Validation of dietary applications of Household Consumption and Expenditures Surveys (HCES) against a 24-hour recall method in Uganda

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Abstract

Background. *The benefits of food fortification depend on the proportion of the population that uses the fortified food (coverage), the amount of the food being consumed, and the additional content of micronutrients in the food. Coverage and amounts consumed can be determined by 24-hour recall or Food Frequency Questionnaires (FFQs). However, these methods are rarely applied. Secondary analysis of data from Household Consumption and Expenditures Surveys (HCES) can be used for these purposes; however, such data analysis has not been validated.*

Objective. *To compare the results of HCES and 24-hour recall for estimating the consumption profile of potential fortification vehicles in Uganda.*

Methods. *Food intake estimates for 24- to 59-month-old children and 15- to 49-year-old women derived from a one-day 24-hour recall carried out in Uganda (Kampala, North, and Southwest) were compared with data from two HCES (2006, nationwide, and 2008, coupled with the 24-hour recall). The analyzed foods were vegetable oil, sugar, wheat flour, maize flour, and rice.*

Results. *Food consumptio`n estimates calculated from HCES may be less accurate than estimates derived by 24-hour recall. Nevertheless, the HCES results are sensitive enough to differentiate consumption patterns among population strata. In Uganda, HCES predicted proportion of the population that consumes the foods, and approximated intakes of main food vehicles by the "observed" consumers (those who reported using the foods), although estimates for the latter were lower for wheat flour and rice.*

Conclusions*. HCES data offer the basic information needed to provide a rationale for, and help design, food fortification programs. Individual intake surveys are still needed, however, to assess intrahousehold use of foods.*

Key words: Food fortification, food intakes, Household Consumption and Expenditures Surveys, micronutrients, nutrient intakes, 24-hour recall surveys, Uganda

Introduction

One cause of micronutrient deficiencies is the low supply of micronutrients in the diet. Low intakes of vitamins and minerals occur in many societies globally, where diets have low diversity and are poor in nutrient-dense foods, such as fresh fruits and vegetables, milk, eggs, fish, poultry, meat, and other animal products. Food fortification is one strategy used to increase micronutrient intake [1]. The amount of food consumed multiplied by the additional micronutrient content of the fortified food determines the additional micronutrient intake that can be provided through fortification. Thus, the public health benefit of food fortification depends on the proportion of the population that uses the fortified food (coverage), the amount of the food being consumed, and the additional content of micronutrients in the fortified food [2]. Therefore, these three parameters must be estimated to assess the potential benefit, guide design, and support monitoring and evaluation, of food fortification programs. The objective of this study was to compare the results of the Household Consumption and Expenditures Survey (HCES) and the traditional 24-hour recall for estimating the first two parameters in Uganda.

Twenty-four-hour recalls and other dietary survey methods such as Food Frequency Questionnaires (FFQs) are rarely used in many countries interested in introducing food fortification to improve diet quality. As an alternative, a simple method that applies a secondary data analysis from the Food and Agriculture Organization (FAO) Food Balance Sheets (FBS) has

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often been used to help plan programs [3]. However, FBS only provide country-level information based on national food supply and per capita consumption. Important potential differences among geographic regions within the country, socioeconomic strata, and demographic and cultural groups cannot be investigated and may be obscured.

For many years, the World Bank and other institutions have carried out periodic, nationally representative, cross-sectional surveys to make economic inferences by different population strata. These surveys constitute a typology now referred to as Household Consumption and Expenditures Surveys (HCES) [2] and include Household Income Expenditure Surveys (HIES), Living Standards Measurement Studies (LSMS), National Household Budget Surveys (NHBS), and others. These surveys collect information about acquisition (purchasing, own production, received as gifts), and sometimes consumption, of certain foods at the household level. They also collect demographic data on the age and sex of each household member. This information has been used to determine the percentage of households using certain foods and to estimate the amounts consumed in terms of Adult Male Equivalent (AME) units per household. The AME refers to the total count of 3,000 kcal/day energy requirements (as the typical adult male daily energy requirement, and hence 1.0 AME) per household, which is calculated by adding the proportional AMEs of each member of the family. For example, women's and children's energy requirements are represented as a fraction, such as 0.78 for a nonpregnant, nonlactating woman, and 0.41 for a child 24 to 59 months of age. This procedure has been used by different authors to estimate the coverage and potential benefits of fortifying wheat flour [4], salt [5], and other foods [6]. The results of those studies are encouraging and have stimulated interest in a wider use of the HCES as a basic tool for assessing the public health implications of food fortification programs. However, validating the HCES results with those derived from more standard dietary measurements has not yet been done. The purpose of this study was to compare the results from HCES against those from a 24-hour recall to estimate coverage and the consumed amounts of foods that are candidates for fortification in Uganda. An accompanying paper in this Supplement describes the potential usefulness of HCES to predict micronutrient dietary gaps in the same country [7].

Methods

A food consumption survey, based on one-day 24-hour recall methodology, was carried out in 2008 in Uganda as a collaborative endeavor of A2Z: the USAID Micronutrient Project, the Global Alliance for Improved Nutrition (GAIN), and the Ugandan office of the World Food Programme (WFP), with the participation of the Makerere University Department of Food Science and Technology [8]. Food intakes of 15- to 49-year-old women and 24- to 59-month-old children were estimated in a single day using a multipass method [9]. During the same survey, A2Z conducted parallel interviews in the same households using the same questionnaire that was used during a Household Consumption and Expenditures Survey* in 2006 by the Ugandan Bureau of Statistics (UBOS), which included a food frequency 7-day recall, as well as demographic information and household composition data, hereafter referred to as A2Z-HCES.

The 2006 HCES was a national, multistage-stratified-random survey, which covered the following strata: geographic regions, and urban and rural. At the district level, a two-stage sampling design was used to draw the sample. At the first stage, enumeration areas were drawn with probability proportional to size. At the second stage, the households were drawn with the use of simple random sampling. The sample of enumeration areas was selected using the Uganda Population and Housing Census Frame for 2002. A2Z accessed the 2006 HCES data set and analyzed it together with the results of the A2Z-HCES, specifically for one urban region (Kampala) and two rural regions (Southwestern and Northern regions).

The main variables in the analysis were the percentage of households reporting use of foods potentially used as fortification vehicles (vegetable oil, sugar, wheat flour, and products containing wheat flour, maize flour, and rice), and the amount of each one of these foods consumed per the "observed" households (those who reported using the foods) in terms of AME units. The proportional amounts consumed per child and woman were computed by multiplying the household consumed amounts per AME by the corresponding AME factor of these two target groups (i.e., 0.41 and 0.78, respectively). The results of food consumption from the HCES and the A2Z-HCES were then compared with those of the 24-hour recall for both children and women. For the 24-hour recall, we estimated the proportion of each one of these foods in the different recipes in order to calculate coverage (i.e. the proportion of the population that uses the fortification vehicle) and the total amounts of each food consumed by both children and women.

The study protocols were approved by the relevant institutional ethical review boards: the Uganda National Council for Science and Technology and the AED/Research Integrity Department.

* The survey was called the Household Income Expenditure Survey; this paper uses the generic term Household Consumption and Expenditures Survey (HCES).

Calculation of food consumption from HCES

Total acquisitions (purchasing, household production, received as gifts) of the selected foods per household and computed per day were transformed to weight amounts (grams), and the total was divided by the total household number of AME units. The recall period of the HCES questionnaires was 7 days.

Data adjustments and handling of outliers were carried out as described by Imhoff-Kunsch and colleagues in this Supplement [10]. Proportional AME units for each family member were taken from FAO [11]. We assumed that food was not wasted or spoiled, that it was not shared outside the household, and that it was not fed to animals. Food consumed outside the household was not included. For wheat flour, the total amount was computed from the proportional quantities present in products manufactured with wheat flour, such as breads, pasta, and cookies, based on recipes used in Uganda. The total amount was identified as wheat flour equivalents. We used a similar procedure for the other foods. In the case of sugar, only the results from direct use are included in this article.

We computed the amounts of food consumed only for the households that reported using selected foods, which we define as the "observed" consumers. We also estimated the consumed amounts for the whole population, which is derived by dividing the total consumed amounts by the total number of AMEs in the studied population. The calculation for the whole population was performed by multiplying the amounts consumed by the "observed" consumers by the proportion of households that reported using the foods. Thus, for example, if the amount of oil consumed in Kampala was 16.0 g/day per AME, and 74% of households reported using this food, then the amount consumed by the whole population was 11.8 g/day per AME (16.0 x 0.74).

Estimates of food consumption from the 24-hour recall

The 24-hour recall methodology is described elsewhere [8]. Briefly, we conducted a cross-sectional study to provide separate estimates of food and micronutrient intakes of 24- to 59-month-old children and 15- to 49-year-old women for each of the three regions. Two districts were selected randomly from a roster of all constituent districts for each rural region. Within each district, two subcounties were randomly selected, for a total of four in each rural region. Two subdivisions were selected in Kampala. The primary sampling unit was an enumeration area as demarcated by UBOS for the 2002 Uganda Population and Housing Census. Each enumeration area had approximately 150 households, and approximately 10 households per enumeration area were visited. Enumeration areas were randomly selected with a probability proportional to their size, and households within the enumeration area were randomly selected. **Table 1** summarizes the sample size for each region and study.

For the 24-hour recall, the consumed amounts of the selected foods were estimated by extracting the proportions of these foods as ingredients of meals and recipes from the database prepared specifically for Uganda. This database was developed from an initial instrument prepared by HarvestPlus. The data were not adjusted for intraindividual variation for estimating usual intakes [12] so as to be comparable with HCES-estimated results.

TABLE 1. Sample size (number of households) of the different surveys by region of Uganda

Survey type	Kampala	Southwestern Region	Northern Region
24-h recall	314	322	321
A2Z-HCES	314	322	321
HCES	2,100	1,770	1,624

HCES, Household Consumption and Expenditures Survey

TABLE 2. Percentage of households reporting specific food use per survey and region in Uganda (an estimate of coverage)

Survey type	Kampala	South-western Region	Northern Region
Vegetable oil			
24-h recall	74	26	64
A2Z-HCES	77	42	43
HCES	62	27	50
Sugar[a]			
24-h recall	94	30	31
A2Z-HCES	98	48	52
HCES	72	41	38
Wheat flour and products			
24-h recall	63	7	4
A2Z-HCES	75	28	5
HCES	30	18	2
Maize flour and products			
24-h recall	43	19	14
A2Z-HCES	75	39	15
HCES	54	36	20
Rice			
24-h recall	32	8	2
A2Z-HCES	71	23	3
HCES	32	15	6

HCES, Household Consumption and Expenditures Survey
a. Only as a direct ingredient.

Results

Percentage of households using potential food fortification vehicles

Table 2 shows the percentage of households observed that consumed the selected foods, as measured with the 24-hour recall during the stipulated period (7 days) or the HCES questionnaires. This parameter (percentage of observed consumers or "coverage") is very useful to identify which products are the most suitable food fortification vehicles in which regions. Regardless of the data source, the urban population of Kampala generally consumed the studied foods in the following decreasing order of use: sugar, vegetable oil, wheat and maize flours, and rice. Only sugar and vegetable oil appeared to penetrate the two rural markets in a significant manner. Use of wheat flour and rice is negligible in the Northern region.

In most cases, the A2Z-HCES identified more households using the foods than the 24-hour recall. This was not unexpected, since not all foods used were necessarily eaten daily. Despite the facts that A2Z-HCES and HCES had different sampling frameworks and were carried out in different years, the similarity of results in terms of the percentage of households using the foods is remarkable and suggests the robustness of HCES data for estimating coverage.

Estimation of amounts consumed

Tables 3 and **4** present estimates of the amounts of foods consumed by women and children, respectively, from the households that reported using those foods (i.e., the "observed" consumers). In all cases, the standard deviations are so large that differences between groups are not significant and therefore are not useful for comparing the results. Such information is better analyzed when presented as percentiles distribution, as shown in **figures 1** and **2**.

With the exception of the estimated consumption of oil in Kampala, the 24-hour recall method computed higher intake values than the HCES. This was markedly evident for consumption of wheat flour equivalents and rice. For wheat flour, this result may be due to the failure of the HCES to ask about all products that contain wheat flour as an ingredient [6]. For rice, the result may be due to artifacts in the calculations (either

TABLE 3. Amounts of specific foods (g/day) consumed by Ugandan women estimated through 24-hour recall and HCES[a]

	Kampala			Southwestern Region			Northern Region		
Survey type	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
Vegetable oil									
24-h recall	12.9	11.6	10.4	12.8	8.6	10.9	25.3	27.2	18.8
A2Z-HCES	17.2	14.7	12.8	15.1	20.2	9.1	13.0	19.1	7.0
HCES	13.4	14.9	9.6	23.3	20.6	17.3	11.4	11.6	8.2
Sugar[b]									
24-h recall	61.2	36.4	55.5	49.7	34.9	40.3	47.7	33.5	39.4
A2Z-HCES	57.2	48.3	45.6	31.0	37.9	21.2	17.3	18.2	12.3
HCES	73.2	52.3	60.5	40.4	30.4	33.4	26.6	20.9	21.2
Wheat flour and products									
24-h recall	63.6	43.3	58.3	52.5	39.9	35.3	41.9	26.9	35.6
A2Z-HCES	47.7	74.9	29.3	20.3	17.7	13.7	12.8	30.0	6.1
HCES	37.8	35.9	26.4	28.3	30.9	18.8	24.3	24.2	17.3
Maize flour and products									
24-h recall	124.7	87.4	115.9	84.9	48.7	78.6	120.8	48.9	130.3
A2Z-HCES	75.0	91.9	44.4	77.5	129.2	49.4	36.0	45.8	19.6
HCES	118.2	116.3	81.1	95.3	87.6	67.9	75.6	101.8	42.2
Rice									
24-h recall	80.3	56.5	63.0	92.1	75.5	81.3	84.2	13.6	84.4
A2Z-HCES	51.9	49.3	37.5	49.6	42.9	33.1	20.4	13.5	17.7
HCES	58.4	53.7	42.6	58.0	55.2	33.8	39.1	26.8	31.4

HCES, Household Consumption and Expenditures Survey

a. Only the figures calculated for "observed" consumers (those who reported use of the foods) and not for the whole population are presented. The estimates using HCES were calculated first per Adult Male Equivalent unit per household, and those values were multiplied by 0.78 to calculate the proportional food consumption by 15- to 49-year-old women.

b. Only as a direct ingredient.

from the 24-hour recall or the HCES), or it may be that children and women are consuming more rice than other family members so that rice is not distributed according to energy needs.

For the Northern region, the 24-hour recall estimates of consumption of vegetable oil, sugar, and maize flour equivalents were larger than those obtained by the HCES. These results can be explained by the distribution of these commodities by WFP, which may vary in short intervals of time, or due to the difficulty by the population of estimating quantities received as gifts.

The results demonstrate that vegetable oil is consumed in similar amounts by the observed consumers in all regions. Conversely, the observed consumers in Kampala eat more sugar, wheat flour, and maize flour than those in the other two regions. Interestingly, although coverage of the use of these foods differed across regions, the differences among the amounts consumed by observed consumers were less variable.

These results also show that using the AME concept (with the HCES data) to estimate the probable amounts of foods consumed by the different members of the family worked reasonably well for 24- to 59-month-old children and 15- to 49-year-old women in Uganda.

Usefulness of estimating average consumed values for target groups across the whole population

The previous sections presented the results for two key variables: percentage of households that use the foods (an estimate of potential coverage), and estimated amounts consumed by the "observed" consumers. The latter data are needed to predict the additional intake of micronutrients that could be delivered to individuals if the selected foods were fortified. The public health benefit of a population-level program will depend on the combination of three parameters: population coverage, the amounts of food consumed at the individual level, and the micronutrient content of the fortified food. The latter variable might be adjustable and under control of the program, and it is not discussed further here. The first two parameters can be combined in a single variable, through the estimation of the amount of food consumed by target groups across the entire population, which provides a simple and fast way to assess the potential of a food fortification program.

As an example, **table 5** shows the average estimates of the amount of each food consumed by all women across the different regions. Based on this information,

TABLE 4. Amounts of specific foods (g/day) consumed by Ugandan children estimated through 24-hour recall and HCES[a]

	Kampala			Southwestern Region			Northern Region		
Survey type	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
Vegetable oil									
24-h recall	7.6	7.2	4.9	8.4	6.6	5.7	13.8	14.0	9.4
A2Z-HCES	9.4	8.1	7.0	8.3	11.0	5.0	7.1	10.5	3.8
HCES	7.3	8.2	5.2	12.7	11.3	9.5	6.2	6.3	4.5
Sugar[b]									
24-h recall	44.7	32.5	38.2	27.8	20.5	23.5	32.9	26.1	25.0
A2Z-HCES	31.2	26.4	24.9	16.9	20.7	11.6	9.4	9.9	6.7
HCES	40.0	28.6	33.0	22.1	16.6	18.2	14.6	11.4	11.6
Wheat flour and products									
24-h recall	47.9	32.4	36.2	44.5	37.9	32.4	30.8	30.2	26.2
A2Z-HCES	26.0	40.9	16.0	11.1	9.7	7.5	7.0	16.4	3.3
HCES	20.7	19.6	14.4	15.5	16.8	10.3	13.2	13.2	9.4
Maize flour and products									
24-h recall	59.9	48.3	49.1	60.0	47.1	41.8	75.2	38.4	69.4
A2Z-HCES	41.0	50.2	24.3	42.4	70.6	27.0	19.7	25.0	10.7
HCES	64.5	63.5	44.3	52.1	47.9	37.1	41.3	55.6	23.1
Rice									
24-h recall	54.3	31.3	47.6	43.8	30.8	33.1	26.3	2.5	27.7
A2Z-HCES	28.4	26.9	20.5	27.1	23.4	18.1	11.2	7.4	9.7
HCES	31.9	29.3	23.2	31.7	39.4	18.4	21.4	14.7	17.1

HCES, Household Consumption and Expenditures Survey

a. Only the figures calculated for "observed" consumers (those who reported use of the foods) and not for the whole population are presented. The estimates using HCES were calculated first per Adult Male Equivalent unit per household, and those values were multiplied by 0.41 to calculate the proportional food consumption by 24- to 59-month-old children.

b. Only as a direct ingredient.

it is possible to deduce that using vegetable oil as a fortification vehicle would provide similar additional intakes of micronutrients to women in the three regions, but that in Kampala, the population would preferentially benefit from the fortification of sugar, wheat flour, maize flour, and rice. Fortification of wheat flour and rice would have, at best, a modest impact on the two rural regions studied. This population parameter is a variable that can easily be calculated with reliability using HCES as a first step to predict the potential benefits of a food fortification program for different sectors and population groups in the same country.

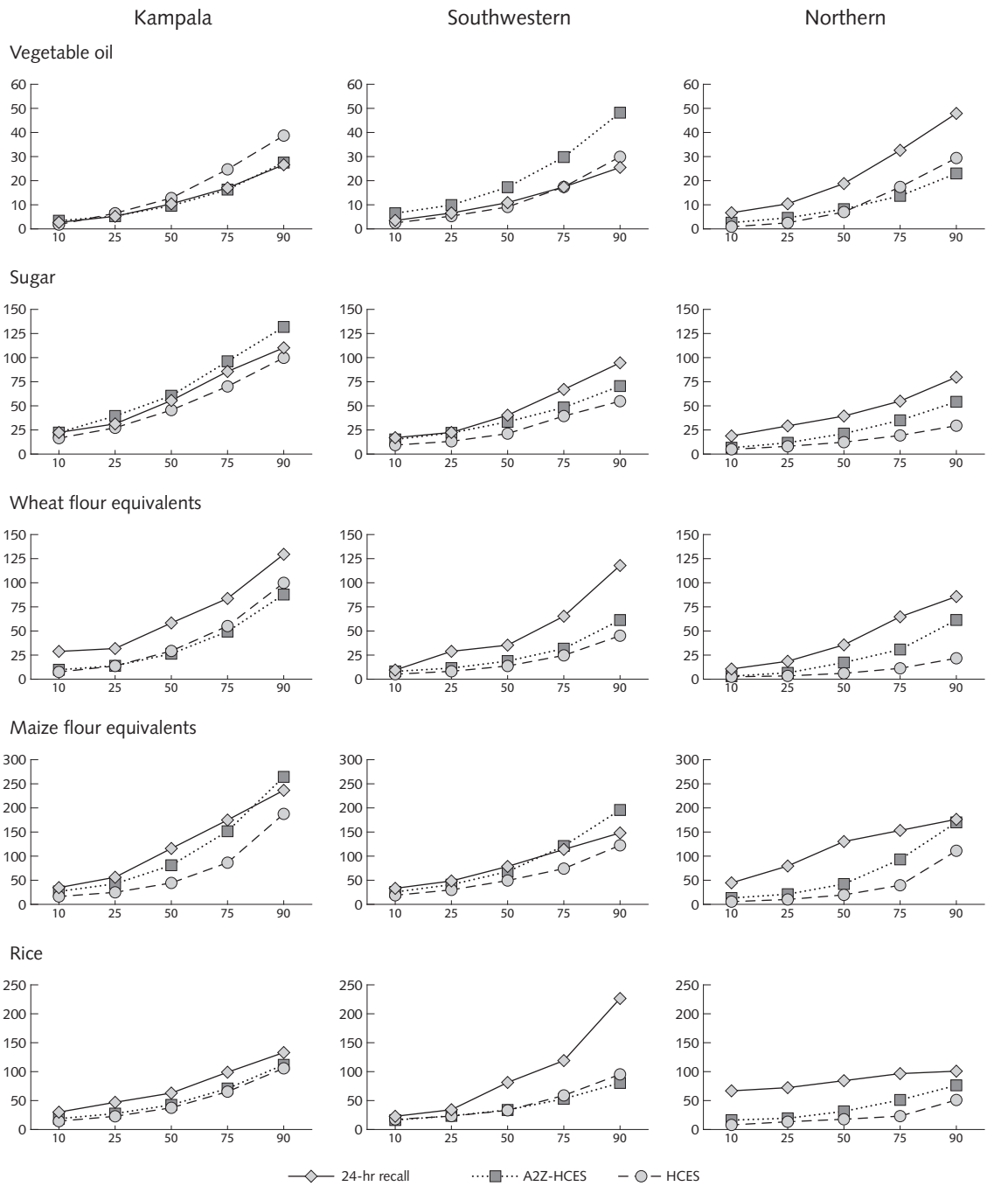

FIG. 1. Consumption profiles of foods commonly eaten by 15- to 49-year-old women in Uganda, by region. Horizontal axis shows population percentiles and vertical axis shows consumption of each food in grams per day. Results obtained by 24-hour recall (◇), A2Z-HCES (■), and HCES (○). Only data calculated for "observed" consumers (those who reported use of the foods) and not for the whole population are presented.

Discussion and conclusions

The results of this study confirm the practicality of using HCES data to estimate coverage and amounts consumed of commonly eaten foods in different populations in Uganda. Although calculations of amounts consumed obtained from HCES may be lower and less accurate than the estimates derived by 24-hour recall, the HCES results are sensitive enough to differentiate consumption patterns among population

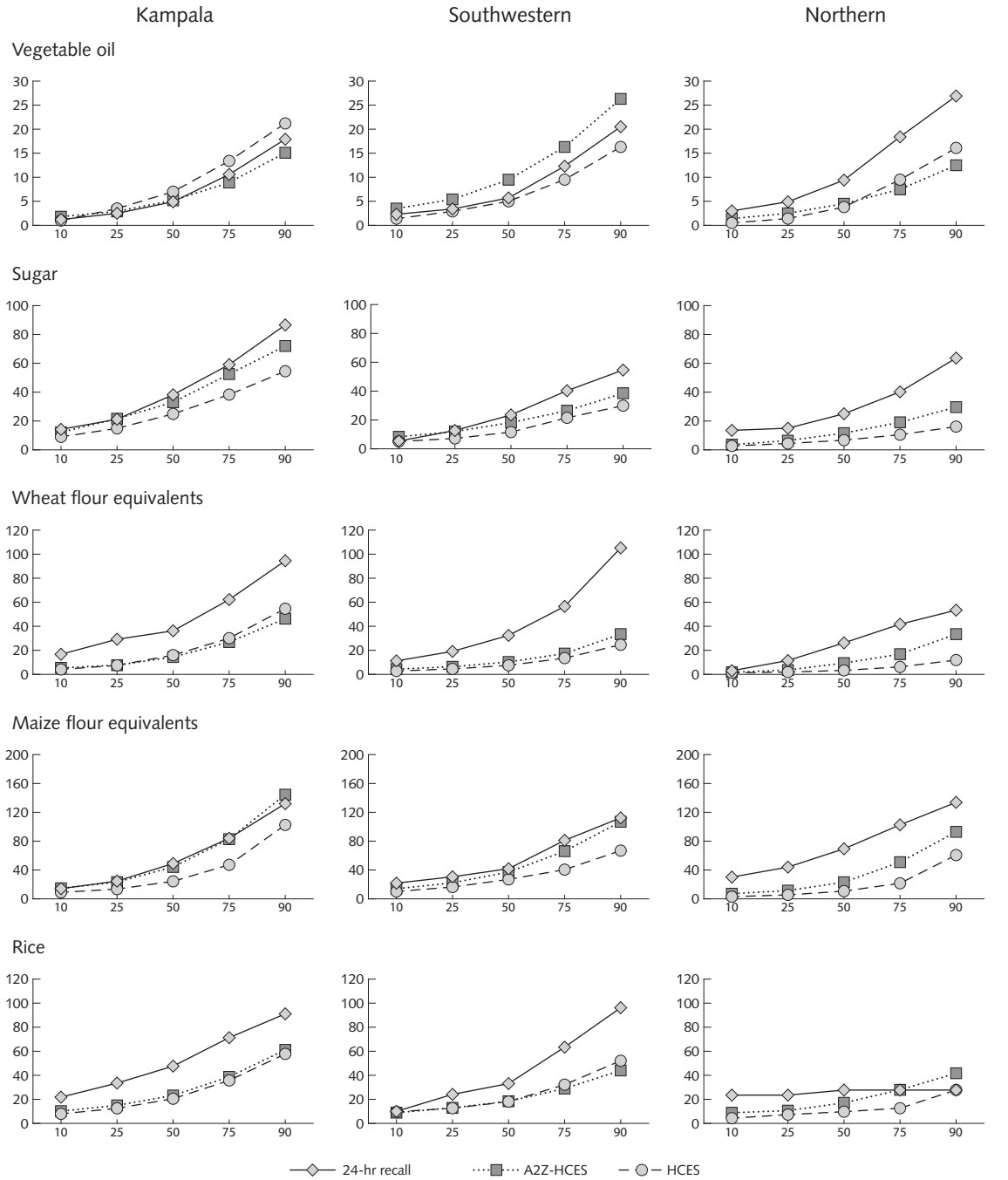

FIG. 2. Consumption profiles of foods commonly eaten by 24- to 59-month-old children in Uganda, by region. Horizontal axis shows population percentiles and vertical axis shows consumption of each food in grams per day. Results obtained by 24-hour recall (◇), A2Z-HCES (■), and HCES (○). Only data calculated for "observed" consumers (those who reported use of the foods) and not for the whole population are presented.

strata. The range of the distribution profiles calculated by HCES also allows for estimation of the range of additional intakes expected as a result of fortifying these food vehicles; one need only to multiply the additional micronutrient content by the different consumption values revealed by the distribution curves.

The main advantages of the HCES are the nationally representative nature of the data, the capacity to disaggregate by strata, and the routine frequency of survey implementation so that a special survey to aid in the planning of a food fortification program may not be necessary.

Despite this study demonstrating that HCES results are acceptable for the commonly eaten foods that were analyzed (vegetable oil, sugar, wheat flour, maize flour, and rice) in Uganda, the situation may be different with micronutrient-dense foods, which may not be distributed equitably or in proportion to the energy requirements of each family member.

We believe that secondary analysis of HCES data provides the basic information needed to provide a rationale for, and help design, food fortification programs. It provides reliable information about potential coverage of food vehicles used by different strata (**table 2**) and offers acceptable estimates of the range of amounts consumed by individuals of different age and sex groups (**figs. 1** and **2**). The distribution profile of food consumption should be done only for the "observed" consumers, because those amounts would help predict additional micronutrient intakes delivered through the food vehicles. These consumption values, rather than the per capita estimates calculated with the use of the FBS, should be used to formulate fortification programs. However, the overall benefit of food fortification as a public health intervention may also be predicted by calculating the average consumption in target groups across the entire population, because this variable combines both coverage and amounts consumed by the "observed" consumers. Nevertheless, despite the usefulness of HCES to help plan and design fortification programs, evaluation of their impact still requires individual intake surveys that assess not only intrahousehold use of foods but also the real additional micronutrient contents of those foods.

TABLE 5. Mean amounts of specific foods (g/day) consumed by women estimated through 24-hour recall and HCES[a]

Survey type	Kampala	Southwestern Region	Northern Region
Vegetable oil			
24-h recall	9.5	3.4	16.2
A2Z-HCES	13.2	6.4	5.6
HCES	8.3	6.2	5.6
Sugar[b]			
24-h recall	57.7	14.7	14.6
A2Z-HCES	56.1	14.8	9.0
HCES	52.5	16.5	10.1
Wheat flour and products			
24-h recall	40.1	3.9	1.6
A2Z-HCES	36.0	5.7	0.6
HCES	11.4	5.0	0.6
Maize flour and products			
24-h recall	53.2	16.1	17.3
A2Z-HCES	55.9	30.6	5.4
HCES	63.7	34.0	15.3
Rice			
24-h recall	26.1	7.4	1.6
A2Z-HCES	36.9	11.2	0.7
HCES	18.5	8.9	2.4

HCES, Household Consumption and Expenditures Survey

a. The mean amounts of food consumed were estimated by multiplying the means of "observed" consumers found in **table 3** by the proportion of households utilizing the foods (**table 2**).

b. Only as a direct ingredient.

Acknowledgments

This article was made possible by the generous support of the American people through the US Agency for International Development (USAID) under the terms of Cooperative Agreement No. GHS-A-00-05-00012-00 to FHI-360 (and before to AED). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the US government.

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