Validity and Reproducibility of a Semi-Quantitative Food Frequency Questionnaire Adapted to an Israeli Population

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Abstract: Assessment of individual representative dietary practices in epidemiologic research has long been a challenge. Given the differences in eating habits and availability of foods between populations, a study was set to test the reproducibility and validity of an Israeli-adapted semi-quantitative food frequency questionnaire (SFFQ) used in case-control studies of cancer etiology.

Two hundred volunteers between the ages 22-60 were randomly assigned to either complete an SFFQ independently or by nutritionist interview. Participants were then asked to fill out a 3-day food record (FR). SSFQ was repeated 3 months later. Reliability of the repeated SSFQ was examined using Pearson correlations; paired t-tests and Mann-Whitney Rank Test were used to measure reliability and validity of the SFFQ.

Overall, there was >85% agreement ± 1 category between the two encounters in over 75% of the food items. Percent of calories from proteins, fats and carbohydrates were similar for both self-administered and interviewed groups. The majority of correlations between the 1st and 2nd SSFQs for the micronutrients were above 0.75. No differences were noted in percent energy from proteins, fats or carbohydrates between self-administered and interviewer-assisted SSFQ and FR.

The Israeli FFQ was found in our study to be highly reproducible and valid compared to a dietary record.

Keywords: Food frequency questionnaire, reliability, validity, Israel.

INTRODUCTION

Assessment of individual representative dietary practices in epidemiologic research has long been a challenge [1-3]. The semi-quantitative food frequency questionnaire (SFFQ), developed by Willet *et al*. for the Nurses Health Study [4], has been validated for use in various populations [5-7]. However it cannot be assumed that the same tool will be valid in an Israeli population, given the differences in eating habits and availability of foods. A strict translation of the questionnaire is insufficient – many foods commonly consumed in Israel are not included in the questionnaire and vice versa; therefore an effort was made to adapt and validate the SFFQ for use in Israel. The questionnaire was translated into Hebrew and adapted to reflect the foods available and consumed in Israel. As there is no true "gold standard" for nutritional assessment for epidemiological studies, validation is attempted by comparing one method against another that is thought to be more accurate in clinical service [7-10]. The questionnaire was further used by us in our case-control studies of colorectal cancer etiology (MECC) and breast cancer etiology (BCA) in Israel.

The purpose of this study was to test the reproducibility of the Israeli-adapted SFFQ and its validity when compared to a 3-day food record, both in terms of nutrient components and for specific food items.

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MATERIALS AND METHODOLOGY

Study Population

The study population consisted of 200 volunteers between the ages 22-60 who were randomly assigned to one of two groups. One group completed the SSFQ independently after a 10-minute explanation by a trained nutritionist who was available for questions while they filled out the form. Upon completion the nutritionist reviewed the form with the participant to ensure completeness. In the second group the SFFQ was completed by interview by the same nutritionist. All participants were then asked to fill out a 3-day food record and were given instructions to record all food and beverage intake. SSFQ was repeated 3 months later, self-administered or by interview, according to the original group allocation (Fig. **1**).

Excluded were pregnant or breastfeeding women, new immigrants less than a year in the country, people unable to read and write in Hebrew and persons with serious illnesses before or diagnosed during the 3-month study period. Also excluded were persons who did not complete all three parts of the study. New volunteers were recruited to replace the dropouts until the goal of 200 subjects was reached.

Dietary Methods

Two methods of dietary evaluation were employed in this study: The semi-quantitative food frequency questionnaire (SFFQ) and a 3-day food record (FR).

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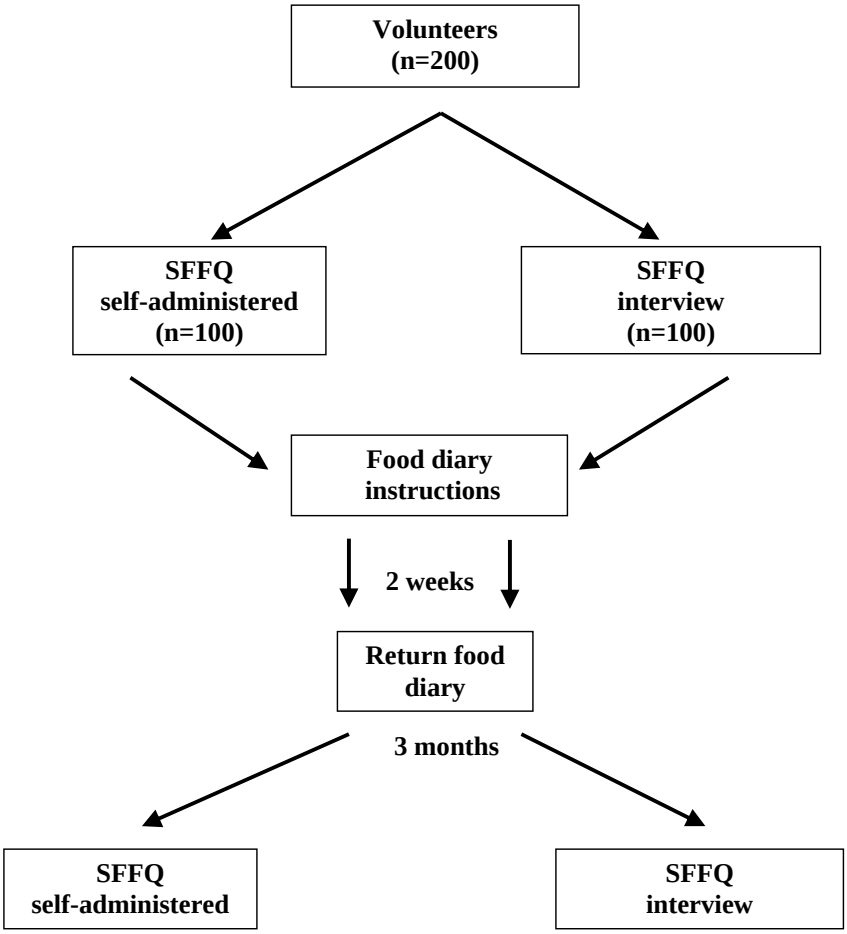

Fig. (1). The design scheme of the study.

Table 1. Correlation of Percent Calories from Protein, Fat and Carbohydrates Between SFFQ1 and SFFQ2, by Completion Method

Nutritional Component	Interview (n=100) Pearson r[1]	Self-administered (n=100) Pearson r[1]	Total Sample (n=200) Pearson r[1]
Protein	0.78	0.77	0.77
Fat	0.75	0.66	0.71
Carbohydrates	0.80	0.68	0.74

[1]Pearson correlations, all p<0.0001.

1) The **SFFQ** consisted of 168 food items with portion sizes designated for each item. Frequency of consumption for each item was recorded into one of 9 pre-coded categories: 0 or <1 time/month, 1-3 times/month, 1/week, 2-4/week, 5-6/week, 1/day, 2-3/day, 4-5/day, 6+/day.

2) All participants were asked to keep a 3-day food record **(FR)** and to record all food, drink and vitamin consumption immediately after eating and to include the hour, the quantity consumed and method of preparation.

Data Analysis

All dietary analyses (SSFQ and FR) were done using an Israeli nutritional database established at the Department of Clinical Nutrition at Rambam Medical Center. The database provided data on overall caloric intake, proteins, carbohydrates and fats in addition to 33 nutritional components. Results from this database, along with demographic data were analyzed using SPSS. Reliability of the repeated SFFQ's was examined using Pearson correlations and paired t-tests. Comparisons between the two methods of completion were done using t-tests and Mann-Whitney Rank Test. Validity of the SSFQ against the FR was done using t-tests and Pearson correlations. For all tests, the level of significance used was $p \leq 0.05$.

RESULTS

a. Reliability-Reproducibility

Each item on the SFFQ was compared for consistency between the 1st and 2nd times of completion. Overall, there was >85% agreement ± 1 category in over 75% of the food

Table 2. Correlation Between SFFQ1 and SFFQ2 for all Nutritional Components, by Completion Method

Nutritional Component	Interview (n=100) Pearson r[1]	Self-administered (n=100) Pearson r[1]	Total Sample (n=200) Pearson r[1]
energy (kcal)	0.79	0.81	0.80
protein (g)	0.80	0.80	0.80
fat (g)	0.73	0.83	0.79
saturated fat (g)	0.68	0.81	0.76
monounsaturated fat (g)	0.81	0.84	0.83
polyunsaturated fat (g)	0.78	0.80	0.79
carbohydrates (g)	0.81	0.78	0.79
fiber (g)	0.84	0.82	0.83
cholesterol (mg)	0.85	0.80	0.82
water (g)	0.86	0.83	0.84
calcium (mg)	0.86	0.77	0.82
iron (mg)	0.72	0.78	0.75
magnesium (mg)	0.82	0.78	0.80
phosphorus (mg)	0.77	0.81	0.79
potassium (mg)	0.83	0.84	0.83
sodium (mg)	0.84	0.79	0.81
zinc (mg)	0.73	0.82	0.78
copper (mg)	0.72	0.80	0.76
manganese (mg)	0.78	0.80	0.79
vit C (mg)	0.85	0.81	0.83
vit B1 (mg)	0.81	0.76	0.78
vit B2 (mg)	0.78	0.82	0.80
niacin (mg)	0.76	0.79	0.77
pantothenic acid (mg)	0.76	0.83	0.79
vit B6 (mg)	0.77	0.76	0.77
folic acid (mcg)	0.73	0.78	0.76
vit B12 (mcg)	0.69	0.89	0.82
vit A (mcg)	0.56	0.79	0.69
carotene (IU)	0.79	0.80	0.79
retinol (IU)	0.58	0.50	0.51
biotin (mcg)	0.58	0.75	0.68
vit E (IU)	0.78	0.86	0.83
vit D (mcg)	0.78	0.86	0.85

[1]Pearson correlations, all $p<0.0001$.

items, i.e. the person gave the same answer, ± 1 category, both times. Percent of calories from proteins, fats and carbohydrates were similar for both self-administered and interviewed groups (Table **1**). The majority of correlations between the 1st and 2nd SSFQs for the micronutrients were above 0.75 for the whole sample and within each method of completion (Table **2**). Paired t-tests were performed to compare the differences in the actual values obtained from the two SSFQs. Significant differences were found only for cholesterol and water in the total sample, for fiber and water within the interviewed group and for protein, cholesterol, zinc and niacin in the self-administered group (Table **3**).

The mean difference in total calories, grams of fats, proteins and carbohydrates, between the 1st and 2nd SSFQ, was calculated and compared between the interviewed and self-administered group. Mean differences were significantly smaller in the interviewed group for the four categories tested (Table **4**).

b. Validity

Two comparisons were made: one of self-administered FFQ compared to interviewer-assisted FFQ, and the second, of FFQ compared to FR.

Table 3. Comparison of Mean (SD) Consumption Between SFFQ1 and SFFQ2, by Completion Method

Nutritional Components	Interview (n=100)			Self-administered (n=100)			Total Sample (n=200)		
	SFFQ1	SFFQ2	Sig.	SFFQ1	SFFQ2	Sig.	SFFQ1	SFFQ2	Sig.
protein (g)	76.1 (26.83)	76.9 (29.18)	0.64	79.1 (34.83)	74.7 (34.02)	0.05	77.6 (31.05)	75.8 (31.63)	0.21
fiber (g)	11.7 (6.26)	10.9 (5.73)	0.04	11.9 (6.29)	12.1 (7.85)	0.78	11.8 (6.26)	11.5 (6.88)	0.26
cholesterol (mg)	227.8 (119.91)	224.1 (110.59)	0.61	231.0 (150.26)	209.5 (143.40)	0.01	229.4 (135.60)	216.8 (127.9)	0.02
water (g)	2339.3 (700.55)	2253.3 (684.73)	0.03	2262.2 (897.37)	2158.9 (873.30)	0.07	2300.7 (803.90)	2206.1 (784.16)	0.01
zinc (mg)	6.1 (2.65)	6.1 (2.86)	0.82	6.2 (3.13)	5.8 (3.00)	0.05	6.1 (2.89)	6.0 (2.93)	0.22
niacin (mg)	23.7 (8.89)	24.0 (9.67)	0.65	25.5 (11.72)	23.7 (11.48)	0.03	24.6 (10.41)	23.9 (10.59)	0.15

None of the 27 other nutritional components had significant differences in mean consumption.

Table 4. Mean Difference (SD) Between SFFQ1 and SFFQ2 Between Completion Methods

Nutritional Components	Interview (n=100)			Self-administered (n=100)			
	SFFQ1	SFFQ2	Mean Difference (SD)	SFFQ1	SFFQ2	Mean Difference (SD)	Sig. *
energy (kcal)	1798.5 (612.85)	1790.7 (717.25)	260.1 (361.89)	1858.7 (814.78)	1802.45 (884.21)	360.0 (364.08)	**0.01**
protein (g)	76.1 (26.83)	76.9 (29.18)	11.5 (12.78)	79.1 (34.83)	74.7 (34.02)	16.0 (15.62)	**0.02**
fat (g)	64.6 (24.09)	64.6 (28.00)	11.4 (15.38)	64.4 (33.11)	63.1 (35.41)	14.0 (13.58)	0.08
carbohydrates (g)	229.7 (87.43)	227.00 (101.04)	36.8 (50.11)	241.6 (112.92)	235.5 (123.30)	52.5 (58.62)	**0.03**

*comparison of mean differences.

No differences were noted in percent energy from proteins, fats or carbohydrates, between self-administered FFQ, interviewer-assisted FFQ and FR (Table **5**). The correlation for percent energy from proteins was the highest and for percent from fats the lowest. Correlation coefficients for total energy, fibers, fats and types of fatty acids (SFA, MUFA, PUFA) as well as proteins and carbohydrates consumed were significant and ranged between 0.54 and 0.29. Interviewer-assisted FFQs were better correlated with FR than self-administered FFQs for all items other than fats and the different fatty acids (Table **6**).

DISCUSSION AND CONCLUSION

The Israeli food frequency questionnaire was found in our study to be highly reproducible and valid compared to a dietary record. Repeated measures of reported consumption of food items and their contribution to total caloric intake and to distribution of the source of calories yielded very close results, both for interviewer-assisted and for self-administered FFQs, with a small advantage to the former. Significant correlations were found between both FFQ methods and the food record method. These correlations were far from being full, though this is reasonable as the two

Table 5. Correlation of Percent Calories from Protein, Fat and Carbohydrates Between SFFQ1 and FR by Completion Method

Nutritional Component	Interview (n=100) Pearson r[1]	Self-administered (n=100) Pearson r[1]	Total Sample (n=200) Pearson r[1]
Protein	0.54***	0.42***	0.46***
Fat	0.29*	0.32**	0.31***
Carbohydrates	0.35**	0.33**	0.35***

[1]Pearson correlations * p<0.01 ** p<0.001 *** p<0.0001.

Table 6. Correlation of Percent Calories from Protein, Fat and Carbohydrates Between SFFQ1 and FR by Completion Method

Nutritional Component	Interview (n=100) Pearson r[1]	Self-administered (n=100) Pearson r[1]	Total Sample (n=200) Pearson r[1]
energy (kcal)	0.42	0.36	0.39
protein (g)	0.47	0.46	0.46
fat (g)	0.38	0.44	0.41
saturated fat (g)	0.30	0.45	0.39
monounsaturated fat (g)	0.47	0.54	0.49
polyunsaturated fat (g)	0.34	0.41	0.38
carbohydrates (g)	0.45	0.29	0.37
fiber (g)	0.54	0.36	0.45

[1]Pearson correlations, all $p<0.01$.

methods serve different purposes; one estimating current consumption and the second measuring usual consumption taking into account a long time period and seasonality.

Overall the average correlation was 0.78, which is comparable, and even superior, to those found in many other studies [4, 12-19] (Table **7**). One potential explanation for the higher correlations observed in the present study is that the interval between FFQs was only 3 months in this study design compared to longer intervals in other studies.

Recently, others have criticized FFQs in epidemiologic studies for a variety of reasons, including poor correspondence between energy intake estimated from FFQs compared to energy intake measured from doubly labeled water, and the failure to detect meaningful dietary associations that are clearly appreciated from dietary biomarkers when using FFQs [20]. Indeed, some have argued that the correspondence between FFQs and dietary records may reflect correlated errors. However, the correlations that are observed in the present study are higher than most, and retinol is the only nutritional component measured with a correlation less than 0.75 (0.50 for retinol) among the values calculated in this study.

The strength of the current study is that the correlations reported here are not adjusted for total energy intake, which

Table 7. Description of 7 Methodologic Studies of Repeated Food Frequency Questionnaires

Source	Population	FFQ design	Interval between FFQs	Average (and range) of Correlations
Willett (4)	Registered nurses (n=150)	116 items	3 years	0.53 (0.44-0.62)
Pietinen (12)	Finnish men (n=121)	276 items	6 months	0.66 (0.56-0.73)
Engle (13)	US Adults (n=50)	120 items	1 month	0.6 (0.53-0.75)
Munger (14)	US older women (n=44)	129 items	5 mo - 2.5 yr	0.65 (0.4-0.87)
Mannisto (15)	Finnish women (n=152)	110 items	3 months	0.68 (0.49-0.81)
Bohlscheid-Thomas (16)	German adults (n=104)	158 items	6 months	0.63 (0.37-0.69)
Keller (17)	Canadian seniors (n=256)	17 items	2 weeks	0.83 -
Laviolle (18)	French adults (n=20)	14 items	15 days	0.81 (0.71-0.93)
Roddam (19)	Million Women Study, UK (n=12,221)	87 items	Up to 2 years	0.50* (0.21-0.81)
Itzhaki	Israeli adults (n=200)	178 items	3 months	0.76 (0.56-0.86)

*Kappa.

tends to inflate correlations. Although the multiplicity of reasons for the high correlations observed in the present study are not entirely clear, we suspect that these results are specific to the Israeli diet and the FFQ adaptation used to measure it. The Israeli diet is rich in vegetables, fruits, grains, and dairy products, the use of which might carry a clearer and repeatable pattern of consumption and which might be easier to quantify than complex dishes.

The evaluated questionnaire, thus, seems suitable for use in epidemiological studies in Israel designed to study the role of overall nutrition and nutritional factors as risk determinants of chronic diseases. Although some have argued that FFQs have outlived their utility in epidemiologic studies, the data in the present study suggest that within specific cultural and dietary contexts, FFQs are still potentially valuable tools in the epidemiologic arsenal.

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