Validation of a simplified food frequency questionnaire for the assessment of dietary habits in Iranian adults: Isfahan Healthy Heart Program, Iran

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Original Article

Abstract

BACKGROUND: Dietary assessment is the first step of dietary modification in community-based interventional programs. This study was performed to validate a simple food frequency questionnaire (SFFQ) for assessment of selected food items in epidemiological studies with a large sample size as well as community trails.

METHODS: This validation study was carried out on 264 healthy adults aged ≥ 41 years old living in 3 district central of Iran, including Isfahan, Najafabad, and Arak. Selected food intakes were assessed using a 48-item food frequency questionnaire (FFQ). The FFQ was interviewer-administered, which was completed twice; at the beginning of the study and 2 weeks thereafter. The validity of this SFFQ was examined compared to estimated amount by single 24 h dietary recall and 2 days dietary record. Validation of the FFQ was determined using Spearman correlation coefficients between daily frequency consumption of food groups as assessed by the FFQ and the qualitative amount of daily food groups intake accessed by dietary reference method was applied to evaluate validity. Intraclass correlation coefficients (ICC) were used to determine the reproducibility.

RESULTS: Spearman correlation coefficient between the estimated amount of food groups intake by examined and reference methods ranged from 0.105 (P = 0.378) in pickles to 0.48 (P < 0.001) in plant protein. ICC for reproducibility of FFQ were between 0.47-0.69 in different food groups (P < 0.001).

CONCLUSION: The designed SFFQ has a good relative validity and reproducibility for assessment of selected food groups intake. Thus, it can serve as a valid tool in epidemiological studies and clinical trial with large participants.

Keywords: Validity, Reliability, Food Frequency Questionnaire, Dietary Intake, Food

Date of submission: 30 Aug 2014, ***Date of acceptance:*** 8 Jan 2015

Introduction

Non-communicable diseases (NCD), including cardiovascular diseases (CVD) and cancers are the principal causes of mortality in Iran along with worldwide.[1,2] Dietary behaviors have a main effect in the CVD risk, and prevention.[3] Thus, nutrition assessment is the first step of dietary modification in community-based interventional programs.[4] However, the biggest challenge in nutrition epidemiological studies is the inaccuracy of dietary information assessed by using various dietary assessment methods.[4] Some dietary assessment methods need several recalls, which are time and cost consuming, much human resources demanding and have high recall bias, which makes them inappropriate in a large population.[4] Thus, development of the alternative method to avoid subject fatigue and use feasible dietary assessment method is the essential components in population-based studies.[5]

Food frequency questionnaire (FFQ) is a simple, inexpensive, quick completion with low recall bias for applying in a large population surveys.[4] FFQs provide the information about the frequency and sometimes the portion size of a defined food items list.[6] This method measures usual intake over a middle or long-term period and monitors usual dietary behaviors.[7] In addition, the FFQ can rank persons according to their food intake, which is usually sufficient for the purposes in health survey.[8]

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However, reducing the food items in FFQ makes it more practicable.[6] Therefore, using a simple FFQ (SFFQ) without specific portion is another approach to have more feasibility particularly for nutritional epidemiologic studies in a large population and community trials, which could reduce the burden on respondents.[9] Previously, SFFQ was validated to use in nutrition survey in other societies.[9] However, FFQs should be adapted for each study population according to their dietary patterns and culture.[10]

Although some studies validated different FFQs for various objectives in Iranian population, in best of our knowledge there is no validated SFFQ in Iranian population.[11,12] Therefore, we required a SFFQ to assess dietary pattern and nutrition improvement in large samples. This study was performed to validate a SFFQ for using in epidemiological studies and community trails with a large population.

Materials and Methods

Subjects were recruited from the participants of the Isfahan Cohort Study, Iran, who had been selected through cluster random sampling among adult population aged ≥ 35 years in Isfahan, Najafabad and Arak, Iran, district in 2001.[13] They were followed 2 years apart for cardiovascular events assessment by telephone interview. In addition repeated measurements including behavioral, biochemical and physical characteristics were carried out in the subject who had not any events in 2007.[14] Among them 300 healthy volunteer aged ≥ 41 years who accepted to complete second FFQ after 2 weeks included in the current validation study. They were included if they were non-diabetic and had no history of CVD, hypercholesterolemia, renal, thyroid, hematological, or mental diseases. Those on special diets and pregnant or lactating women were excluded. Excluding all the under- and over-reporting of dietary intake (daily energy intake < 800 or > 5000 Kcal), our sample size of n = 264 was selected from this subsample.

The FFQ was completed twice; at the beginning of the study and 2 weeks thereafter. The total number of samples studied was 300. The initial FFQ was accompanied by a demographic questionnaire and a 24 h diet recall, which were administered by trained dietitian. The respondents or one of their family members were also trained to complete two self-reported diet records in the same week. The study protocol was approved by the research council of the Isfahan Cardiovascular Research Center (ICRC).

Detailed home interviews were carried out by trained health professionals at study baseline to obtain required information about participants' general characteristics, including socioeconomic and demographic characteristics as well as data on dietary behaviors, smoking and physical activity status.[15,16] Physical activity was assessed by means of a validated Baeck physical activity questionnaire. A trained interviewer measured standing height without shoes and recorded to the nearest 0.5 cm at the baseline visit. Body weight was measured with the subjects wearing light clothes, without shoes and recorded to the nearest 0.5 kg. Body mass index (BMI) was calculated as body weight (kg)/height (m^2).

A 48-item FFQ was designed based on the nutrition questionnaire of Countrywide Integrated Non-communicable Disease Intervention program to assess usual food intakes contributing in prevention or occurrence of CVD and relevant risk factors. Face and content validity of the questionnaire were assessed by an expert panel, consisting of five nutritionists. The FFQ was tested in pilot for clarity and comprehensiveness among 30 adults who were not entered in the main study participants and had the same characteristics to study population.

Participants reported their frequency consumption of several food items over the last preceding year on a daily, weekly or monthly basis in an open-ended format. Subjects were also requested to choose the "never/seldom" response if they never consumed a given food item. The reported frequency of each food item was converted into a daily consumption. Seldom and never were calculated as "zero."

All participants also completed a single 24 h recall and 2 food records for 3 non-consecutive days, including 2 weeks days and 1 weekend during a week. We used two dietary assessment methods as the gold standard, because completing three 24 h dietary recalls were difficult. Hence, a single 24 h recall was completed by interviewing to train participants for self-reporting 2 dietary records.

In the case of mixed dishes, to estimate the serving size of each person, the total amount of cooked food as well as the number of persons who consumed it was collected and the amount of the food intake for each person was then calculated. The participants were asked to complete two self-reported food records. If he/she was illiterate and was not able to complete the questionnaire, a family member was requested and trained to do it. The samples were followed by phone to verify and complete self-reported food records. First trained

nutritionists rechecked and grouped the food items into the same 13 groups in both SFFQ and dietary reference method, which were presented in table 1. Then, they entered the data including the frequency (time/week) consumption of foods groups based on the SFFQ and reference method, as well as the quantitative amount of food groups, intake based on dietary reference method. To estimate quantitative amount of foods intake, gram weights of food intakes were determined based on the previously established weights of the measure.[17] Food groups extracted from reference dietary assessment method were similar to FFQ item.

The data were analyzed using SPSS for Windows (version 11.5, SPSS Inc., Chicago, IL, USA).The distributions of dietary intake values were examined for normality by the Kolmogorov–Smirnov test. All foods were non-normally distributed; therefore, non-parametric tests were performed. Validation of the FFQ was determined using Spearman correlation coefficients between daily frequency consumption of food groups, which assessed by the FFQ and the qualitative amount of daily food groups intake accessed by dietary reference method. Participants were divided into four groups based on frequency consumption of food groups assessed by the FFQs or dietary reference method. Then, the frequencies of subjects in the same, adjacent, one quartile apart and opposite quartiles of 2 dietary assessment methods were estimated. Intraclass correlation coefficients (ICC) were used to determine the reproducibility of 2 FFQs. $P < 0.05$ was considered as significant.

Results

The study sample was consisted of 264 subjects including 127 males and 137 females. Table 2 shows the baseline characteristic including mean of age, BMI and total daily physical activity as well as frequency of ever smoker, educational level and urbanization in total participants.

Table 3 shows Spearman's rank correlation coefficients between frequency of various food groups derived from SFFQ compared to the qualitative amount of those from the reference method based on genders. The significant Spearman's rank correlation coefficients ranged from 0.239 in beverages ($P = 0.046$) to 0.480 in plant protein ($P < 0.001$). The Spearman's rank correlation coefficients were no significant for pickles, sweets, grains and animal fat in the total population. There were significant Spearman's rank correlation coefficients varied from 0.253 for beverages ($P = 0.042$) to 0.473 for plant protein ($P < 0.001$) in male and 0.278 for animal protein ($P = 0.009$) to 0.491 for plant protein ($P < 0.001$) in females. The Spearman's rank correlation coefficients were no significant for pickles, sweets, grains and animal fat in male and for pickles, sweets, grains, animal fat and beverages in female (Table 3).

Table 4 illustrates that the reliability of the SFFQ was between [ICC (95% confidence interval) = 0.47 (0.25-0.70)] for grain and [ICC (95% CI) = 0.69 (0.48-0.85)] for dairy products in total population, [ICC (95% CI) = 0.47 (0.26-0.69)] for grain and [ICC (95% CI) = 0.68 (0.48-0.92)] for non-HVO in male and [ICC (95% CI) = 0.45 (0.32-0.59)] for beverages and [ICC (95% CI) = 0.69 (0.47-0.91)] for HVO in female.

The cross-classification frequency consumption of food groups between the SFFQ and the reference method revealed that from 28% (pickles) to 50% (nuts) of participants were classified in the same quartile of two methods, from 3 % (dairy products) to 13% (grain) categorized in the opposite quartile (Table 5).

Table 1. Studied food and food groups in the validation study

Hydrogenated vegetable oils	Hydrogenated vegetable oil, hard margarine
Non-hydrogenated vegetable oils	Non- hydrogenated vegetable oil, olive oil and soft margarine
Animal fats	Ghee, butter, cream, visceral fat and liver, kidney, heart and other organ meats
Fast foods	Frankfurter, sausages, hamburger , pizza and canned food
Animal proteins	Red meat, poultry, fish and egg
Plant proteins	Lentil, pea, bean, mung pea and soy protein
Fruits and vegetables	fruits, fresh fruit juices, raw, cooked and dried vegetables
Grains	Bread, rice and potato
Dairy products	Cheese, low and whole fat milk and yogurt
Sweets	Sweet, chocolate, biscuit, cake, cookie and jam
Nuts	Walnut, almond, hazelnut, pistachio and seeds
Beverages	Coke, diet coke, canned fruits and industrial fruit juices
Pickles	Sour and salty pickles

Table 2. Baseline characteristics of study population based on gender

Characteristic	Mean ± SD	n (%)
Age (year)	55.3 ± 9.6	
BMI (kg/m^2)	26.8 ± 3.7	
Daily physical activity (METs minute/day)	1133.1 ± 548.9	
Ever smoker [n (%)]		41 (15.5)
Education [n (%)]		
Illiterate		45 (17.0)
Primary school		118 (45.0)
> Primary school		101 (38.0)
Urbanization		224 (85.0)

SD: Standard division; BMI: Body mass index; MET: Metabolic equivalents

Table 3. Spearman's rank correlation coefficients between frequency of food consumption accessed by simplified food frequency questionnaire and quantitative amount of food intake assessed by mean of single 24 h recall and two food records based on gender

	Male		Female		Total	
	Spearman's correlation coefficients	P	Spearman's correlation coefficients	P	Spearman's correlation coefficients	P
HVO	0.324	< 0.001	0.346	< 0.001	0.352	< 0.001
Non-HVO	0.315	< 0.007	0.322	0.006	0.319	0.008
Animal fat	0.192	0.231	0.116	0.314	0.205	0.211
Animal protein	0.308	0.008	0.278	0.009	0.294	0.007
Dairy products	0.457	< 0.001	0.467	< 0.001	0.467	< 0.001
Plant protein	0.473	< 0.001	0.491	< 0.001	0.480	< 0.001
Grains	0.183	0.227	0.127	0.270	0.226	0.134
Nuts	0.465	< 0.001	0.479	< 0.001	0.468	< 0.001
Fruits and vegetables	0.328	0.006	0.315	0.009	0.338	< 0.001
Fast foods	0.334	0.005	0.319	0.007	0.326	0.003
Sweets	0.108	0.315	0.097	0.441	0.113	0.174
Beverages	0.253	0.042	0.108	0.416	0.239	0.046
Pickles	0.091	0.433	0.084	0.508	0.105	0.378

HVO: Hydrogenated vegetable oil

Table 4. Reproducibility of the simplified food frequency questionnaire for foods/food based on gender

Food/food groups (time/day)	ICC (95% CI)		
	Male	Female	Total
HVO	0.64 (0.42-0.85)	0.69 (0.47-0.91)	0.66 (0.44-0.89)
Non-HVO	0.68 (0.48-0.92)	0.67 (0.46-0.90)	0.67 (0.45-0.91)
Animal fat	0.53 (0.34-0.71)	0.57 (0.35-0.73)	0.59 (0.36-0.75)
Animal protein	0.61 (0.46-0.79)	0.63 (0.47-0.79)	0.67 (0.49-0.83)
Dairy products	0.65 (0.48-0.83)	0.68 (0.45-0.84)	0.69 (0.48-0.85)
Plant protein	0.56 (0.34-0.72)	0.59 (0.36-0.75)	0.61 (0.39-0.78)
Grains	0.47 (0.26-0.69)	0.46 (0.22-0.66)	0.47 (0.25-0.70)
Nuts	0.64 (0.40-0.89)	0.65 (0.39-0.92)	0.67 (0.40-0.93)
Fruits and vegetables	0.52 (0.29-0.76)	0.58 (0.31-0.79)	0.51 (0.28-0.74)
Fast foods	0.65 (0.42-0.88)	0.62 (0.40-0.85)	0.64 (0.41-0.86)
Sweets	0.55 (0.32-0.76)	0.60 (0.34-0.87)	0.59 (0.34-0.88)
Beverages	0.48 (0.31-0.64)	0.45 (0.32-0.59)	0.49 (0.36-0.63)
Pickles	0.59 (0.37-0.80)	0.63 (0.42-0.85)	0.61 (0.40-0.82)

ICC (95% CI): Intra class correlation coefficient (95% confidence interval); HVO: Hydrogenated vegetable oil

Table 5. Cross classification frequency consumption of food groups between the simplified food frequency questionnaire and the mean of single 24 h recall and 2 days dietary records

Food/food groups (time/day)	Same quartile	Adjacent quartile	One quartile apart	Opposite quartile
HVO	46	26	21	7
Non-HVO	48	31	16	5
Animal fat	29	35	26	10
Animal protein	42	36	16	6
Dairy products	49	37	11	3
Plant protein	47	38	11	4
Grains	32	32	23	13
Nuts	50	37	8	5
Fruits and vegetables	41	39	14	6
Fast foods	43	33	15	9
Sweets	35	41	18	6
Beverages	30	43	19	8
Pickles	28	39	24	9

HVO: Hydrogenated vegetable oil

Discussion

We assessed the validity of a SFFQ to estimate the habitual dietary pattern and its improvement in epidemiological studies or community trials with a large sample of Iranian adults as well as its ability to rank individuals based on their consumption of specific foods and food groups. This SFFQ was developed by comparing with one 24 h recall and 2 days diet record to evaluate food groups intake. In addition, we investigated the short-term reliability of the non-quantitative FFQ by comparing two FFQ over a 2 weeks period.

Our design was relatively the same as validation study a FFQ which was develop to assess food groups in New Zealand adolescents[18] and Huang et al.'s study which was carried out in Taiwanian elderly to evaluate validation of a SFFQ compared to 2 or 3 24 h recall for using in the Nutrition and Health Survey.[9] We found that the SFFQ, as short as 48-items, could provide good estimations of dietary intake frequency as measured dietary reference method. In the validation study, the correlation coefficients of food intake between examined and reference method should be ≥ 0.3, preferably more than 0.4 and optimally 0.5-0.7 [4,8]. Thus, a majority of the questions in this FFQ had an acceptable correlation and can be applied to rank individuals according to several important food intakes.

The relative validity for specific food groups including plant protein, dairy products and nuts was good and for HVO, non-HVO, fruits and vegetables and fast foods were reasonable in both genders. In addition, the validity of animal protein was acceptable in men and moderate in women. In contrast, validity for animal fat, sweets, beverages, and pickles were relatively poor in both genders. Huang et al.'s study reported the Spearman's rank correlation coefficients between SFFQ frequencies and weight of food intakes calculated from 24 h recall ranged from −0.291 for total grains to 0.620 for dairy products in males and −0.014 for whole grains to 0.812 for dairy products for females.[9]

The validity of a FFQ which was performed to calculate the intake of specific food groups in Brazilian was high for dairy products and soy products; however, it was moderate for legumes and processed meat and poor for the meat group.[19] Another FFQ which was developed to assess food groups the consumption had optimal validity for fruits, vegetables and naturals juice.[20] The validity of a FFQ, which was develop in German population compared to two 24 h dietary recalls revealed a reasonable to good agreement in ranking of participants based on their intake for most food groups. The correlation coefficients ranged from 0.15 to 0.80.[21] In agreement to our findings sweets and biscuits, beverages and meat had low validity. The inconsistencies between the validity of different FFQ might be relevant to various reference methods, sample size, culture of the populations in different studies.[22] Disagreement might be seen mostly in food that is consumed seldom. Therefore, this issue may be solved by completing more recalls as a reference method.[4] Moreover, the differences between 24 h recall and FFQ are expected because the FFQ belongs to long-term memory, and the 24 h recall short-term memory.[8]

Consistent to our findings in Eysteinsdottir et al. study[23] the correlation coefficients of dairy product,

fruits and vegetables were higher than 0.3 in both genders, whereas it was no significant for soft drinks/sweetened juices. They used 3 days food record as a reference method, which was relatively like our study. In addition, the relative validity of FFQ against to 2 h recalls in Jackson et al.'s study varied from 0.27 to 0.56 and reliability in this study was good and correlation coefficients between 0.50-0.88.[24] SFFQ without reporting portion size leads to diminish the difficulty of participants. Furthermore using portion size does not improve the validity.[9] Pietinen et al.[25] and Wakai et al.[26] designed SFFQs which had reasonable validity to estimate food intake in Finnish and Japanese people, respectively.

It was noted that splitting the frequency consumption of foods with a narrow distribution of answers may improve the validity since the global questions lead to intake underestimation.[10] Thus, there was no overestimation in our results. Nonetheless most of the previous studies reported that an overestimation is a common concern in FFQ compared with other dietary assessment methods.[27,28] This inconsistency probably was due to using short lists of foods without portion size. Furthermore, the validity in food items consumed occasionally had a poor validity.[29]

According to the Fleiss's study that was reported the values from 0.40 to 0.75 of ICC as "fair to good,"[30] the short-term reliability of this SFFQ over a 2 weeks was reasonable. Our finding was in agreement with the results of Wong et al. in New Zealand that was carried out the reliability of a non-qualitative FFQ during the 2 weeks period.[18] The short-term period of study might be the reason of relatively higher reliability of this study.

Several studies have shown relatively good reliability of FFQ with different interval period. The reliability of FFQ administered about 2 years apart in the Shu et al.'s study ranged from 0.37 to 0.66 for food groups.[27] Zhang and Ho reported that the reproducibility of two FFQ administered in 1 year apart was between 0.30 and 0.68.[29] Hence, comparing to previous validation studies our findings show relatively good reproducibility for food groups.[28,31,32]

Moreover, one of the main objectives of diet-disease relation epidemiological studies is ranking the participants to the correct category. Thus, we examined the cross-classification of the SFFQ compared to reference method and it revealed that this SFFQ could classified the participants correctly with the mean percentage of participants assigned into the same quartile by the two methods was 40%, which was in lined with the finding of Zhang and Ho that was reported 43% for food groups.[29]

Conclusion

We concluded that the relative validity of the developed SFFQ compared to reference method and it's reproducibility were reasonably good in estimating food groups and satisfactory for evaluating the relationship of diet with risk of disease in both genders. In addition, it is applicable for ranking population based on food groups consumption and may be utilized in future population-based studies to assess dietary patterns of Iranian adults population as well as community trials, which evaluate the impact of nutrition intervention for NCD prevention.

Strengths and limitations

This study had several strengths including using interviewer-administered FFQ instead of self-administered which was improved the quality of data;[28] as participants were randomly selected sample, this study might have no selection bias, hence generalizability of these findings to all populations may be more possible; this study had ideal sample since previous studies suggested that between 100 and 200 should be used;[4] non-quantitative design and approximately short FFQ which make it is practical for administering in time-limited or population-based surveys with large sample size when the exact amount of food intakes are not reasonable.

However, there were several limitations in the design and validation of this SFFQ. Firstly, the reproducibility was examined in 2 weeks apart, which is a short period and might be overestimate the reliability. It is impossible to achieve an accurate estimate of nutrients intake by this SFFQ due to lack of portion size data and limited food items. Another consideration is that the 24 h recall and dietary records were collected within 1 week. Hence, it could not cover seasonal variation in food intake. In addition repeated 24 h recall monthly during a year is the ideal dietary reference method. However it was not feasible in our study, therefore we applied the minimum dietary recall or record that was possible.

Acknowledgments

This program was conducted by Isfahan Cardiovascular Research Center, a World Health Organization (WHO) Collaborating Center in collaboration with Isfahan Provincial Health Office, both affiliated to Isfahan University of Medical Sciences. We are thankful to collaborating teams in ICRC, Isfahan Provincial Health Office, Najaf-

Abad Health Office and Arak University of Medical Sciences.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Mohammadifard N, Sajjadi F, Maghroun M, Alikhasi H, Nilforoushzadeh F, Sarrafzadegan N. **Validation of a simplified food frequency questionnaire for the assessment of dietary habits in Iranian adults: Isfahan Healthy Heart Program, Iran.** ARYA Atheroscler 2015; 11(2): 139-46.