Development of a Food Frequency Questionnaire (FFQ) for an Elderly Population Based on a Population Survey[1]

Danit Shahar,[2] Drora Fraser,*† Iris Shai† and Hillel Vardi*

*The S. Daniel Abraham International Center for Health and Nutrition, Ben-Gurion University of the Negev, Beer-Sheva, Israel; *Epidemiology and Health Sciences Evaluation Department, Faculty for Health Sciences, Ben-Gurion University of the Negev, Beer-Sheva, Israel; and †Harvard School of Public Health, Boston, MA*

ABSTRACT Older people have different eating patterns than their younger counterparts, although in most nutritional studies of older populations, food frequency questionnaires (FFQ) that were developed and validated for the general adult population are used. In this paper, we present the advantages of developing an FFQ for an older population based on a population survey. A random sample of the Negev's (Southern Israel) Jewish population ≥ 35 y old was recruited and interviewed for their dietary intake using 24-h recalls. Foods eaten were aggregated into conceptually similar groups and entered into stepwise regression models to predict variation in nutrient intake. We interviewed 796 people age 35–64 y and 377 people ≥ 65 y old for the study. Significantly more items were required to reach 80% between-person variability for zinc, magnesium, vitamin E and protein for the elderly compared with the younger age group. Portion sizes of most items consumed by the elderly were smaller compared with the Israeli Ministry of Health portion sizes booklet and the younger age group's intake estimates. The nutrient values assigned for each line based on a weighted mean of the intake of the elderly were different from those using the most frequently used item. The above findings highlight some of the advantages of developing an FFQ for an older population based on a population survey. Further studies are required to compare the validity of existing tools adapted for the elderly to those developed on the basis of population surveys. J. Nutr. 133: 3625–3629, 2003.

KEY WORDS: • *food frequency questionnaire* • *between-person variation* • *elderly*

Older people have different eating patterns than their younger counterparts. Their eating characteristics include higher consumption frequency of ethnic foods, smaller portion sizes and a more organized, traditional three meals a day (1–4). These differences are important with regard to both nutritional aspects in the elderly and the appropriateness of assessment tools used in research.

A food frequency questionnaire (FFQ) is a common method used to assess individual long-term dietary intake of foods and nutrients. The questionnaires elicit a subjectively reported "usual frequency" of consuming an item from a list of foods (5). The process required to develop an FFQ is reported in detail in the Methods section. Clearly, such a process is laborious, time consuming and costly. Therefore, FFQ are being developed selectively and usually require a major national effort or coordinated task force. Subsequently, FFQ are validated using serial 24-h recalls, food records or biomarkers as the gold standard.

Several validation studies evaluating the use of standard FFQ in the elderly have demonstrated a satisfactory correlation between FFQ results and gold standard methods (6–9). However, most of these studies did not include a substantial number of people ≥ 75 y old. For example, the Iowa Women's Health Study used the Harvard FFQ, developed for 34- to 59-y-old women, after validation for use with women 55–69 y old. The results of the validation study revealed reasonable agreement between the FFQ and food records (10). Most nutritional studies of older populations use FFQ developed and validated in the general adult population, with minor adjustments in the administration protocol. The modifications include the use of interviewers and of portion-size models and pictures (6–8), whereas the list of foods and portion sizes remain similar for all age groups.

An alternative approach to the modification of a "general adult FFQ" is to utilize a method based on population data in selecting particular food items (11–17) for the older population. This involves data collection using measured food records or quantitative recalls from a representative sample (11–17). Issues in the development of an FFQ include composing the foods list, defining portion size and assigning nutrient values to each line item. In several major studies, including a few that were conducted in Israel (18), some of the values of the food groups (line) in the FFQ used were based on the item reported most frequently (W. Willett and L. Sampson, personal communication.). In surveyed populations, it is possible to base the assigned nutrient values on any of several parameters including means, medians, weighted means or me-

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[2] To whom correspondence should be addressed.
E-mail: Dshahar@bgumail.bgu.ac.il.

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dians of all foods aggregated for this line (12,15), or food items reported most frequently.

In this paper we present the advantages of developing an FFQ for an older population based on a nutritional survey and the procedures undertaken to assign nutritional values for the food lines.

SUBJECTS AND METHODS

Population. We randomly selected 377 community-dwelling participants ≥ 65 y old from the Negev to be included in the study, using a proportionate geographic cluster sampling method. This sample was part of the Negev Nutrition Study, which assessed dietary intake and eating patterns of the Negev population ≥ 35 y old. The sample surveyed included 1173 people.

Demographic characteristics were obtained using questions regarding age, place of birth, date of immigration and number of school years completed. BMI was calculated from reported weight and height. The study was approved by the Ben-Gurion University of the Negev's Ethics Committee and participants signed an informed consent upon entering the study.

Dietary assessment. The entire survey was described previously in detail (4,19). In brief, participants were interviewed at home regarding their dietary intake using an adapted multiple-pass USDA 24-h recall questionnaire with additional questions addressing health and eating habits (20,21). The questionnaire was translated into Hebrew and pretested by the Central Bureau of Statistics. The Nutrition Department of the Ministry of Health (Jerusalem) translated and modified the Food Instruction Booklet and developed a Weight Guide Booklet for the Israeli population (22). Data entry of the 24-h questionnaires was performed using a program conceptually similar to the Food Intake Analysis System (20). Israeli food products were added, codes were assigned according to the USDA coding system (21) and weight per volume was calculated for each product.

For the purpose of developing an FFQ, one 24-h recall was used for each participant in the analysis. A key element distinguishing development from validation is the use of single vs. multiple questionnaires. Validation requires minimal within-person variation, and therefore multiple questionnaires are required to eliminate the unexplained variation. Conversely, in the process of developing an FFQ, pooled data are used, obviating the need for repeated interviews.

Development of the food frequency questionnaire. The results of the survey were used to develop the FFQ using the following steps:

1. Conceptually similar foods were aggregated into groups on the basis of their fat and energy content per portion eaten. Fruits and vegetables were aggregated on the basis of their vitamins and minerals content per portion. Conceptually similar foods are food items sharing features of both nutritional content and manner of serving. For example, peaches and nectarines are conceptually similar foods in the sense that they have close nutrient content, are both served in the same manner and are both scored by item in the FFQ. Conversely, hot dogs and lunch meats are conceptually dissimilar foods despite their nearly identical nutrient content. Lunch meats are served by slice vs. hot dogs, which are served by unit.
2. Aggregated food items were examined for their range of fat and energy content per portion. Registered dietitians monitored the aggregation of items for outliers in each group. This quality control method was used to evaluate the aggregation process. In addition, the questionnaire was sent to 20 people (professional and lay persons) for further evaluation and feedback. The ease of administration was field tested in both groups and remarks were integrated into the questionnaire.
3. Using stepwise multiple regression analysis, food groups contributing to between-person variation were identified. Foods in the model that explained 80% of the between-person variability were considered for the final questionnaire. The procedure described was undertaken for 27 nutrients including energy, folic acid, calcium, vitamin E and dietary fiber. The number of food items required to explain 80% of the between-person variation was compared between the two age groups using χ^2 tests.

The final FFQ included 126 food items. Our goal to improve the quantification of food intakes led us to define three portion sizes (large, 75th percentile; medium, 50th percentile; and small, 25th percentile) of selected dishes. These were included in the questionnaire and, based on the nutritional survey, 15 picture sets were added to assess portion sizes of commonly eaten foods such as breads and rolls, rice and breakfast cereals.

Portion size calculation. For the purpose of evaluating the questionnaire, the mean portion size of each item included in the questionnaire was calculated. Each food item was assigned a portion size by dividing the total amount reported by the number of persons reporting the item. For example, 11,047 g of mixed beef dishes were eaten by 55 people, thus resulted in a portion of 146 g/person. The size of the portion was compared between the younger age group and standard portion sizes eaten by the Israeli population, as published by the Israeli Ministry of Health (22).

Nutritional values of aggregated items (line). Each aggregated food item was assigned a nutritional value on the basis of weighted means of all items included in the group (12,15). Different values were calculated for men and women as well as for the younger (35–64 y) and older (≥65 y) groups.

Statistical analysis. Statistical analyses were conducted using SPSS version 10 (Chicago, IL). The comparison between persons age 65–74 y and ≥75 y was performed using ANOVA for continuous

TABLE 1

Selected characteristics of the study population by age group and gender[1]

Age range, *y*	35–64		65–74		75+	
Variable	Men	Women	Men	Women	Men	Women
n	354	442	96	128	76	77
Age, *y*	51.5 ± 7.8	50.1 ± 7.7	68.8 ± 2.8	68.9 ± 2.7	79.9 ± 4.6	80.5 ± 4.7
BMI, kg/m^2	26.5 ± 4.2	26.9 ± 4.8	26.8 ± 4.1	28.1 ± 4.7	25.7 ± 3.8	26.6 ± 4.9
Marital status, %						
Married	89.2	78.5	87.5	44.2	65.0	16.7
Widowed	2.9	10.4	5.2	45.7	32.5	77.8
Single	3.2	1.9	2.1	1.6	0.0	4.2
Divorced	4.7	0.2	5.2	8.5	2.5	1.4
Education, %						
>12 y	42.7	39.3	41.2	27.6	33.3	25.0
<12 y	57.3	60.7	58.8	72.4	66.7	75.0

1 Values are means ± SD.

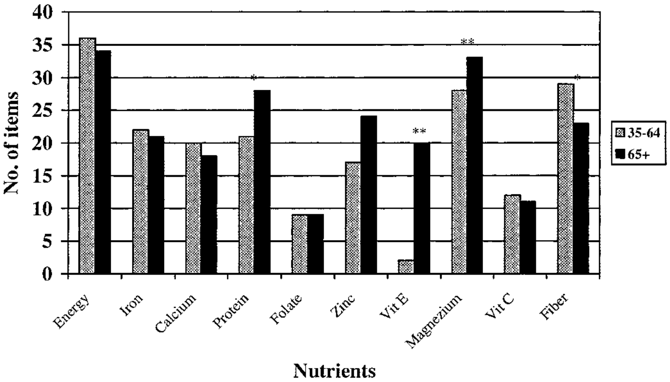

FIGURE 1 Number of foods explaining 80% (R^2 = 0.8) of the between-person variability based on the regression model for selected nutrients in the older group (age 65+ y) compared with the younger group (age 35–64 y). *Age groups differ, $P < 0.05$ and **$P < 0.01$ using χ^2 test.

variables and χ^2 for dichotomous variables. The assessment of the number of foods required to reach the level of 80% between-person variability was done using χ^2 test; portion sizes were compared using *t* test. Stepwise regression models were used to determine the list of foods to be included in the FFQ on the basis of the between-person variability added by each item.

RESULTS

The study group included 796 people age 35–64 y and 377 people ≥65 y (**Table 1**). The older group include 172 men and 205 women, 224 between age 65 and 74 y and 153 ≥ 75 y. The BMI was significantly lower among people ≥75 y old compared with people 65–74 y old. A higher percentage of men were married compared with the women.

The number of foods needed to reach the level of $R^2 = 0.8$ for selected nutrients was compared between the two age groups, 35–64 y and ≥65 y (**Fig. 1**). We chose to show 10 nutrients that were representative of various food groups and food sources. The highest number of foods was required to classify people by their energy in both age groups, 36 for age 35–64 y and 34 for people ≥ 65 y. In the case of folic acid, nine items were required to explain 80% of the between-person variation in both groups. For zinc ($P < 0.05$), magnesium ($P < 0.01$), protein ($P < 0.05$) and vitamin E ($P < 0.01$), higher numbers of items were required to reach the level of 80% between-person variability for the older group (χ^2 test was used). In the case of vitamin E, sunflower seeds contributed >70% of the between-person variability among the younger (35–64 y) age group, whereas for the older group (≥65 y), the list of items consisted of vegetable oils (28%), fried potatoes (6.5%), cookies (6%), sunflower seeds (5.5%), cooked tomatoes (3%), nuts (3%), baked fish (3%), bread (3%), fried chicken (2%), mixed beef dishes (2%), avocado (2%), pizza (2%), tomato sauce (2%), cooked vegetables (2%), falafel (2%), puffed pastry with filling (2%), cooked salads (2%), yams (1.5%), cooked fruits (1.5%) and French fries (1%).

Portions sizes of selected items, based on their calculated mean intake, were compared with standard general population portion sizes, as published in the Israeli Ministry of Health portion sizes booklet (21), and the younger participants of our survey (age 35–64 y) using a two-sided *t* test (**Table 2**). In general, for most food groups (109/126, 86%), the elderly consumed smaller portion sizes. We chose to present items that were eaten in various portions, as opposed to items eaten in standard portion sizes (one can of yogurt or one egg). The difference was calculated in relation to the reference group (standard portion or younger age group). The percentage difference between our portion sizes and the standard portion sizes for the Israeli population ranged from –3 to –60%. For one item (hard cheese), the portions eaten by our sample were larger (+31%). In comparing the two age groups who participated in the study, the range of difference was –14 to −53% for most items except vegetable salad for which portion size was somewhat larger among the elderly (+4%). The differences between the two age groups were also significant for cottage cheese ($P < 0.01$), hard cheese ($P < 0.05$), chicken with skin ($P < 0.05$), rice ($P < 0.01$) and potatoes ($P < 0.01$).

For selected food items, a comparison was made between the method of weighted means (15) based on the population survey and the method of using the most frequently used item by the older population (**Table 3**). As demonstrated in the table, differences in energy values per 100 g are shown mainly in mixed food items such as chicken, beef dishes, pizza and

TABLE 2

A comparison between the older (≥65 y) and younger (35–64 y) population's portion sizes and the general Israeli population and the percentage difference

	Negev Nutrition Survey			Israeli Ministry of Health[1]	
Age range, *y*	65+	35–64			
Food	Portion Size[2]	Portion size[2]	% Difference	Portion size	% Difference
	g			*g*	
Cottage cheese	28 ± 4.6	60 ± 57.6**	−53	40	−30
Hard cheese	38 ± 14.8	44 ± 27.9*	−14	29 (Slice)	31
Chicken with skin	77 ± 43.2	90 ± 53.4*	−14	130	−41
Beef mixed dishes	146 ± 90.5	197 ± 163.2	−26	150	−3
Rice	97 ± 63.6	123 ± 75.6**	−21	120	−19
Potatoes	83 ± 47.6	120 ± 92.0**	−31	150–210	−45 to −60
Vegetable salad	100 ± 43.8	96 ± 70.1	+4	125	−20

1 Based on the Israeli Ministry of Health portion size booklet (23).
2 Values are means ± SD. Different from younger age group, * $P < 0.05$; ** $P < 0.001$.

TABLE 3

Energy values based on a weighted mean of the intake among the elderly in the Negev Nutrition Survey (NNS) compared with the values of the most frequently eaten food[1,2]

Food	NNS		Most frequently used product	% Difference	
	Men	Women		Men	Women
	kcal/100 g product				
Cottage cheese	108 ± 58.3	105 ± 46.6	100	8	5
Margarine	748 ± 249.3	748 ± 234.3	756	−1	−1
Tuna salad	188 ± 132.6	160 ± 116.6	198	−5	−19
Pizza	344 ± 255.6	355 ± 194.0	258	33	37.6
Chicken, with skin	212 ± 113.2	209 ± 74.0	168	26	24
Beef mixed dishes	247 ± 146.4	223 ± 153.3	195	27	14
Internal organs	199 ± 108.0	187 ± 94.1	156	22	20
Fried fish	210 ± 152.8	228 ± 145.7	277	−24	−18
Beef	272 ± 112.7	245 ± 123.8	251	8	2

[1] Values are means ± SD, $n = 377$.
[2] To convert kcal/100 g to kJ/100 g, multiply by 4.184.

tuna salad. The items shown in Table 3 are for food groups composed of >10 individual food items.

Finally, the list of 126 foods included in the FFQ was assessed for the percentage of between-person variability explained by the model for selected nutrients among the younger and older group, e.g., energy, iron, zinc, vitamin E, calcium or folic acid. The list of foods included in the questionnaire explained >90% of the between-person variability for both age groups.

DISCUSSION

Although several survey-based tools for assessing nutritional intake in the elderly have been developed (12,15–17), many of these studies used FFQ developed for the general adult population and adapted them for the elderly (6–10). In the Iowa Women's Health Study, the Harvard FFQ was adapted and shown to be reasonably reproducible and accurate in epidemiologic studies of older women age 55–69 y (10). In the Netherlands (7) a 170-item semiquantitative FFQ was adapted for use for people age 55–75 y. In both studies, the size of the portions and the food composition database behind each item were the same as those for younger age groups. In the Seneca study (8), a dietary history questionnaire developed for younger age groups was used, although differences of 10–20% for most nutrients were shown compared with 3-d estimated records.

In our study, the list of foods and portion sizes were based on a population survey of the elderly. Naturally, one would not expect the total list of food to differ in the elderly because various foods overlap in their contribution to different nutrients. However, the food items chosen to represent the line and the portion sizes may be different in the old. The same approach was used by Block (12) and Subar (15). Block's questionnaire, for example, was based on a dietary survey of 11,658 respondents of the Second National Health and Nutrition Examination Survey and the portion sizes and the assigned nutrient values were age (6 age groups) and sex specific (12). Subar's questionnaire (Diet History Questionnaire) is an improvement of Block's, based on the Continuing Survey of Food Intakes by Individuals (23). A population survey set the stage for analyzing each food item by the specific dietary intake of the elderly and further specified for age groups and gender within a large group of people ≥65 y old. Like the above surveys (12,23), our survey included a group of people ≥75 y old (12% in our sample vs. 7% in the Negev population), allowing for the use of the FFQ for the very old as well.

The number of food items required to explain 80% of the between-person variability was approximately the same for most nutrients assessed. Surprisingly, a longer list of foods was required to reach the level of 80% between-person variability for vitamin E, magnesium, protein and zinc. Although two items explained >90% of the between-person variability for vitamin E for the younger age groups (these being assorted seeds, e.g., sunflower and vegetable oils), among the elderly, the list included 20 items. We feel that this striking difference regarding vitamin E variance contributors is related to the Israeli nutritional habit of consuming large amounts of assorted seeds. In the younger age group, which is better physically able to consume peanuts, sunflower seeds and the like, these become the major contributors to the between-person variability in vitamin E. Conversely, in the elderly, who are often edentulous, this variance has to be met from many sources. Less extreme were the differences in the number of foods included to reach the level of 80% between-person variability for zinc, magnesium and protein. We presume that these differences stem from the tendency of older people to eat more traditionally, thereby adhering to their ethnic eating habits. Although these patterns tend to be similar within each ethnic group, the differences between the groups themselves may be relatively high, as was shown in our previous study (24). In a multiethnic population, the elderly tend to continue consuming their native/ethnic foods, which demands the inclusion of more items in the questionnaire, despite decreased intake.

As we demonstrated, the mean portion sizes eaten by the older population were considerably smaller than those consumed by the general Israeli population, as well as the younger participants of our survey. Food portion size may affect overall dietary assessment and increase the risk for misclassification bias, with some people erroneously categorized as having high intake. In a few studies of the elderly population using FFQ, the sizes of the portions used were the same as for younger age group (6,7), thereby allowing a potential measurement error to occur. In other studies, efforts were made to use food models to improve accuracy (8) and/or three sizes were offered to the interviewee (12). We found differences in the mean portion sizes for chicken (77 g vs. 130 g), potatoes and rice, all of which were consumed in smaller portion sizes by the older population. Therefore, it seems that to classify the elderly according to their dietary exposure using an FFQ, an adjustment of portion sizes should be made according to population data.

Assigning each line nutritional values that are based on a weighted mean of the intake of the studied population, while taking into account the frequency and amount consumed, may also improve accuracy of classification (15). This method also takes into consideration the frequency and the amount of each food eaten by the population with the ability to separate values by gender and ethnic group, if appropriate. As indicated by our findings, nutritional values that are based on the weighted mean of all foods aggregated into a single line differed from the nutritional values of the most frequently used item, especially for items that are composites of several types of foods. For example, the item "beef mixed dishes" includes a composite of several kinds of beef dishes with varying nutrient content. As described by Subar et al. (15), this method of assigning nutrient values may improve FFQ by reducing the measurement error.

Our study has several limitations; first, although we tried to make our sample representative of the Negev's population, it may not be universally representative of elderly persons per se. Although with respect to the Negev population, we oversampled individuals $\geq$75 y old (12% in the sample vs. 7% in the population), this figure may still be low for "older elderly" populations. For example, when the entire population of the elderly in Israel is considered, ~50% of the elderly are >75 y old. A potential contributor to the relative underrepresentation of the elderly is their lack of ability to totally comply with the assessment. Another reason may be a higher rate of institutionalization in those $\geq$75 y old because the study was conducted solely in the general community. Additionally, our sample size was considerably smaller compared with samples used for developing FFQ in other countries (12,16,17). Thus the small sample size may predispose to a β-type error, namely, insufficient power for highlighting differences. Fortunately, in our survey, we were able to demonstrate significant differences in numerous variables. Therefore the β-type error may have manifest itself in those variables for which we did not demonstrate these findings, and therefore does not compromise the positive findings of the study.

The above findings highlight some of the difficulties encountered while assessing elderly nutritional intake using an FFQ. In light of these, it seems that the use of validated tools modified for the elderly could result in incomplete or only partially reliable assessments. Therefore, we propose the method of a population survey as the tool of choice for the development of an age-specific FFQ. Needless to say, only a validation study testing the performance of both FFQ (general vs. age-specific) will enable us to determine whether any of these improvements make an appreciable difference. Further research is warranted to help clarify the utility of such a method and its application among the elderly.

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