demographic composition of households gives similar results.

Nationally representative estimates show a much higher prevalence of food insecurity in Sri Lanka than the 2 percent we obtained for the tsunami-affected households in three coastal districts from the FCS classification. Thirty-seven percent of the population was food insecure in Sri Lanka in 2001–2003, according to Food Balance Sheet data, and estimates from a household expenditure survey in 1999 show that 57 percent of the population had less than 2,100 kilocalories per capita per day at their disposal (recalculated with the energy requirement used by WFP and data in FAO 2006b; Smith and Subandoro 2005).

These national estimates differ[21] and are lower than the proportion of people consuming less than 2,100 kilocalories per capita per day that we find in our survey data. Based on calorie consumption per

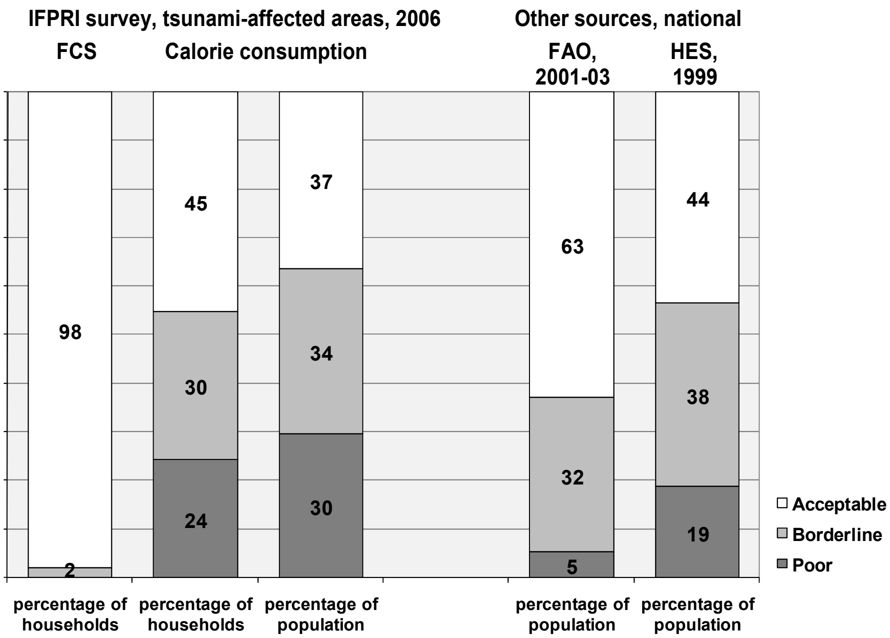
---

[20] On average, the tsunami-affected households that were surveyed consumed sugar on 6.7 days and oil on 4.5 days in the past week (see Appendix Table A.21).

[21] Throughout 1999, the year of the household expenditure survey, Sri Lanka suffered from considerable political uncertainty, a volatile security situation due to elections, and intensified civil conflict. These factors may help explain the country's relatively high rate of calorie deficiency at the time of its survey (Smith and Wiesmann 2007).

capita, 64 percent of the people in tsunami-affected households in our sample are food insecure. Although this number is higher than national estimates from other sources, it is more plausible than a prevalence of food insecurity of only 2 percent among the food or cash beneficiaries surveyed: transfers were targeted to families who had their houses completely or partly destroyed by the tsunami, lost their main livelihoods, or were considered destitute. Although these needy households received assistance, it is unlikely that they were much better off than the national average in terms of their food security. Many of these households had been dislocated, and about two-thirds lived in shelter camps.

Figure 9. Classification of food security in Sri Lanka, based on the food consumption score and calorie consumption per capita



Notes: IFPRI = International Food Policy Research Institute; FCS = Food Consumption Score; FAO = Food and Agriculture Organization of the United Nations; HES = Household Expenditure Survey. Numbers do not always sum to 100 percent because of rounding.

When we cross-tabulate the FCGs based on the FCS with categories of calorie consumption (see Table 17), we find extremely low sensitivity combined with very high specificity (that is, huge errors of exclusion together with minimal errors of inclusion). The FCS cutoff of 28 identifies no households as having poor food consumption, although 24 percent of households consumed less than 1,470 kilocalories/capita/day during the previous week. The proportion of households in the borderline FCG is only 2 percent, much lower than the share of households with borderline calorie consumption, which is about 30 percent. Almost one-quarter of households are in the acceptable FCG but have poor calorie consumption, and 30 percent are in the acceptable FCG although they have borderline calorie consumption.

The findings from the cross-tabulation are reflected in unfavorable combinations of sensitivity and specificity for the current FCS cutoffs. Because none of the severely calorie-deficient households is identified at the lower cutoff of 28, we arrive at a sensitivity of 0 percent and a specificity of 100 percent (the latter means that no households that are *not* severely calorie deficient are wrongly included); see Appendix Table A.22. At the higher cutoff of 42, sensitivity is merely 2.2 percent, denoting the proportion of severely to moderately calorie-deficient households that are rightly identified by the FCG classification. Conversely, specificity is very high, amounting to 98.5 percent, because a very low proportion of households falls into the borderline FCG and none into the poor FCG.

Table 17. Cross-tabulation of food consumption groups (FCGs), based on the food consumption score and categories of calorie consumption, tsunami-affected areas in Sri Lanka

Percentage of cases		Categories of calorie consumption per capita: Poor	Borderline	Acceptable	Total
FCGs	Poor ≤28	0.0	0.0	0.0	0.0
	Borderline >28–≤42	0.7	0.5	0.7	1.9
	Acceptable >42	23.5	29.9	44.6	98.1
	Total	24.2	30.5	45.3	100.0

Good match	45.2%
Close match	31.3%
Poor match	23.5%

Given these results, we now turn to analysis that helps us understand these findings and assesses whether alternative indicators would produce better results.

The Association of the Proxy Indicators with the Benchmark Variable

We begin with Figure 10: data from tsunami-affected households in Sri Lanka show no association between the FCS and calories per capita. The observations not only are widely scattered but also give nearly horizontal lines of best fit. Varying the specification of the line of best fit from linear to logarithmic or polynomial does not provide a solution: all three options produce an *R*-squared below 0.4 percent (meaning that less than 0.4 percent in the variation of calorie consumption per capita can be predicted by the FCS), and the evidence for a nonlinear relationship is weak.

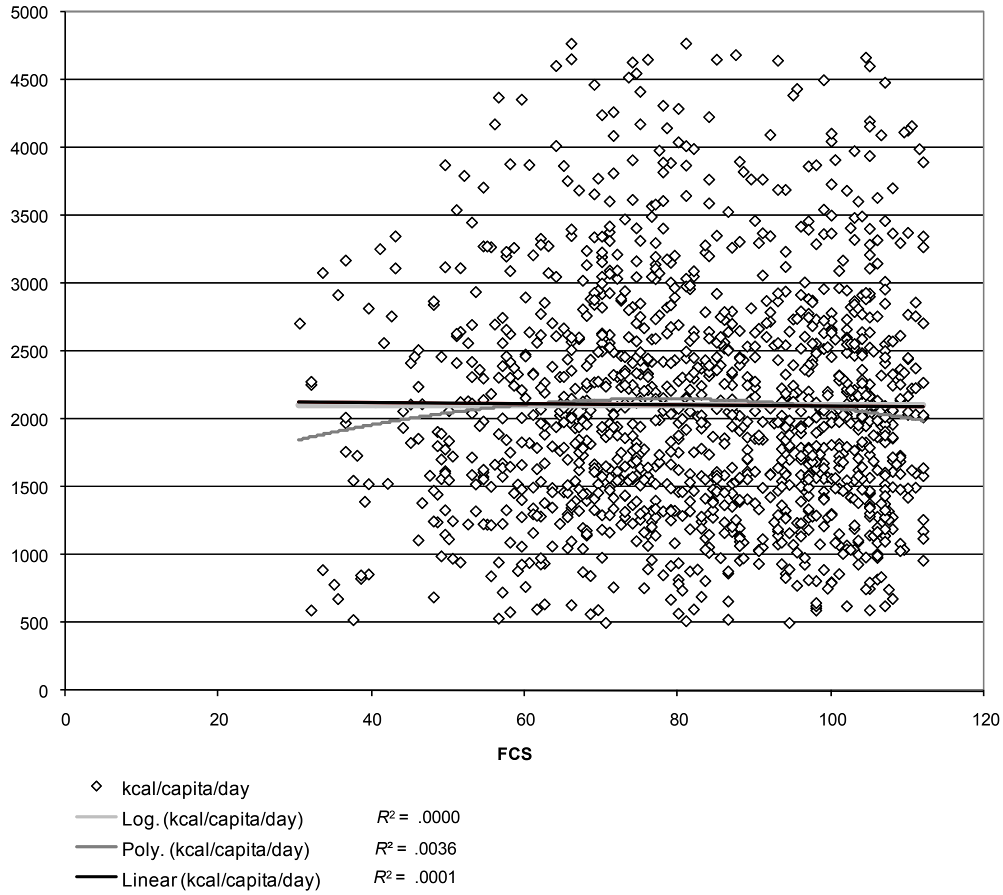
Exploring the relationship between the FCS and calorie consumption per capita separately for food and cash beneficiaries, we find that food transfers have a negative effect on the association of the variables. The lines of best fit are bent downward, suggesting that average calorie consumption per capita falls when the FCS increases (graph not shown). This may seem counterintuitive; yet Sharma (2006) finds that

> overall, the results indicate a number of significant differences in consumption patterns between cash- and food-receiving households. . . . Cash-receiving households were more likely to spend some of their benefits in improving the diversity of their diets, both in terms of buying more expensive cereals, purchasing more meat and dairy products, and buying more processed foods. However, this increased diversity in consumption was achieved at the expense of reduced consumption of the basic staple, rice (p. vii).

This was observed although the food transfers, except for wheat flour, were considered infra-marginal (Sharma 2006).

However, we do not find a strong association between the FCS and calorie consumption per capita when considering only recipients of cash transfers. It should be noted that the cash beneficiaries covered by the WFP's program might also have received transfers in the form of food from other sources. About 50 NGOs assisted the tsunami-affected households in the survey region in various ways. It was difficult, if not impossible, to find out exactly what kind of assistance was received and from whom (Manohar Sharma, personal communication). The fact that about two-thirds of the households resided in shelter camps underscores that their living conditions were not "normal."

Figure 10. Calorie consumption per capita plotted against food consumption score (FCS), tsunami-affected areas in Sri Lanka

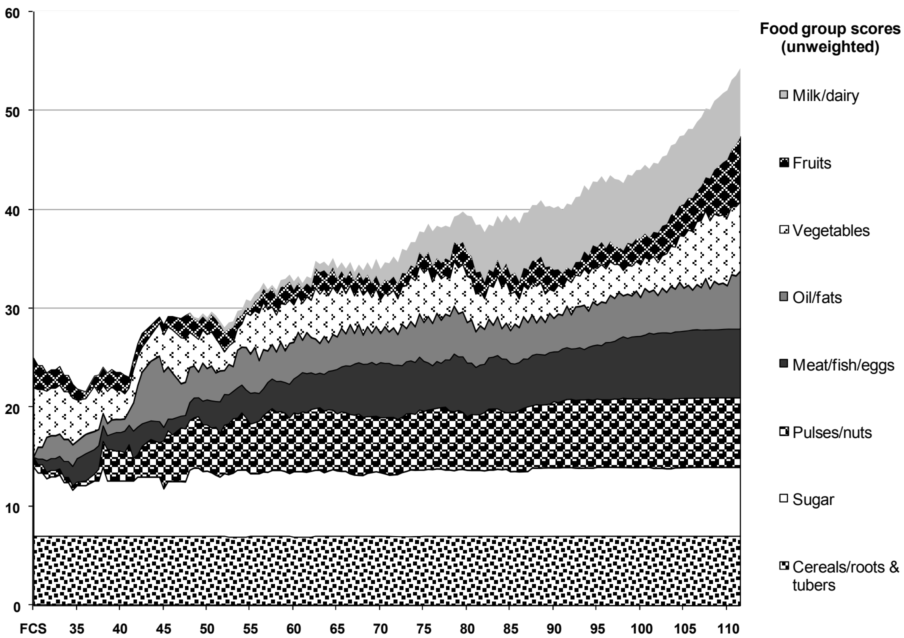


Notes: kcal = kilocalories; Log. = logarithmic; Poly. = polynomial.

An unweighted FCS based on nontruncated food group scores performs better than the weighted and truncated FCS, particularly for cash transfer recipients. (Figure 11 shows how the FCS builds up from food group scores; the straight line for staples results from the truncation. Sugar also does not contribute much to the variation of the FCS.) For the subsample of cash recipients, there is a positive and linear relationship with the nontruncated, unweighted FCS, but the R^2 for these specifications is only about 2 percent.

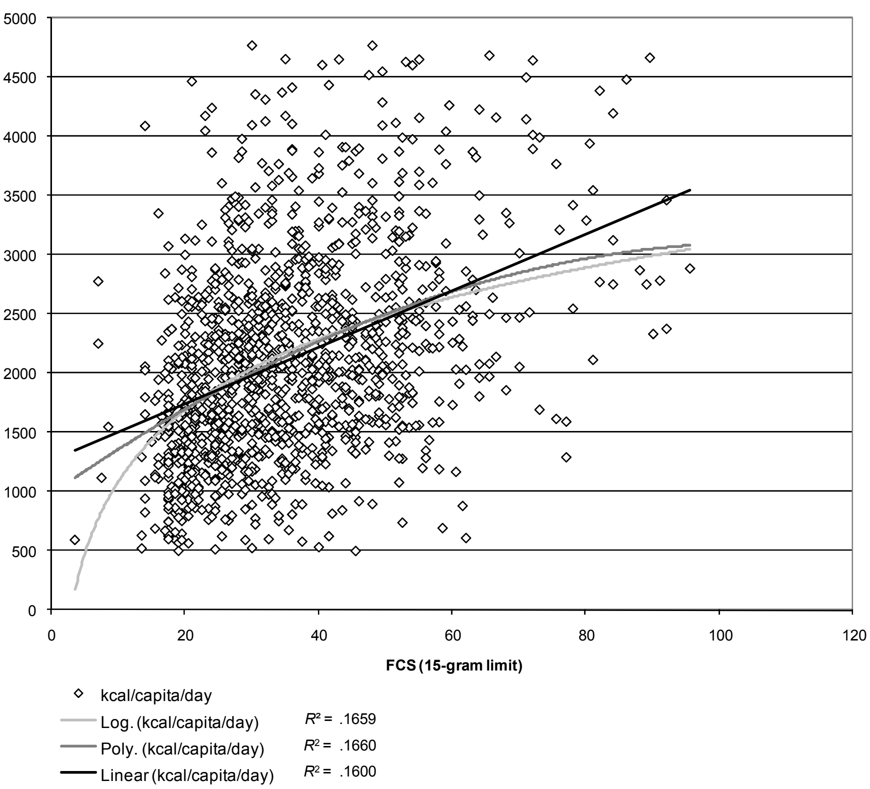
Whereas the impact of food transfers and some aspects of the standard FCS calculation method partly explain the poor correlation with calorie consumption per capita, we find that the frequent consumption of foods in condiment quantities in the Sri Lankan setting is far more relevant. The picture changes dramatically when we plot calorie consumption per capita against an FCS (weighted and based on truncated food group scores) that aggregates food frequencies if more than 15 grams of a food per capita and per consumption day were consumed. We observe a strong, positive, weakly nonlinear association between the variables, and the *R*-squared jumps to 16 to 17 percent; see Figure 12.

Figure 11. Contribution of truncated food group scores to the food consumption score (FCS), tsunami-affected areas in Sri Lanka



Note: This graph is based on shifting averages.

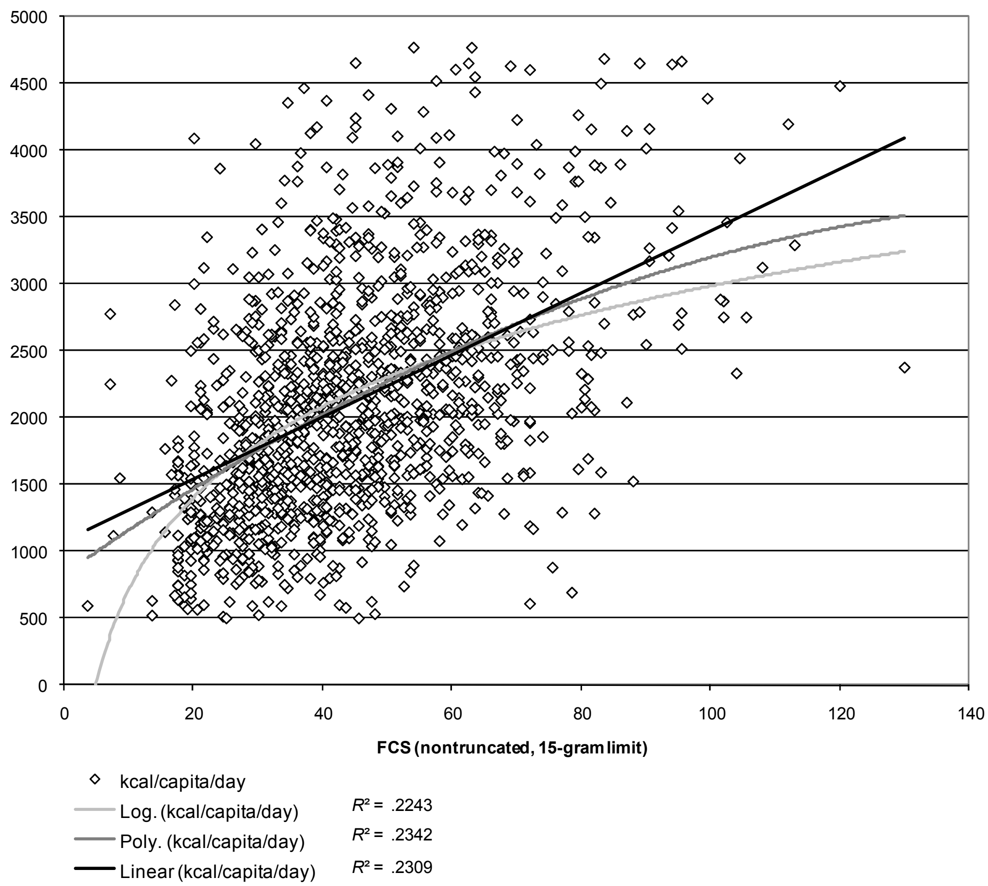
Figure 12. Calorie consumption per capita plotted against food consumption score (FCS) with exclusion of small quantities (≤15 grams), tsunami-affected areas in Sri Lanka



Notes: kcal = kilocalories; Log. = logarithmic; Poly. = polynomial.

We find further improvements in the association with calories per capita when applying the 15-gram limit to the FCS and omitting the truncation and weighting. We gain about 7 percentage points in explanatory power for all three specifications when skipping the truncation; compare Figures 12 and 13. The additional omission of weighting leads to a smaller increase in the *R*-squared of 0.5 to 2 percentage points and makes the relationship more linear, which is good for classification purposes (graph not shown).

Figure 13. Calorie consumption per capita plotted against food consumption score (FCS) with exclusion of small quantities (≤ 15 Grams), based on nontruncated food group scores, tsunami-affected areas in Sri Lanka



Notes: kcal = kilocalories; Log. = logarithmic; Poly. = polynomial.

Correlation analysis corroborates the above findings about weighting and truncation (see Table 18). We find no significant correlation between calories per capita and the FCS calculated according to the standard method and a low correlation (.08) between calorie consumption per capita and the nontruncated, unweighted FCS. While correlations increase with higher disaggregation of food groups—as they did in Burundi and Haiti—they remain low even when considering a detailed list of more than 200 foods. Unlike the scores for Burundi and Haiti, food frequency scores are not clearly superior to dietary diversity scores for Sri Lanka. In terms of correlation coefficients, the simple count of the number of foods or food groups performs as well as, or even better than, the food frequency scores. This is particularly true at lower levels of disaggregation of food groups. Again, correlations with calories per adult equivalent and Spearman rank correlations give us basically the same results; see Appendix Table A.18.

Table 18. Pearson's correlations of calorie consumption per capita with measures of dietary diversity and food frequency, food and cash beneficiaries, tsunami-affected areas in Sri Lanka

Type of proxy indicator	Number of foods/food groups	Dietary diversity	Food frequency	Truncation	Weighting	Correlation coefficient: Total sample	By type of transfer: Food	By type of transfer: Cash
Alternative dietary diversity scores	8	X		NA	No	.06**	.05**	.07**
	12	X		NA	No	.10***	.06***	.14***
	15	X		NA	No	.14***	.10***	.18***
	219	X		NA	No	.16***	.12***	.22***
World Food Programme Food Consumption Score	8		X	Yes	Yes	–.01	–.04	.04
Alternative food consumption scores	8		X	Yes	No	.04	.01	.06
	12		X	Yes	No	.05*	.00	.10*
	15		X	No	Yes	.02	–.04	.09
	15		X	No	No	.08***	.04***	.13***
	219		X	No	No	.17***	.10***	.24***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 219 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 1,300. * = significant at the 10 percent level. ** = significant at the 5 percent level. *** = significant at the 1 percent level.

If we analyze subsamples of households receiving cash or food transfers separately, we see that correlation coefficients are consistently lower for food beneficiaries than for cash beneficiaries (see Table 18). This is in line with the confounding effect of food transfers we mentioned earlier. Looking at differences by type of transfer, we find that cash beneficiaries consume, on average, about 80 kilocalories per capita less but have significantly higher dietary diversity regarding the number of foods consumed.

Imposing a quantity restriction for the consideration of a food or food group in the score dramatically improves the correlations for all proxy indicators; see Table 19. We now obtain correlation coefficients in a similar range as for Burundi and Haiti (when applying no quantity restriction for these countries). The higher the quantity limit, the better is the performance of the proxy indicators. The 12-group food frequency indicator (with truncation and without weighting) now appears as a viable alternative to the food consumption scores without truncation. For the 45-gram restriction, a slight advantage of the food frequency vis-à-vis the dietary diversity indicators emerges. Other basic patterns remain unchanged: alternative versions of the FCS without truncation perform better than the weighted and truncated FCS based on eight food groups. Higher levels of disaggregation of food groups still tend to produce higher correlations.

Descriptive statistics by calorie consumption group give us further insights into the effects of truncating, weighting, and excluding small quantities. The descriptive results show that households with poor calorie consumption consume pulses, fish, milk, and vegetables more frequently than households with adequate calorie consumption (see Appendix Table A.21). This counterintuitive pattern of more frequent consumption of some foods among households with lower calories per capita translates to the eight food group scores via aggregation.

For staples and the pulses and nuts group, the truncation levels off the ability to differentiate among calorie consumption groups. In the case of the tsunami-affected households in Sri Lanka, the weighting factors weaken the ability of the FCS to predict calorie consumption per capita. After aggregation of food frequencies and truncation, oils and fats are the only food group that can strongly differentiate among calorie consumption groups and do so in the expected direction. Yet this group has a low weighting factor of 0.5. The differences for the vegetable group are significant, but its food group score falls with increasing calorie consumption. A similar trend is observed for the milk group, which has a high weight of 4. The meat, fish, and eggs group shows no clear trend but peaks for the middle group with borderline calorie consumption and is also weighted with the factor 4.

Table 19. Pearson's correlations of calorie consumption per capita with measures of dietary diversity and food frequency, with exclusion of small quantities, tsunami-affected areas in Sri Lanka

Type of proxy indicator	Number of foods/food groups	Dietary diversity	Food frequency	Truncation	Weighting	Correlation Coefficient: Limit for exclusion from score: 5 grams	15 grams	45 grams
Alternative dietary diversity scores	8	X		NA	No	.26***	.43***	.50***
	12	X		NA	No	.33***	.48***	.50***
	15	X		NA	No	.35***	.50***	.55***
	219	X		NA	No	.40***	.50***	.51***
World Food Programme Food Consumption Score	8		X	Yes	Yes	.25***	.40***	.43***
Alternative food consumption scores	8		X	Yes	No	.24***	.42***	.54***
	12		X	Yes	No	.31***	.49***	.52***
	15		X	No	Yes	.32***	.48***	.53***
	15		X	No	No	.32***	.50***	.61***
	219		X	No	No	.53***	.59***	.61***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 219 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 1,300.
*** = significant at the 1 percent level.

This explains why only the unweighted version of the FCS without truncation shows any ability to differentiate across calorie consumption categories. For the FCS with weighting and truncation, the mean values even slightly fall when going from the lowest to the highest calorie consumption group (the differences are not significant).

When approximating the exclusion of foods consumed in small quantities (15 grams) from the food frequencies, the counterintuitive patterns for pulses, fish, milk, and vegetables disappear completely. We find consistent increases in mean food frequencies from the poor to the adequate calorie consumption group, with highly significant differences. This shows that households with lower calorie consumption consume these foods more frequently, but in smaller quantities than households with higher calorie consumption. The favorable effect of excluding small quantities translates to the aggregated food group scores. As a consequence, the predictive power of all four FCS versions is boosted enormously when excluding quantities of 15 grams or less, with the nontruncated, unweighted score performing best.

We also note that excluding small quantities leads to considerable declines in average frequencies for many foods. Consumption frequencies for eggs and nuts drop to almost zero, and there are noteworthy declines for other foods as well, especially for fish and milk. This shifts the mean of the FCS and changes the meaning of the cutoffs for creating FCGs. We will examine the cutoffs used for the FCS classification in the next section.

Revisiting the Cutoffs

Looking for alternative cutoff points for the FCS, we find no acceptable combinations of sensitivity and specificity that would balance errors of inclusion and exclusion (see Appendix Tables A.22 and A.23). This is to be expected, given the poor association between the FCS and calorie consumption per capita discussed earlier. The statistics for the AUC shown in Appendix Table A.19 confirm that the FCS without quantity restriction is not suitable for classifying households by level of calorie consumption. The AUC of the FCS is virtually identical to 0.50, and all other proxy indicators remain below the acceptable threshold of 0.60 as well.

Given the importance of excluding small quantities for the Sri Lankan setting, we prefer to use an FCS version with quantity restriction to improve the cross-classification. Using an AUC of about 0.70 or higher as a criterion for a suitable proxy indicator (see Appendix Table A.20), we select a weighted and truncated FCS with food frequencies excluded from the score for quantities of 15 grams or less. Table 20 shows the resulting cross-tabulation with calorie consumption categories and FCGs for cutoffs of 24 and 34. Inevitably, the proportion of false positives (errors of inclusion) has increased, while the proportion of false negatives (errors of exclusion) has declined considerably. The new cutoffs have been set to result in matching prevalence rates for the two indicators. The share of households on the diagonal of the table ("good match") has slightly increased. The proportion of close matches has increased notably, and the proportion of poor matches has been more than halved.

Table 20. Cross-tabulation of food consumption groups (FCGs), based on the food consumption score with exclusion of small quantities (≤ 15 grams) and categories of calorie consumption, tsunami-affected areas in Sri Lanka

		Categories of calorie consumption per capita			
Percentage of cases		**Poor**	**Borderline**	**Acceptable**	**Total**
FCGs	Poor ≤ 24	11.5	7.8	5.5	24.8
	Borderline > 24 – ≤ 34	7.0	9.7	13.2	29.9
	Acceptable > 34	5.7	12.9	26.6	45.2
	Total	24.2	30.5	45.3	100.0

Good match	47.8%
Close match	41.0%
Poor match	11.2%

Note: Numbers do not sum exactly because of rounding.

The optimal cutoffs of 24 and 34 for the FCS with a 15-gram restriction are below the cutoffs for "high sugar and oil consumption" used for the FCS without quantity restriction but lead to much more accurate estimates of the prevalence of calorie deficiency.[22] For the FCS without quantity restriction, the cutoffs would have been raised to 69 and 86 to arrive at corresponding prevalence rates, and this method would result in much higher misclassification.

[22] The cutoffs suggested by sensitivity-specificity analysis for the Food Consumption Score with 15-gram restriction would be slightly different—around 27 and 32—but are in a range similar to the range for matching prevalence estimates.

4. SYNTHESIS AND DISCUSSION OF FINDINGS

This study confirms the usefulness of dietary diversity and food frequency indicators, including WFP's FCS, for assessing household food security (as measured by calorie consumption per capita). We summarize our findings in the following sections and draw lessons for improving the data collection, calculation method, and cutoff points for the FCS.

Summary of Findings on the Association between Proxy Indicators and the Benchmark Variable

We observe robust, medium-sized, positive correlations between calorie consumption per capita and WFP's FCS in Burundi (rural areas) and Haiti (North and Northeast regions), but not in our sample of tsunami-affected households in Sri Lanka. Correlations improve when we account for the frequency of consumption as well as the diversity of diets. The increase of correlation coefficients with higher levels of disaggregation of the proxy indicators is another very consistent pattern we find for all three study sites. Simulating the exclusion of foods consumed in small quantities from the food frequency and dietary diversity scores markedly and consistently improves these correlations; see Table 21.

Table 21. Overview of Pearson's correlations of calorie consumption per capita with measures of dietary diversity and food frequency, with and without exclusion of small quantities

	Correlation coefficients (range for alternative scores)					
	No quantity restriction			Exclusion from score if ≤ 15 grams are consumed		
Type of proxy indicator	Burundi	Haiti	Sri Lanka	Burundi	Haiti	Sri Lanka
Alternative dietary diversity scores	.14–.24	.33–.44	.06–.16	.32–.33	.42–.53	.43–.50
World Food Programme Food Consumption Score	.27	.44	–.01	.36	.50	.40
Alternative food consumption scores	.28–.40	.45–.52	.04–.17	.39–.52	.54–.69	.42–.59

Notes: All food consumption scores are based on food frequencies. See Table 3 for details on the composition of alternative dietary diversity and food consumption scores, sample sizes, and significance of correlation coefficients.

The correlation coefficients for the FCS calculated according to WFP's guidelines generally fall in between the highest correlations for dietary diversity scores and the lowest correlations for alternative FCSs. The most important strategy to obtain stronger associations with calorie consumption per capita would be to exclude small consumption quantities from the FCS (such as ≤ 15 grams; compare Table 21). For all settings, we also observe slight increases in the correlations when the truncation and weighting of the standard FCS are omitted, but these effects are minor.

It is straightforward to explain the effects of truncation and weighting. When the food frequencies for main staples (cereals, roots and tubers, plantains and bananas, and processed foods such as bread and pasta) are summed, the mean of the resulting food-group score increases when moving from the poor to the adequate calorie consumption group. The food-group score for main staples also shows highly significant differences across the three calorie consumption groups, which means it, too, differentiates among levels of calorie consumption. The significant differences of the main staple food group score are eroded by the truncation at a value of seven because almost all households have a food group score higher than seven after the food frequencies for main staples are summed. That said, truncation helps achieve greater comparability of the FCS across countries.

Likewise, for the purpose of predicting diet *quantity,* the weighting of food group scores might be improved.[23] For all three settings, correlation coefficients slightly drop when the weights are applied. In our bivariate analysis, we identified the food groups for which food frequencies differentiate best among calorie consumption categories, with average frequencies increasing from the lowest to the highest calorie consumption category. To improve the prediction of calorie consumption per capita via the FCS, these food groups should be assigned the highest weights. These food groups vary across countries, and we do not find empirical support for using the weights presently recommended by WFP.[24] However, our findings also do not provide a strong rationale for omitting the weights, nor do they suggest a different set of universally applicable weights.

The unweighted food frequency indicator aggregated from 12 truncated food group scores (following the FANTA HDDS classification) performs slightly better than the FCS (with or without weighting) that is based on eight truncated food group scores. For 12-group indicator, the disaggregation of the main staples group into cereals and cereal products and roots and tubers diminishes the leveling effect of the truncation. Significant variance across calorie consumption groups is likely to be left for these two groups when they are not lumped together. In addition, the "other foods" group following the FANTA HDDS classification is able to differentiate across calorie consumption groups in our case studies. This 12-food-group indicator would be slightly superior to the FCS and could be easily constructed from data collected with the WFP food consumption module if one line for other foods (beverages, condiments, spices) were added to the questionnaire.

Summary of Findings on Cutoffs

The cutoff points that are presently recommended by WFP lead to serious underestimation of food insecurity (as measured by calorie consumption per capita) in all three study sites. For Burundi and Sri Lanka, the differences between the prevalence of calorie deficiency and the proportion of households in the poor or borderline FCG according to the FCS classification are most striking. Cross-tabulations of the FCGs with calorie consumption categories show large errors of exclusion that lead to low sensitivity (that is, a low share of calorie-deficient households' being identified by the FCS classification).

Adjusting cutoff points to capture the prevalence of calorie deficiency in our study populations more accurately is one option to deal with the problem of large errors of exclusion, or low sensitivity. Table 22 gives an overview of recommended and adjusted cutoff points for the FCS classification (because the focus of this study is improving the FCS, no cutoffs are presented for alternative proxy indicators of food security). The adjusted cutoff points are much higher than the recommended ones.

The picture improves considerably when food frequencies with consumption quantities of 15 grams or less are excluded from the FCS (see the right-hand-side of Table 22). For Burundi and Sri Lanka, the cutoffs adjusted to the FCS with a 15-gram quantity restriction are relatively close to the existing cutoff points used by WFP. For Haiti, the cutoffs adjusted to the FCS with a 15-gram restriction remain considerably above the WFP cutoffs, however. Figures 14 to 16 show how varying thresholds for exclusion of small quantities affects estimates of food insecurity from the FCS; the cutoff of 45 grams is included mainly to illustrate the effect of varying the threshold because operationalizing this cutoff in the field would be challenging.

---

[23] We note that our analysis does not examine the usefulness of the weights for assessing diet *quality*. Diet quality is another aspect besides diet quantity that the weights are meant to consider (see the justification of weights in Box 3).

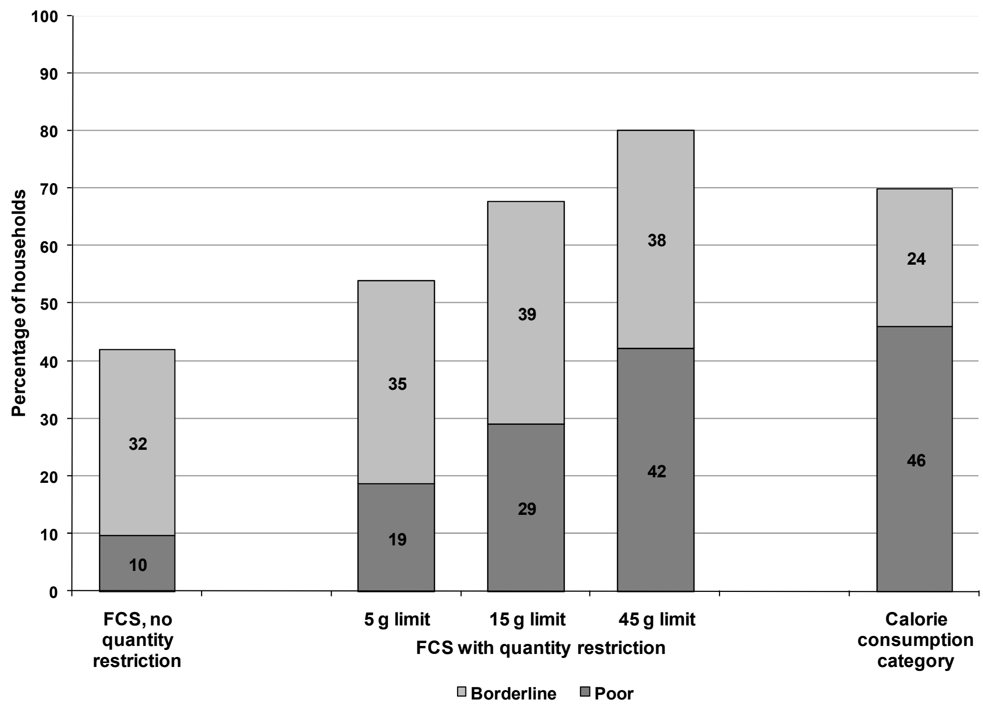
[24] We find that the best candidates among food groups vary with the local food consumption pattern. They do not always coincide with the food groups to which WFP assigned the highest weights. For Burundi, the food groups that differentiate best among calorie consumption groups are the pulses and nuts, which also have a relatively high weighting factor of 3, and oil, which has a low weighting factor of 0.5. For Haiti, pulses and nuts, as well as meat, fish, and eggs, are the best candidates, a pattern that matches WFP's weighting factors relatively well. For Sri Lanka, oil is the only food group with highly significant differences across calorie consumption groups when small quantities are not excluded from the scores. After excluding small quantities, oil (with a low weight of 0.5) and meat, fish, and eggs (with a high weight of 4) stand out.

Table 22. Overview of recommended and adjusted cutoff points for the food consumption score

Cutoffs recommended by World Food Programme		Cutoffs adjusted to match prevalence of calorie deficiency					
		No quantity restriction			Exclusion from score if ≤ 15 grams are consumed		
Normal	High sugar and oil consumption	Burundi	Haiti	Sri Lanka[a]	Burundi	Haiti	Sri Lanka
21	28	37	45	69	27	38.5	24.5
35	42	47	61	86	36.5	51.5	34

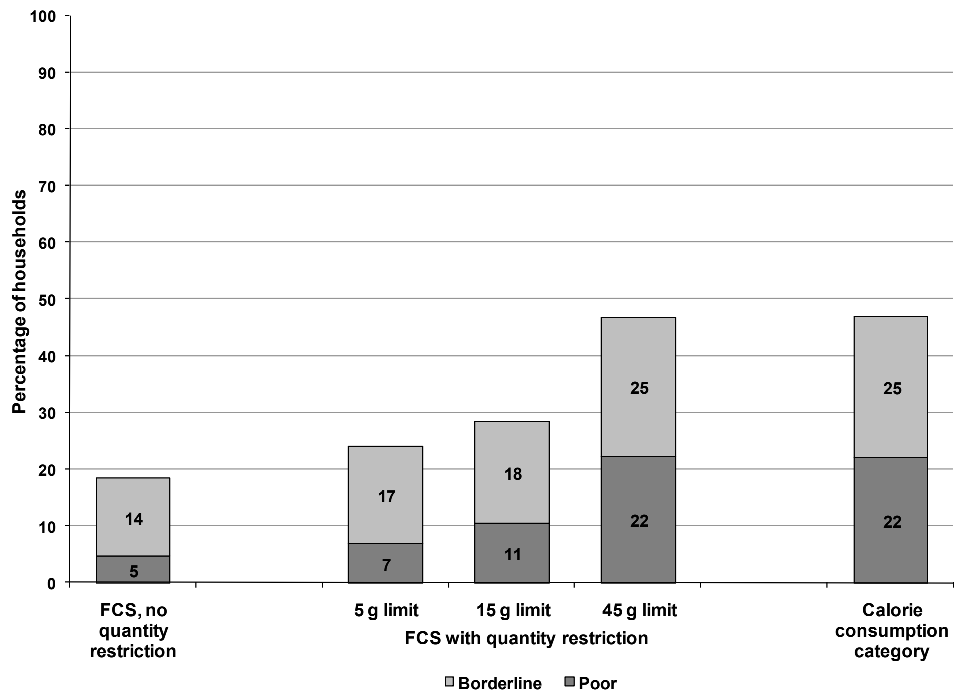
[a] These cutoff points for Sri Lanka are not very meaningful because the Food Consumption Score without quantity restriction lacks a positive association with calorie consumption per capita. They are shown only as an example.

Figure 14. Estimates of food insecurity from calorie consumption per capita and food consumption scores (FCS) with and without exclusion of small quantities, FCS cutoffs of 21 and 35, rural Burundi



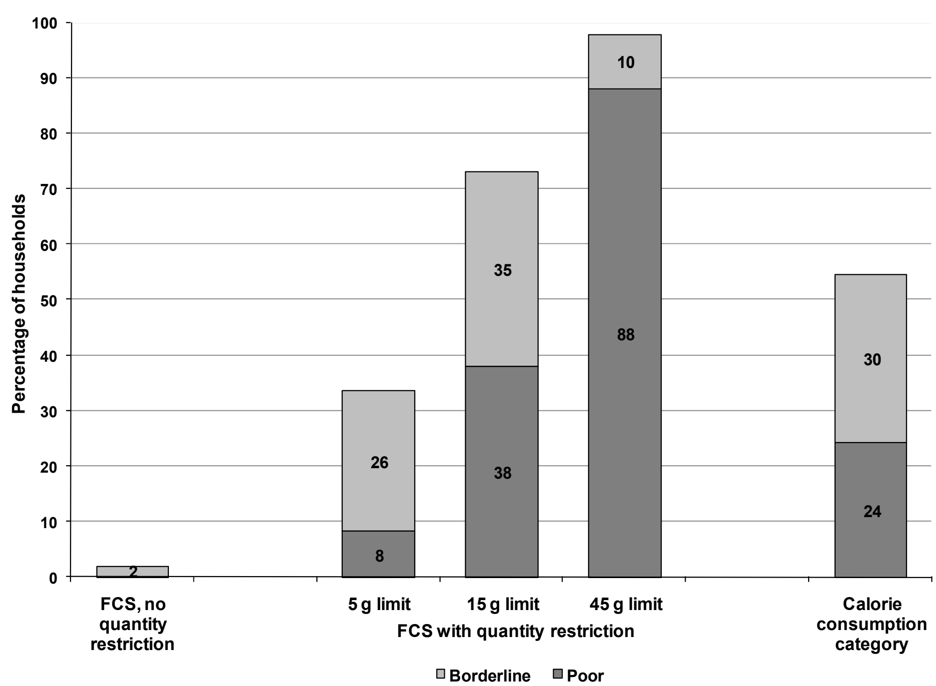
Note: g = grams.

Figure 15. Estimates of food insecurity from calorie consumption per capita and food consumption scores (FCS) with and without exclusion of small quantities, FCS cutoffs of 28 and 42, Haiti, North and Northeast regions



Note: g = grams.

Figure 16. Estimates of food insecurity from calorie consumption per capita and food consumption scores (FCS) with and without exclusion of small quantities, FCS cutoffs of 28 and 42, tsunami-affected households in Sri Lanka



Note: g = grams.

For Burundi, a quantity restriction of 15 grams for calculating the FCS would give us a realistic estimate of overall food insecurity. For Sri Lanka, this threshold would already lead to an overestimate of food insecurity when used with the cutoffs for high sugar and oil consumption.[25] Because of the particular food consumption pattern with a highly diverse diet and frequent consumption of small quantities in Sri Lanka, a 45-gram threshold would produce an extreme overestimate of nearly 98 percent of households' being food insecure and 88 percent severely food insecure. By contrast, a 45-gram restriction for the FCS leads to estimates of food insecurity for Haiti that are just about right.

This suggests that country-specific adaptation of the cutoffs for the FCS and/or varying the thresholds for excluding small quantities is necessary.

Recommendations for Data Collection

We recommend the exclusion of small quantities when collecting food frequency data for the FCS. The exclusion of foods consumed in condiment quantities from food frequencies requires consideration during data collection. The existing FCS Technical Guidance Sheet recommends two separate lines in the food frequency module for fish and for milk/dairy, distinguishing between use for flavor only and consumption as main food; see Appendix Table A.1.

Listing foods consumed as main food or condiments in separate rows has the disadvantage that overlap in frequencies of consumption might not be captured; for example, dairy as a main food and milk in tea in small amounts could have been consumed on the same day. For some purposes, such as systematically testing the effect of excluding small quantities on the FCS, it would be helpful to know on how many days the food was consumed in any quantity, on how many days it was eaten in larger quantities, and on how many days it was eaten only in condiment quantities. The (schematic) questionnaire format shown in Table 23 would allow collection of this kind of information.

Table 23. Alternative questionnaire format for excluding foods consumed as condiments

Food item	Days eaten in past week, as main food or condiment (0-7 days)	Days eaten only in small amounts in past week: 1 tablespoon per person per day or less[a] (0-7 days)
List of staples		
List of nonstaples		

[a] The quantity limit of 1 tablespoon is only an example; 1 teaspoon might also be used if this threshold is more appropriate. One teaspoon corresponds to about 5 grams; one tablespoon corresponds to 15 grams of foods such as milk, sugar, oil, tomato paste, or dried coconut meat. Foods like flour, fish powder, or spices have lower weights per teaspoon or tablespoon. A tablespoon or teaspoon could be shown to the respondent; assessing foods in volumetric quantities is usually much easier than estimating food weights.

The total number of days a food was eaten could be used for comparison with data from earlier surveys when no provision for excluding small quantities was made (such as previous rounds of the Burundi and Haiti FSMSs). The number of days a food was eaten in larger amounts would be taken into account for the FCS. It can be calculated as the difference between the total number of days the food was consumed and the number of days it was eaten only in condiment quantities. This information also would be helpful for identifying foods for which small consumption quantities should be excluded routinely: this would be primarily foods for which the frequency of consuming larger amounts makes up a small fraction of the total food frequency.

Trying to exclude small quantities from food frequencies of main staples is not recommended, because they are eaten mostly in larger amounts. Our explorations showed that applying quantity

[25] The use of these higher cutoffs is debatable for Sri Lanka and Haiti; moreover, when excluding small quantities, the average consumption frequency of oil and sugar falls.

restrictions to staples did not make much of a difference for the FCS (partly due to the truncation of food group scores).

The nonstaple foods for which quantity restrictions should be applied will vary with the local context. For Sri Lanka, the ability to differentiate across calorie consumption groups increased greatly for all seven nonstaple food-group scores when excluding quantities of $\leq$ 15 grams per person and consumption day. For Burundi and Haiti, the quantity restriction made a difference for only some food groups. In all three settings, vegetables, sugar, and oil were good candidates for imposing a limit of 15 grams. This quantity restriction did not increase the significance of differences for eggs in any of the three sites. However, excluding condiment quantities from food frequencies can have benefits even when it does not improve the ability of the food-group score to differentiate across levels of calorie consumption. This is the case when frequent consumption of a food in small amounts inflates the FCS; see the example of nuts discussed for Sri Lanka in Section 3.

Regarding the food list in the WFP food consumption modules, we note discrepancies between the Haiti and Burundi FSMSs. For example, sugar was not included in the food consumption module for Burundi, although it is supposed to be one of the eight major aggregate food groups. For Burundi, we find a list of six vegetables for which food frequencies are requested, including tomatoes, carrots, cabbage, and three types of local leaves. Onions, which are one of the most frequently consumed vegetables in Burundi (they are eaten by more than half of all households according to our detailed food consumption data), are not included. For Haiti, the food frequency of vegetables is inquired about only for vegetables/leaves as an entire group.

5. CONCLUSIONS

Overall, our findings on the usefulness of the dietary diversity and food frequency indicators tested in this study are encouraging. The associations with calorie consumption per capita are mostly as expected with regard to direction and strength (especially when small quantities are excluded from food frequencies). In two out of three study sites, food frequency scores are clearly superior to simpler measures of diet diversity (food or food group count). Higher levels of disaggregation are advantageous, but with diminishing marginal returns. It is therefore not worthwhile to set up a very detailed food list for collecting information on dietary diversity or food frequency; a list grouping food items into broader categories will be sufficient.

All these observations support the use of WFP's FCS for food security assessments. However, the cutoff points recommended by WFP to define poor, borderline, and adequate FCGs are far too low when the FCS classification is compared to estimates of calorie deficiency from our survey data and other sources, and the association of the FCS with calorie consumption per capita is very weak in one out of three sites (Sri Lanka) if small consumption quantities are not excluded from the score. To further improve the validity of the FCS for predicting calorie deficiency, we make the following suggestions, in descending order of importance:

1. **Exclude foods consumed in small quantities from the FCS.** Applying this principle consistently appears to be the most important measure to improve the FCS. We expect that the association between the FCS and calorie consumption per capita would improve, in particular for settings where frequent consumption of small amounts confounds the score. At the same time, the cutoff points for the FCS recommended by WFP would become more suitable, if not adequate, for predicting the prevalence of calorie deficiency accurately; frequent consumption of foods in small quantities tends to inflate the FCS. We recommend that foods generally consumed as condiments (milk or sugar for tea or fish powder, for example) be excluded from the frequency of consumption used for calculating the FCS, as suggested by WFP in its most recent guidelines. We note that finding appropriate cutoffs for the FCS would require repeating the validation exercise after excluding condiments from the score; our findings in this regard should be considered tentative because we had to rely on an approximation method to exclude small quantities, and volumetric cutoffs, such as less than 1 teaspoon/tablespoon, would be more appropriate for field use than gram cutoffs.
2. **Adjust the cutoff points for the FCS**. The present cutoff points of 21 and 35 (or, alternatively, 28 and 42 for populations with high sugar and oil consumption) lead to serious underestimates of food insecurity when compared to the yardstick of calorie consumption per capita. Thus, reducing the large errors of exclusion is paramount and can be done by raising the cutoffs. The problem can also be mitigated to some extent by excluding small quantities from the FCS and thereby shifting its mean, but this measure is unlikely to be sufficient. We find no evidence for the existence of universal cutoffs, with or without exclusion of small quantities.
3. **Skip the truncation or use a 12-group classification.** The truncation levels off some significant variation of the food group score for main staples across calorie consumption groups. The predictive power of the FCS is diminished slightly by this step. Alternatively, a 12-group food frequency indicator with truncated food group scores that follows the FANTA HDDS classification could be used. This would have benefits similar to those achieved when skipping the truncation because main staples are split into two groups and the additional group for "other foods" (beverages, condiments) differentiates well across levels of calorie consumption.
4. **Reconsider the weighting factors.** This is the last and least important point in our list of suggestions. The weights are meant to take into account qualitative *and* quantitative aspects

of the diet, as WFP's justification of weighting factors demonstrates. Our results show that using WFP's weighting factors does not produce stronger associations between the FCS and calorie consumption per capita. Correlation coefficients slightly drop when the weights are applied. This means the weights do not fulfill one part of their purpose, that is, to improve the association of the FCS with diet quantity. The weights may still be useful to enhance the ability of the FCS to reflect diet quality; we could not research this question within the scope of this study. Based on our present knowledge, there is no strong rationale for dropping the weights. Yet if WFP is mainly interested in assessing the quantitative aspect of food security, the simpler approach (no weights) might be preferred, since the more complex procedure does not improve correlations with calorie consumption per capita.

We note several limitations of our study. We did not validate the proxy indicators against diet quality, because measuring micronutrient adequacy requires the collection of individual 24-hour recall data, as explained in the introduction. This was beyond the scope of our study. The use of seven-day household recall data is a limitation for our analysis; information about dietary intakes from individual 24-hour recalls is generally considered more accurate. The lack of precise information about the effects of excluding small quantities from food frequencies is another constraint that could be overcome more easily by modifying the food consumption modules.

Another concern that emerges from our analysis is that the provision of food aid seems to weaken the association of the FCS with calorie consumption. We observe that food aid beneficiaries in Sri Lanka have higher calorie consumption and lower dietary diversity than cash beneficiaries. This confounds the relationship between the FCS and calorie consumption per capita. The validity of food frequency and dietary diversity indicators for predicting calorie consumption may be called into question for populations that are heavily dependent on food aid.

Finally, dietary patterns in South Asia greatly differ from those in Sub-Saharan Africa, and this may require region-specific adaptations of the FCS method. The consumption of a wide variety of foods in small quantities is typical not only for our Sri Lankan setting but for South Asian countries in general. Smith and Wiesmann (2007) show that dietary diversity is much higher in South Asia than in Sub-Saharan Africa (see, also, Wiesmann et al. 2006; Arimond et al. 2008), but the share of calories from starchy staples and the prevalence of severe to moderate calorie deficiency are about the same; higher dietary diversity in South Asia does not necessarily indicate better diet quality or greater food security. This should be taken into account with regard to cutoffs for the FCS and also concerning thresholds for exclusion of foods eaten as condiments.

With these limitations in mind, we end by noting the following issues for which further study would be useful:

- exclude foods consumed in small amounts from food frequencies in the process of data collection, and explore the effects on the FCS and its association with calorie consumption;
- identify foods that are primary candidates for excluding small quantities and define appropriate thresholds (which could be expressed in volumetric measures such as teaspoons or tablespoons);
- adapt cutoff points for the FCS at the level of countries or (sub)regions, considering the particular dietary patterns in South Asia;
- examine the impact of food transfers on the validity of the FCS;
- validate dietary diversity and food frequency indicators against micronutrient adequacy as a measure of diet quality from individual 24-hour recalls; and
- research whether two separate proxy indicators should be used for predicting diet quantity and diet quality.

APPENDIX: SUPPLEMENTARY BOX AND TABLES

Box A.1. Summary of results from the qualitative survey in Haiti, North and Northeast regions

A qualitative survey was conducted to provide more information about the factors that affect household food consumption and about household behavior patterns and perspectives on food consumption. A total of 15 households were interviewed, with enumerators usually speaking to the female head of household or the person responsible for purchasing and preparing food.

The questions covered four main topic areas: (1) what households perceive as "eating well," (2) how decisions about food consumption are made, (3) the relative well-being of households (in terms of food consumption) compared to the recent past, and (4) patterns of eating with other households.

Perceptions of "Eating Well"

When asked what "eating well" means to the household, eight households responded that it meant eating three meals per day, and two responded that these had to be complete meals. Several of these households specified that even though the number of meals is important, food quality is also critical. Four other households echoed this sentiment, with one head of household explaining, "Certainly we eat to fill our bellies, but both quality and quantity should be taken into consideration."[a]

All but two households said that eating well meant consuming a variety of foods. The foods that households most commonly mentioned as important for a varied diet were meat (10 households), vegetables (9 households), beans (8 households), milk (7 households), and eggs (7 households). Three of these households explained that the body needs three food groups, which were generally described as

foods that help build the body (e.g., meat, eggs, beans, milk);
foods that provide energy and strength (e.g., milk, corn, rice, oil, bananas); and
foods that protect the body (e.g., vegetables, fruits, juice).[b]

One household described the following two categories: food from Haiti and food from the Dominican Republic. The female head of household explained, "Food coming from the Dominican Republic is not recommended because the food coming from Haitian gardens is better."[a]

Two households explained that these notions of eating well were difficult for them to attain. One said, "Eating well is far from becoming a reality," and the other said, "Eating well is a utopia. With life so expensive, how can we say we eat well?"

Decisions about Household Food Consumption

All but two households mentioned that money was the main factor influencing their decisions about household food consumption. After money, the season (five households reporting this), food availability at the market (five households reporting this), and food prices (four households reporting this) determined food consumption. While two households said that taste and food preferences affected food consumption, four households said they could not base food consumption decisions on food preferences. One household explained, "We can't pay high prices for the luxury of eating what we want. We eat what we can find."[c]

Relative Well-being over Time

All of the households interviewed stated that they ate better in the past. The most common explanation for this was that environmental conditions (drought and flood) had ruined gardens and harvests (six households reporting this). The next most common reasons were high food prices (five households reporting this) and higher prices for other goods (three households reporting this). Two households mentioned that they had less work and that potential clients had less to spend, resulting in the household's having less money with which to buy food.

Patterns of Eating with Other Households

Every household but one said that they do not send children or any other household members to eat with other households. Some explained that this was fundamentally not part of their tradition, while others said that they did not have enough to share or did not want to beg from other families. One head of household explained that the children occasionally go to neighbors' houses to find something to eat but that he had been putting in a greater effort to prevent this "bad habit." One family said they shared food with people in the neighborhood, usually the midday meal.

---

[a] Household in the town of Carice.
[b] One household mentioned meat and eggs for this category.
[c] Household in the town of Grison Garde.

Table A.1. Example of a food frequency module used by the World Food Programme

Question: I would like to ask you about all the different foods that your household members have eaten in the **last seven days**. Could you please tell me **how many days** in the past week your household has eaten the following foods? (For each food, ask what the primary source of each food item eaten that week was, as well as the second main source of food, if any.)

Food item	**Days eaten in past week (0-7 days)**	**Sources of food (see codes below)**	
		Primary	**Secondary**
1. Maize			
2. Rice			
3. Bread/wheat			
4. Tubers			
5. Groundnuts and pulses			
6. Fish (eaten as a main food)			
7. Fish powder (used for flavor only)			
8. Red meat (sheep/goat/beef)			
9. White meat (poultry)			
10. Vegetable oil, fats			
11. Eggs			
12. Milk and dairy products (main food)			
13. Milk in tea in small amounts			
14. Vegetables (including leaves)			
15. Fruits			
16. Sweets, sugar			

Food Source Codes:

purchase = 1; own production = 2; traded goods/services, barter = 3; borrowed = 4; received as gift = 5; food aid = 6; other (specify) = 7.

Source: World Food Programme (2007).
Note: This example is not final and will be updated and further detailed in the forthcoming Vulnerability Analysis and Mapping Questionnaire Design guidance.

Table A.2. Section of questionnaire used for seven-day food frequency recall, by major food groups in the Sri Lanka survey

1. Please ask about the consumption of the food groups listed in the table.
Record the number of days (zero to seven) on which household members have eaten foods from these food groups in the **PAST WEEK**. Quote the examples given in parentheses to make sure the respondent is aware of various prepared or canned foods belonging to these food groups.

Food item	Code	On how many days during the past week did you consume these foods? Number (0-7)
2.	3.	4.
Rice and rice products (rice flour, pittu, hoppers, string hoppers)	2001	
Wheat and wheat products (bread, noodles)	2002	
Other cereals (millet, maize, barley, etc.)	2003	
Roots and tubers (cassava, potatoes, etc.)	2004	
Lentils, beans, other pulses and pulse products (thosai, papadam, soya meat)	2005	
Meat (chicken, beef, goat, pork) or meat products (sausages, bacon, packed/canned meat)	2006	
Fish (fresh, dried, and canned)	2007	
Eggs	2008	
Milk and milk powder, curd, yogurt, cheese, etc.	2009	
Cooking oil	2010	
Nuts (coconut, groundnut, cashewnut)	2011	
Vegetables (fresh and canned)	2012	
Fruits (fresh, dried, and canned)	2013	
Household sugar	2014	
Confectionery (ice cream, candy, chocolates, biscuits, cakes)	2015	

Source: Evaluation of the cash transfer pilot project, follow-up household survey questionnaire, 2006. The survey was conducted by the World Food Programme and the International Food Policy Research Institute and administered by Manohar Sharma and his team; the content and purpose of the survey are explained in Sharma (2006).

Table A.3. Excerpt from Comprehensive Food Consumption Module developed for Haiti

SECTION 7: CONSOMMATION ALIMENTAIRE PENDANT LA SEMAINE PASSÉE—COMPRÉHENSIVE

7.07		7.08	7.09	7.10A	7.10B	7.11	7.12	7.13	
CODE	**PENDANT LA SEMAINE PASSÉE (7 DERNIERS JOURS), VOTRE MÉNAGE, A-T-IL CONSOMMÉ DE [...]** OUI .1 NON .0 (*»ALIMENT SUIVANT*)		**COMBIEN DE JOURS PENDANT LA SEMAINE PASSÉE VOTRE MÉNAGE A-T-IL CONSOMMÉ DE [...]?**	**QUELLE QUANTITÉ AU TOTAL DE [...] VOTRE MÉNAGE A-T-IL CONSOMMÉ?**		**EST-CE QUE L'ALIMENT A ÉTÉ MANGÉ PRINCIPALEMENT COMME CONDIMENT ?** OUI .1 NON .0	**QUEL ÉTAIT LE MODE PRINCIPAL D'ACQUISITION DE [...]?**[b] (*SI 4, 5 OU 99 »ALIMENT SUIVANT*)	**QUELLE ÉTAIT LA VALEUR MARCHANDE APPROXIMATIVE DE [...] CONSOMMÉ PAR VOTRE MÉNAGE (EN GOURDES)?**	*ESPACE POUR LES CALCULS ET LES NOTES*
				QUANTITÉ TOTALE (7 JOURS)	UNITÉ DE MESURE[a]				
	CÉRÉALES								
101	MAÏS—EN ÉPIS (GRILLÉ, BOUILLI) (*ZEPI MAYI*)								
102	MAÏS—MOULU								
103	MAÏS—FARINE								
104	BLÉ—EN GRAIN								
105	BLÉ—FARINE (*FARINE FRANS*)								
	etc.								

[a]**UNITÉ DE MESURE**

1. Gobelet (ti marmite)
2. Marmite (grande marmite)
3. Ti boite ou mesure (1/3 gobelet)
4. Pièce/Unité
5. Paquet
6. Plat (repas complet)
7. Kola (375 ml)
8. Kè (1/2 kola)
9. Glosse
10. Bouteille de rhum (750 ml)
11. Cuillère (petite = 5 ml)
12. Litre
13. Millilitre
14. Gallon
15. Kilogramme
16. Gramme
17. Autre unité (précisez dans l'espace à droite)

[b]**MODE D'ACQUISITION**

1. Propre production
2. Achat
3. Dons (famille, amis, voisins, communauté)
4. Transfert de l'étranger
5. Aide alimentaire (ONG, PAM, etc.)
99. Ne sait pas/non applicable/pas de réponse

Note: ONG = Organisation non gouvernementale (non-governmental organization); PAM = Programme alimentaire mondial (World Food Programme). A question about the frequency of consumption of each item was included to construct a highly disaggregated food frequency indicator (see section 2.3).

Table A.4. Food groups in the Food Frequency Module for the Burundi Food Security Monitoring Surveys

1	Corn	Main staples
2	Wheat	
3	Sorghum	
4	Rice	
5	Manioc (roots, flour)	
6	Sweet potatoes/tubers	
7	Plantains/bananas	
8	Peanuts/legumes/beans	Pulses
9	Vegetable oil/other fats	Oil
10	Fish	Meat and fish
11	Poultry	
12	Meat	
13	Eggs	
14	Insects (termites/crickets)	
15	Milk/dairy	Milk
16	Fruit	Fruit
17	Bread/donuts	Main staples
18	Tomatoes	Vegetables
19	Cabbage	
20	Carrots	
21	Amaranth leaves	
22	Manioc leaves	
23	Peanut leaves/bean leaves	

Source: Burundi: Etude sur la sécurité alimentaire et vulnérabilité, questionnaire de ménage, 2007. The survey was conducted by the World Food Programme in rural Burundi in 2007.
Note: Food frequency for sugar was not included in this section by the World Food Programme and was calculated from the comprehensive food consumption module.

Table A.5. Food groups in the Food Frequency Module for the Haiti Food Security Monitoring Surveys

1	Corn	Main staples
2	Wheat	
3	Millet	
4	Rice	
5	CSB, WSB	
6	Manioc	
7	Sweet potatoes/yams/potatoes	
8	Plantains/bananas	
9	Breadfruit/breadfruit nut	
10	Legumes	Pulses
11	Peanuts/nuts/peanut butter	
12	Vegetable oil/fats/coconut	Oil
13	Fish/seafood	Meat and fish
14	Poultry	
15	Meat	
16	Eggs	
17	milk/dairy	Milk
18	Vegetables/leaves	Vegetables
19	Fruits	Fruit
20	Spaghetti/macaroni	Main staples
21	Bread/donuts	
22	Sugar	Sugar
23	Bouillon	—

Source: Haïti: Suivi de la sécurité alimentaire – questionnaire du ménage, 2008. The survey was conducted by the World Food Programme in the North and Northeast regions of Haiti in 2008.
Note: CSB = corn soy blend; WSB = wheat soy blend. Dash indicates that this food item could not be assigned to any of the 8 major food groups.

Table A.6. Pearson's and Spearman rank correlations of calorie consumption with measures of dietary diversity and food frequency, calories per capita and per adult equivalent, rural Burundi

						Correlation coefficient			
						Pearson's		Spearman rank	
Type of proxy indicator	Number of foods/ food groups	Dietary diversity	Food frequency	Truncation	Weighting	Calories per capita	Calories per adult equivalent	Calories per capita	Calories per adult equivalent
Alternative dietary diversity scores	8	X		NA	No	.14***	.16***	.15***	.16***
	12	X		NA	No	.19***	.21***	.21***	.21***
	24	X		NA	No	.20***	.22***	.20***	.21***
	120	X		NA	No	.24***	.26***	.26***	.26***
World Food Programme Food Consumption Score	8		X	Yes	Yes	.27***	.28***	.32***	.33***
Alternative food consumption scores	8		X	Yes	No	.28***	.30***	.33***	.34***
	12		X	Yes	No	.34***	.35***	.37***	.38***
	24		X	No	Yes	.33***	.34***	.36***	.37***
	24		X	No	No	.34***	.35***	.37***	.37***
	120		X	No	No	.40***	.40***	.42***	.42***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 120 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 381.
*** = Significant at the 1 percent level.

Table A.7. Area under the Curve (AUC) from receiver operating characteristic analysis for measures of dietary diversity and food frequency, 1,470 and 2,100 kilocalories per capita cutoffs, rural Burundi

Type of proxy indicator	Number of foods/food groups	Dietary diversity	Food frequency	Truncation	Weighting	AUC	
						1,470 kilocalories/ capita/day cutoff	2,100 kilocalories/ capita/day cutoff
Alternative dietary diversity scores	8	X		NA	No	0.57**	0.57***
	12	X		NA	No	0.59***	0.60***
	24	X		NA	No	0.58***	0.60***
	120	X		NA	No	0.61***	0.65***
World Food Programme Food Consumption Score	8		X	Yes	Yes	0.66***	0.64***
Alternative food consumption scores	8		X	Yes	No	0.67***	0.65***
	12		X	Yes	No	0.67***	0.68***
	24		X	No	Yes	0.67***	0.67***
	24		X	No	No	0.67***	0.67***
	120		X	No	No	0.69***	0.71***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 120 food items, was taken from the IFPRI comprehensive food consumption module. The asterisks indicate whether the AUC is significantly different from 0.50, the threshold that indicates no association between the test and the benchmark variable. Number of observations = 381. ** = Significant at the 5 percent level, *** = significant at the 1 percent level.

Table A.8. Area under the Curve (AUC) from receiver operating characteristic analysis for measures of dietary diversity and food frequency with exclusion of small quantities, 1,470 and 2,100 kilocalories per capita cutoffs, rural Burundi

						AUC Limit for exclusion from score: 15 grams	
Type of proxy indicator	**Number of foods/food groups**	**Dietary diversity**	**Food frequency**	**Truncation**	**Weighting**	**1,470 kilocalories/ capita/day cutoff**	**2,100 kilocalories/ capita/day cutoff**
Alternative dietary diversity scores	8	X		NA	No	0.68***	0.65***
	12	X		NA	No	0.67***	0.67***
	24	X		NA	No	0.64***	0.67***
	120	X		NA	No	0.68***	0.70***
World Food Programme Food Consumption Score	8		X	Yes	Yes	0.70***	0.67***
Alternative food consumption scores	8		X	Yes	No	0.72***	0.69***
	12		X	Yes	No	0.71***	0.71***
	24		X	No	Yes	0.70***	0.70***
	24		X	No	No	0.71***	0.71***
	120		X	No	No	0.76***	0.77***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 120 food items, was taken from the IFPRI comprehensive food consumption module. The asterisks indicate whether the AUC is significantly different from 0.50, the threshold that indicates no association between the test and the benchmark variable. Number of observations = 381. *** = Significant at the 1 percent level.

Table A.9. Descriptive statistics, by calorie consumption group, rural Burundi, October 2007

	No quantity restriction					Food frequency = 0 if ≤15 g/capita/consumption day consumed				
		By calorie consumption category					By calorie consumption category			
	Total sample	Poor	Borderline	Adequate	Significance of group differences	Total sample	Poor	Borderline	Adequate	Significance of group differences
	Mean values				F-statistic	Mean values				F-statistic
Food frequency scores										
Corn	1.23	1.01	1.31	1.49	3.0*	1.15	0.94	1.24	1.41	3.0*
Wheat	0.02	0.03	0.02	0.02	0.1	0.02	0.02	0.02	0.02	0.0
Sorghum	0.32	0.34	0.22	0.37	0.4	0.30	0.31	0.22	0.34	0.3
Rice	0.44	0.31	0.40	0.68	6.0***	0.37	0.24	0.33	0.61	6.3***
Manioc	3.38	2.91	3.74	3.82	6.0***	3.31	2.85	3.64	3.76	5.7***
Sweet potatoes/tubers	3.18	3.43	2.69	3.18	2.8*	3.05	3.32	2.55	3.04	3.0*
Plaintains/bananas	1.16	0.94	1.07	1.56	6.2***	1.00	0.81	0.82	1.44	8.7***
Pulses/peanuts	2.88	2.27	2.96	3.75	12.4***	2.70	2.09	2.93	3.46	10.8***
Oil/fats	4.39	3.74	4.65	5.20	11.8***	2.33	1.23	2.90	3.57	26.9***
Fish	2.04	1.74	2.44	2.18	3.7**	0.81	0.48	1.10	1.11	7.2***
Poultry	0.10	0.09	0.16	0.07	0.7	0.02	0.01	0.02	0.03	0.3
Meat	0.24	0.15	0.16	0.43	6.8***	0.19	0.12	0.10	0.39	7.7***
Eggs	0.02	0.01	0.01	0.04	2.0	0.00	0.00	0.00	0.00	—
Insects	0.01	0.00	0.01	0.04	1.0	0.00	0.00	0.01	0.00	1.6
Milk/dairy	0.10	0.10	0.01	0.18	1.7	0.08	0.06	0.01	0.16	1.7
Fruit	0.48	0.23	0.52	0.82	5.7***	0.28	0.11	0.33	0.51	4.9***
Bread/donuts	1.92	1.88	1.95	1.97	0.1	0.12	0.11	0.12	0.15	0.2
Tomatoes	0.38	0.37	0.30	0.46	0.5	0.28	0.27	0.21	0.34	0.4
Cabbage	1.07	0.79	1.23	1.39	4.4**	0.92	0.71	0.99	1.18	2.8*
Carrots	0.11	0.11	0.04	0.18	1.5	0.00	0.00	0.00	0.00	—
Amaranth leaves	1.71	1.74	1.37	1.93	1.4	1.30	1.31	1.09	1.47	0.8
Manioc leaves	1.63	1.46	1.98	1.62	1.8	1.16	0.92	1.52	1.25	3.0**
Peanut leaves/bean leaves	0.65	0.71	0.71	0.49	0.9	0.26	0.20	0.37	0.26	1.2
Sugar	0.59	0.45	0.59	0.79	1.8	0.38	0.20	0.38	0.65	4.4**

(continued)

Table A.9. Continued

	No quantity restriction					Food frequency = 0 if ≤15 g/capita/consumption day consumed				
	Total sample	By calorie consumption category: Poor	Borderline	Adequate	Significance of group differences	Total sample	By calorie consumption category: Poor	Borderline	Adequate	Significance of group differences
	Mean values				F-statistic	Mean values				F-statistic
Food frequency scores, nontruncated										
Main staples	11.65	10.85	11.38	13.10	10.7***	9.33	8.60	8.95	10.77	14.8***
Pulses/nuts	2.88	2.27	2.96	3.75	12.4***	2.70	2.09	2.93	3.46	10.8***
Vegetables	5.55	5.18	5.64	6.06	1.9	3.92	3.40	4.18	4.52	3.6**
Fruits	0.48	0.23	0.52	0.82	5.7***	0.28	0.11	0.33	0.51	4.9***
Meat/fish/eggs	2.40	1.98	2.79	2.75	4.8***	1.03	0.61	1.23	1.52	10.2***
Milk	0.10	0.1	0.01	0.18	1.7	0.08	0.06	0.01	0.16	1.7
Sugar	0.59	0.45	0.59	0.79	1.8	0.38	0.20	0.38	0.65	4.4**
Oil	4.39	3.74	4.63	5.20	11.8***	2.33	1.23	2.90	3.57	26.9***
Food group scores, truncated										
Main staples	6.86	6.81	6.92	6.90	1.5	6.65	6.55	6.64	6.82	2.4*
Pulses/nuts	2.88	2.27	2.96	3.75	12.4***	2.70	2.09	2.93	3.46	10.8***
Vegetables	4.67	4.43	4.87	4.89	1.5	3.46	3.06	3.80	3.82	3.3***
Fruits	0.48	0.23	0.52	0.82	5.7***	0.28	0.11	0.33	0.51	4.9***
Meat/fish/eggs	2.31	1.93	2.64	2.65	5.2***	1.02	0.60	1.22	1.51	10.4***
Milk	0.10	0.10	0.01	0.18	1.7	0.08	0.06	0.01	0.16	1.7
Sugar	0.59	0.45	0.59	0.79	1.8	0.38	0.20	0.38	0.65	4.4**
Oil	4.39	3.74	4.63	5.20	11.8***	2.33	1.23	2.90	3.57	26.9***
Food Consumption Scores (FCSs)										
WFP FCS	39.7	35.3	41.3	45.1	17.13***	30.9	25.9	32.8	37.1	27.6***
Unweighted FCS with truncation	22.3	20.0	23.1	25.2	18.86***	16.9	13.9	18.2	20.5	36.5***
Weighted FCS with truncation	50.5	44.3	51.6	59.0	20.7***	36.8	30.4	37.8	45.8	31.3***
Unweighted FCS w/o truncation	28.0	24.8	28.5	32.7	21.8***	20.1	16.3	20.9	25.2	37.3***

Notes: g = grams; WFP = World Food Programme. Number of observations = 381. * = Significant at the 10 percent level; ** = significant at the 5 percent level; *** significant at the 1 percent level.

Table A.10. Sensitivity-specificity analysis for rural Burundi, 1,470 kilocalories per capita cutoff

Percentage of observations at or below cutoff point	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
0.3	≤6	0.6	100.0	100.0	0.0	45.9	45.9	100.6
0.3	≤7	0.6	100.0	100.0	0.0	45.9	45.9	100.6
0.3	≤8	0.6	100.0	100.0	0.0	45.9	45.9	100.6
0.3	≤9	0.6	100.0	100.0	0.0	45.9	45.9	100.6
0.3	≤10	0.6	100.0	100.0	0.0	45.9	45.9	100.6
0.3	≤11	0.6	100.0	100.0	0.0	45.9	45.9	100.6
0.8	≤12	1.7	100.0	100.0	0.0	45.4	45.4	101.7
0.8	≤13	1.7	100.0	100.0	0.0	45.4	45.4	101.7
2.1	≤14	2.8	98.5	62.5	0.8	44.9	45.7	101.4
2.9	≤15	4.0	98.1	63.6	1.1	44.4	45.4	102.0
3.1	≤16	4.0	97.6	58.3	1.3	44.4	45.7	101.5
3.4	≤17	4.6	97.6	61.5	1.3	44.1	45.4	102.1
4.2	≤18	5.7	97.1	62.5	1.6	43.6	45.1	102.8
6.0	≤19	9.1	96.6	69.6	1.8	42.0	43.8	105.7
7.3	≤20	11.9	96.6	75.0	1.8	40.7	42.5	108.5
9.7	≤21	14.8	94.6	70.3	2.9	39.4	42.3	109.4
12.3	≤22	18.2	92.7	68.1	3.9	37.8	41.7	110.9
14.4	≤23	21.6	91.7	69.1	4.5	36.2	40.7	113.3
16.0	≤24	23.3	90.2	67.2	5.3	35.4	40.7	113.5
18.4	≤25	25.6	87.8	64.3	6.6	34.4	40.9	113.4
20.2	≤26	26.7	85.4	61.0	7.9	33.9	41.7	112.1
22.3	≤27	29.6	83.9	61.2	8.7	32.6	41.2	113.5
24.4	≤28	31.8	82.0	60.2	9.7	31.5	41.2	113.8
27.6	≤29	35.8	79.5	60.0	11.0	29.7	40.7	115.3
30.2	≤30	39.2	77.6	60.0	12.1	28.1	40.2	116.8
31.8	≤31	42.1	77.1	61.2	12.3	26.8	39.1	119.1
33.3	≤32	43.2	75.1	59.8	13.4	26.3	39.6	118.3
36.0	≤33	47.2	73.7	60.6	14.2	24.4	38.6	120.8
38.6	≤34	51.7	72.7	61.9	14.7	22.3	37.0	124.4
42.0	≤35	56.3	70.2	61.9	16.0	20.2	36.2	126.5
44.4	≤36	58.5	67.8	61.0	17.3	19.2	36.5	126.3
46.5	≤37	60.8	65.9	60.5	18.4	18.1	36.5	126.7
48.3	≤38	62.5	63.9	59.8	19.4	17.3	36.8	126.4
51.4	≤39	66.5	61.5	59.7	20.7	15.5	36.2	127.9
53.8	≤40	68.2	58.5	58.5	22.3	14.7	37.0	126.7
55.9	≤41	70.5	56.6	58.2	23.4	13.7	37.0	127.0
59.1	≤42	72.7	52.7	56.9	25.5	12.6	38.1	125.4
60.6	≤43	73.3	50.2	55.8	26.8	12.3	39.1	123.5
64.3	≤44	77.8	47.3	55.9	28.4	10.2	38.6	125.2
66.9	≤45	79.0	43.4	54.5	30.5	9.7	40.2	122.4
69.0	≤46	80.1	40.5	53.6	32.0	9.2	41.2	120.6
71.4	≤47	81.8	37.6	52.9	33.6	8.4	42.0	119.4
72.7	≤48	83.0	36.1	52.7	34.4	7.9	42.3	119.1
74.0	≤49	83.5	34.2	52.1	35.4	7.6	43.0	117.7
76.4	≤50	84.1	30.2	50.9	37.5	7.4	44.9	114.3
78.0	≤51	86.4	29.3	51.2	38.1	6.3	44.4	115.6
79.8	≤52	87.5	26.8	50.7	39.4	5.8	45.1	114.3
81.1	≤53	88.1	24.9	50.2	40.4	5.5	45.9	113.0

Cutoff recommended by the World Food Programme.	Cutoffs to balance sensitivity and specificity, that is, errors of exclusion and inclusion (includes ≤ 37 here).	Cutoff for best match of proportion of food-insecure households.

(continued)

Table A.10. Continued

Number of observations at or below cutoff	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
83.7	≤54	90.3	22.0	49.8	42.0	4.5	46.5	112.3
84.5	≤55	91.5	21.5	50.0	42.3	3.9	46.2	112.9
86.6	≤56	93.8	19.5	50.0	43.3	2.9	46.2	113.3
87.7	≤57	94.3	18.1	49.7	44.1	2.6	46.7	112.4
89.8	≤58	94.9	14.6	48.8	45.9	2.4	48.3	109.5
91.3	≤59	96.0	12.7	48.6	47.0	1.8	48.8	108.7
92.4	≤60	97.2	11.7	48.6	47.5	1.3	48.8	108.9
93.7	≤61	97.7	9.8	48.2	48.6	1.1	49.6	107.5
94.5	≤62	97.7	8.3	47.8	49.3	1.1	50.4	106.0
95.0	≤63	97.7	7.3	47.5	49.9	1.1	50.9	105.0
95.8	≤64	98.3	6.3	47.4	50.4	0.8	51.2	104.6
96.1	≤65	98.3	5.9	47.3	50.7	0.8	51.4	104.2
96.1	≤66	98.3	5.9	47.3	50.7	0.8	51.4	104.2
96.1	≤67	98.3	5.9	47.3	50.7	0.8	51.4	104.2
96.3	≤68	98.9	5.9	47.4	50.7	0.5	51.2	104.7
96.6	≤69	98.9	5.4	47.3	50.9	0.5	51.4	104.2
96.6	≤70	98.9	5.4	47.3	50.9	0.5	51.4	104.2
96.6	≤71	98.9	5.4	47.3	50.9	0.5	51.4	104.2
97.1	≤72	98.9	4.4	47.0	51.4	0.5	52.0	103.3
97.6	≤73	99.4	3.9	47.0	51.7	0.3	52.0	103.3
98.7	≤74	99.4	2.0	46.5	52.8	0.3	53.0	101.4
98.7	≤75	99.4	2.0	46.5	52.8	0.3	53.0	101.4
98.7	≤76	99.4	2.0	46.5	52.8	0.3	53.0	101.4
98.7	≤77	99.4	2.0	46.5	52.8	0.3	53.0	101.4
98.7	≤78	99.4	2.0	46.5	52.8	0.3	53.0	101.4
98.7	≤79	99.4	2.0	46.5	52.8	0.3	53.0	101.4
99.0	≤80	99.4	1.5	46.4	53.0	0.3	53.3	100.9
99.0	≤81	99.4	1.5	46.4	53.0	0.3	53.3	100.9
99.2	≤82	99.4	1.0	46.3	53.3	0.3	53.5	100.4
99.2	≤83	99.4	1.0	46.3	53.3	0.3	53.5	100.4
99.2	≤84	99.4	1.0	46.3	53.3	0.3	53.5	100.4
99.5	≤85	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤86	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤87	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤88	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤89	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤90	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤91	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤92	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤93	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤94	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤95	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤96	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.5	≤97	99.4	0.5	46.2	53.5	0.3	53.8	99.9
99.7	≤98	100.0	0.5	46.3	53.5	0.0	53.5	100.5
99.7	≤99	100.0	0.5	46.3	53.5	0.0	53.5	100.5
100.0	≤100	100.0	0.0	46.2	53.8	0.0	53.8	100.0

Table A.11. Sensitivity-specificity analysis for rural Burundi, 2,100 kilocalories per capita cutoff

Percentage of observations at or below cutoff point	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
0.3	≤6	0.4	100.0	100.0	0.0	69.8	69.8	100.4
0.3	≤7	0.4	100.0	100.0	0.0	69.8	69.8	100.4
0.3	≤8	0.4	100.0	100.0	0.0	69.8	69.8	100.4
0.3	≤9	0.4	100.0	100.0	0.0	69.8	69.8	100.4
0.3	≤10	0.4	100.0	100.0	0.0	69.8	69.8	100.4
0.3	≤11	0.4	100.0	100.0	0.0	69.8	69.8	100.4
0.8	≤12	1.1	100.0	100.0	0.0	69.3	69.3	101.1
0.8	≤13	1.1	100.0	100.0	0.0	69.3	69.3	101.1
2.1	≤14	2.3	98.3	75.0	0.5	68.5	69.0	100.5
2.9	≤15	3.4	98.3	81.8	0.5	67.7	68.2	101.6
3.1	≤16	3.4	97.4	75.0	0.8	67.7	68.5	100.7
3.4	≤17	3.8	97.4	76.9	0.8	67.5	68.2	101.1
4.2	≤18	4.5	96.5	75.0	1.1	66.9	68.0	101.0
6.0	≤19	7.1	96.5	82.6	1.1	65.1	66.1	103.6
7.3	≤20	9.0	96.5	85.7	1.1	63.8	64.8	105.5
9.7	≤21	12.4	96.5	89.2	1.1	61.4	62.5	108.9
12.3	≤22	15.0	93.9	85.1	1.8	59.6	61.4	108.8
14.4	≤23	17.6	93.0	85.5	2.1	57.7	59.8	110.6
16.0	≤24	19.1	91.2	83.6	2.6	56.7	59.3	110.3
18.4	≤25	21.4	88.6	81.4	3.4	55.1	58.5	109.9
20.2	≤26	22.1	84.2	76.6	4.7	54.6	59.3	106.3
22.3	≤27	24.3	82.5	76.5	5.3	53.0	58.3	106.8
24.4	≤28	26.6	80.7	76.3	5.8	51.4	57.2	107.3
27.6	≤29	30.3	79.0	77.1	6.3	48.8	55.1	109.3
30.2	≤30	33.7	78.1	78.3	6.6	46.5	53.0	111.8
31.8	≤31	36.0	78.1	79.3	6.6	44.9	51.4	114.0
33.3	≤32	38.2	78.1	80.3	6.6	43.3	49.9	116.3
36.0	≤33	41.6	77.2	81.0	6.8	40.9	47.8	118.8
38.6	≤34	44.9	76.3	81.6	7.1	38.6	45.7	121.3
42.0	≤35	48.3	72.8	80.6	8.1	36.2	44.4	121.1
44.4	≤36	50.6	70.2	79.9	8.9	34.7	43.6	120.7
46.5	≤37	52.4	67.5	79.1	9.7	33.3	43.0	120.0
48.3	≤38	54.7	66.7	79.4	10.0	31.8	41.7	121.4
51.4	≤39	58.1	64.0	79.1	10.8	29.4	40.2	122.1
53.8	≤40	59.9	60.5	78.1	11.8	28.1	39.9	120.5
55.9	≤41	62.2	58.8	77.9	12.3	26.5	38.9	120.9
59.1	≤42	65.2	55.3	77.3	13.4	24.4	37.8	120.4
60.6	≤43	66.3	52.6	76.6	14.2	23.6	37.8	118.9
64.3	≤44	71.2	51.8	77.6	14.4	20.2	34.7	122.9
66.9	≤45	72.7	46.5	76.1	16.0	19.2	35.2	119.2
69.0	≤46	74.2	43.0	75.3	17.1	18.1	35.2	117.1
71.4	≤47	77.2	42.1	75.7	17.3	16.0	33.3	119.3
72.7	≤48	78.3	40.4	75.5	17.9	15.2	33.1	118.6
74.0	≤49	80.2	40.4	75.9	17.9	13.9	31.8	120.5
76.4	≤50	80.9	34.2	74.2	19.7	13.4	33.1	115.1
78.0	≤51	82.8	33.3	74.4	20.0	12.1	32.0	116.1
79.8	≤52	84.3	30.7	74.0	20.7	11.0	31.8	115.0
81.1	≤53	85.0	28.1	73.5	21.5	10.5	32.0	113.1

Cutoff recommended by the World | Cutoffs to balance sensitivity and specificity, | Cutoff for best match of proportion of

Food Programme.	that is, errors of exclusion and inclusion.	food insecure households.

(continued)

Table A.11. Continued)

Number of observations at or below cutoff	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
83.7	≤54	88.0	26.3	73.7	22.1	8.4	30.5	114.3
84.5	≤55	88.8	25.4	73.6	22.3	7.9	30.2	114.2
86.6	≤56	90.6	22.8	73.3	23.1	6.6	29.7	113.4
87.7	≤57	91.4	21.1	73.1	23.6	6.0	29.7	112.4
89.8	≤58	92.9	17.5	72.5	24.7	5.0	29.7	110.4
91.3	≤59	94.8	16.7	72.7	24.9	3.7	28.6	111.4
92.4	≤60	96.3	16.7	73.0	24.9	2.6	27.6	112.9
93.7	≤61	97.4	14.9	72.8	25.5	1.8	27.3	112.3
94.5	≤62	97.4	12.3	72.2	26.3	1.8	28.1	109.7
95.0	≤63	97.8	11.4	72.1	26.5	1.6	28.1	109.2
95.8	≤64	98.1	9.7	71.8	27.0	1.3	28.4	107.8
96.1	≤65	98.5	9.7	71.9	27.0	1.1	28.1	108.2
96.1	≤66	98.5	9.7	71.9	27.0	1.1	28.1	108.2
96.1	≤67	98.5	9.7	71.9	27.0	1.1	28.1	108.2
96.3	≤68	98.9	9.7	71.9	27.0	0.8	27.8	108.5
96.6	≤69	98.9	8.8	71.7	27.3	0.8	28.1	107.7
96.6	≤70	98.9	8.8	71.7	27.3	0.8	28.1	107.7
96.6	≤71	98.9	8.8	71.7	27.3	0.8	28.1	107.7
97.1	≤72	99.3	7.9	71.6	27.6	0.5	28.1	107.2
97.6	≤73	99.6	7.0	71.5	27.8	0.3	28.1	106.6
98.7	≤74	99.6	3.5	70.7	28.9	0.3	29.1	103.1
98.7	≤75	99.6	3.5	70.7	28.9	0.3	29.1	103.1
98.7	≤76	99.6	3.5	70.7	28.9	0.3	29.1	103.1
98.7	≤77	99.6	3.5	70.7	28.9	0.3	29.1	103.1
98.7	≤78	99.6	3.5	70.7	28.9	0.3	29.1	103.1
98.7	≤79	99.6	3.5	70.7	28.9	0.3	29.1	103.1
99.0	≤80	99.6	2.6	70.6	29.1	0.3	29.4	102.3
99.0	≤81	99.6	2.6	70.6	29.1	0.3	29.4	102.3
99.2	≤82	99.6	1.8	70.4	29.4	0.3	29.7	101.4
99.2	≤83	99.6	1.8	70.4	29.4	0.3	29.7	101.4
99.2	≤84	99.6	1.8	70.4	29.4	0.3	29.7	101.4
99.5	≤85	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤86	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤87	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤88	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤89	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤90	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤91	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤92	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤93	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤94	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤95	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤96	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.5	≤97	99.6	0.9	70.2	29.7	0.3	29.9	100.5
99.7	≤98	100.0	0.9	70.3	29.7	0.0	29.7	100.9
99.7	≤99	100.0	0.9	70.3	29.7	0.0	29.7	100.9
100.0	≤100	100.0	0.0	70.1	29.9	0.0	29.9	100.0

Table A.12. Pearson's and Spearman rank correlations of calorie consumption with measures of dietary diversity and food frequency, calories per capita and per adult equivalent, Haiti, North and Northeast regions

Type of proxy indicator	Number of foods/ food groups	Dietary diversity	Food frequency	Truncation	Weighting	Correlation coefficient: Pearson's: Calories per capita	Pearson's: Calories per adult equivalent	Spearman Rank: Calories per capita	Spearman Rank: Calories per adult equivalent
Alternative dietary diversity scores	8	X		NA	No	.33***	.31***	.37***	.36***
	12	X		NA	No	.34***	.33***	.37***	.36***
	22	X		NA	No	.35***	.35***	.38***	.38***
	141	X		NA	No	.41***	.39***	.44***	.42***
World Food Programme Food Consumption Score	8		X	Yes	Yes	.44***	.43***	.48***	.47***
Alternative food consumption scores	8		X	Yes	No	.45***	.44***	.49***	.49***
	12		X	Yes	No	.46***	.45***	.49***	.48***
	22		X	No	Yes	.46***	.46***	.50***	.49***
	22		X	No	No	.47***	.46***	.50***	.49***
	141		X	No	No	.52***	.50***	.57***	.56***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 141 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 390.
*** = Significant at the 1 percent level.

Table A.13. Area under the curve (AUC) from receiver operating characteristic analysis for measures of dietary diversity and food frequency, 1,470 and 2,100 kilocalories per capita cutoffs, Haiti, North and Northeast regions

Type of proxy indicator	Number of foods/food groups	Dietary diversity	Food frequency	Truncation	Weighting	AUC	
						1,470 kilocalories/ capita/day cutoff	2,100 kilocalories/ capita/day cutoff
Alternative dietary diversity scores	8	X		NA	No	0.67***	0.70***
	12	X		NA	No	0.71***	0.70***
	22	X		NA	No	0.71***	0.71***
	141	X		NA	No	0.74***	0.74***
World Food Programme Food Consumption Score	8		X	Yes	Yes	0.75***	0.76***
Alternative food consumption scores	8		X	Yes	No	0.76***	0.77***
	12		X	Yes	No	0.75***	0.77***
	22		X	No	Yes	0.77***	0.77***
	22		X	No	No	0.77***	0.77***
	141		X	No	No	0.80***	0.80***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 141 food items, was taken from the IFPRI comprehensive food consumption module. The asterisks indicate whether the AUC is significantly different from 0.50, the threshold that indicates no association between the test and the benchmark variable. Number of observations = 390. *** = Significant at the 1 percent level.

Table A.14. Area under the curve (AUC) from receiver operating characteristic analysis for measures of dietary diversity and food frequency with exclusion of small quantities, 1,470 and 2,100 kilocalories per capita cutoffs, Haiti, North and Northeast regions

						AUC Limit for exclusion from score: 15 grams	
Type of proxy indicator	**Number of foods/food groups**	**Dietary diversity**	**Food frequency**	**Truncation**	**Weighting**	**1,470 kilocalories/ capita/day cutoff**	**2,100 kilocalories/ capita/day cutoff**
Alternative dietary diversity scores	8	X		NA	No	0.73***	0.74***
	12	X		NA	No	0.77***	0.74***
	22	X		NA	No	0.77***	0.75***
	141	X		NA	No	0.80***	0.79***
World Food Programme Food Consumption Score	8		X	Yes	Yes	0.80***	0.78***
Alternative food consumption scores	8		X	Yes	No	0.80***	0.80***
	12		X	Yes	No	0.82***	0.80***
	22		X	No	Yes	0.84***	0.82***
	22		X	No	No	0.84***	0.82***
	141		X	No	No	0.87***	0.88***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 141 food items, was taken from the IFPRI comprehensive food consumption module. The asterisks indicate whether the AUC is significantly different from 0.50, the threshold that indicates no association between the test and the benchmark variable. Number of observations = 390. *** = Significant at the 1 percent level.

Table A.15. Descriptive statistics, by calorie consumption group, Haiti, North and Northeast regions, February 2008

	No quantity restriction					Food frequency = 0 if ≤15 g/capita/consumption day consumed				
		By calorie consumption category			Significance of group differences		By calorie consumption category			Significance of group differences
	Total sample	Poor	Borderline	Adequate		Total sample	Poor	Borderline	Adequate	
	Mean values				F-statistic	Mean values				F-statistic
Food frequency scores										
Corn	1.38	1.36	1.24	1.45	0.7	1.32	1.26	1.19	1.41	0.8
Wheat	0.46	0.40	0.35	0.53	1.5	0.44	0.33	0.34	0.53	2.2
Millet	0.27	0.19	0.15	0.37	2.6*	0.26	0.14	0.15	0.36	3.0*
Rice	4.75	3.76	4.60	5.23	14.8***	4.73	3.67	4.59	5.23	16.3***
CSB/WSB	0.11	0.09	0.18	0.08	0.8	0.03	0.00	0.04	0.04	0.6
Manioc	2.40	1.97	2.71	2.43	2.3*	2.32	1.79	2.57	2.42	2.9*
Sweet potatoes/yams/ potatoes	2.40	1.97	2.37	2.59	3.2**	2.29	1.87	2.26	2.47	2.9*
Plaintains/bananas	1.90	1.40	1.42	2.33	10.6***	1.65	0.90	1.27	2.14	15.4***
Breadfruit/breadfruit nut	0.24	0.15	0.24	0.28	0.6	0.15	0.07	0.15	0.17	0.8
Pulses	4.99	3.53	4.69	5.73	35.1***	4.82	3.14	4.55	5.64	40.6***
Nuts/peanut butter	1.58	0.94	1.24	2.01	7.2***	0.65	0.22	0.63	0.85	4.2**
Oil/fats/coconut	6.72	6.37	6.75	6.85	5.0***	5.96	4.37	5.91	6.64	31.3***
Fish/seafood	1.39	0.93	1.03	1.74	8.1***	0.57	0.37	0.42	0.71	2.7*
Poultry	0.38	0.28	0.32	0.45	1.6	0.30	0.20	0.24	0.37	1.9
Meat	1.64	1.03	1.43	2.00	11.8***	1.43	0.78	1.18	1.82	15.3***
Eggs	0.84	0.38	0.65	1.12	7.1***	0.48	0.19	0.35	0.67	5.1***
Milk/dairy	1.73	1.15	1.19	2.22	10.4***	1.59	0.85	1.06	2.14	14.5***
Vegetables/leaves	1.74	1.14	1.54	2.08	9.2***	1.70	0.97	1.54	2.08	13.0***
Fruits	2.93	1.91	2.37	3.62	15.7***	2.69	1.69	2.10	3.38	15.5***
Spaghetti/macaroni	2.11	1.47	1.66	2.58	11.4***	1.88	0.98	1.58	2.39	16.5***
Bread/donuts	4.41	3.70	3.97	4.91	7.5***	3.43	2.40	2.76	4.18	13.9***
Sugar	4.85	3.94	4.33	5.46	15.7***	4.45	3.30	3.92	5.17	18.5***

(continued)

Table A.15. Continued

	No quantity restriction					Food frequency = 0 if ≤15 g/capita/consumption day consumed				
		By calorie consumption category					By calorie consumption category			
	Total sample	Poor	Borderline	Adequate	Significance of group differences	Total sample	Poor	Borderline	Adequate	Significance of group differences
	Mean values				F-statistic	Mean values				F-statistic
Food frequency scores, nontruncated										
Main staples	20.42	16.43	18.89	22.79	28.5***	18.48	13.40	16.90	21.33	50.9***
Pulses/nuts	6.57	4.48	5.93	7.74	31.9***	5.47	3.36	5.18	6.49	38.3***
Vegetables	1.74	1.14	1.54	2.08	9.2***	1.70	0.97	1.54	2.08	13.0***
Fruits	2.93	1.91	2.37	3.62	15.7***	2.69	1.69	2.10	3.38	15.5***
Meat/fish/eggs	4.25	2.63	3.41	5.31	24.4***	2.78	1.53	2.19	3.57	21.7***
Milk	1.73	1.15	1.19	2.22	10.4***	1.59	0.85	1.06	2.14	14.5***
Sugar	4.85	3.94	4.33	5.46	15.7***	4.45	3.30	3.92	5.17	18.5***
Oil	6.72	6.37	6.75	6.85	5.0***	5.96	4.37	5.91	6.64	31.3***
Food group scores, truncated										
Main staples	6.97	6.91	6.98	7.00	3.3**	6.95	6.85	6.96	6.99	5.3***
Pulses/nuts	5.45	4.13	5.12	6.16	33.4***	5.03	3.35	4.73	5.86	42.0***
Vegetables	1.74	1.14	1.54	2.08	9.2***	1.70	0.97	1.54	2.08	13.0***
Fruits	2.93	1.91	2.37	3.62	15.7***	2.69	1.69	2.10	3.38	15.5***
Meat/fish/eggs	3.71	2.44	3.07	4.53	28.9***	2.60	1.49	2.09	3.29	24.2***
Milk	1.73	1.15	1.19	2.22	10.4***	1.59	0.85	1.06	2.14	14.5***
Sugar	4.85	3.94	4.33	5.46	15.7***	4.45	3.30	3.92	5.17	18.5***
Oil	6.72	6.37	6.75	6.85	5.0***	5.96	4.37	5.91	6.64	31.3***
Food Consumption Scores (FCSs)										
WFP FCS	62.5	48.8	55.8	71.3	52.8***	55.3	39.6	49.3	64.7	68.9***
Unweighted FCS with truncation	34.1	28.0	31.4	37.9	53.2***	31.0	22.9	28.3	35.6	81.4***
Weighted FCS w/o truncation	94.9	69.6	83.4	110.8	55.1***	80.4	52.9	70.9	96.3	92.1***
Unweighted FCS w/o truncation	49.2	38.1	44.4	56.1	56.1***	43.1	29.5	38.8	50.8	102.6***

Notes: g = grams; CSB/WSB = corn soy blend/wheat soy blend; WFP = World Food Programme. Number of observations = 390. * = Significant at the 10 percent level; ** = significant at the 5 percent level; *** significant at the 1 percent level.

Table A.16. Sensitivity-specificity analysis for Haiti, North and Northeast regions, 1,470 kilocalories per capita cutoff

Percentage of observations at or below cutoff point	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
0.3	≤13	1.2	100.0	100.0	0.0	21.8	21.8	101.2
1.0	≤14	1.2	99.0	25.0	0.8	21.8	22.6	100.2
1.0	≤15	1.2	99.0	25.0	0.8	21.8	22.6	100.2
1.0	≤16	1.2	99.0	25.0	0.8	21.8	22.6	100.2
1.0	≤17	1.2	99.0	25.0	0.8	21.8	22.6	100.2
1.3	≤18	2.3	99.0	40.0	0.8	21.5	22.3	101.3
1.3	≤19	2.3	99.0	40.0	0.8	21.5	22.3	101.3
1.8	≤20	4.7	99.0	57.1	0.8	21.0	21.8	103.7
2.3	≤21	5.8	98.7	55.6	1.0	20.8	21.8	104.5
2.8	≤22	5.8	98.0	45.5	1.5	20.8	22.3	103.8
2.8	≤23	5.8	98.0	45.5	1.5	20.8	22.3	103.8
3.1	≤24	5.8	97.7	41.7	1.8	20.8	22.6	103.5
3.3	≤25	7.0	97.7	46.2	1.8	20.5	22.3	104.7
3.3	≤26	7.0	97.7	46.2	1.8	20.5	22.3	104.7
3.6	≤27	7.0	97.4	42.9	2.1	20.5	22.6	104.4
4.6	≤28	9.3	96.7	44.4	2.6	20.0	22.6	106.0
4.9	≤29	10.5	96.7	47.4	2.6	19.7	22.3	107.2
5.9	≤30	14.0	96.4	52.2	2.8	19.0	21.8	110.3
6.9	≤31	17.4	96.1	55.6	3.1	18.2	21.3	113.5
7.9	≤32	19.8	95.4	54.8	3.6	17.7	21.3	115.2
9.2	≤33	23.3	94.7	55.6	4.1	16.9	21.0	118.0
9.7	≤34	23.3	94.1	52.6	4.6	16.9	21.5	117.3
10.5	≤35	24.4	93.4	51.2	5.1	16.7	21.8	117.8
11.8	≤36	25.6	92.1	47.8	6.2	16.4	22.6	117.7
13.1	≤37	29.1	91.5	49.0	6.7	15.6	22.3	120.5
14.4	≤38	33.7	91.1	51.8	6.9	14.6	21.5	124.8
15.1	≤39	34.9	90.5	50.9	7.4	14.4	21.8	125.3
16.4	≤40	36.1	89.1	48.4	8.5	14.1	22.6	125.2
16.9	≤41	38.4	89.1	50.0	8.5	13.6	22.1	127.5
18.5	≤42	40.7	87.8	48.6	9.5	13.1	22.6	128.5
19.5	≤43	41.9	86.8	47.4	10.3	12.8	23.1	128.7
21.3	≤44	45.4	85.5	47.0	11.3	12.1	23.3	130.9
22.6	≤45	46.5	84.2	45.5	12.3	11.8	24.1	130.7
23.8	≤46	48.8	83.2	45.2	13.1	11.3	24.4	132.1
25.6	≤47	51.2	81.6	44.0	14.4	10.8	25.1	132.7
26.4	≤48	51.2	80.6	42.7	15.1	10.8	25.9	131.8
28.5	≤49	53.5	78.6	41.4	16.7	10.3	26.9	132.1
31.5	≤50	54.7	75.0	38.2	19.5	10.0	29.5	129.7
32.6	≤51	55.8	74.0	37.8	20.3	9.7	30.0	129.8
34.6	≤52	60.5	72.7	38.5	21.3	8.7	30.0	133.2
36.4	≤53	64.0	71.4	38.7	22.3	8.0	30.3	135.3
37.4	≤54	66.3	70.7	39.0	22.8	7.4	30.3	137.0
39.0	≤55	68.6	69.4	38.8	23.9	6.9	30.8	138.0
40.0	≤56	69.8	68.4	38.5	24.6	6.7	31.3	138.2
41.3	≤57	70.9	67.1	37.9	25.6	6.4	32.1	138.0
41.5	≤58	72.1	67.1	38.3	25.6	6.2	31.8	139.2
43.8	≤59	75.6	65.1	38.0	27.2	5.4	32.6	140.7

Cutoffs recommended by the World Food Programme (higher cutoff for high sugar and oil consumption is used).	Cutoffs to balance sensitivity and specificity, that is, errors of exclusion and inclusion.	Cutoff for best match of proportion of food-insecure households.

(continued)

Table A.16. Continued

Number of observations at or below cutoff	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
45.1	≤60	76.7	63.8	37.5	28.2	5.1	33.3	140.6
46.4	≤61	77.9	62.5	37.0	29.2	4.9	34.1	140.4
48.7	≤62	79.1	59.9	35.8	31.3	4.6	35.9	138.9
50.3	≤63	79.1	57.9	34.7	32.8	4.6	37.4	137.0
51.3	≤64	79.1	56.6	34.0	33.9	4.6	38.5	135.7
53.1	≤65	80.2	54.6	33.3	35.4	4.4	39.7	134.8
54.6	≤66	81.4	53.0	32.9	36.7	4.1	40.8	134.4
56.4	≤67	83.7	51.3	32.7	38.0	3.6	41.5	135.0
59.5	≤68	86.1	48.0	31.9	40.5	3.1	43.6	134.1
60.0	≤69	87.2	47.7	32.1	40.8	2.8	43.6	134.9
62.3	≤70	87.2	44.7	30.9	43.1	2.8	45.9	132.0
64.6	≤71	89.5	42.4	30.6	44.9	2.3	47.2	132.0
65.1	≤72	89.5	41.8	30.3	45.4	2.3	47.7	131.3
66.2	≤73	89.5	40.5	29.8	46.4	2.3	48.7	130.0
67.9	≤74	93.0	39.1	30.2	47.4	1.5	49.0	132.2
70.5	≤75	94.2	36.2	29.5	49.7	1.3	51.0	130.4
72.3	≤76	94.2	33.9	28.7	51.5	1.3	52.8	128.1
73.8	≤77	94.2	31.9	28.1	53.1	1.3	54.4	126.1
75.9	≤78	95.4	29.6	27.7	54.9	1.0	55.9	125.0
78.7	≤79	95.4	26.0	26.7	57.7	1.0	58.7	121.3
80.0	≤80	95.4	24.3	26.3	59.0	1.0	60.0	119.7
81.3	≤81	95.4	22.7	25.9	60.3	1.0	61.3	118.1
82.8	≤82	95.4	20.7	25.4	61.8	1.0	62.8	116.1
84.4	≤83	95.4	18.8	24.9	63.3	1.0	64.4	114.1
85.9	≤84	95.4	16.8	24.5	64.9	1.0	65.9	112.1
87.7	≤85	95.4	14.5	24.0	66.7	1.0	67.7	109.8
88.2	≤86	96.5	14.1	24.1	66.9	0.8	67.7	110.7
89.2	≤87	96.5	12.8	23.9	68.0	0.8	68.7	109.3
90.0	≤88	96.5	11.8	23.7	68.7	0.8	69.5	108.4
90.5	≤89	96.5	11.2	23.5	69.2	0.8	70.0	107.7
90.8	≤90	96.5	10.9	23.5	69.5	0.8	70.3	107.4
91.5	≤91	96.5	9.9	23.3	70.3	0.8	71.0	106.4
91.8	≤92	96.5	9.5	23.2	70.5	0.8	71.3	106.1
92.3	≤93	96.5	8.9	23.1	71.0	0.8	71.8	105.4
92.8	≤94	97.7	8.6	23.2	71.3	0.5	71.8	106.2
93.3	≤95	97.7	7.9	23.1	71.8	0.5	72.3	105.6
93.6	≤96	97.7	7.6	23.0	72.1	0.5	72.6	105.2
94.4	≤97	98.8	6.9	23.1	72.6	0.3	72.8	105.8
95.1	≤98	100.0	6.3	23.2	73.1	0.0	73.1	106.3
96.4	≤99	100.0	4.6	22.9	74.4	0.0	74.4	104.6
96.9	≤100	100.0	4.0	22.8	74.9	0.0	74.9	104.0
97.2	≤101	100.0	3.6	22.7	75.1	0.0	75.1	103.6
97.4	≤102	100.0	3.3	22.6	75.4	0.0	75.4	103.3
97.4	≤103	100.0	3.3	22.6	75.4	0.0	75.4	103.3
97.4	≤104	100.0	3.3	22.6	75.4	0.0	75.4	103.3
97.7	≤105	100.0	3.0	22.6	75.6	0.0	75.6	103.0
98.2	≤106	100.0	2.3	22.5	76.2	0.0	76.2	102.3
99.2	≤107	100.0	1.0	22.2	77.2	0.0	77.2	101.0
99.5	≤108	100.0	0.7	22.2	77.4	0.0	77.4	100.7
99.5	≤109	100.0	0.7	22.2	77.4	0.0	77.4	100.7
99.5	≤110	100.0	0.7	22.2	77.4	0.0	77.4	100.7
99.5	≤111	100.0	0.7	22.2	77.4	0.0	77.4	100.7
100.0	≤112	100.0	0.0	22.1	78.0	0.0	78.0	100.0

Table A.17. Sensitivity-specificity analysis for Haiti, North and Northeast regions, 2,100 kilocalories per capita cutoff

Percentage of observations at or below cutoff point	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
0.3	≤13	0.6	100.0	100.0	0.0	46.7	46.7	100.6
1.0	≤14	1.1	99.0	50.0	0.5	46.4	46.9	100.1
1.0	≤15	1.1	99.0	50.0	0.5	46.4	46.9	100.1
1.0	≤16	1.1	99.0	50.0	0.5	46.4	46.9	100.1
1.0	≤17	1.1	99.0	50.0	0.5	46.4	46.9	100.1
1.3	≤18	1.6	99.0	60.0	0.5	46.2	46.7	100.7
1.3	≤19	1.6	99.0	60.0	0.5	46.2	46.7	100.7
1.8	≤20	2.7	99.0	71.4	0.5	45.6	46.2	101.8
2.3	≤21	3.8	99.0	77.8	0.5	45.1	45.6	102.9
2.8	≤22	4.9	99.0	81.8	0.5	44.6	45.1	104.0
2.8	≤23	4.9	99.0	81.8	0.5	44.6	45.1	104.0
3.1	≤24	5.5	99.0	83.3	0.5	44.4	44.9	104.5
3.3	≤25	6.0	99.0	84.6	0.5	44.1	44.6	105.0
3.3	≤26	6.0	99.0	84.6	0.5	44.1	44.6	105.0
3.6	≤27	6.6	99.0	85.7	0.5	43.9	44.4	105.6
4.6	≤28	8.2	98.6	83.3	0.8	43.1	43.9	106.8
4.9	≤29	8.7	98.6	84.2	0.8	42.8	43.6	107.3
5.9	≤30	10.4	98.1	82.6	1.0	42.1	43.1	108.5
6.9	≤31	12.6	98.1	85.2	1.0	41.0	42.1	110.6
7.9	≤32	14.8	98.1	87.1	1.0	40.0	41.0	112.8
9.2	≤33	17.5	98.1	88.9	1.0	38.7	39.7	115.6
9.7	≤34	18.6	98.1	89.5	1.0	38.2	39.2	116.7
10.5	≤35	19.1	97.1	85.4	1.5	38.0	39.5	116.2
11.8	≤36	21.9	97.1	87.0	1.5	36.7	38.2	119.0
13.1	≤37	23.5	96.1	84.3	2.1	35.9	38.0	119.6
14.4	≤38	26.2	96.1	85.7	2.1	34.6	36.7	122.4
15.1	≤39	27.9	96.1	86.4	2.1	33.9	35.9	124.0
16.4	≤40	30.1	95.7	85.9	2.3	32.8	35.1	125.7
16.9	≤41	31.2	95.7	86.4	2.3	32.3	34.6	126.8
18.5	≤42	33.3	94.7	84.7	2.8	31.3	34.1	128.0
19.5	≤43	35.0	94.2	84.2	3.1	30.5	33.6	129.2
21.3	≤44	37.2	92.8	81.9	3.9	29.5	33.3	129.9
22.6	≤45	38.8	91.8	80.7	4.4	28.7	33.1	130.6
23.8	≤46	41.0	91.3	80.7	4.6	27.7	32.3	132.3
25.6	≤47	42.6	89.4	78.0	5.6	26.9	32.6	132.0
26.4	≤48	43.7	88.9	77.7	5.9	26.4	32.3	132.6
28.5	≤49	45.9	87.0	75.7	6.9	25.4	32.3	132.9
31.5	≤50	48.6	83.6	72.4	8.7	24.1	32.8	132.2
32.6	≤51	50.3	83.1	72.4	9.0	23.3	32.3	133.4
34.6	≤52	53.0	81.6	71.9	9.7	22.1	31.8	134.7
36.4	≤53	55.2	80.2	71.1	10.5	21.0	31.5	135.4
37.4	≤54	56.8	79.7	71.2	10.8	20.3	31.0	136.5
39.0	≤55	58.5	78.3	70.4	11.5	19.5	31.0	136.7
40.0	≤56	59.0	76.8	69.2	12.3	19.2	31.5	135.8
41.3	≤57	60.7	75.9	68.9	12.8	18.5	31.3	136.5
41.5	≤58	61.2	75.9	69.1	12.8	18.2	31.0	137.1
43.8	≤59	64.5	74.4	69.0	13.6	16.7	30.3	138.9

Cutoffs recommended by the World Food Programme (higher cutoff for high sugar and oil consumption is used).	Cutoffs to balance sensitivity and specificity, that is, errors of exclusion and inclusion.	Cutoff for best match of proportion of food insecure households.

(continued)

Table A.17. Continued

Number of observations at or below cutoff	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
45.1	≤60	65.0	72.5	67.6	14.6	16.4	31.0	137.5
46.4	≤61	65.6	70.5	66.3	15.6	16.2	31.8	136.1
48.7	≤62	68.3	68.6	65.8	16.7	14.9	31.5	136.9
50.3	≤63	68.9	66.2	64.3	18.0	14.6	32.6	135.0
51.3	≤64	71.0	66.2	65.0	18.0	13.6	31.5	137.2
53.1	≤65	73.2	64.7	64.7	18.7	12.6	31.3	138.0
54.6	≤66	74.3	62.8	63.9	19.7	12.1	31.8	137.1
56.4	≤67	76.5	61.4	63.6	20.5	11.0	31.5	137.9
59.5	≤68	79.8	58.5	62.9	22.1	9.5	31.5	138.2
60.0	≤69	80.9	58.5	63.3	22.1	9.0	31.0	139.3
62.3	≤70	80.9	54.1	60.9	24.4	9.0	33.3	135.0
64.6	≤71	83.6	52.2	60.7	25.4	7.7	33.1	135.8
65.1	≤72	84.2	51.7	60.6	25.6	7.4	33.1	135.8
66.2	≤73	84.7	50.2	60.1	26.4	7.2	33.6	134.9
67.9	≤74	86.9	48.8	60.0	27.2	6.2	33.3	135.7
70.5	≤75	88.5	45.4	58.9	29.0	5.4	34.4	133.9
72.3	≤76	89.6	43.0	58.2	30.3	4.9	35.1	132.6
73.8	≤77	89.6	40.1	56.9	31.8	4.9	36.7	129.7
75.9	≤78	91.3	37.7	56.4	33.1	4.1	37.2	128.9
78.7	≤79	92.4	33.3	55.1	35.4	3.6	39.0	125.7
80.0	≤80	92.9	31.4	54.5	36.4	3.3	39.7	124.3
81.3	≤81	94.0	30.0	54.3	37.2	2.8	40.0	123.9
82.8	≤82	95.1	28.0	53.9	38.2	2.3	40.5	123.1
84.4	≤83	95.6	25.6	53.2	39.5	2.1	41.5	121.2
85.9	≤84	96.2	23.2	52.5	40.8	1.8	42.6	119.4
87.7	≤85	96.2	19.8	51.5	42.6	1.8	44.4	116.0
88.2	≤86	96.7	19.3	51.5	42.8	1.5	44.4	116.0
89.2	≤87	96.7	17.4	50.9	43.9	1.5	45.4	114.1
90.0	≤88	96.7	15.9	50.4	44.6	1.5	46.2	112.7
90.5	≤89	96.7	15.0	50.1	45.1	1.5	46.7	111.7
90.8	≤90	97.3	15.0	50.3	45.1	1.3	46.4	112.2
91.5	≤91	97.3	13.5	49.9	45.9	1.3	47.2	110.8
91.8	≤92	97.3	13.0	49.7	46.2	1.3	47.4	110.3
92.3	≤93	97.3	12.1	49.4	46.7	1.3	48.0	109.4
92.8	≤94	97.8	11.6	49.5	46.9	1.0	48.0	109.4
93.3	≤95	98.4	11.1	49.5	47.2	0.8	48.0	109.5
93.6	≤96	98.4	10.6	49.3	47.4	0.8	48.2	109.0
94.4	≤97	98.9	9.7	49.2	48.0	0.5	48.5	108.6
95.1	≤98	99.5	8.7	49.1	48.5	0.3	48.7	108.2
96.4	≤99	99.5	6.3	48.4	49.7	0.3	50.0	105.7
96.9	≤100	99.5	5.3	48.2	50.3	0.3	50.5	104.8
97.2	≤101	99.5	4.8	48.0	50.5	0.3	50.8	104.3
97.4	≤102	99.5	4.4	47.9	50.8	0.3	51.0	103.8
97.4	≤103	99.5	4.4	47.9	50.8	0.3	51.0	103.8
97.4	≤104	99.5	4.4	47.9	50.8	0.3	51.0	103.8
97.7	≤105	99.5	3.9	47.8	51.0	0.3	51.3	103.3
98.2	≤106	99.5	2.9	47.5	51.5	0.3	51.8	102.4
99.2	≤107	99.5	1.0	47.0	52.6	0.3	52.8	100.4
99.5	≤108	99.5	0.5	46.9	52.8	0.3	53.1	99.9
99.5	≤109	99.5	0.5	46.9	52.8	0.3	53.1	99.9
99.5	≤110	99.5	0.5	46.9	52.8	0.3	53.1	99.9
99.5	≤111	99.5	0.5	46.9	52.8	0.3	53.1	99.9
100.0	≤112	100.0	0.0	46.9	53.1	0.0	53.1	100.0

Table A.18. Pearson's and Spearman rank correlations of calorie consumption with measures of dietary diversity and food frequency, calories per capita and per adult equivalent, tsunami-affected areas in Sri Lanka

						Correlation coefficient			
						Pearson's		Spearman Rank	
Type of proxy indicator	Number of foods/ food groups	Dietary diversity	Food frequency	Truncation	Weighting	Calories per capita	Calories per adult equivalent	Calories per capita	Calories per adult equivalent
Alternative dietary diversity scores	8	X		NA	No	.06**	.06**	.03	.03
	12	X		NA	No	.10***	.11***	.10***	.10***
	15	X		NA	No	.14***	.15***	.14***	.15***
	219	X		NA	No	.16***	.17***	.16***	.17***
World Food Programme Food Consumption Score	8		X	Yes	Yes	–.01	–.01	–.02	–.03
Alternative food consumption scores	8		X	Yes	No	.04	.03	.01	.00
	12		X	Yes	No	.05*	.06**	.03	.03
	15		X	No	Yes	.02	.03	.01	.00
	15		X	No	No	.08***	.09***	.07**	.07**
	219		X	No	No	.17***	.18***	.14***	.16***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 219 food items, was taken from the IFPRI comprehensive food consumption module. Number of observations = 1,300.
* = Significant at the 10 percent level; ** = significant at the 5 percent level; *** = significant at the 1 percent level.

Table A.19. Area under the curve (AUC) from receiver operating characteristic analysis for measures of dietary diversity and food frequency, 1,470 and 2,100 kilocalories per capita cutoffs, tsunami-affected areas in Sri Lanka

Type of proxy indicator	Number of foods/ food groups	Dietary diversity	Food frequency	Truncation	Weighting	AUC	
						1,470 kilocalories/ capita/day cutoff	2,100 kilocalories/ capita/day cutoff
Alternative dietary diversity scores	8	X		NA	No	0.52	0.50
	12	X		NA	No	0.57***	0.53
	15	X		NA	No	0.58***	0.55***
	219	X		NA	No	0.60***	0.56***
World Food Programme Food Consumption Score	8		X	Yes	Yes	0.49	0.49
Alternative food consumption scores	8		X	Yes	No	0.51	0.50
	12		X	Yes	No	0.53	0.51
	15		X	No	Yes	0.51	0.50
	15		X	No	No	0.54*	0.53**
	219		X	No	No	0.57***	0.56***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 219 food items, was taken from the IFPRI comprehensive food consumption module. The asterisks indicate whether the AUC is significantly different from 0.50, the threshold that indicates no association between the test and the benchmark variable. Number of observations = 1,300. * = Significant at the 10 percent level; ** = significant at the 5 percent level; *** = significant at the 1 percent level.

Table A.20. Area under the curve (AUC) from receiver operating characteristic analysis for measures of dietary diversity and food frequency with exclusion of small quantities, 1,470 and 2,100 kilocalories per capita cutoffs, tsunami-affected areas in Sri Lanka

						AUC Limit for exclusion from score: 15 grams	
Type of proxy indicator	**Number of foods/ food groups**	**Dietary diversity**	**Food frequency**	**Truncation**	**Weighting**	**1,470 kilocalories/ capita/day cutoff**	**2,100 kilocalories/ capita/day cutoff**
Alternative dietary diversity scores	8	X		NA	No	0.73***	0.70***
	12	X		NA	No	0.75***	0.73***
	15	X		NA	No	0.77***	0.74***
	219	X		NA	No	0.75***	0.73***
World Food Programme Food Consumption Score	8		X	Yes	Yes	0.72***	0.69***
Alternative food consumption scores	8		X	Yes	No	0.73***	0.70***
	12		X	Yes	No	0.75***	0.73***
	15		X	No	Yes	0.76***	0.73***
	15		X	No	No	0.77***	0.74***
	219		X	No	No	0.77***	0.77***

Notes: NA = not applicable. The 12 food groups roughly correspond to the groups used for the Food and Nutrition Technical Assistance Project Household Dietary Diversity Score. Information for the dietary diversity and food frequency indicators, based on 219 food items, was taken from the IFPRI comprehensive food consumption module. The asterisks indicate whether the AUC is significantly different from 0.50, the threshold that indicates no association between the test and the benchmark variable. Number of observations = 1,300. *** = Significant at the 1 percent level.

Table A.21. Descriptive statistics, by calorie consumption group, tsunami-affected areas in Sri Lanka, February–March 2006

	No quantity restriction					Food frequency = 0 if ≤15 g/capita/consumption day consumed				
		By calorie consumption category					By calorie consumption category			
	Total sample	Poor	Borderline	Adequate	Significance of group differences	Total sample	Poor	Borderline	Adequate	Significance of group differences
	Mean values				F-statistic	Mean values				F-statistic
Food frequency scores										
Rice	6.80	6.79	6.76	6.84	1.0	6.77	6.68	6.74	6.83	2.3
Wheat	4.07	3.64	3.94	4.38	11.1***	3.32	2.35	3.06	4.02	47.8***
Other cereals	1.87	1.31	1.81	2.22	25.7***	0.29	0.12	0.27	0.39	8.9***
Roots/tubers	2.72	2.43	2.81	2.81	6.6***	0.95	0.51	0.79	1.28	31.4***
Pulses	2.01	***2.61***	***1.89***	***1.77***	17.8***	0.82	***0.44***	***0.79***	***1.04***	17.8***
Meat	1.09	0.77	1.08	1.26	15.0***	0.61	0.34	0.51	0.82	26.0***
Fish	3.58	***3.82***	***3.66***	***3.39***	5.0***	1.35	***0.71***	***1.33***	***1.70***	27.1***
Eggs	1.39	1.34	1.39	1.42	0.3	0.03	0.02	0.04	0.03	0.8
Milk/dairy	4.28	***4.51***	***4.30***	***4.14***	1.6	0.43	***0.24***	***0.20***	***0.69***	16.9***
Oil	4.45	4.01	4.27	4.80	12.9***	3.69	2.62	3.31	4.52	61.8***
Nuts	5.93	5.85	5.91	5.99	0.5	0.01	0.00	0.00	0.02	1.4
Vegetables	4.05	***4.24***	***4.25***	***3.81***	3.3**	3.11	***2.37***	***3.19***	***3.45***	13.2***
Fruits	2.16	1.93	2.25	2.23	2.5*	1.24	0.86	1.26	1.44	10.0***
Sugar	6.63	6.45	6.68	6.69	3.1**	6.34	5.90	6.40	6.54	11.1***
Confectionary	1.94	1.89	1.93	1.98	0.2	0.31	0.12	0.18	0.49	16.9***
Food Group Scores, nontruncated										
Main staples	15.46	14.17	15.32	16.24	31.4***	11.33	9.67	10.87	12.52	82.8***
Pulses/nuts	7.95	***8.46***	***7.80***	***7.77***	5.2***	0.83	***0.44***	***0.79***	***1.06***	18.6***
Vegetables	4.05	***4.24***	***4.25***	***3.81***	3.3**	1.24	***0.86***	***1.26***	***1.44***	10.0***
Fruits	2.16	1.93	2.25	2.23	2.5*	3.11	2.37	3.19	3.45	13.2***
Meat/fish/eggs	6.05	***5.94***	***6.13***	***6.06***	0.4	1.99	***1.07***	***1.87***	***2.55***	41.9***
Milk	4.28	***4.51***	***4.30***	***4.14***	1.6	0.43	***0.24***	***0.20***	***0.69***	16.9***
Sugar	8.57	8.34	8.61	8.67	1.6	6.65	6.03	6.58	7.03	21.8***
Oil	4.45	4.01	4.27	4.80	12.9***	3.69	2.62	3.31	4.52	61.8***

(continued)

Table A.21. Continued

	No quantity restriction					Food frequency = 0 if ≤15 g/capita/consumption day consumed				
		By calorie consumption category					By calorie consumption category			
	Total sample	Poor	Borderline	Adequate	Significance of group differences	Total sample	Poor	Borderline	Adequate	Significance of group differences
	Mean values				F-statistic	Mean values				F-statistic
Food group scores, truncated										
Main staples	6.99	6.99	6.97	7.00	2.5*	6.92	6.85	6.93	6.95	2.4*
Pulses/nuts	6.19	6.12	6.16	6.26	0.7	0.83	0.44	0.79	1.06	18.5***
Vegetables	4.05	***4.24***	***4.25***	***3.81***	3.3**	3.11	***2.37***	***3.19***	***3.45***	13.2***
Fruits	2.16	1.93	2.25	2.23	2.5*	1.24	0.86	1.26	1.44	10.0***
Meat/fish/eggs	5.31	***5.25***	***5.39***	***5.29***	0.6	1.93	***1.04***	***1.84***	***2.47***	43.8***
Milk	4.28	***4.51***	***4.30***	***4.14***	1.6	0.43	***0.24***	***0.20***	***0.69***	16.9***
Sugar	6.74	6.64	6.75	6.79	1.6	6.37	5.97	6.40	6.57	10.0***
Oil	4.45	4.01	4.27	4.80	12.9***	3.69	2.62	3.31	4.52	61.8***
Food Consumption Scores (FCSs)										
WFP FCS	82.7	82.9	83.2	82.3	0.3	35.2	27.7	33.7	40.2	91.8***
Unweighted FCS with truncation	40.2	39.7	40.3	40.3	0.9	24.5	20.4	23.9	27.1	118.4***
Weighted FCS without truncation	106.6	105.9	106.6	107.0	0.2	44.3	33.4	41.8	51.9	143.2***
Unweighted FCS without truncation	53.0	51.6	52.9	53.7	3.8**	29.3	23.3	28.1	33.3	176.9***

Notes: g = grams; WFP = World Food Programme. Food items/food groups and mean values of food frequencies/food group scores by calorie consumption category are in bold italics if mean values decline from poor to acceptable calorie consumption and this counterintuitive tendency is reversed when quantities of 15 grams or less are excluded. Number of observations = 1,300. * = Significant at the 10 percent level; ** = significant at the 5 percent level; *** significant at the 1 percent level.

Table A.22. Sensitivity-specificity analysis for tsunami-affected areas in Sri Lanka, 1,470 kilocalories per capita cutoff

Percentage of observations at or below cutoff point	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
0.0	≤21	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤22	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤23	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤24	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤25	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤26	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤27	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤28	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤29	0.0	100.0	—	0.0	24.2	24.2	100.0
0.0	≤30	0.0	100.0	—	0.0	24.2	24.2	100.0
0.1	≤31	0.0	99.9	0.0	0.1	24.2	24.3	99.9
0.3	≤32	0.3	99.7	25.0	0.2	24.2	24.4	100.0
0.3	≤33	0.3	99.7	25.0	0.2	24.2	24.4	100.0
0.5	≤34	0.6	99.6	33.3	0.3	24.1	24.4	100.2
0.5	≤35	1.0	99.6	42.9	0.3	24.0	24.3	100.6
0.7	≤36	1.3	99.5	44.4	0.4	23.9	24.3	100.8
1.0	≤37	1.3	99.1	30.8	0.7	23.9	24.6	100.4
1.2	≤38	1.6	98.9	31.3	0.9	23.9	24.7	100.5
1.5	≤39	2.5	98.9	42.1	0.9	23.6	24.5	101.4
1.7	≤40	2.9	98.7	40.9	1.0	23.5	24.5	101.5
1.8	≤41	2.9	98.6	39.1	1.1	23.5	24.6	101.4
1.9	≤42	2.9	98.4	36.0	1.2	23.5	24.8	101.2
2.2	≤43	2.9	98.1	32.1	1.5	23.5	25.0	100.9
2.3	≤44	2.9	97.9	30.0	1.6	23.5	25.2	100.7
2.5	≤45	2.9	97.6	27.3	1.9	23.5	25.4	100.4
2.9	≤46	3.2	97.2	26.3	2.2	23.5	25.6	100.3
3.1	≤47	3.5	97.1	27.5	2.2	23.4	25.6	100.6
3.5	≤48	4.1	96.7	28.3	2.5	23.2	25.8	100.8
4.2	≤49	5.1	96.0	29.1	3.0	23.0	26.0	101.1
5.1	≤50	6.0	95.2	28.8	3.6	22.8	26.4	101.3
5.6	≤51	6.7	94.7	28.8	4.0	22.6	26.6	101.4
6.0	≤52	7.0	94.3	28.2	4.3	22.5	26.9	101.3
6.8	≤53	7.3	93.3	25.8	5.1	22.5	27.5	100.6
7.2	≤54	7.6	92.9	25.5	5.4	22.4	27.8	100.5
8.2	≤55	8.3	91.9	24.5	6.2	22.2	28.4	100.1
8.8	≤56	8.9	91.3	24.6	6.6	22.1	28.7	100.2
9.8	≤57	10.2	90.3	25.0	7.4	21.8	29.2	100.4
11.0	≤58	11.1	89.0	24.5	8.3	21.5	29.9	100.2
11.5	≤59	11.8	88.5	24.7	8.7	21.4	30.1	100.3
12.8	≤60	13.3	87.4	25.3	9.5	21.0	30.5	100.7
13.7	≤61	14.6	86.6	25.8	10.2	20.7	30.9	101.2
14.9	≤62	16.2	85.5	26.3	11.0	20.3	31.3	101.7
15.8	≤63	17.1	84.6	26.2	11.7	20.1	31.8	101.7
16.8	≤64	18.1	83.7	26.2	12.4	19.9	32.2	101.8
17.9	≤65	18.7	82.3	25.3	13.4	19.7	33.1	101.1
20.0	≤66	21.3	80.4	25.8	14.9	19.1	33.9	101.7

Cutoffs recommended by the World Food Programme (higher cutoff for high sugar and oil consumption is used).	Cutoffs to balance sensitivity and specificity, that is, errors of exclusion and inclusion (no appropriate cutoffs here).	Cutoff for best match of proportion of food-insecure households.

(continued)

Table A.22. Continued

Number of observations at or below cutoff	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
21.2	≤67	21.9	79.1	25.1	15.9	18.9	34.8	101.0
23.3	≤68	24.8	77.2	25.7	17.3	18.2	35.5	101.9
24.7	≤69	26.0	75.7	25.6	18.4	17.9	36.3	101.8
26.8	≤70	27.6	73.4	24.9	20.2	17.5	37.7	101.0
28.8	≤71	28.6	71.2	24.1	21.9	17.3	39.2	99.7
30.4	≤72	29.5	69.3	23.5	23.2	17.1	40.3	98.9
32.1	≤73	31.1	67.6	23.5	24.5	16.7	41.2	98.7
33.6	≤74	31.8	65.8	22.9	25.9	16.5	42.5	97.5
36.2	≤75	33.0	62.8	22.1	28.2	16.2	44.4	95.9
37.7	≤76	34.9	61.4	22.5	29.2	15.8	45.0	96.3
39.9	≤77	37.5	59.3	22.7	30.9	15.2	46.0	96.8
41.2	≤78	38.1	57.8	22.4	32.0	15.0	47.0	95.9
43.1	≤79	39.7	55.8	22.3	33.5	14.6	48.1	95.5
44.7	≤80	41.9	54.4	22.7	34.5	14.1	48.6	96.3
46.1	≤81	43.2	53.0	22.7	35.6	13.8	49.4	96.2
47.9	≤82	44.8	51.1	22.6	37.1	13.4	50.5	95.8
49.1	≤83	46.4	50.1	22.9	37.9	13.0	50.9	96.4
51.0	≤84	48.9	48.3	23.2	39.2	12.4	51.5	97.2
52.6	≤85	50.2	46.6	23.1	40.5	12.1	52.5	96.8
54.0	≤86	51.8	45.3	23.2	41.5	11.7	53.2	97.0
55.9	≤87	54.3	43.6	23.5	42.8	11.1	53.9	97.8
57.7	≤88	57.5	42.2	24.1	43.8	10.3	54.1	99.7
59.0	≤89	58.4	40.8	24.0	44.9	10.1	54.9	99.2
60.1	≤90	58.7	39.5	23.7	45.9	10.0	55.9	98.2
61.4	≤91	61.0	38.5	24.1	46.6	9.5	56.1	99.4
62.2	≤92	61.3	37.5	23.9	47.4	9.4	56.8	98.7
63.6	≤93	63.2	36.2	24.1	48.3	8.9	57.2	99.4
65.9	≤94	65.7	34.0	24.2	50.0	8.3	58.3	99.7
67.4	≤95	67.0	32.5	24.1	51.2	8.0	59.2	99.5
69.2	≤96	69.5	30.9	24.3	52.4	7.4	59.8	100.4
72.1	≤97	72.1	27.9	24.2	54.6	6.8	61.4	100.0
74.3	≤98	74.3	25.7	24.2	56.3	6.2	62.5	100.0
76.2	≤99	75.9	23.8	24.1	57.8	5.9	63.6	99.6
78.2	≤100	78.1	21.8	24.2	59.2	5.3	64.5	99.9
79.8	≤101	79.4	20.0	24.1	60.6	5.0	65.6	99.4
81.9	≤102	80.6	17.7	23.9	62.4	4.7	67.1	98.3
83.9	≤103	82.9	15.7	23.9	63.9	4.2	68.0	98.6
86.7	≤104	84.4	12.6	23.6	66.2	3.8	70.0	97.0
90.0	≤105	88.6	9.5	23.9	68.5	2.8	71.3	98.1
91.8	≤106	91.8	8.2	24.2	69.5	2.0	71.5	100.0
94.3	≤107	95.2	6.0	24.5	71.2	1.2	72.4	101.2
96.0	≤108	97.5	4.5	24.6	72.4	0.6	73.0	101.9
97.2	≤109	98.1	3.2	24.5	73.4	0.5	73.9	101.2
98.2	≤110	98.7	2.0	24.4	74.2	0.3	74.5	100.8
98.9	≤111	98.7	1.0	24.2	75.0	0.3	75.3	99.8
100.0	≤112	100.0	0.0	24.2	75.8	0.0	75.8	100.0

Note: Dashes indicate that the statistic cannot be calculated, because this would involve dividing by zero.

Table A.23. Sensitivity-specificity analysis for tsunami-affected areas in Sri Lanka, 2,100 kilocalories per capita cutoff

Percentage of observations at or below cutoff point	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
0.0	≤21	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤22	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤23	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤24	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤25	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤26	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤27	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤28	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤29	0.00	100.00	—	0.00	54.69	54.69	100.00
0.0	≤30	0.00	100.00	—	0.00	54.69	54.69	100.00
0.1	≤31	0.00	99.83	0.00	0.08	54.69	54.77	99.83
0.3	≤32	0.14	99.49	25.00	0.23	54.62	54.85	99.63
0.3	≤33	0.14	99.49	25.00	0.23	54.62	54.85	99.63
0.5	≤34	0.28	99.32	33.33	0.31	54.54	54.85	99.60
0.5	≤35	0.42	99.32	42.86	0.31	54.46	54.77	99.74
0.7	≤36	0.56	99.15	44.44	0.38	54.38	54.77	99.71
1.0	≤37	0.98	98.98	53.85	0.46	54.15	54.62	99.97
1.2	≤38	1.41	98.98	62.50	0.46	53.92	54.38	100.39
1.5	≤39	1.83	98.98	68.42	0.46	53.69	54.15	100.81
1.7	≤40	2.11	98.81	68.18	0.54	53.54	54.08	100.92
1.8	≤41	2.11	98.64	65.22	0.62	53.54	54.15	100.75
1.9	≤42	2.25	98.47	64.00	0.69	53.46	54.15	100.72
2.2	≤43	2.25	97.96	57.14	0.92	53.46	54.38	100.21
2.3	≤44	2.53	97.96	60.00	0.92	53.31	54.23	100.49
2.5	≤45	2.67	97.62	57.58	1.08	53.23	54.31	100.30
2.9	≤46	2.95	97.11	55.26	1.31	53.08	54.38	100.07
3.1	≤47	3.09	96.94	55.00	1.38	53.00	54.38	100.04
3.5	≤48	3.66	96.60	56.52	1.54	52.69	54.23	100.26
4.2	≤49	4.78	96.43	61.82	1.62	52.08	53.69	101.22
5.1	≤50	6.05	96.10	65.15	1.77	51.38	53.15	102.14
5.6	≤51	6.47	95.42	63.01	2.08	51.15	53.23	101.89
6.0	≤52	6.61	94.74	60.26	2.38	51.08	53.46	101.35
6.8	≤53	7.17	93.55	57.30	2.92	50.77	53.69	100.72
7.2	≤54	7.59	93.21	57.45	3.08	50.54	53.62	100.80
8.2	≤55	8.58	92.36	57.55	3.46	50.00	53.46	100.94
8.8	≤56	9.14	91.68	57.02	3.77	49.69	53.46	100.82
9.8	≤57	10.41	90.83	57.81	4.15	49.00	53.15	101.24
11.0	≤58	11.25	89.30	55.94	4.85	48.54	53.38	100.56
11.5	≤59	11.67	88.62	55.33	5.15	48.31	53.46	100.30
12.8	≤60	13.08	87.61	56.02	5.62	47.54	53.15	100.69
13.7	≤61	14.06	86.76	56.18	6.00	47.00	53.00	100.82
14.9	≤62	15.47	85.74	56.70	6.46	46.23	52.69	101.21
15.8	≤63	16.46	84.89	56.80	6.85	45.69	52.54	101.35
16.8	≤64	17.30	83.87	56.42	7.31	45.23	52.54	101.17
17.9	≤65	18.57	82.85	56.65	7.77	44.54	52.31	101.42
20.0	≤66	20.68	80.81	56.54	8.69	43.38	52.08	101.49

Cutoffs recommended by the World Food Programme (higher cutoff for high sugar and oil consumption is used).	Cutoffs to balance sensitivity and specificity, that is, errors of exclusion and inclusion (no appropriate cutoffs here).	Cutoff for best match of proportion of food-insecure households.

(continued)

Table A.23. Continued

Number of observations at or below cutoff	Cutoff point	Sensitivity	Specificity	Positive predicted value	Proportion of false positives	Proportion of false negatives	Proportion misclassified	Sum of sensitivity and specificity
21.2	≤67	22.22	80.14	57.45	9.00	42.54	51.54	102.36
23.3	≤68	24.47	78.10	57.43	9.92	41.31	51.23	102.57
24.7	≤69	25.74	76.57	57.01	10.62	40.62	51.23	102.31
26.8	≤70	27.14	73.51	55.30	12.00	39.85	51.85	100.66
28.8	≤71	28.83	71.31	54.81	13.00	38.92	51.92	100.14
30.4	≤72	30.52	69.78	54.94	13.69	38.00	51.69	100.30
32.1	≤73	31.93	67.74	54.44	14.62	37.23	51.85	99.67
33.6	≤74	33.33	66.04	54.23	15.38	36.46	51.85	99.38
36.2	≤75	35.16	62.65	53.19	16.92	35.46	52.38	97.81
37.7	≤76	36.57	60.95	53.06	17.69	34.69	52.38	97.52
39.9	≤77	38.26	58.06	52.41	19.00	33.77	52.77	96.32
41.2	≤78	39.24	56.37	52.05	19.77	33.23	53.00	95.61
43.1	≤79	40.93	54.33	51.96	20.69	32.31	53.00	95.26
44.7	≤80	42.76	52.97	52.32	21.31	31.31	52.62	95.73
46.1	≤81	43.74	51.10	51.92	22.15	30.77	52.92	94.84
47.9	≤82	45.15	48.73	51.52	23.23	30.00	53.23	93.87
49.1	≤83	46.69	48.05	52.04	23.54	29.15	52.69	94.74
51.0	≤84	48.24	45.67	51.73	24.62	28.31	52.92	93.91
52.6	≤85	50.07	44.31	52.05	25.23	27.31	52.54	94.38
54.0	≤86	51.20	42.61	51.85	26.00	26.69	52.69	93.81
55.9	≤87	53.16	40.75	51.99	26.85	25.62	52.46	93.91
57.7	≤88	55.41	39.56	52.53	27.38	24.38	51.77	94.97
59.0	≤89	57.10	38.71	52.93	27.77	23.46	51.23	95.81
60.1	≤90	57.67	37.01	52.50	28.54	23.15	51.69	94.68
61.4	≤91	59.35	36.16	52.88	28.92	22.23	51.15	95.52
62.2	≤92	59.92	34.97	52.66	29.46	21.92	51.38	94.89
63.6	≤93	61.32	33.62	52.72	30.08	21.15	51.23	94.94
65.9	≤94	64.28	32.09	53.33	30.77	19.54	50.31	96.36
67.4	≤95	65.82	30.73	53.42	31.38	18.69	50.08	96.55
69.2	≤96	68.21	29.54	53.89	31.92	17.38	49.31	97.76
72.1	≤97	71.45	27.16	54.22	33.00	15.62	48.62	98.61
74.3	≤98	73.70	24.96	54.24	34.00	14.38	48.38	98.66
76.2	≤99	76.09	23.77	54.65	34.54	13.08	47.62	99.86
78.2	≤100	77.78	21.39	54.43	35.62	12.15	47.77	99.17
79.8	≤101	79.89	20.20	54.72	36.15	11.00	47.15	100.09
81.9	≤102	81.72	17.83	54.55	37.23	10.00	47.23	99.54
83.9	≤103	83.12	15.11	54.17	38.46	9.23	47.69	98.23
86.7	≤104	85.94	12.39	54.21	39.69	7.69	47.38	98.33
90.0	≤105	89.03	8.83	54.10	41.31	6.00	47.31	97.86
91.8	≤106	91.28	7.64	54.40	41.85	4.77	46.62	98.92
94.3	≤107	94.23	5.60	54.65	42.77	3.15	45.92	99.84
96.0	≤108	96.48	4.58	54.97	43.23	1.92	45.15	101.07
97.2	≤109	97.61	3.40	54.95	43.77	1.31	45.08	101.00
98.2	≤110	98.31	2.04	54.78	44.38	0.92	45.31	100.35
98.9	≤111	98.87	1.02	54.67	44.85	0.62	45.46	99.89
100.0	≤112	100.00	0.00	54.69	45.31	0.00	45.31	100.00

Cutoff recommended by the World Food Programme (higher cutoff used).	Cutoffs to balance sensitivity and specificity, that is, errors of exclusion and inclusion (no appropriate cutoffs here).	Cutoff for best match of proportion of food-insecure households.

Note: Dashes indicate that the statistic cannot be calculated, because this would involve dividing by zero.

REFERENCES

Ahmed, A. U., R. Vargas Hill, L. C. Smith, D. Wiesmann, and T. Frankenberger. 2007. *The world's most deprived: Characteristics and causes of extreme poverty and hunger.* 2020 Discussion Paper 43. Washington, D.C.: International Food Policy Research Institute.

Arimond, M., D. Wiesmann, E. Becquey, A. Cariquirry, M. Daniels, M. Deitchler, N. Fanou, E. Ferguson, G. Kennedy, M. Joseph, Y. Martin-Prével, and L. Elin Torheim. 2008. Dietary diversity as a measure of women's diet quality in resource-poor areas: Summary of results from five sites. Report submitted to the Food and Nutrition Technical Assistance Project/Academy for Educational Development, Washington, D.C., by the International Food Policy Research Institute.

Barrett, C. B. 2002. Food security and food assistance programs. In *Handbook of agricultural economics*, ed. B. L. Gardner and G. C. Rausser, 2103-2190. Amsterdam: Elsevier.

Cayemittes, M., M. F. Placide, S. Mariko, B. Barrère, and B. Sévère. 2001. *Enquête Mortalité, Morbidité et Utilisation des Services, EMMUS-III, Haïti 2000.* Calverton, Md., U.S.A.: Ministère de la Santé Publique et de la Population, Institut Haïtien de l'Enfance and ORC Macro.

Centre de Recherches sur la Nutrition de la Faculté des Sciences Agronomiques de l'Université d'Etat à Gand. 1991. *Table de composition des aliments du Burundi.* Ghent, Belgium: Ghent University.

CIA (Central Intelligence Agency of the United States). 2008. *The world factbook 2008.* Washington, D.C. <http://www.cia.gov/cia/ publications/factbook/index.htm>.

Cohen, M., D. Wiesmann, P. Menon, M. Ruel, and N. Smith. 2007. Implementing a conditional cash transfer program in Haiti: Opportunities and challenges. Report submitted to the Inter-American Development Bank, Washington, D.C., by International Food Policy Research Institute.

Deaton, A. 1997. The analysis of household surveys: A microeconomic approach to development policy. Washington, D.C.: World Bank.

FAO (Food and Agriculture Organization of the United Nations). 1996. *Rome Declaration on World Food Security and World Food Summit Plan of Action*. Rome.

________. 2005. Sri Lanka. Special programme for food security: Asia. Rome.

________. 2006a. FAO food security statistics. <http://www.fao.org/faostat/foodsecurity/index_en.htm>. Accessed April, 2008.

________. 2006b. The state of food insecurity in the world 2006. Rome.

________. 2007. The FAOSTAT database. <http://faostat.fao.org>. Accessed June, 2007.

FAO/WHO/UNU (Food and Agriculture Organization of the United Nations/World Health Organization/United Nations University). 1985. *Protein and energy requirements.* Rome: FAO.

Ferro-Luzzi, A. 2002. Individual food intake survey methods. In *Measurement and assessment of food deprivation and undernutrition*. Proceedings of International Scientific Symposium held by the Food and Agriculture Organization of the United Nations, June 26–28, 2002, in Rome.

Gibson, R. S. 2005. *Principles of nutritional assessment*. 2nd ed. New York: Oxford University Press, Inc.

Hatløy, A., L. Torheim, and A. Oshaug. 1998. Food variety—A good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition* 52 (12): 891–898.

Hoddinott, J., and Y. Yohannes. 2002. *Dietary diversity as a food security indicator.* Food Consumption and Nutrition Division Discussion Paper 136. Washington, D.C.: International Food Policy Research Institute.

INCAP/OPS (Instituto de Nutrición de Centro América y Panamá/Organización Panamericana de la Salud). 1996. *Valor nutritivo de los Alimentos de Centroamérica.* Guatemala City, Guatemala.

Messer, E., and M. J. Cohen. 2007. Conflict, food insecurity, and globalization. *Food, Culture and Society: An International Journal of Multidisciplinary Research* 10 (2): 297–315.

Mulder-Sibanda, M. 1998. Nutritional status of Haitian children, 1978–1995: Deleterious consequences of political instability and international sanctions. *Revista Panamericana de Salud Pública* 4 (5): 346–349.

Naiken, L. 2003. FAO methodology for estimating the prevalence of undernourishment. In *Measurement and assessment of food deprivation and undernutrition*. Proceedings of the International Scientific Symposium held by the Food and Agriculture Organization of the United Nations, June 26–28, 2003, in Rome.

Platt, B. S. 1962. *Tables of representative values of foods commonly used in tropical countries.* London: Medical Research Council. Reproduced. London: London School of Hygiene and Tropical Medicine, Department of Human Nutrition, 1985.

Ruel, M. 2002. *Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs.* Food Consumption and Nutrition Division Discussion Paper 140. Washington, D.C.: International Food Policy Research Institute.

Sharma, M. P. 2006. An assessment of the effects of the cash transfer pilot project on household consumption patterns in tsunami-affected areas of Sri Lanka. Report submitted to the World Food Programme, Rome, by International Food Policy Research Institute, Washington, D.C.

Sletten, P., and W. Egset. 2004. *Poverty in Haiti.* Fafo Paper 31. Oslo, Norway: Fafo.

Smith, L. C., and A. Subandoro. 2005. Improving the empirical basis for assessing food insecurity in developing countries: Asia. Report submitted to the Department for International Development of the United Kingdom and to the Australian Agency for International Development by International Food Policy Research Institute. International Food Policy Research Institute, Washington, D.C.

________. 2007. *Measuring food security using household expenditure surveys.* Food Security in Practice Technical Guide Series 3. Washington, D.C.: International Food Policy Research Institute.

Smith, L. C., and D. Wiesmann. 2007. *Is food insecurity more severe in South Asia or sub Saharan Africa?* IFPRI Discussion Paper 00712. Washington, D.C.: International Food Policy Research Institute.

Smith, L. C., H. Alderman, and D. Aduayom. 2006. *Food insecurity in Sub-Saharan Africa: New estimates from household expenditure surveys.* Research Report 146. Washington, D.C.: International Food Policy Research Institute.

Swindale, A., and P. Bilinsky. 2005. *Household Dietary Diversity Score (HDDS) for measurement of household food access: Indicator guide.* Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Torheim, L. E., F. Ouattara, M. M. Diarra, F. D. Thiam, I. Barikmo, A. Hatløy, and A. Oshaug. 2004. Nutrient adequacy and dietary diversity in rural Mali: Association and determinants. *European Journal of Clinical Nutrition* 58 (4): 594–604.

UNICEF (United Nations Children's Fund). 2006. *The state of the world's children 2006.* New York.

________. 2007. The state of the world's children 2007. New York.

Uppsala Conflict Data Program. 2006. *Uppsala conflict database.* Department of Peace and Conflict Research. <http://www.pcr.uu.se/database/index.php>.

West, C. E., F. Pepping, I. Scholte, W. Jansen, and H. F. F. Albers. 1987. *Food composition table for foods commonly eaten in East Africa.* Wageningen, the Netherlands: Technical Center for Agricultural and Rural Cooperation/East, Central, and Southern Africa Food and Nutrition Cooperation.

WFP (World Food Programme). 2005. *Emergency food security assessment handbook.* 1st ed. Rome.

________. 2007. Food consumption analysis: Calculation and use of the Food Consumption Score in food consumption and food security analysis. Technical Guidance Sheet (draft). Rome.

________. 2008. Haiti country overview. Rome. <http://www.wfp.org/country brief/indexcountry.asp?country=332>. Accessed March 2008).

WHO (World Health Organization). 2006. *WHO global database on child growth and malnutrition.* Geneva. <http://www.who.int/nutgrowthdb/>. Accessed May 2007.

Wiesmann, D. 2006. *A global hunger index: Measurement concept, ranking of countries and trends.* Food Consumption and Nutrition Division Discussion Paper 212. Washington, D.C.: International Food Policy Research Institute.

Wiesmann, D., J. Hoddinott, N.-L. Aberman, and M. Ruel. 2006. Review and validation of dietary diversity, food frequency, and other proxy indicators of household food security. Report submitted to the World Food Programme, Rome, by International Food Policy Research Institute.

Wiesmann, D., I. Schöninger, A. K. Sost, H. Dalzell, S. Collins, L. Kiess, and T. Arnold. 2007. *The challenge of hunger 2007.* Bonn, Germany; Washington, DC; and Dublin, Ireland: Deutsche Welthungerhilfe, International Food Policy Research Institute, and Concern.

Williamson, J. 1975. *Useful plants of Malawi.* Revised edition. Limbe, Cameroon: Montfort.

Working Group on Infant and Young Child Feeding Indicators. 2006. Developing and validating simple indicators of dietary quality and energy intake of infants and young children in developing countries: Summary of findings from analysis of 10 data sets. Report submitted to the Food and Nutrition Technical Assistance Project, Washington, D.C., August, 2006.

World Bank. 2006. Repositioning nutrition as central to development: A strategy for large-scale action. Washington, D.C.

________. 2007. *World development indicators on CD-ROM.* Washington, D.C.: Development Data Group.

RECENT IFPRI DISCUSSION PAPERS

For earlier discussion papers, please go to www.ifpri.org/pubs/pubs.htm#dp.
All discussion papers can be downloaded free of charge.

869. *Rebuilding after emergency: Revamping agricultural research in Sierra Leone after civil war.* Kwadwo Asenso-Okyere, Sindu Workneh, Edward Rhodes, John Sutherland. 2009.

868. *Farmers' health status, agricultural efficiency, and poverty in rural Ethiopia.* John M. Ulimwengu. 2009

867. *Joint water quantity/quality management analysis in a biofuel production area: Using an integrated ecomomic hydrologic model.* Márcia Maria Guedes Alcoforado de Moraes, Ximing Cai, Claudia Ringler, Bruno Edson Albuquerque, Sérgio P. Vieira da Rocha, Carlos Alberto Amorim. 2009.

866. *Economywide economic impact of Avian flu in Ghana: A dynamic CGE model analysis.* Xinshen Diao. 2009

865. *Brazil: Shadow WTO agricultural domestic support notifications.* Andre M. Nassar and Diego Ures, 2009**.**

864. *HIV/AIDS, growth and poverty in KwaZulu-Natal and South Africa: Integrating firm-level surveys with demographic and economywide modeling*. James Thurlow, Gavin George, and Jeff Gow, 2009.

863. *The short-run macroeconomic impact of foreign aid to small states: an agnostic time series analysis*. Henrik Hansen and Derek Headey, 2009.

862. *European Union preferential trade agreements with developing countries and their impact on Colombian and Kenyan carnation exports to the United Kingdom.* Guyslain K. Ngeleza and Andrew Muhammad, 2009

861. *The linkages between agriculture and malaria: Issues for policy, research, and capacity strengthening*. Kwadwo Asenso-Okyere, Felix A. Asante, Jifar Tarekegn, and Kwaw S. Andam, 2009.

860. *La biotecnología agropecuaria en América Latina: Una visión cuantitativa.* José Falck-Zepeda, César Falcón, Maria José Sampaio-Amstalden, José Luis Solleiro Rebolledo, Eduardo Trigo, and Javier Verástegui, 2009.

859. *Preferential trade agreements between the monetary community of Central Africa and the European Union: Stumbling or building blocks? A general equilibrium approach*. Guyslain K. Ngeleza and Andrew Muhammad, 2009.

858. *Preliminary evidence on internal migration, remittances, and teen schooling in India.* Valerie Mueller and Abusaleh Shariff, 2009.

857. *Productivity convergence in Brazil: The case of grain production.* Eduardo Magalhaes and Xinshen Diao, 2009.

856. *Dynamics of structural transformation: An empirical characterization in the case of China, Malaysia, and Ghana*. Thaddee Badibanga, Xinshen Diao, Terry Roe, and Agapi Somwaru, 2009.

855. *Do institutions limit clientelism? A study of the district assemblies common fund in Ghana*. Afua Branoah Banful, 2009.

854. *The evolution of Chinese entrepreneurial firms: Township-village enterprises revisited*. Chenggang Xu and Xiaobo Zhang, 2009.

853. *Evaluating the impact of land tenure and titling on access to credit in Uganda*. Carly K. Petracco and John Pender, 2009.

852. *Participation by Men and Women in Off-Farm Activities: An Empirical Analysis in Rural Northern Ghana*. Nancy McCarthy and Yan Sun, 2009.

851. *Measuring agricultural innovation system properties and performance: Illustrations from Ethiopia and Vietnam*. David J. Spielman and Dawit Kelemework, 2009.

850. *Are returns to mothers' human capital realized in the next generation?: The impact of mothers' intellectual human capital and long-run nutritional status on children's human capital in Guatemala*. Jere R. Behrman, Alexis Murphy, Agnes R. Quisumbing, and Kathryn Yount, 2009.

849. *Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin, South Africa*. Glwadys Aymone Gbetibouo, 2009.

848. *Agglomeration, migration, and regional growth: A CGE analysis for Uganda*. Paul Dorosh and James Thurlow, 2009.

847. *Biosafety decisions and perceived commercial risks: The role of GM-free private standards*. Guillaume Gruère and Debdatta Sengupta, 2009.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

www.ifpri.org

IFPRI HEADQUARTERS

2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

IFPRI ADDIS ABABA

P. O. Box 5689
Addis Ababa, Ethiopia
Tel.: +251 11 6463215
Fax: +251 11 6462927
Email: ifpri-addisababa@cgiar.org

IFPRI NEW DELHI

CG Block, NASC Complex, PUSA
New Delhi 110-012 India
Tel.: 91 11 2584-6565
Fax: 91 11 2584-8008 / 2584-6572
Email: ifpri-newdelhi@cgiar.org