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Evaluation of a Novel Single-administration Food Frequency Questionnaire for Assessing Seasonally Varied Dietary Patterns among Women in Rural Nepal

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Novel dietary assessment methods are needed to study chronic disease risk in agrarian cultures where food availability is highly seasonal. In 16,320 rural Nepalese women, we tested a novel food frequency questionnaire, administered once, to assess past 7-day intake and usual frequency of intake throughout the year for year-round foods and when in season for seasonal foods. Spearman rank correlations between usual and past 7-day intakes were 0.12–0.85 and weighted kappa statistics,

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representing chance-corrected agreement, were 0.10–0.80, with better agreement for frequently consumed foods. The questionnaire performed well, but may require refinement for settings of extremely low dietary diversity.

KEYWORDS diet assessment, food frequency questionnaire, Nepal, seasonal foods, undernutrition

Assessment of usual dietary intake is of increasing importance in rural societies of low income countries where food insecurity can be chronic but transitioning diets and lifestyles are also gradually increasing risks of obesity and chronic diseases (Black et al. 2013). Current methodology in population-based dietary assessment relies mainly on 24-hour recalls and food frequency questionnaires (FFQ), usually directed to current intakes. Both methods have been widely implemented and validated for use in diverse settings (Margetts and Nelson 1997). Where there is a high degree of seasonal variation in dietary intake, however, it is not clear that either of these methods, when deployed at one time of year, adequately captures usual dietary variability throughout the year. An improved method, more aligned with obtaining recalls of typical, year-round dietary patterns, would enable researchers to better estimate dietary intakes and evaluate diet-disease and intervention-health outcome relationships in low income settings.

Typically during a 24-hour recall, the interviewer employs a multi-pass method to record all foods and ingredients consumed by the respondent in the 24 hours prior to the interview. The FFQ can be self- or interviewer-administered and employs a pre-specified food list asking respondents to recall intake frequency of each food over a specified, recent period of time. The FFQ, commonly used in epidemiologic studies, has a presumed advantage over the 24-hour recall in that a single administration is assumed to capture an individual's usual diet, which is likely more relevant for studies of chronic disease or food insecurity than diet in a single 24 hour period (Margetts and Nelson 1997). Cross-sectional studies generally utilize a one-time FFQ administration, while in longitudinal studies, dietary assessments are repeatedly done but historically at intervals of more than a year, implicitly assuming that individual dietary patterns are stable over shorter time periods (Margetts and Nelson 1997). However, in settings where dietary intakes can vary markedly over the year, such as rural South Asia, assumptions of dietary stability and accuracy of a one-time assessment in reflecting an individual's long term dietary pattern are largely untested. Several recent studies examining dietary intakes in rural South Asia failed to mention any consideration of the extent of seasonal variation in the diet (Chandyo et al. 2007; Parajuli, Umezaki, and Watanabe 2012; Wang, Dang, and Yan 2010). Others that did incorporate seasonality into their survey designs and analyses did not report the extent of seasonal variation in the diet or its relationship to nutrient intake throughout the year (Hebert et al. 1998; Hebert et al. 1999). Assessments that do not consider seasonal variation have the potential for lower accuracy and greater misclassification. Those that employ analytical adjustments for seasonality rely on untested assumptions about accuracy of participant recollection of intake during a given season.

The present investigation explores the ability to assess year-round and seasonal usual frequencies of dietary intake with a novel, singly administered FFQ, drawing on information from the agricultural calendar to identify seasonality of foods. The study was carried out over the course of two years in a population of adult women in the rural southern plains of Nepal. Presented are measures of agreement between dietary intake frequencies as assessed by two components of the FFQ, a cross-seasonal usual intake questionnaire and a past 7-day intake questionnaire, with the aim of assessing the accuracy of data collected with a single administration of the cross-seasonal portion of the FFQ.

MATERIALS AND METHODS

Setting

The data for the present study were collected in the Sarlahi district in the southern plains region (Terai) of Nepal in a follow-up to the 1993-7 NNIPS 2 trial, a cluster-randomized, placebo-controlled trial of antenatal vitamin A and β-carotene supplementation (West et al. 1999), designed to assess long term effects of antenatal supplementation and determinants of health and nutritional status in women and their offspring in this rural Nepali population. Eligibility criteria were having contributed a pregnancy in the original study and living in the study area at the time of follow-up. Women were approached on a single occasion during 2006–2008 for the follow-up interview and assessments. Pregnant women (n = 421) were excluded from this analysis because pregnancy may alter dietary norms. The initial trial was approved by the Nepal Health Research Council (Kathmandu, Nepal), the Joint Committee on Clinical Investigation at the Johns Hopkins School of Medicine (Baltimore, MD, USA), and the Teratology Society (Bethesda, MD, USA). The follow-up study was approved by the institutional review boards of Johns Hopkins University and the Institute of Medicine, Tribhuvan University (Kathmandu, Nepal). Oral consent was collected from the women at the time of the follow-up interview.

Dietary Assessment

An interviewer-administered FFQ was developed for the cohort follow-up survey, the details of which are described elsewhere (Campbell et al. 2014). Briefly, the questionnaire contained 59 commonly consumed foods, including fruits and vegetables separated into ten year-round, available at a stable quantity and price throughout the year, and 18 seasonal, available only during specific times of year. As the interviewers reviewed the food list respondents were first asked the *usual* frequency per day, week, month or year with which they consume each food considered available throughout the year. For seasonal vegetables and fruits, women were asked the usual frequency per day, week, month or season with which they ate the food during specified months when it was *in season*, based on a local agricultural calendar. The usual frequency interview normally required 15–18 minutes to conduct.

Once the usual intake interview was completed, the same list of 59 foods was independently reviewed in the same order a second time by the interviewer. On that pass, respondents were asked how many times they consumed each listed food, both year-round and seasonally available, in the seven days prior to the interview.

Assessment of Covariates

Interviews occurred at women's homes and the trained interviewers also asked after and observed participants' household possessions, land ownership and the physical quality of their house structure. Women were also asked their age, number of live births and level of education.

Analytical Procedures

Observations above the 99th percentile of consumption frequency for each food were considered likely reporting or recording errors and dropped from the analysis (mean 39.4, maximum 233 observations [1.5% of the study population] dropped per food). Participants with outlying values for individual foods were not excluded from the analysis of other foods as total macro- and micro-nutrient consumption was not calculated. Questionnaire food items were combined prior to analysis for foods with similar nutrient profiles and consumption patterns. Food groups were defined based on the Food Composition Table for Nepal 2012 (National Nutrition Program 2012). All intake frequencies and units for reported usual and past 7-day intakes were converted to times per week.

An in-season period was assigned to each seasonal vegetable and fruit (Campbell et al. 2014) and interviews were classified accordingly as in-season or out-of-season for each food. The in-season period for each food was divided into thirds, and interviews in the middle third of the in-season period were classified as "in peak season".

Statistical Analysis

Usual and past 7-day intakes for individual foods were categorized as none/1–3 times (> 0 and < 4 for usual intakes)/≥ 4 times per week across all foods to provide a consistent basis for comparison. However, when assessing agreement, intake frequencies were stratified for each food into lower/middle/upper thirds of intake distribution. For each food, nonparametric summary statistics (median, inter-quartile range [IQR]) were calculated and agreement between past 7-day and usual intake was assessed with Spearman rank correlation coefficients, weighted kappa scores, and percentage of participants classified in the same, adjacent and extreme opposite thirds of the distribution. For seasonal foods, only women interviewed during the in-season period were included in the tests of agreement for that food. Measures of agreement were repeated for women interviewed in peak season (for seasonal foods), for those with reported intake > 0 times per week, and stratified by level of SES. Statistical analyses were performed using STATA version 11.1 (StataCorp, College Station, TX).

RESULTS

Sociodemographic Characteristics

A total of 16,320 women participated in the follow-up study. The majority of women were age 30–39 years (57.9%), and belonged to households that owned land (77.1%) and at least one cow or goat (85.7%) (table 1). Only 19.5% of women's houses had walls made of cement. The literacy rate was 15.1% in the study sample. Socioeconomic status was consistent across the groups of study participants interviewed during different seasons.

TABLE 1 Socio-demographic Characteristics of Women Participants

	Total (%)	Spring (%)	Summer (%)	Fall (%)	Winter (%)
Age					
< 30	25.7	25.7	27.4	26.2	23.8
30–39	57.9	58.2	57.4	56.4	59.7
> 40	16.4	16.1	15.2	17.4	16.5
n	15,578	4,931	2,947	4,303	3,397
Live births					
≤ 2	8.6	8.7	6.7	8.9	9.6
3–6	72.6	73.3	73.1	73.3	70.5
> 6	18.8	18.0	20.3	17.7	19.9
n	15,812	4,995	2,998	4,370	3,449
Attended school	14.5	13.1	10.7	16.5	17.3
n	15,876	5,017	3,006	4,388	3,465
Landless	22.9	25.4	26.1	19.2	21
n	15,800	4,999	3,001	4,347	3,453
Owns livestock	85.7	85.1	84.7	87.4	85.3
n	15,873	5,018	3,013	4,378	3,464
House construction					
Cement walls	19.5	20.6	23.1	17.7	17.2
n	15,877	5,018	3,014	4,380	3,465
Upper floor	49.1	46.8	40.9	49.0	59.5
n	15,875	5,019	3,014	4,378	3,464

Diet Characteristics

Usual diet in this study sample as assessed by the past 7-day portion of the FFQ has been described previously (Campbell et al. 2014). Briefly, the vast majority of women reported consuming rice, potatoes and vegetable oil ≥ 4 times in the week preceding the interview (96.8%, 81.6%, and 97.9%, respectively) and 65.5% reported consuming legumes ≥ 4 times (table 2). Consumption of animal products, fruits and vegetables was low. Leafy green vegetables was the most frequently consumed vegetable type available year-round, and tomato and cauliflower when in season were the most frequently consumed seasonal vegetables (table 3).

With few exceptions, reported usual intakes were shifted toward higher consumption frequency categories compared to reported past 7-day intakes. The differences in median reported consumption between the past 7 days and usual, though mostly of small magnitude, were larger for seasonal fruits and vegetables.

Agreement between Usual and Past 7-day Intake

Spearman correlation coefficients between past 7-day and usual intakes for year-round foods ranged from 0.28 for green pumpkin to 0.85 for potato, with correlations for 24 of 34 (70.6%) year-round foods ≥ 0.50 (table 4). Correlations were lowest for snails, vegetable oil, hydrogenated oil and several vegetables, all foods with extremely high or low consumption frequencies and very little variation in consumption within the study population. Correlation coefficients for seasonal foods calculated for women interviewed during each food's in-season period ranged from 0.12 for ripe mango to 0.58 for cauliflower (table 5). Tomato and cauliflower, the seasonal foods with the most women in the highest category of past 7-day intake, had the highest correlation coefficients (0.57 and 0.58, respectively). Correlation coefficients for all other seasonal foods were < 0.50.

For 31 of 34 year-round foods, ≥ 50% of women were classified in the same third of intake by the 7-day and usual intake survey sections. For year-round foods, the mean percent classified in the same third of intake was 63.3% (range 38.6%–96.8%). The mean percent grossly misclassified into opposite thirds of intake was 11.7% (0.1%–28.9%). For seasonal foods, the mean percent classified in the same third of intake was 80.8% (65.4%–98.2%) and the mean percent misclassified into opposite thirds of intake was 3.5% (0.5%–14.5%). When this analysis was repeated across strata of SES, food consumption, and peak season for each seasonal food, these findings were not substantively different (data not shown).

Weighted kappa scores for agreement between past 7-day and usual intake of year-round foods ranged from 0.10 for green pumpkin to 0.80 for potatoes. Kappa scores for 13 foods demonstrated moderate agreement (>

TABLE 2 Distribution of Women's Reported Past 7-day and Usual Dietary Intakes of Year-round Foods

	7-day FFQ				Usual FFQ			
Food/Food group[1]	*n*	0	1–3	≥ 4	*n*	0	> 0–< 4	≥ 4
Cereal and cereal products	15,483	0.1	0	99.9	15,614	0	0.08	99.9
Rice[2]	15,706	1.1	2.1	96.8	15,831	0.7	2.2	97.2
Corn[3]	15,812	74.3	10.9	14.9	15,798	69.7	12.5	17.8
Wheat *roti*	15,710	45.2	13.4	41.4	15,843	20	24.4	55.6
Millet *roti*	15,858	95	3.3	1.8	15,847	94.7	3.3	2
Pulses, legumes, and nuts	15,464	8.7	25.8	65.5	15,627	2.2	21.9	75.9
Daal	15,735	15.6	34.9	49.5	15,847	9.8	35.1	55.1
Maseura	15,716	61.7	31.7	6.6	15,861	52.3	38.3	9.4
Peanut	15,798	85.7	11.1	3.2	15,730	79.3	15.3	5.4
Other legumes	15,821	74.8	22.2	3	15,804	72.8	23.8	3.4
Vegetables	14,931	9.6	33.6	56.8	15,201	1	17.7	81.4
Leafy green vegetables	15,762	25.4	48.9	25.7	15,843	10.7	52.6	36.7
Dried leafy green vegetables	15,794	76	20.1	3.9	15,713	72.3	22.8	4.9
Eggplant	15,716	65.7	29.6	4.7	15,858	54.8	37.6	7.6
Green peas	15,722	94.5	5.1	0.4	15,796	76.9	18.2	4.9
Bottle gourd	15,712	72.3	25.2	2.6	15,848	55.5	37.2	7.3
Ripe pumpkin	15,756	89	11	0	15,717	86.7	12.8	0.5
Green pumpkin	15,762	95.6	4.4	0	15,706	88.8	10.8	0.4
Green papaya	15,730	89.9	10.1	0	15,710	89.4	10.3	0.3
Tubers	15,760	6.2	12.2	81.6	15,839	2.7	11.2	86.2
Potatoes	15,760	6.2	12.2	81.6	15,839	2.7	11.2	86.2
Fruits	15,740	74	24.5	1.5	15,823	76.3	21.6	2.1
Banana	15,740	74	24.5	1.5	15,823	76.3	21.6	2.1
Meat, egg, and fish products	15,217	44.6	45.6	9.8	15,309	38.4	48.1	13.5
Chicken	15,764	81.7	18.3	0	15,738	86.1	13.9	0
Other meat	15,714	70.1	29	0.9	15,817	77.3	21.3	1.4
Fish	15,671	74.7	24.3	1	15,594	77	21.4	1.6
Snails	15,745	94.9	5.2	0	15,747	94	6	0
Eggs	15,723	88.6	11	0.4	15,835	86.8	11.6	1.7
Milk and milk products	15,448	27.4	26.1	46.5	15,591	17.9	27.8	54.4
Milk	15,840	47.2	23.1	29.7	15,789	39.9	26.3	33.8
Curd	15,751	60	30.7	9.4	15,824	52.2	36.1	11.7
Whey	15,749	82	15.1	3	15,831	78.4	17	4.5
Tea	15,732	70.7	7.3	22.1	15,737	66.6	9.5	23.9
Fats and edible oils	15,524	0.7	0.4	98.8	15,623	0.4	0.7	98.9
Vegetable oil	15,721	1.4	0.8	97.9	15,804	0.8	1.1	98.2
Ghyu	15,829	80.6	10.6	8.9	15,848	77	13.2	9.8
Hydrogenated oil	15,710	94.4	5.1	0.4	15,711	95.8	3.9	0.4
Miscellaneous	15,185	21.5	39	39.5	15,210	8.4	36.3	55.3
Fried snacks[4]	15,396	54.4	37.7	8	15,466	44.5	44.2	11.4
Biscuits	15,728	83.8	15.4	0.8	15,853	82.6	15.7	1.8
Unfried snacks[5]	15,745	30	45.3	24.7	15,590	18	47.1	34.9
Alcohol	15,729	93.5	3	3.5	15,768	92.4	3.1	4.5
Jaard	15,729	93.5	3	3.5	15,768	92.4	3.1	4.5

[1]Food name translations: *daal* (lentils), *maseura* (lentil patty), *ghyu* (clarified butter), *roti* (flatbread), *jaard* (brewed millet drink).

[2]Includes boiled rice and rice flour bread.

[3]Includes boiled corn and corn flour bread.

[4]Includes noodles, *samosas* (fried vegetable-filled snacks), *pakaudas* (fried vegetable-filled snacks), fried sweet snacks, and *dalmot* (snack mix of fried rice, lentils, spices).

[5]Includes un-fried puffed or roasted corn and rice snacks.

TABLE 3 Distribution of Women's Reported Past 7-day and Usual Dietary Intakes of Seasonal Vegetables and Fruits

	In-season 7-day FFQ				Usual FFQ			
Food/Food group	*n*	0	1–3	≥ 4	*n*	0	> 0–< 4	≥ 4
Vegetables								
Okra	8,818	64.8	29.9	5.3	15,109	10.8	55.1	34.1
Long bean	8,900	69.2	27.8	3.0	15,450	17.3	58.5	24.3
Sponge gourd	8,874	53.5	32.0	14.5	15,665	6.5	42.0	51.5
Bitter gourd	8,896	79.5	20.5	0.0	14,968	33.7	54.2	12.2
Green bean	8,403	61.6	30.4	8.1	15,517	11.4	48.8	39.9
Tomato	8,412	41.4	21.0	37.6	15,029	9.7	28.2	62.1
Cauliflower	5,177	28.6	35.7	35.7	15,779	6.7	33.8	59.6
Cabbage	3,415	54.5	39.5	6.0	14,802	23.3	59.9	16.8
Lima bean	3,427	86.3	13.7	0.0	12,566	63.1	29.9	7.1
Drumstick	4,906	66.4	30.9	2.7	14,559	57.7	35.1	7.2
Green jackfruit	3,201	80.1	19.9	0.0	14,215	68.2	28.9	2.9
Fruits								
Ripe mango	2,303	66.3	28.1	5.6	15,273	21.1	41.1	37.8
Jackfruit	1,659	84.9	15.1	0.0	13,615	67.6	29.8	2.7
Guava	3,379	56.6	27.6	15.8	14,597	28.0	39.9	32.0
Orange/Tangerine	9,799	84.2	15.2	0.7	13,716	84.2	13.9	1.9
Ripe papaya	10,092	79.8	19.6	0.6	12,768	67.4	28.7	3.9
Apple	3,628	86.7	13.3	0.0	13,011	88.1	11.4	0.6
Pineapple	1,732	94.9	5.1	0.0	7,389	81.9	15.9	2.2

0.40) and kappa scores for six foods (milk, tea, *daal* [lentils], rice, potatoes, and *jaard* [alcoholic beverage]) showed good agreement (> 0.60) (Altman 1991). Kappa scores for seasonal foods ranged from 0.05 for ripe mango to 0.37 for ripe papaya, with half (nine foods) classified as fair agreement and half as poor.

DISCUSSION

The present study examined agreement between reported usual and past 7-day dietary intake among women living in the Terai of Nepal. Reported usual intake frequencies exceeded past 7-day intake frequencies for most foods, but agreement between the two measures for foods consumed with some regularity or moderate to high variability was good as assessed by Spearman correlation coefficients, weighted kappa scores, and percent classified in the same and extreme opposite thirds of the intake distribution. Agreement for seasonal foods was lower than for year-round foods. The different measures of agreement tended to rank the foods similarly, but often classified them into different categories of agreement (good, fair, poor, etc.). In particular, Spearman coefficients and percent agreement tended to rate agreement as good when kappa scores rated agreement as fair.

TABLE 4 Agreement between Estimates of Women's FFQ Reported Past 7-day and Usual Intake of Year-round Foods

	Spearman correlation coefficient		Percent classified in			
Food/Food group[1]	r_s	p	Same third	Adjacent third	Extreme third	K_w
Cereal and cereal products						
Rice[2]	0.77	<0.0001	75.18	23.91	0.92	0.67
Corn[3]	0.73	<0.0001	68.89	22.29	8.82	0.57
Wheat *roti*	0.67	<0.0001	51.72	47.42	0.87	0.33
Millet *roti*	0.5	<0.0001	83.53	0	16.47	0.32
Pulses, legumes, and nuts						
Daal	0.84	<0.0001	80.98	18.23	0.79	0.71
Maseura	0.67	<0.0001	63.42	32.77	3.81	0.52
Peanut	0.46	<0.0001	45.58	38.96	15.46	0.26
Other legumes	0.62	<0.0001	55.24	32.3	12.46	0.42
Vegetables						
Leafy green vegetables	0.6	<0.0001	62.32	31.56	6.12	0.5
Dried leafy green vegetables	0.65	<0.0001	58.43	32.06	9.52	0.46
Eggplant	0.63	<0.0001	60.32	29.25	10.43	0.47
Green peas	0.26	<0.0001	38.63	38.47	22.9	0.1
Gourd	0.47	<0.0001	57.36	23.18	19.46	0.34
Ripe pumpkin	0.38	<0.0001	46.73	34.03	19.24	0.2
Green pumpkin	0.28	<0.0001	52.79	18.28	28.93	0.1
Green papaya	0.48	<0.0001	62.85	14.37	22.78	0.27
Tubers						
Potatoes	0.85	<0.0001	89.75	10.2	0.05	0.8
Fruits						
Banana	0.53	<0.0001	63.23	20.22	16.55	0.42
Meat, egg, and fish products						
Chicken	0.57	<0.0001	51.69	34.34	13.97	0.34
Other meat	0.63	<0.0001	54.6	37.77	7.63	0.45
Fish	0.56	<0.0001	51.05	38.02	10.93	0.38
Snails	0.39	<0.0001	70.73	3.57	25.7	0.19
Eggs	0.53	<0.0001	65.79	19.27	14.94	0.36
Milk and milk products						
Milk	0.8	<0.0001	76.85	19.73	3.42	0.71
Curd	0.7	<0.0001	63.56	28.53	7.92	0.53
Whey	0.63	<0.0001	65.08	21.22	13.7	0.45
Tea	0.83	<0.0001	78.81	16.56	4.64	0.71
Fats and edible oil						
Vegetable oil	0.39	<0.0001	90.6	0	9.4	
Ghyu	0.69	<0.0001	69.79	15.92	14.29	0.5
Hydrogenated oil	0.42	<0.0001	69.47	7.01	23.51	0.21

(*Continued*)

TABLE 4 (Continued)

Food/Food group[1]	Spearman correlation coefficient r_s	p	Percent classified in Same third	Adjacent third	Extreme third	K_w
Miscellaneous						
Fried snacks[4]	0.67	<0.0001	61.71	32.01	6.28	0.51
Biscuits	0.57	<0.0001	56.91	25.36	17.73	0.35
Unfried snacks[5]	0.67	<0.0001	64.72	29.18	6.1	0.53
Alcohol						
Jaard	0.82	<0.0001	96.76	0	3.24	0.78

[1]Food name translations: *daal* (lentils), *maseura* (lentil patty), *ghyu* (clarified butter), *roti* (flatbread), *jaard* (brewed millet drink).
[2]Includes boiled rice and rice flour bread.
[3]Includes boiled corn and corn flour bread.
[4]Includes noodles, *samosas* (fried vegetable-filled snacks), *pakaudas* (fried vegetable-filled snacks), fried sweet snacks, and *dalmot* (snack mix of fried rice, lentils, spices).
[5]Includes un-fried puffed or roasted corn and rice snacks.

TABLE 5 Agreement between Estimates of Women's FFQ Reported Past 7-day and Usual Intake of Seasonal Foods for Women Interviewed during the Foods' In-season Periods

Food/Food group	Spearman correlation coefficient r_s	p	Percent classified in Same third	Adjacent third	Extreme third	K_w
Vegetables						
Okra	0.20	< 0.0001	71.9	14.6	13.6	0.14
Long bean	0.26	< 0.0001	68.1	17.4	14.5	0.15
Sponge gourd	0.13	< 0.0001	65.4	23.7	10.9	0.10
Bitter gourd	0.23	< 0.0001	66.1	25.5	8.4	0.14
Green bean	0.17	< 0.0001	68.6	19.0	12.4	0.09
Tomato	0.57	< 0.0001	67.0	32.5	0.5	0.19
Cauliflower	0.58	< 0.0001	84.3	14.2	1.6	0.36
Cabbage	0.49	< 0.0001	90.3	7.3	2.5	0.35
Lima bean	0.32	< 0.0001	90.0	7.3	2.8	0.16
Drumstick	0.38	< 0.0001	85.8	10.8	3.4	0.30
Green jackfruit	0.33	< 0.0001	88.8	8.6	2.6	0.19
Fruit						
Ripe mango	0.12	< 0.0001	92.2	4.3	3.6	0.05
Jackfruit	0.31	< 0.0001	95.0	3.1	1.9	0.21
Guava	0.43	< 0.0001	90.5	5.4	4.1	0.28
Orange/Tangerine	0.41	< 0.0001	68.3	22.3	9.4	0.26
Ripe papaya	0.48	< 0.0001	75.4	14.5	10.2	0.37
Apple	0.39	< 0.0001	89.1	8.5	2.5	0.24
Pineapple	0.34	< 0.0001	98.2	1.1	0.7	0.26

Most published evaluations of FFQs implemented in similar settings have used estimates of the nutrient composition of participants' diets rather than consumption of individual foods to validate the FFQ against a gold-standard or previously validated instrument (Hebert et al. 1999), making it difficult to directly assess the comparability of our results. Two studies in populations similar to our cohort reported systematic overestimation of dietary intake by FFQs but average or better correlation coefficients between the FFQ and multiple 24-hour recalls (Cheng et al. 2008; Hebert et al. 1999). Other validation studies did not report systematic overestimation by a FFQ compared to 24-hour recalls (Hebert et al. 1998; Johnson et al. 2009), but the number of food items included in the FFQ food list is known to influence the observed absolute intakes (Krebs-Smith et al. 1995). When FFQs are used to rank participants rather than quantify absolute intake, as they typically are, these concerns are less paramount. Still, guidelines for developing FFQs recommend including only foods consumed by a substantial proportion of the population, as infrequently consumed foods tend to be poorly assessed by FFQs and are not useful for differentiating participants by dietary pattern (Cade et al. 2002; Willett 1998).

Several factors may contribute to the low agreement between usual and past 7-day intake of most seasonal foods observed in the present study. While a number of studies have reported on cognitive processes required to accurately respond to a FFQ (Margetts and Nelson 1997; Wirfält 1998), no research to our knowledge has been published on cognitive demands related to recalling consumption frequencies for periodically consumed foods. It is possible that people recall their consumption of seasonal foods during the peak of the season only, rather than averaged across the entire in-season period, or that people recall their consumption during a generalized or idealized season rather than during a typical year. Additionally, infrequently consumed foods, seasonal or otherwise, generally show low agreement in FFQ validation studies, as discussed above. Our finding that tomato and cauliflower, both seasonally available but consumed by a large proportion of the population when in season, showed good agreement between usual and past 7-day intake supports the role of low consumption rather than poor recall of seasonal diet in the low agreement observed for the majority of seasonal foods.

Previous studies of diet and health status in Nepali women have shown that even small amounts of vitamin A–rich foods appear protective for pregnancy and perinatal complications (Christian et al. 1998). One important application of a single-administration dietary questionnaire in this population would be to differentiate low consumers from non-consumers of vitamin A-rich fruits and vegetables that may not be available at the time of year in which the questionnaire is administered. Based on the results of this study, a usual intake FFQ may not be a suitable instrument for that purpose in this population, as most vitamin A–rich fruits and vegetables are consumed infrequently even when in season.

We present multiple statistical measures to convey different aspects of agreement. The measures concur in their ranking of foods according to level of agreement, though in some cases foods with the same Spearman correlation coefficient had very different kappa scores (e.g., *maseura* and wheat *roti*). The measures differed most markedly, however, in their classification of agreement as "good," "average," "fair," and so on. In particular, when percent classified in the same third of intake and Spearman coefficients were greater than 0.50, weighted kappa scores frequently classified agreement as "average" or "fair". This may be expected in that kappa measures the agreement in excess of what would be expected by chance, while the other measures are of any agreement. Similar disagreement in classification has been reported in FFQ validation studies previously (Masson et al. 2003).

We employed a past 7-day intake assessment, querying a large number of participants across the seasons of the year, as the basis for evaluating the performance of the usual intake FFQ. Our analysis rested on an assumption the assessed women's weekly samples would be random, and therefore representative of the population's intake in a given week of the year, which appeared to be a reasonable assumption based on comparability of participants by season of assessment. Strengths of the present study include its large sample size, seven days of recalled diet, and use of multiple statistical measures of agreement. Additionally, the separate examination of year-round and seasonal foods and the distribution of interviews throughout the calendar year are strengths of the study, as seasonality significantly influences dietary intake patterns in this population. Limitations relate to the use of a method that is not considered a gold-standard for assessing recent diet, including the assessment of recent and usual diet on the same occasion, the use of a single 7-day recall period rather than multiple 24-hour recalls, and the use of a set food list rather than an open-ended recall to measure recent diet.

This study describes a promising direction in dietary assessment in rural low and middle income country settings where diet is subject to seasonal variation, and demonstrates the viability of an interviewer-administered FFQ to assess diet in this type of setting. In particular, usual consumption of seasonally available foods can be estimated for the purpose of ranking individuals with a single-administration questionnaire, provided the food is consumed with non-zero frequency in a large portion of the population. Additional research is warranted to further improve upon this FFQ method, especially to adapt it to settings of low dietary diversity. For studies where infrequently consumed micronutrient-rich foods are of particular interest, further investigation is needed to determine the best method for assessing consumption patterns of those foods.

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