

Advances in Developing Country Food Insecurity Measurement

Development and Validation of an Experience-Based Measure of Household Food Insecurity within and across Seasons in Northern Burkina Faso^{1,2}

Edward A. Frongillo*³ and Siméon Nanama[†]

*Division of Nutritional Sciences, Cornell University, Ithaca, NY 14853-6301 and [†]Micronutrient Initiative, 12 BP 223, Ouagadougou 12, Burkina Faso

ABSTRACT Organizations measure household food insecurity for program design, planning, targeting, implementation, monitoring, and evaluation, but existing measures often are inadequate. Qualitative and quantitative methods were used to develop and validate an experience-based measure of the access component of food insecurity in northern Burkina Faso. In-depth interviews on food insecurity were done with 10 household heads and 26 women using interview guides. We identified themes, classified households, created a table of food insecurity categories, identified items to add to or delete from an initial questionnaire, and developed and revised answer choices. A longitudinal study provided quantitative data on changes over time in household food insecurity, economic situation, and related factors. Data were collected on 126 simple and complex households from 9 villages each July and January from 2001 to 2003 (5 waves). These data allowed examination of changes in household food insecurity twice annually across the best and worst seasons for food, and evaluation of the ability of the experience-based measure to differentiate changes in household food insecurity. Validity was assessed by examining reliability and by comparing the experience-based food insecurity measure with economic status, dietary, and anthropometric measures and with a measure created by an observer who rated the households' food insecurity. The results provide strong evidence that the food insecurity score, calculated from experience-based questionnaire items, was valid for determining seasonal differences in household food insecurity, differences among households in food insecurity at a given time, and changes in household food insecurity over time in northern rural Burkina Faso. *J. Nutr.* 136: 1409S–1419S, 2006.

KEY WORDS: • *food insecurity* • *dietary intake* • *anthropometry* • *validity* • *economic status*

Household food insecurity results when food is not available, cannot be accessed with certainty in socially acceptable ways, or is not physiologically utilized completely. Development organizations and other institutions need to measure household food insecurity for program design, planning, targeting, implementation, monitoring, and evaluation. Measures of food availability alone are inadequate and should be augmented by measures

of access to food (1). One promising approach to developing such a measure is that used for developing the U.S. Household Food Security Survey Module. The U.S. approach developed a measure based on understanding of the experiences of food-insecure people obtained from in-depth, qualitative interviews (1). Qualitative research methods have been used in a number of instances to gain an understanding of people's experiences of food insecurity in particular locations (1–9).

This project aimed to use qualitative and quantitative methods to develop and validate an experience-based measure of household food insecurity (i.e., access to food) in northern Burkina Faso. The project was implemented in collaboration with the nongovernmental, nonprofit organization Africare, which specializes in aid to Africa. Africare began implementing the Zondoma Food Security Initiative (ZFSI)⁴ in 2000 in rural Zondoma province. The ZFSI is a Title II food aid-funded development project designed to improve food security. The ZFSI is coordinated at Gourcy, the main town of Zondoma

¹ Published in a supplement to *The Journal of Nutrition*. This publication was made possible through the support provided to the Food and Nutrition Technical Assistance (FANTA) Project by the Office of Health, Infectious Disease and Nutrition of the Bureau for Global Health and the Office of Food for Peace of the Bureau for Democracy, Humanitarian Assistance and Conflict at the U.S. Agency for International Development, under terms of Cooperative Agreement No. HRN-A-00-98-00046-00 awarded to the Academy for Educational Development (AED). The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U.S. Agency for International Development. Guest Editors for this publication were: Jennifer Coates, Edward A. Frongillo, Anne Swindale, Beatrice Lorge Rogers, Patrick Webb, and Paula Bilinsky. Guest editor disclosure: Jennifer Coates received compensation from AED for additional, noneditorial support for the management of the supplement publication; Edward A. Frongillo has no relationships to disclose; Anne Swindale is Deputy Director of the Food and Nutrition Technical Assistance Project, employed by the Academy for Educational Development; Beatrice Lorge Rogers has no relationships to disclose; Patrick Webb has no relationships to disclose; Paula Bilinsky is an employee of AED.

² Author disclosure: E. A. Frongillo, see above; S. Nanama, no relationships to disclose.

³ To whom correspondence should be addressed. E-mail: eaf1@cornell.edu.

⁴ Abbreviations used: BMI, body mass index; CFA, Communauté Financière Africaine; FANTA, Food and Nutrition Technical Assistance; HAZ, height-for-age z-score; MUAC, mid-upper-arm circumference; ROC, receiver operating characteristic; UNICEF, United Nations Children's Fund; WAZ, weight-for-age z-score; WHZ, weight-for-height z-score; ZFSI, Zondoma Food Security Initiative.

province, which is located 140 km north of Ouagadougou, the capital city, and is implemented in surrounding villages.

METHODS

Qualitative study: development and refinement of the food insecurity items

We undertook a qualitative study to obtain an in-depth understanding of the concept, experience, and dynamics of household food insecurity in Zondoma province. Two interview guides, 1 addressing household heads and the other addressing women-children subgroups, were developed drawing from 1 used previously in Bangladesh (6), on prior qualitative research done in the area (S. Gervais, personal communication), and from a prior effort to develop a baseline questionnaire for Africare. The guide for household heads had 8 general themes: 1) identification and demographic information, 2) agricultural production and decisions about production and uses of food, 3) cooking and eating patterns, 4) perception of food quality, 5) daily concerns, 6) income sources and utilization, 7) medium-term strategies to escape from food insecurity, and 8) short-term coping mechanisms. The women's guide had 7 general themes: 1) identification and demographic information, 2) agricultural production and decisions about production and uses of food, 3) cooking and eating patterns, 4) child feeding, 5) daily concerns, 6) income sources and utilization, and 7) short-term coping mechanisms.

Two of 40 ZFSI villages were chosen based on the fact that the project villages could be grouped in 2 categories regarding some slight differences in language and culture. In each of the 2 villages, 5 households were intentionally selected with consideration of characteristics including secure and insecure, simple and complex (i.e., households from production units that produce together in a common plot), and polygamous and monogamous households.

We selected 3 key informants in each village. Selection criteria included having lived in the village for at least 10 y, being at least 30 y of age, knowing about most of their village households, and showing some sense of confidentiality not to disclose the content of the interview. Each key informant was asked independently to list and rank the most secure and insecure households in his village. A semifinal list of households was obtained by matching the lists of secure and insecure households from the key informants with the ranked list created during Africare's initial Rapid Rural Appraisal. Next, the key informants provided a brief description of each household. The final selection was then done to get simple, complex, polygamous, and monogamous households. After this final selection, the team went to each household to register the names of all people who should be interviewed (i.e., household head and his wife or wives, any other married man or woman in the household).

Four interviewers who had completed at least secondary school (i.e., high school) and had prior involvement in research conducted the study. The interviews were conducted in the household by 2 teams of 2 persons each, 1 guiding the interviews and the other taking notes. At the end of each interview day, each team read their notes and made the necessary completions and editing.

Data analysis was done in 6 steps. First, a summary of the interviews was made to identify themes that mostly discriminated among the households regarding their food insecurity status. Second, a summary was created of each interview by household. Third, using the household summaries, 2 researchers independently classified the 10 households regarding their current and past food insecurity status. Fourth, a table was created of food insecurity categories (in rows) versus themes (in columns) with the entries being the level of severity. Fifth, based on this table, items were identified that could be added to the initial questionnaire and also that could be deleted if either redundant or not relevant. Sixth, the answer choices were developed and revised.

The specific themes that discriminated between the food-secure and -insecure households were 1) the amount and reduction of the *mondé* (i.e., the daily food ration from the collective store), 2) the frequency and duration of *robi* (i.e., when *mondé* is not given, the food ration from the own stores of the household women-children subunit), 3) adult eating pattern (i.e., number of daily meals and meal composition), 4) daily concern (i.e., order of main concerns and how

acute the concern is about food insecurity), 5) income sources, 6) utilization of income (both for women and men), 7) food buying (i.e., buying unit, amount, and buying period), 8) medium-term management strategies (e.g., use of agricultural techniques), and 9) short-term coping mechanisms. The set of items that resulted from the specific themes that discriminated among households is presented in **Table 1**.

Quantitative study: longitudinal measurement of food insecurity and related factors

Sampling. A multistage sampling method was used with both purposive and random sampling to obtain a sample that represented the diversity of households. The first stage was a purposive selection of departments. Then, within each department, 3 villages were purposively selected. Production units were then randomly selected in each village, and finally, households were purposively selected within each production unit.

Three of the 5 departments in Zondoma province were selected on the basis of cultural and socioeconomic characteristics and distance from the semiurban town. Africare's ZFSI project initially covered 40 villages, 15 of which entered the project in the first year and 25 in the second year. To account for the year of entry, 1 first-year village and 2 second-year villages were selected randomly in each department.

Production units with children <5 y of age were randomly drawn from a census of all production units in each village because nutritional (i.e., anthropometric) status of young children is often used as a proxy for food insecurity. In each production unit, the household of the head of the production unit was included in the sample. If the production unit had more than 1 household, a second household with children <5 y of age was also randomly selected. In each selected household, the head of household and his wife (if monogamous) or his first wife (if polygamous) were included in the sample of respondents even if she did not fulfill the inclusion condition of having a child <5 y of age. If the household was polygamous, another wife with a child under 5 y was selected in addition. In total, 126 households were selected.

Data collection. Data were collected every July (hungry season) and January (postharvest season) by trained enumerators. The months of July and January were chosen because we had prior information suggesting that the January-versus-July contrast would capture the best and worst periods for food insecurity. January and July fall 3 and 9 months after the harvest. The harvest normally starts in the middle of October and finishes most often by the end of October, although it sometimes extends to the middle of November. It was logistically feasible to work during July (when heavy and crucial activities such as clearing fields and planting are over, and before the heaviest rains have occurred) and January (when people have finished harvesting and have a clear idea of what they have in store). January is also a time when people are available (agricultural work is over, and social events such as funerals have not started).

Questionnaires were developed to cover several topics including food production and uses, use of new agricultural techniques, money transfer from various places, food transfer, livestock ownership, revenues and sources of income, and gardening. Most topics were asked of both men and women, but some topics were asked of men only or women only, as appropriate.

Food insecurity in Burkina Faso has a strong seasonal pattern. The "hungry" season lasts from June (sometimes from May) to September, and the "food plenty" season lasts from the harvest in October to April. We expected seasonal differences in the answers to the food insecurity items. Because we wanted the food insecurity questionnaire to capture these seasonal differences, it was important to set the recall periods in such a way that they did not overlap the 2 seasons. For agricultural production and socioeconomic variables, during wave 1, the recall period was "since the last harvest," which corresponds to an 8-month production cycle (not including July). For waves 2 to 5, questions referred to a 6-month production cycle (since our last visit). Wave 1 had a different recall period because it was the first one, and the most meaningful reference period for the respondent was the harvest (not January). After wave 1, we could refer to our last visit because we visited the households every 6 mo (January and July). For the food insecurity items, the recall period was "since the last harvest" at waves 1, 2, and 4, and "since our last visit" for waves 3 and 5.

TABLE 1

Items on household food insecurity, with scores assigned, and frequency of affirmative responses at waves 1 to 5

Number	Food insecurity item	Responses	Score ¹	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Q1	Does your household eat until satisfied right now?	Yes	0	35.7	85.5	48.8	84.7	63.2
		No	1	64.3	14.5	50.4	15.3	36.8
Q2	In what form do you usually give the mondé when you do it from your home store?	In grain	0	50.0	27.4	57.9	72.9	56.5
		In ear	1	50.0	72.6	42.1	27.0	43.6
Q3	Since the last harvest, did you reduce the mondé because there wasn't enough food?	Yes	1	73.0	29.0	57.1	18.7	42.4
		No	0	27.0	71.0	42.9	81.3	57.6
Q3.1	If yes, how many times did you reduce the mondé?	1	0	79.3	77.8	81.9	100	83.0
		2	0.5	9.8	8.3	16.7	0	13.2
		>3	1	10.9	13.9	1.4	0	3.8
Q3.2	When (in which month) did the first reduction occur?		NS	—	—	—	—	—
Q3.3	Today's mondé represents:	More than half the initial mondé	0	69.6	64.9	77.8	87.0	90.4
		Half the initial mondé	0.5	21.7	29.7	19.4	13.0	9.6
		Less than half the initial mondé	1	8.7	5.4	2.8	0	0
Q4	Since the last harvest, did you or other adults in your household reduce the number of their daily meal because there wasn't enough food?	Yes	1	65.1	25.0	54.8	15.3	37.6
		No	0	34.9	75.0	45.2	84.7	62.4
Q4.1	If yes which meal(s) did you suppress?	Early morning meal (Breakfast)	0	67.1	74.2	56.5	78.9	78.72
		Day meal (Lunch)	0.5	6.1	12.9	2.9	5.3	0
		Night meal (Dinner)	0.5	20.7	3.2	26.1	10.5	2.1
		Breakfast and Lunch	0.5	0	0	0	5.3	0
		Lunch and Dinner	1	0	0	0	0	0
		Breakfast and Dinner	0.5	6.1	9.7	14.5	0	19.2
Q5	How many times in a month can you afford the following foods for your HH members?	Rice >4	0	7.1	8.1	15.0	19.4	18.6
		Else	1	92.9	91.9	84.9	80.7	81.5
		Meat >4	0	19.0	21.8	18.3	29.0	26.4
		Else	1	81.0	78.2	81.7	71.0	73.6
		Fish >20	0	6.3	16.1	11.9	3.2	8.8
		5–20	0.5	56.4	32.3	57.9	47.2	58.4
Q6	What worries more in your daily life?	<5	1	37.3	51.6	30.2	39.5	32.8
		Milk	NS	—	—	—	—	—
		Health	0	15.1	26.6	20.6	41.9	34.4
		Not having enough food	1	82.5	65.3	76.4	54.0	61.6
		Other	0	2.4	8.1	4.0	4.0	4.0
		Q6.1	If "Not having enough food," do you worry you will lack food for	Next week	1	14.4	2.5	23.2
Next month	0.5			33.7	7.4	31.6	0	16.9
In the coming two months	0.5			29.8	11.1	21.1	11.9	29.9
In three months	0			14.4	24.7	15.8	17.9	22.1
In four months or later	0			7.7	54.3	8.4	70.1	7.8
Q6.2	Does this concern give you insomnia right now?	Yes	1	92.3	64.2	87.4	77.3	87.0
		No	0	7.7	35.8	12.6	22.7	13.0
Q6.3	If "yes," how often does this happen in a week?	>3	1	84.5	67.3	31.3	76.9	59.1
		else	0	15.5	32.7	68.7	23.1	40.9
Q6.4	Did you lose weight because of this concern?	Yes	1	92.3	57.5	80.0	41.5	61.0
		No	0	7.7	42.5	20.0	58.5	39.0
Q7	Since the last harvest, did you buy cereals to feed your family because there wasn't enough at home?	Yes	1	77.8	13.7	57.9	12.1	48.0
		No	0	22.2	86.3	42.1	87.9	52.0
Q7.1	If "yes," when did you start buying cereals (give the season)?		NS	—	—	—	—	—
Q7.2	How much cereal did you buy since then?		NS	—	—	—	—	—
Q7.3	In which selling unit you usually buy cereals?	100 kg bag	0	56.1	17.6	60.3	37.5	55.0
		Tine	0.5	25.5	29.4	15.1	25.0	20.0
		Yoruba	1	12.2	41.2	15.1	37.5	16.7
		Tomato can	1	2.0	0	9.6	0	8.3
		Bol	1	4.1	11.8	0	0	0
Q7.4	Where do you usually get money to buy cereals?	Gift from migrant (mainly in Ivory Coast)	0	23.5	5.9	20.5	0	18.3
		Sale of cow	0	9.2	23.5	9.6	28.6	11.6
		Sale of small ruminants	0.5	41.8	29.4	27.4	14.3	18.3
		Sale of poultry	1	3.1	5.9	0	7.1	6.7
		Income-generating activity	0	11.2	23.5	27.4	42.9	30.0
		Other	NS	—	—	—	—	—
Q8	Since the last harvest, did you ever borrow cereals to feed your family because there weren't any cereals left in any form?	Yes	1	11.9	0.8	4.0	1.6	1.6
		No	0	88.1	99.2	96.0	98.4	98.4

TABLE 1 (continued)

Items on household food insecurity, with scores assigned, and frequency of affirmative responses at waves 1 to 5

Number	Food insecurity item	Responses	Score ¹	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Q8.1	If "yes" whom did you borrow from	Uncle	0	13.3	0	0	0	0
		Friend	0.5	33.3	0	40.0	0	50.0
		Direct parents	1	33.3	0	60.0	50.0	50.0
Q9	Since the last harvest, did your family ever eat food it didn't want to eat because there wasn't enough or no food at all at home?	Yes	1	33.3	4.8	14.3	4.8	13.6
		No	0	66.7	95.2	85.7	95.2	86.4
Q9.1	How many times did they eat food they don't want over the past 7 days?	0-2	0	78.6	66.7	35.3	50.0	11.8
		3-4	0.5	14.3	26.6	41.1	33.3	23.5
		>4	1	7.1	6.7	23.6	16.7	29.4
Q9.1	If "yes," which type of hungry food did they eat?	Bean leaves	0	11.9	66.7	44.4	50.0	64.7
		Sorrel leaves	0	28.6	83.3	72.2	100.0	47.1
		Lelongo	1	78.6	0	55.6	66.7	82.5
		Keguendo	0	83.3	0	61.1	0	94.1
		Kesga	1	2.4	0	0	0	0
		Gilgo	1	2.4	0	5.6	16.6	17.7

¹ Some items were not scored, and therefore, frequencies are not reported. These items either were needed to interact with the respondents but were not discriminating with regard to food insecurity or only applied in one season or the other.

Anthropometric measures were taken by trained enumerators. Standardization was conducted on a sample of 10 children less than 5 y of age and 10 adults (10). Adult anthropometric data included height (at wave 1) and weight of the head of the household and sampled women, and women's mid-upper-arm circumference (MUAC). Child height, weight, and MUAC were collected on all children less than 5 y of age who depended on the sampled women for their care. At each subsequent wave, newborns and children under 5 y of age who joined the units were included.

The experience-based food insecurity questionnaire that was developed from the qualitative study was administered to each household head. Questions on household agricultural and socioeconomic issues were asked to the head of the household. Similar questions were asked to women but about what happens within their subunits, not in the household. In the study location, resources are not always shared between the household and the household subunits such as the mother-children units. Given the complexity of the households and the objective to assess household food insecurity, the household head was in the best position to understand and convey the household's status.

During the second and subsequent waves, dietary data were collected at 2 occasions per wave, usually on nonconsecutive days. The dietary data collected included food-frequency data (1-week recall), number of eating occasions during the previous 24 h, as well as a 24-h recall on the amount of energy-rich food consumed (11).

An alternate reference measure was developed by having a single observer classify the households as to whether they were food secure, moderately food secure, or food insecure on the basis of his integrated, in-depth knowledge of each household's situation. This method was developed by Frongillo et al. (12) and has subsequently been used successfully in other studies (4,5,7). The observer measure was free of respondent bias and was implemented to minimize observer bias. The observer visited each household multiple times to understand what changes were occurring in the households (e.g., births, deaths, migration) and in the villages (i.e., new well, market, or school). These visits were not related to the quantitative data collection. The classification was made twice, during the periods between waves 3 and 4 and between waves 4 and 5.

Construction of variables. For this study, anthropometric data from individuals were averaged within households separately for adults and children under 5 y of age to produce household-level anthropometric variables. Body mass index (BMI) was calculated as weight (kg)/height² (m²). For children, weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) z-scores were calculated using Epi-Info version 6. The 24-h recall information was converted to adult equivalents of energy per day (11). We used the energy requirement of an active adult man as a reference to compute the adult equivalent.

The adult equivalent was not recalculated to account for possible changes in activity level with season because it was not clear how such an adjustment should be made.

To score the food insecurity items, each main item received a score of 1 for an affirmative answer and 0 otherwise, and some of the subitems received a score of 0.5 (Table 1). With this scoring system, the higher the score, the greater the food insecurity. Likewise, the food-frequency items were scored 1 if the household had eaten the food group during the week before the survey and 0 otherwise.

Several variables about economic status of the household were calculated. The 4 variables that are numbered below are the ones analyzed and reported because they represented key aspects of economic status. 1) *Total assets* were obtained by summation of the value of agricultural assets, including plows, carts, and traction animals, and the value of nonagricultural assets, i.e., bicycle, motorbikes, and mopeds. *Total income* was estimated by the value of wages in cash and in kind, the value of home-produced foods (cash crop, food crop, and garden products), the value of pension, the value of private and nonprivate food and cash transfers to the household, and all other income provided by other sources than those mentioned above. Renting is not a common practice and was therefore not accounted for in the computation of total income. *Net income* was calculated as the difference between total income and the cost of farm inputs (organic and nonorganic fertilizers). All households were agricultural and pastoral. Their main activity is subsistence farming, but they do have cattle or small ruminants as life savings; paid labor is not used. In absence of a detailed estimate of total expenditure, net income was used to approximate total expenditure. 2) *Net income per adult equivalent* was computed using the ratio of net income to household size expressed in adult equivalent units. The number of household equivalent adults was calculated using a conversion coefficient based on the energy requirement of each household member given his age and sex and the energy requirement of an adult equivalent. *Food expenditure* includes the value of food consumed from home production plus food bought plus food transferred to the household by private and nonprivate sources. It does not include seed (included in food store) or animal feed (not common). The question about the amount of each crop consumed was introduced at wave 2. Therefore, the amount of home-produced food consumed was not available at wave 1, and food expenditure, food share, and food store could not be calculated for this wave. 3) *Food share* was obtained by the ratio between food expenditure and net income. 4) *Food store* is the difference between the total value of home-produced food and the total value of home-produced food that was used in various ways including consumption, gifts, sale, losses, and so on during the previously presented recall periods. That is, food store is the value of food that is still there for the

household to dispose of during the months following the survey, calculated as a residual after accounting for possible uses. This could be computed more reliably for the 2 January waves than the July waves because for July waves it is given by the difference between food store in January (of the same year) and foods used since the January.

Analysis. Descriptive statistics were run, and paired-sample *t* tests were used to compare means between waves. For analyses, total assets, net income per adult equivalent, and food stores were transformed using the natural logarithm to account for positive skewness in these 3 variables.

The analytic strategy to examine the validity of the food insecurity score was based on the criteria developed by Frongillo (13). In particular, accuracy was assessed by comparing the food insecurity score with comparison measures, these being either expected determinants or consequences of food insecurity, other measures of food insecurity, or the observer measure. Reliability was assessed by Cronbach's α .

Analyses were based on the conceptual framework (1) presented in **Figure 1**. In this framework, low economic status leads to food insecurity, which, in turn, leads to inadequate food intake and ultimately to poor nutritional status. The 4 economic variables (i.e., total assets, net income per adult equivalent, food stores, and food share) each measure an aspect of economic status and theoretically influence the ability of a household to access food. The food insecurity score assessed the experience of food insecurity of the households, including the certainty of the household about food provisioning. The outcomes of food insecurity are inadequate dietary intake and poor nutritional status. Based on the conceptual framework, if the food insecurity score accurately reflects household food insecurity, then we would expect that the food insecurity score will be 1) more related to measured economic status and dietary intake than to measured nutritional status and 2) more related to measured dietary intake and nutritional status than measured economic status is related to measured dietary intake and nutritional status.

The associations of the food insecurity score with variables for economic status (i.e., a determinant), dietary intake, and nutritional status (i.e., outcomes) at each wave were assessed using bivariate Pearson's correlation coefficients. Analysis of variance was used to assess the association of the observational categorization of food

insecurity with other variables. To further evaluate the performance of the food insecurity score in discriminating among households according to their food insecurity status as classified by the observer measure, multinomial logistic regression models, with the observer measure as the response variable, were run for each of the variables that were significant in the analysis of variance at wave 4. The models were run for each variable alone as well as for food insecurity score, with each of the other variables controlled for separately. Logistic models were used to estimate how well the variables predicted the classes from the observer measure using the area under the Receiver Operator Characteristic (ROC) curve. This area ranges from 0.5 to 1.0, with 0.5 meaning that the prediction is no better than chance and 1.0 meaning perfect prediction. The area is interpreted as the proportion of pairs of households that were classified correctly by the model, assuming that the observer classification was accurate.

The associations between changes in food insecurity score and changes in the other variables over an interval defined by 2 successive waves were assessed by bivariate correlation and linear regression. In the linear regression models, the response variable was the change in a comparison variable, and the predictor variable of interest was the change in food insecurity score. These linear regressions also controlled for the food insecurity score and the comparison variable at the beginning of the interval. These regressions were used to assess the association of change in food insecurity score with change in other variables, accounting for the initial value of the food insecurity score, and were not intended to convey causal relations. Using change in total assets between waves 1 and 2 as an example, the model was as follows:

$$\Delta \text{Assets}_{2-1} = \beta_0 + \beta_1 \text{Assets}_1 + \beta_2 \text{FIS}_1 + \beta_3 \Delta \text{FIS}_{2-1}$$

where FIS is food insecurity score, the β 's are regression coefficients, and Δ is the change. The regression coefficient of interest is β_3 . For ease of interpretation, it is reported as a standardized regression coefficient, meaning that it represents the difference in standard-deviation units of the response variable (e.g., $\Delta \text{Assets}_{2-1}$) for a 1 standard-deviation difference in the predictor variable (i.e., ΔFIS_{2-1}).

RESULTS

Data were collected on 126 households from 9 villages. At baseline (July 2001), 51% of the selected households were from complex production units, i.e., production units with more than 1 household. The number of households in the complex production units varied from 2 to 5. Household size ranged from 3 to 31 members, with a mean of 9.6 members per household.

The total population from the selected households was 1219 individuals. Of these individuals, 77% were Muslim, 16% were Animists, and 7% were Christians. The age of the selected household member ranged from 0 (<1 y) to 82 y, with a mean of 19.7 y. Fifty-three percent of the members of the selected households were female. Ninety-three percent were Mossi; the others were Samo or Peulh. Educational level was low. Fifty-eight percent of those over 6 y of age had no formal education, and 57% of those over 7 y of age were illiterate.

Descriptive statistics for changes over seasons. Table 1 shows the food insecurity items, the score for each response choice, and the frequency of affirmative responses for each item at waves 1 to 5. At each wave, the Cronbach's α reliability coefficients for the food insecurity score were 0.81 to 0.85, indicating adequate reliability, and each food insecurity item contributed about the same to the reliability.

Table 2 shows the means and standard deviations of demographic, economic status, dietary intake, anthropometric, and food insecurity variables at each of the 5 waves: 1) July 2001, 2) January 2002, 3) July 2002, 4) January 2003, and 5) July 2003. Household size expressed in number of active members (i.e., an adult or child who contributes to the household production) and number of adult equivalents increased

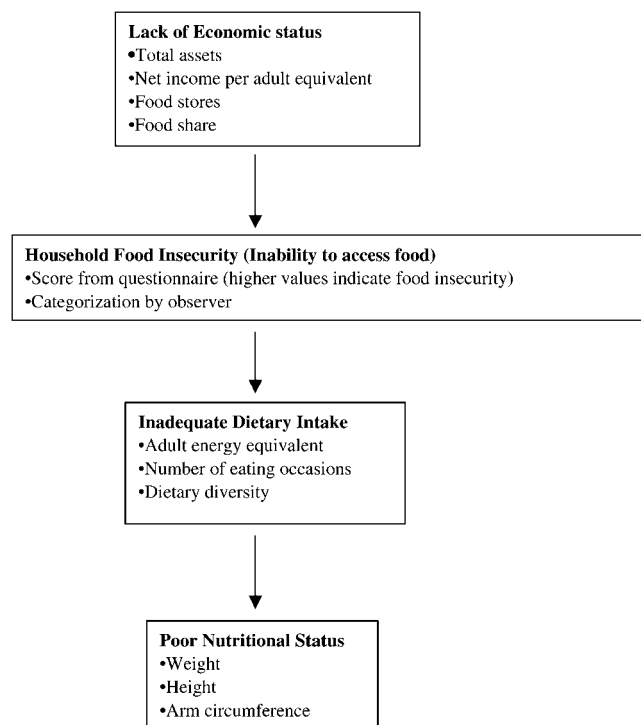


FIGURE 1 Conceptual model of relationships among lack of economic status, food insecurity, inadequate dietary intake, and poor nutritional status, with constructs (bold) and measures (not bold).

TABLE 2

Means and standard deviations of demographic, economic status, dietary and nutritional variables at waves 1 to 5

Variables	Wave 1 (July 2001)			Wave 2 (January 2002)			Wave 3 (July 2002)			Wave 4 (January 2003)			Wave 5 (July 2003)		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Demographic															
Number of active members	126	4.16	2.47	124	5.05	2.53	126	5.63	2.84	126	4.71	2.47	125	6.31	3.63
Number of adult equivalent	126	6.07	3.22	124	7.29	3.42	126	7.38	3.55	126	6.83	3.18	125	7.97	4.19
Age of children	195	28.80	17.57	193	33.76	19.28	200	36.26	20.07	209	40.93	21.74	235	43.27	23.90
Economic status															
Total assets (1000 CFA)	126	416.11	485.85	124	473.38	522.23	126	414.99	541.80	124	411.35	459.40	125	444.49	574.08
Net income per adult equivalent (1000 CFA)	126	32.20	26.66	124	23.59	17.35	126	26.55	18.71	124	21.89	12.46	125	24.59	13.92
Food in store (1000 CFA)				124	66.14	59.33				124	81.66	51.35	123	5.94	10.65
Food share				124	0.49	0.22	125	0.72	0.23	124	0.65	0.26	125	0.67	0.18
Dietary intake															
Number of eating occasions				121	3.41	0.66	126	3.60	0.94	124	3.00	0.60	125	3.38	0.86
Energy (kcal) per adult equivalent				121	2566.87	1020.31	126	2376.76	802.44	124	2113.14	736.59	125	2222.53	991.11
Food diversity score				124	11.15	2.81	126	11.04	2.34	124	9.99	2.85	125	11.54	2.24
Adult anthropometry															
Adult weight (kg)	126	55.24	4.74	123	56.55	5.34	126	55.93	5.53	121	56.30	5.60	125	55.40	5.70
Women's MUAC (cm)	126	25.73	1.78	113	25.79	1.71	121	25.89	1.71	111	25.77	1.64	122	25.86	1.64
Adult BMI (kg/m ²)	126	19.99	1.43	123	20.44	1.49	126	20.24	1.57	121	20.34	1.61	125	19.99	1.53
Child anthropometry															
Child MUAC (cm)	114	14.09	1.17	108	13.80	1.27	108	14.22	1.21	93	13.75	1.07	112	14.39	1.11
Child WHZ	113	-0.99	0.87	108	-0.97	0.83	107	-0.80	0.80	93	-0.97	0.86	112	-0.94	0.71
Child WAZ	114	-1.70	1.02	108	-1.86	0.93	108	-1.67	0.79	93	-1.82	0.93	112	-1.69	0.82
Child HAZ	114	-1.54	1.27	108	-1.85	1.10	108	-1.75	0.96	93	-1.78	0.95	112	-1.58	0.93
Food insecurity score	126	10.71	4.63	124	4.92	3.42	126	7.50	4.06	124	4.46	2.76	125	6.22	4.06

somewhat across waves. The mean number of active household members ranged from 4.71 in July 2001 to 6.31 in July 2003. The mean number of adult equivalents ranged from 6.79 in July 2001 to 7.97 in July 2003.

The mean food insecurity score was higher in the July waves 1 (10.71), 3 (7.50), and 5 (6.22) than in the January waves 2 (4.92) and 4 (4.46) (Fig. 2). This pattern was as expected, indicating that food insecurity is more severe during the hungry season than during the postharvest season.

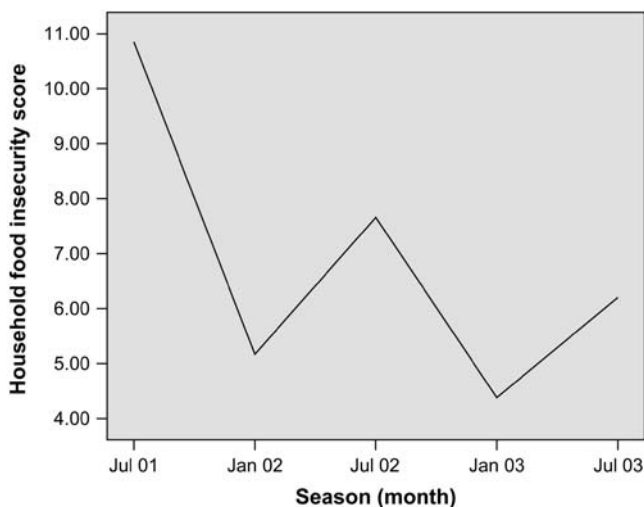


FIGURE 2 Household food insecurity score by season (month) in northern Burkina Faso.

The mean value of household total assets was higher in wave 2 (472,000 CFA francs) than in waves 1, 3, and 4, with a rise again at wave 5. Net income per adult equivalent was higher at the July waves 1, 3, and 5 than at the January waves 2 and 4, largely because of higher transfers from other countries, particularly Ivory Coast, during the July waves. The value of food store was 66,140 CFA francs at January wave 2 and 81,660 CFA francs at January wave 4; the values of food store at July waves 3 and 5 were zero and near zero (5.94), respectively. Food share was 0.49 in wave 2, 0.72 in wave 3, 0.65 in wave 4, and 0.67 in wave 5, with wave 2 significantly different from waves 3, 4, and 5, and wave 3 significantly different from wave 4. This reflects that food insecurity is more prevalent in July than in January.

The mean number of eating occasions also differed with seasons, being higher in July than in January. The mean energy intake per equivalent adult decreased progressively from January 2002 (2566 kcal) to January 2003 (2113 kcal), and then increased somewhat to July 2003. Food diversity at waves 2 and 3 were similar (about 11), with both higher than that at wave 4 (9.99) and lower than at wave 5 (11.54).

The average household adult weight was consistently about 1 kg higher in January than in July waves. This result is as expected because, not only is July the peak of the hungry season, it is also a period of heavy agricultural work resulting in increased energy expenditure. The household average women's MUAC was similar at each wave. The average adult BMI was higher in January 2002 (20.44 kg/m²) and in January 2003 (20.34 kg/m²) than in July 2001 (19.99 kg/m²), July 2002 (20.24 kg/m²), and July 2003 (19.99 kg/m²). For child anthropometry, all the indices were lower in January than in July.

TABLE 3

Means and standard deviations of changes in demographic, economic status, dietary and nutritional variable between waves

Variables	Wave 2 - Wave 1				Wave 3 - Wave 2				Wave 4 - Wave 3				Wave 5 - Wave 4			
	N	Mean	SD	P-value	N	Mean	SD	P-value	N	Mean	SD	P-value	N	Mean	SD	P-value
Demographic																
Number of active members	124	0.30	1.42	0.022	123	0.65	1.56	0.000	124	-0.93	1.87	0.000	123	1.64	2.48	0.000
Number of adult equivalent	124	0.43	1.40	0.001	123	0.15	1.79	0.352	124	-0.55	1.92	0.002	123	1.20	2.68	0.000
Economic status																
Total assets (1000 CFA)	124	51.68	244.83	0.020	123	-53.64	291.38	0.043	124	-3.70	237.32	0.863	121	42.88	307.61	0.128
Net income per adult equivalent (1000 CFA)	124	-8.668	20.63	0.000	123	3.2	12.52	0.005	124	-4.73	18.69	0.006	123	-55.85	53.72	0.000
Food in store (1000 CFA)													123	-74.55	48.54	0.000
Food share					123	0.25	0.25	0.000	124	-0.08	0.28	0.003	121	0.02	0.25	0.308
Dietary intake																
Number of eating occasions					120	0.18	1.04	0.061	124	-0.61	1.04	0.000	121	0.41	0.86	0.000
Energy (kcal) per equivalent adult					120	-213.77	1288.31	0.072	124	-270.70	1037.84	0.004	121	81.41	1046.94	0.394
Food diversity score					123	-0.13	2.57	0.576	124	-1.04	2.74	0.000	121	1.54	2.71	0.000
Adult anthropometry																
Adult weight (kg)	123	1.31	1.96	0.000	122	-0.75	4.14	0.047	121	0.58	3.57	0.077	118	-1.16	3.27	0.000
Women's MUAC (cm)	113	0.16	0.98	0.092	110	-0.07	1.16	0.554	110	-0.12	0.87	0.125	106	0.15	1.04	0.129
Adult BMI (kg/m ²)	123	0.48	0.72	0.000	122	-0.24	1.32	0.047	121	0.11	0.78	0.128	118	-0.38	0.79	0.000
Child anthropometry																
Child MUAC (cm)	108	-0.31	1.04	0.003	102	0.49	0.95	0.000	92	-0.38	1.02	0.001	91	0.52	1.02	0.000
Child WHZ	107	.007	0.78	0.926	102	0.19	0.71	0.010	91	-0.11	0.77	0.159	91	-0.73	0.79	0.383
Child WAZ	108	-0.17	0.99	0.071	102	0.23	0.67	0.001	92	-0.13	0.73	0.081	91	0.03	0.77	0.691
Child HAZ	108	-0.31	1.11	0.004	102	0.16	0.59	0.006	92	-0.08	0.83	0.354	91	0.15	0.77	0.068
Food insecurity score	124	-5.80	4.28	0.000	123	2.68	3.65	0.000	124	-3.03	3.61	0.000	121	1.67	3.24	0.000

Table 3 presents the data from Table 2 as changes from each wave to the next wave. The *P*-values indicate that there was sufficient statistical power with the sample size of households to reliably measure overall changes.

Validity of the household food insecurity score at each wave. To test the validity of the food insecurity score, we examined at each wave how it was associated with variables that are commonly used to measure food insecurity: economic status, dietary intake, and anthropometry (Table 4). Total assets and net income per adult equivalent were negatively and significantly correlated with food insecurity score at wave 1, as expected, indicating that higher food insecurity score was associated with lower assets and net income per adult equivalent. Similar associations were observed at waves 2 to 5. Food store was negatively associated with food insecurity score at waves 2 to 5, whereas food share was positively associated with food insecurity score, as expected.

The number of eating occasions was negatively and significantly correlated with food insecurity score at waves 2 and 3. Higher food insecurity score was associated with fewer eating occasions. Energy per adult equivalent was negatively associated with food insecurity score at waves 2, 3, and 5 but not at wave 4. Food diversity was significantly and negatively correlated with food insecurity score at waves 3 to 5 but not wave 2. These results are as expected except for food diversity at wave 2 and energy per equivalent adult at wave 4. Waves 2 and 4 took place in January (postharvest season), when differences among households in eating patterns are minimal. In addition, energy intake and food diversity score measured the current food situation, whereas the food insecurity score captured both the current and future food situation.

Adult weight was significantly and negatively (the expected direction) associated with food insecurity score at waves 1, 3, 4,

and 5, but not at wave 2. BMI was significantly and negatively associated with food insecurity score at waves 1, 3, and 5 (i.e., the hungry, preharvest seasons). There were no significant associations between food insecurity and women's MUAC at any of the waves. Child anthropometric indices were generally negatively correlated with food insecurity score at the 5 waves, but few of the correlation coefficients had low *P*-values.

In summary, the household food insecurity score was overall associated as expected with its proximal determinant (i.e., economic status) and its proximal consequence (i.e., dietary intake) (Fig. 1). It was weakly and inconsistently associated with its more distal consequence, adult and child anthropometry.

We also examined at each wave correlation coefficients and *P*-values for the associations among total assets, net income per adult equivalent, food store, and food share with dietary intake and anthropometry at each wave and compared these patterns with the analogous pattern of correlation coefficients for the household food insecurity score shown in Table 4. Figure 1 suggests that the food insecurity score would be more closely associated with dietary intake and anthropometry than would the economic status variables. The household food insecurity score had, on average, the strongest associations with dietary intake (results not shown). The household food insecurity score and total assets had, on average, the strongest associations with adult anthropometry. For child anthropometry, the associations, on average, were low for the food insecurity score and the economic status variables. These results provide further evidence of the validity of the food insecurity score because they are consistent with what we would expect if the food insecurity score accurately measures food insecurity.

An alternate way to test the validity of the food insecurity score was to compare its performance to that of the observer measure. The analysis of variance results in Table 5 indicate that

TABLE 4

Bivariate correlation between food insecurity score and demographic, economic status, dietary intake, and nutritional status for waves 1 to 5

Variable	Wave 1 (July 2001)		Wave 2 (January 2002)		Wave 3 (July 2002)		Wave 4 (January 2003)		Wave 5 (July 2003)	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Economic status ¹										
Total assets	-0.224	0.012	-0.348	0.000	-0.347	0.000	-0.425	0.000	-0.438	0.000
Net income per adult equivalent	-0.192	0.031	-0.271	0.002	-0.237	0.008	-0.267	0.003	0.022	0.811
Food in store			-0.239	0.008			-0.511	0.000	-0.288	0.001
Food share			0.377	0.000	0.465	0.000	0.317	0.000	0.317	0.000
Dietary intake										
Number of eating occasion			-0.215	0.018	-0.280	0.001	-0.126	0.166	-0.068	0.450
Energy (kcal) per equivalent adult			-0.160	0.079	-0.185	0.038	-0.049	0.494	-0.235	0.008
Food diversity score			-0.064	0.484	-0.263	0.003	-0.253	0.005	-0.281	0.001
Adult anthropometry										
Adult weight (kg)	-0.198	0.026	-0.014	0.878	-0.171	0.056	-0.200	0.029	-0.182	0.042
Women's MUAC (cm)	-0.031	0.734	-0.054	0.571	-0.094	0.308	-0.095	0.198	0.051	0.573
Adult BMI (kg/m ²)	-0.238	0.007	-0.106	0.247	-0.186	0.038	-0.121	0.187	-0.243	0.006
Child anthropometry										
Child MUAC (cm)	-0.152	0.105	-0.088	0.367	-0.056	0.565	0.043	0.687	-0.105	0.270
Child WHZ	0.031	0.742	-0.148	0.128	-0.012	0.898	-0.089	0.400	-0.054	0.575
Child WAZ	-0.012	0.903	-0.155	0.111	-0.133	0.169	-0.106	0.314	-0.128	0.180
Child HAZ	-0.035	0.714	-0.118	0.228	-0.201	0.037	-0.057	0.591	-0.138	0.146

¹ All economic status variables but food share have been transformed using the natural logarithm.

at wave 4 the observer measure was strongly associated with total assets, food insecurity score, and food store. That is, differences among households in the classification of food insecurity by the observer measure were manifested mostly in the total assets, food insecurity score, and food store. Another interpretation of these results is that total assets, food insecurity score, and food store best predict the classification of households as to their food insecurity status by the observer measure. At wave 5, the observer measure was strongly associated with total assets and food insecurity score but not with food store as in wave 4.

The results for wave 4 of the multinomial logistic regression analyses with the observer measure as the response variable are presented in Table 6. The proportions of pairs of households correctly classified by the food insecurity score were 0.7212 and 0.6813, respectively, less than the corresponding proportions for total assets but greater than those for net income per adult equivalent, food share, and food store.

When household food insecurity score was added to each model with an economic status variable, the fit of the models significantly improved. These results suggest that the house-

hold food insecurity score discriminated among the food insecurity classes beyond that captured by the economic status variable alone. These results are further confirmed by the change in the area under the ROC. For example, when the logistic regression was run with total assets alone, comparing the moderately secure to the secure, the area under the ROC was 0.79, indicating that total assets alone correctly classified 79% of the households between these 2 food insecurity categories. When the food insecurity score was added to the model, the proportion of correctly classified households increased slightly to 81%. The model that best predicted household food insecurity status as measured by the observer is the one with both total assets and food insecurity score. This model had the best combination of discriminating between the secure and moderately secure households (81%) as well as discriminating between the moderately secure and the insecure (70%).

The odds ratios in columns 5 and 6 indicate that, controlling for total assets, the odds of being classified as moderately food secure were 1.22 times the odds of being classified as food secure for a 1-point difference in the food insecurity score.

TABLE 5

Comparison of economic status and insecurity across categories of food insecurity as rated by a single observer in waves 4 and 5

Variables	Wave 4		Wave 5	
	F	P-value	F	P-value
Total assets ¹	26.770	0.000	32.631	0.000
Food insecurity score	14.736	0.000	19.708	0.000
Food store	11.062	0.000	2.730	0.069
Net income per adult equivalent	3.308	0.040	1.528	0.221
Food share	3.281	0.041	1.291	0.279

¹ All the variables except food share and food insecurity score were transformed using the natural logarithm.

TABLE 6

Changes in the multinomial logistic model fit and changes in the area under the ROC curve of the binary logistic models using the single observer rating of the households as response variable in wave 4

Model	Δ in fit with adding food insecurity score		Odds ratio for food insecurity score		Area under the ROC curve	
	Chi-square	P-value	Moderately secure vs. secure	Insecure vs. moderately secure	Moderately secure vs. secure	Insecure vs. moderately secure
1 Total assets ¹					0.7937	0.6749
2 Net income per adult equivalent					0.5377	0.6300
3 Food share					0.6195	0.5577
4 Food store					0.6391	0.7308
5 Food insecurity score					0.7217	0.6813
6 Total assets + food insecurity score	11.642	0.003	1.219	1.250	0.8126	0.7024
7 Net income per adult equivalent + food insecurity score	23.401	0.000	1.360	1.242	0.7168	0.6923
8 Food share + food insecurity score	22.983	0.000	1.314	1.290	0.7187	0.6877
9 Food store + food insecurity score	13.967	0.001	1.333	1.174	0.7191	0.7454

¹ All variables except food share and food insecurity score were transformed using the natural logarithm.

Similarly, the odds of being classified as insecure were 1.25 times the odds of being classified as moderately secure.

Validity of the household food insecurity score to assess changes in household food insecurity across waves. The validity of the household food insecurity score for capturing changes in a household's food insecurity was tested by comparing the association between change in household food insecurity score with changes in economic status, dietary intake, and anthropometric variables using both bivariate correlation and linear regression analysis. Change in household food insecurity score was significantly associated with change in household total assets, net income per adult equivalent, and food share, with the average (across pairs of adjacent waves) correlation coefficients being -0.15 , -0.14 , and 0.21 , respectively, and the average standardized regression coefficients being -0.25 , -0.19 , and 0.27 , respectively. This means, for example, that a difference of 1 standard deviation in the change in household food insecurity scores from wave to wave was associated with a -0.25 standard deviation difference in the change in total assets. Change in household food insecurity score was not associated significantly with the other variables tested.

DISCUSSION

Validity to capture overall seasonal differences. From a technical perspective, the least demanding use of the household food insecurity score would be to capture overall differences in household food insecurity status across the seasons. We expected that household food insecurity would be lowest in January and highest in July. The patterns found for the household food insecurity score, net income per adult equivalent, and food share were consistent with this expectation.

Validity to discriminate among households at each wave. The conceptual framework (Fig. 1) guided the analysis of the validity of the household food insecurity score to discriminate among households at each wave in conjunction with the 6 criteria for validity from Frongillo (13). A method suitable for providing useful analytic measurement for a given purpose and context is one for which 1) its construction is well grounded in an understanding of the phenomenon, 2) its performance is consistent with that understanding, 3) it is pre-

cise within specified performance standards, 4) it is dependable within specified performance standards, 5) it is accurate within specified performance standards, and 6) its accuracy is attributable to the well-grounded understanding for that purpose and context.

Criterion 1 was met because of the in-depth qualitative data collection and analysis that led to the development of the items in the household food insecurity score. Criterion 2 was met because the frequency of affirmative responses for the items was as expected, as seen in Table 1. For criteria 3 and 4, the Cronbach's α coefficients at each wave indicated that the household food insecurity score was reliable (i.e., precise and dependable).

For criterion 5, from the conceptual framework, if the household food insecurity score accurately reflected household food insecurity, then the household food insecurity score should have been associated with 1) variables known to be indicative of household food insecurity, 2) dietary intake more than with nutritional status (i.e., anthropometry), 3) dietary intake and nutritional status more than economic status was associated with dietary intake and nutritional status, and 4) the reference measure created by an observer. Overall, the household food insecurity score was associated with the variables usually known to be indicative of household food insecurity, and was, in general, more strongly associated with dietary intake than with nutritional (i.e., anthropometric) status. The association between household food insecurity score and dietary intake was stronger than that between economic status variables and dietary intake. Furthermore, the household food insecurity score was strongly associated with the observer measure. Note that the household food insecurity score captures the access component of household food insecurity and not the utilization component. It is possible that a measure that included utilization would be more strongly related to anthropometry than was the household food insecurity score.

For criterion 6, the comparison of the household food insecurity score with the observer measure provides evidence that the performance of the household food insecurity score is attributable to its ability to capture household food insecurity status beyond that of other measures. When the household food insecurity score was added to the multinomial model with each of the economic status variables, the fit significantly improved, and the area under the ROC curve increased slightly, indicating that household food insecurity score captured some

aspects of household food insecurity beyond that captured by the economic status variables.

Validity to discriminate changes in households across waves. The correlation and linear regression analyses provide evidence that the household food insecurity score validly discriminated changes in the household food insecurity status of households over waves. Change in the household food insecurity score was associated in the expected direction with changes in economic status. The evidence for the validity of the household food insecurity score across waves, however, is not as strong as that for the validity at each wave for 3 reasons. First, any unreliability in the household food insecurity score and comparison variables was doubled when a change was calculated. Second, we did not create an alternate measure for change in household food insecurity using an observer. An observer can assess household food insecurity status at a given time but cannot easily determine through direct observation absolute or relative changes over time. Third, application of the analyses implied by the conceptual framework in Figure 1 for comparing the strength of associations between the sets of variables could not be done in a reasonably simple and interpretable manner for changes across waves.

Association of household food insecurity score and child nutritional status. Child nutritional status was better in July (when food was limited) than in January (when food was more plentiful). In addition, there was a consistent lack of association between the household food insecurity score and anthropometry, especially with child's nutritional status. Several possible reasons could explain this finding.

First, all the variables analyzed had been collected as household-level variables except for anthropometry. Anthropometric data were averaged within households to produce an estimate of household adult and child nutritional status. This averaging may have obscured a significant association between household food insecurity score and individual nutritional status, but it could not have produced better nutritional status in July than in January. Changes in household composition could theoretically have affected the pattern of average nutritional status, but changes in household composition were minor and did not coincide with the pattern of nutritional status observed.

Second, child nutritional status is determined not only by the access to food but also by other factors including physiological utilization of food, disease episodes, and the quality of childcare. Morbidity data indicated that in January the prevalence of children with child fever (49%) and cough (75%) tended to be higher than in July (38% and 22%, respectively). These results suggest that child illness may explain at least part of the lower anthropometric status at January waves.

Third, as shown in Table 2, the mean age of children increased over the 4 waves. Although every effort was made to include any newborns in the sample, it is possible that some were missed at later waves. Other possible reasons for a higher mean age over time could be higher rates of miscarriages or infant deaths over time or reduced birth rates, for example, reasons of fertility and/or mortality. These reasons could have resulted in an overall trend across the seasons, but not for the seasonal fluctuations that were observed.

Fourth, it is possible that adults in time of food shortage buffer children by giving a high priority to the feeding of children at their own expense. To test for this buffering hypothesis, linear regressions were run, regressing changes in both adult and child anthropometry on dietary intake while controlling for the initial value of anthropometric indices and for the initial dietary intake. If the buffering hypothesis were true, then one would have expected a significant association between dietary

intake and adult anthropometry but not with child anthropometry. The regression results (not reported) did not support the hypothesis that children were given higher priority at the expense of the adults.

Fifth, the analysis for this report focused on the assessment of household food insecurity as assessed by heads of households. It is possible that household food insecurity as assessed by women will be more related to child anthropometry because women have more responsibility for child feeding and other care. This could not explain, however, the pattern of child anthropometry across seasons.

Assessment of dietary intake. The mean energy intake per adult equivalent decreased progressively across 3 waves during which it was measured, increasing somewhat at the last wave. The number of eating occasions had a similar pattern. The explanation for this pattern is not obvious. Perhaps over time the households progressively underreported intake, as has sometimes been observed. Examination of the components of the variability showed that, for waves 2 to 4, the day-to-day variability decreased across the waves, whereas the among-household variability remained constant; both sources of variability increased in wave 5. As a consequence, the percentage of total variability of the 2-day average that was caused by among-household variability increased across waves. It is possible that the day-to-day variability decreased because of underreporting of nonusual items or because the quality of data collection increased (i.e., there was less measurement error over time). There is not sufficient information to separate out these possible explanations. These trends over time do not, however, affect the assessment of validity of the household food insecurity score relative to dietary intake for discriminating among households at a given wave or across waves.

Conclusions. This project provides strong evidence that the experience-based household food insecurity score, calculated from items administered by questionnaire, is valid for determining seasonal differences in the availability and access components of household food insecurity, differences among households in food insecurity at a given time, and changes in household food insecurity over time in production units with children under 5 years of age in northern rural Burkina Faso.

The household food insecurity questionnaire is a simple tool that could be used in this setting by organizations to assess, evaluate, or monitor the access component of household food insecurity. This information can also support design, planning, targeting, and implementation of programs by identifying possible interventions, points of entry for services, and subgroups most in need or who might most benefit. The household food insecurity questionnaire has advantages over some other methods that are often used to evaluate the success of development projects that aim to reduce household food insecurity. Data on dietary energy intake are difficult and time-consuming to collect and analyze, especially in the African context with complex family structure. Anthropometric data are easier to collect and analyze than are dietary data, but anthropometric data tend to not be sensitive or specific to changes in food availability and access.

This research reaffirms the value of gaining in-depth understanding of household food insecurity. From this and prior work, we believe that implementing this approach, rather than translating and adapting items developed elsewhere, may lead to the best experience-based measures for assessing household food insecurity in other countries. Nevertheless, our knowledge to date also suggests that commonalities in the experience of household food insecurity across locations and cultures makes it possible to consider sharing common items across a region or from 1 location to another, with adaptation to

local constructs and language (14). Such common items may not capture all aspects of the experience of household food insecurity in a particular location but will likely be adequate to serve some purposes in many locations. Further research is needed to compare the performance of measures fully developed through ethnography in a particular location with ones adapted from other locations.

ACKNOWLEDGMENTS

We are grateful to the Africare country representative, project coordinator, and other staff who provided logistic support during data collection. We are grateful to the villagers who participated in the studies and to the enumerators who collected the quantitative data. We appreciate the various contributions that these individuals made to the project: Judy Bryson, Harold Tarver, Ambroise Nanema, Kebré Boukari, Nanema Lucienne, Sanakra Issiaka, Bougma Karim, Alison Goldberg, Françoise Vermeylen, Coleen McCracken, Anne Swindale, Patricia Bonnard, Alice Willard, Tony Castleman, Gilles Bergeron, Per Pinstrup-Andersen, Suzanne Gervais, Avril Armstrong, and Ji-Yun Hwang. Jennifer Coates, Beatrice Rogers, Patrick Webb, Anne Swindale, Robert Houser, Nadra Franklin, and Eunyong Chung made valuable suggestions to improve a previous draft. Any mistakes are solely those of the authors.

LITERATURE CITED

1. Wolfe WS, Frongillo EA. Building household food security measurement tools from the ground up. *Food Nutr Bull.* 2001;22:5–12.
2. Radimer KL, Olson CM, Greene JC, Campbell CC, Habicht JP. Understanding hunger and developing indicators to assess it in women and children. *J Nutr Educ.* 1992;24:36S–45S.
3. Wolfe WS, Olson CM, Kendall A, Frongillo EA. Understanding food insecurity in the elderly: A conceptual framework. *J Nutr Educ.* 1996;28:92–100.
4. Wolfe WS, Olson CM, Kendall A, Frongillo EA. Hunger and food insecurity in the elderly: Its nature and measurement. *J Aging Health.* 1998;10:327–50.
5. Wolfe WS, Frongillo EA, Valois P. Understanding the experience of elderly food insecurity suggests ways to improve its measurement. *J Nutr.* 2003;133:2762–9.
6. Frongillo EA, Chowdhury N, Ekström EC, Naved RT. Understanding the experience of household food insecurity in rural Bangladesh leads to a measure different from that used in other countries. *J Nutr.* 2003;133:4158–62.
7. Hamelin AM, Beadry M, Habicht JP. Characterization of household food insecurity in Québec: food and feelings. *Soc Sci Med.* 2002;54:119–32.
8. Studdert LJ, Frongillo EA, Valois P. Measuring household food insecurity in Java during Indonesia's economic crisis. *J Nutr.* 2001;131:2685–91.
9. Coates J, Wilde PE, Webb P, Rogers BL, Houser RF. Comparison of a qualitative and a quantitative approach to developing a household food insecurity scale for Bangladesh. *J Nutr.* 2006;136:1420–30.
10. World Health Organization. Measuring change in nutritional status: guidelines for assessing the nutritional impact of supplementary feeding programmes for vulnerable groups. Geneva: World Health Organization, 1983.
11. Swindale A, Ohri-Vachaspati P. Measuring household food consumption: a technical guide. Washington: Food and Nutrition Technical Assistance Project, Academy for Educational Development, 1999. <www.fantaproject.org>
12. Frongillo EA, Rauschenbach BS, Olson CM, Kendall A, Colmenares AG. Questionnaire-based measures are valid for the identification of rural households with hunger and food insecurity. *J Nutr.* 1997;127:699–705.
13. Frongillo EA. Validation of measures of food insecurity and hunger. *J Nutr.* 1999;129:506S–9S.
14. Coates J, Frongillo EA, Rogers B, Webb P, Wilde PE, Houser RF. Commonalities in the experience of household food insecurity across cultures: What are measures missing? *J Nutr.* 2006;136:1438S–48.