Usefulness of a short food frequency questionnaire for screening of low intake of fruit and vegetable and for intake of fat

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Background: Simple screening tools to identify intake of fruit, vegetables and fat are necessary to design effective public health intervention strategies in order to increase intake of fruit and vegetable and to reduce fat intake.

Methods: 108 men recorded their food intake for 14 days and filled in a 27-item food frequency questionnaire (FFQ) 1.5–2 months later. Estimates of fruit, vegetables and fat intake from the FFQ were compared with those from the weighed records. Results: Mean intake of vegetables and fruit estimated from the diet records increased with increasing categories for frequency of intake assessed by the FFQ. Spearman correlation coefficient between frequency of intake of vegetables and fruit from the FFQ and amount of these food items estimated from the weighed records was 0.46 and 0.66, respectively. The ability of the FFQ to predict those having inadequate intake of fruits and vegetables based on weighed record data, was more than 90%. Almost 95% who reported use of fat spreads by the FFQ also reported this by the records. The correlation coefficient between the amount of fat used on bread from the two methods was 0.79. The correlation between fat intake estimated from both methods was 0.36 and for saturated fat intake the correlation was 0.38. Conclusion: The FFQ could be used to screen for low consumers of fruit, vegetable and fat spread in intervention programmes. However, the ability of the FFQ to identify persons with high (or low) intake of fat and saturated fat was not good.

Keywords: epidemiology, fat, food questionnaire, fruit, vegetable

Food frequency questionnaires (FFQs) have been used as an epidemiological tool for several decades. Many FFQs of variable length have been developed and validated regarding nutrient intake. However, questionnaires allowing calculation of nutrient intake are not necessary in all situations. In some studies short questionnaires to assess intake of food groups of interest are enough, for instance intake of fruit and vegetables. Only a few studies have evaluated short FFQs at the food intake level. The advantages of a short questionnaire are the possibility to collect dietary data more often because it is cheaper than other traditional dietary assessment methods. Furthermore, the time used for data processing is reduced compared to other methods and it is less burdensome for the participants to complete.

The 27-item food frequency questionnaire evaluated in this study was designed to identify groups of individuals with low versus high intake of fruits, vegetables, coffee, soft drinks (with and without sugar), and alcohol. A further aim was to identify fat intake by estimating intake of drinking milk and fat spread, known to contribute significantly to total fat and saturated fat intake in Norway.

In the present study the suitability of the short food frequency questionnaire was evaluated for its ability to identify subjects with low intake of fruit and vegetables and subjects with low versus high intake of fat. Such information is necessary to design effective public health intervention strategies in order to increase intake of fruit and vegetable and to reduce fat intake.

MATERIALS AND METHODS

Healthy men working at Ørland air force station (a military station located on the west coast in mid-Norway) were invited to participate in the study. The study was conducted in autumn 1995 and winter 1996. All male workers on the air force station were invited to participate and 137 subjects responded and were instructed how to keep weighed food records for 14 days. Of the initial 137 participants 125 completed the records. A 27-item food frequency questionnaire was filled in by 109 of the participants 1.5–2 months after the weighed records were completed. A total of 108 participants completed both weighed records and the short questionnaire (table 1). Weight and height were measured at the start of the first recording period. The study protocol was approved by the regional ethical committee, and all participants gave written informed consent.

Food frequency questionnaire

The questions from the short questionnaire used for analyses in this paper were eight questions about intake
of the following fruit and vegetables; potatoes, carrots, 'cauliflower, cabbage, broccoli', 'other vegetables', orange juice, 'apple, pears', citrus fruit, and 'other fruits'. The fruits and vegetables included in the questionnaire were the ones consumed in largest amounts in Norway.\textsuperscript{15} Further questions included two about intake of milk (whole fat and low fat milk) and one about use of margarine/butter on bread; what type and how much they used. The participants were asked to have their habits during the last year in mind when filling in the questionnaire.

For milk and orange juice the measure was the number of glasses per day and glasses per week, respectively. The frequency scale used was never, less than one glass, 1–2 glasses, 3–4 glasses, 5–6 glasses, 7–8 glasses, 9–10 glasses, 11 or more glasses per day or week. The same frequency scale was used for the intake of vegetables and fruits, however, the unit used for these food groups was times per week.

**Weighed diet records (reference method)**

The 14-day weighed diet records were split into five shorter periods (3 + 3 + 3 + 3 + 2-day units) by 1-week intervals. The total 14-day period consisted of 10 weekdays and 4 weekend days (2 Mondays, 2 Tuesdays etc.).\textsuperscript{16} The men were provided with blank diary forms and a digital scale with a precision of ±1 g and a maximum capacity of 2500 g. They were given both oral and written instructions on how to weigh and describe in detail the consumption of foods and beverages, and how to fill in the diary forms. Furthermore, the subjects were asked to monitor their ‘normal’ food intake and to avoid any temptation to change the diet in order to lose weight or simplify the recording. The use of household measures was accepted when it was impossible to use the scale.

The diary form from the first 3-day period was checked for completeness immediately after finishing this first period, and each participant was contacted by phone to clarify improper responses.

**Calculation of food and nutrient intake**

The daily intake of foods, fat and saturated fat was computed from the 14-day weighed records by using a food database and software systems developed at the Institute for Nutrition Research, University of Oslo. The food database is mainly based on the official food composition table,\textsuperscript{17} and is continuously supplemented with data on new food items and nutrients.

**Evaluation of energy intake using cut-off values**

Estimates of basal metabolic rate (BMR) were calculated from standard equations based on height, weight, age and sex.\textsuperscript{18} The equations for males aged 18–29 and 30–60 years were used. A comparison of energy intake with estimates of BMR can be used to calculate number of respondents in a dietary survey who may underreport their energy intake.\textsuperscript{19} Based on estimates of BMR with 95% confidence limits and a diet recording period of 14 days, a ratio between measured energy intake and BMR (EI/BMR) below 1.12 for individual records may indicate underreporting.

**Statistics**

Statistical analyses were performed with SPSS (SPSS 9.0). Food intakes measured by the 14-day weighed records were not normally distributed, therefore, non-parametric statistical methods were chosen. Relations between the two methods were investigated by using Spearman rank correlation and classification into quartiles. Furthermore, to evaluate the ability of the short FFQ to rank groups of individuals by levels of food consumption we calculated mean daily intakes from the weighed records for people within the frequency categories on the FFQ. A non-parametric method for ordered groups was used to test if the FFQ categories ranked daily intake in a specific order.\textsuperscript{20}

The FFQ was evaluated for its sensitivity and specificity according to recommendations of fruit and vegetables. Specificity for fruit and vegetables was defined as the number of subjects having less than the recommended number of servings by both records and FFQ as a percentage of those actually having less than the recommended servings according to the diet record. Sensitivity for fruit and vegetables was the number of those having adequate servings by both records and FFQ as a percentage of those actually having adequate servings by records. When calculating specificity and sensitivity for intake of fruit and vegetables the weekly frequency of fruit, vegetables and potatoes reported by the FFQ were converted to daily frequency. Furthermore, one time per day reported in the FFQ was used as equivalent to one serving. The intake of fruit, vegetables and potatoes in gram per day from the weighed record were converted into servings using reference portions in the Norwegian recommendations.\textsuperscript{21} One serving of fruit (apple etc.), one serving of juice and one serving of potatoes and vegetables were defined as 150 g.

A variable called ‘fat from the FFQ’ was calculated as the sum of fat (fat calculated as a nutrient) from whole fat milk, low fat milk and from fat spread. To calculate fat from whole milk and low fat milk glasses of milk reported in the FFQ were converted to gram per day by using a standard size of glass (150 g per glass). Fat from fat spread used on bread was calculated using the information about slices of bread per day, amount of fat spread used on one slice of bread and type of fat spread used. Saturated fat from the FFQ was calculated in a similar way.

**Table 1** Characteristics of the participants completing the short food frequency questionnaire and 14-day weighed records, \(n=108\)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Median (min–max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>36 (20–55)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>80.5 (59–111)</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.80 (1.65–1.97)</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>24.8 (20.5–34.2)</td>
</tr>
<tr>
<td>EI/BMR g/1.12</td>
<td>(n=14) (13%)</td>
</tr>
</tbody>
</table>

BMI: body mass index; EI/BMR: energy intake/basal metabolic rate
RESULTS

Characteristics of the participants are shown in table 1. Fourteen men (13%) had a ratio between energy intake reported by 14-day weighed records and estimated BMR at or below 1.12.

The frequency scale in the FFQ ranged from never to 11 or more per day or week. The highest two frequency categories ‘9–10’ and ‘more than 11’ were never used for intake of fruit and vegetables except for intake of boiled potatoes and orange juice. This means that combining the highest two frequency categories in a new questionnaire will hardly reduce the information about variation in intake from the questionnaire. In table 2 the two highest frequency categories in the questionnaire are combined into one category called ‘9+’.

Fruit and vegetables

Table 2 shows the Spearman correlation coefficients between the frequency from the questionnaire and the amount (gram per day) from the weighed records. The correlation ranged from 0.20 for ‘cauliflower, cabbage, broccoli’ to 0.66 for ‘orange juice’. When data from the three questions about vegetables included in the FFQ were combined, the correlation coefficient between total intake of vegetables from the FFQ and total intake of vegetables from the records was 0.46. Similarly, for fruit combined we found a correlation of 0.66. Classification of subjects by quartiles of total intake of potatoes, vegetables and fruit from the weighed records and the FFQ showed that 44% of the subjects were correctly classified. Only 1% was grossly misclassified into opposite quartiles (data not shown).

As expected the mean intake from the dietary record increased with increasing frequency categories (table 2). We found a significant trend for all food items except for ‘cauliflower, cabbage, broccoli’.

Sensitivity and specificity for intake of fruits and vegetables are presented in table 3. The specificity was high. For example, out of 106 who had less than four servings of potatoes, vegetables and fruits by diet records 97 of these also reported this level of intake by the FFQ. The sensitivity of the FFQ was low, especially for total intake of potatoes, vegetables and fruits. Two subjects had adequate servings of fruit, vegetables and potatoes according to diet records, but none of these were identified by the FFQ.

Table 2 Mean intake (g/day) reported by 14-day weighed food records ranged by frequency of intake reported by short food questionnaire, Spearman correlation coefficients between the two measures and number of subjects in parentheses, n=108

<table>
<thead>
<tr>
<th>Food groups</th>
<th>Frequency (glass per day, glass per week, times per week)</th>
<th>n=108</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never &lt;1 1–2 3–4 5–6 7–8 ≥9 correlation coefficient</td>
<td></td>
</tr>
<tr>
<td>Whole fat milk</td>
<td>(91) 48 (12) 212 (3) 156 (2) 0.29</td>
<td></td>
</tr>
<tr>
<td>Low fat milk</td>
<td>(25) 101 (16) 273 (39) 423 (24) 611 (2) 0.80</td>
<td></td>
</tr>
<tr>
<td>Orange juice</td>
<td>(22) 12 (42) 34 (23) 57 (10) 181 (6) 0.66</td>
<td></td>
</tr>
<tr>
<td>Potatoes, boiled</td>
<td>(5) 46 (5) 59 (15) 84 (47) 114 (33) 0.45</td>
<td></td>
</tr>
<tr>
<td>Carrots</td>
<td>(2) 6 (9) 18 (49) 32 (31) 41 (8) 0.46</td>
<td></td>
</tr>
<tr>
<td>Cauliflower, cabbage, broccoli</td>
<td>(5) 1 (51) 14 (46) 20 (4) 6 (2) a 0.20</td>
<td></td>
</tr>
<tr>
<td>Other vegetables</td>
<td>(5) 48 (21) 49 (54) 54 (21) 67 (5) 0.27</td>
<td></td>
</tr>
<tr>
<td>Vegetables combined</td>
<td>(1) 43 (1) 46 (6) 70 (49) 91 (17) 0.46</td>
<td></td>
</tr>
<tr>
<td>Citrus fruits</td>
<td>(5) 0 (45) 14 (36) 30 (16) 72 (6) 0.45</td>
<td></td>
</tr>
<tr>
<td>Apple, pear</td>
<td>(8) 0 (37) 23 (44) 50 (10) 59 (8) 218 (1) 0.58</td>
<td></td>
</tr>
<tr>
<td>Other fruits, berries</td>
<td>(6) 13 (6) 20 (48) 22 (38) 50 (10) 81 (6) 0.22</td>
<td></td>
</tr>
<tr>
<td>Fruit combined</td>
<td>(1) 16 (1) 7 (2) 23 (6) 39 (41) 71 (13) 46 (17) 123 (28) 0.66</td>
<td></td>
</tr>
</tbody>
</table>

a: A non-parametric method was used to test for trend across ordered groups. For all food items shown in table 2 there were significant trends (p<0.01) except for ‘Cauliflower, cabbage, broccoli’.

b: All correlation coefficients were significant; r=0.20–0.22 had p<0.05, all others had p<0.01.

c: In Norway the recommendations for intake of vegetable and potatoes are three portions per day, however only one participant had an intake at this level. Therefore, we have calculated the sensitivity for intake of two portions of vegetables and potatoes per day.

Table 3 Sensitivity a and specificity b of the food frequency questionnaire (FFQ) for assessing adequacy of intake of servings of fruit and vegetables, n=108

<table>
<thead>
<tr>
<th>Recommended number of portions</th>
<th>Number meeting recommendation</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>2</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>Vegetables, potatoes</td>
<td>2</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>Fruit, vegetables and potatoes</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

a: Sensitivity: the number of subjects having adequate servings by records and the FFQ as a percentage of those having adequate servings by records.

b: Specificity: the number of subjects having less than the recommended number of servings by records and FFQ as a percentage of those having less than recommended by records.

c: In Norway the recommendations for intake of vegetable and potatoes are three portions per day, however only one participant had an intake at this level. Therefore, we have calculated the sensitivity for intake of two portions of vegetables and potatoes per day.
**Fat intake**

The correlation coefficients between intake of low fat milk from the FFQ and the records, respectively, were high (table 2), while the correlation for whole fat milk was low. Seventy-seven of the 81 men who reported using fat spreads in the FFQ also reported this in the records (table 4). Twenty-four of the 27 men who reported not using fat spreads in the FFQ did not do that during the recording period. The proportion of subjects correctly classified according to intake of fat type by the FFQ varied from 0% for butter to 70% for ‘other types of margarine’.

Spearman correlation coefficient between the amount of fat used on bread from the two methods was 0.79 ($p<0.001$). Classification of subjects by quartiles of amount of fat on bread from the weighed records and the FFQ showed that 60% of the subjects were correctly classified, whereas only 1% were grossly misclassified into opposite quartiles (data not shown). Table 5 shows the correlations between different measures of fat from the short FFQ and the weighed records both in the total sample and in the group of men actually using fat spread on bread. The highest correlations were observed in the group of men using fat spread on bread. The correlations between the amount of fat and saturated fat from the FFQ and the total amount of fat (total fat calculated as a nutrient) and saturated fat from the weighed records were 0.48 and 0.50, respectively.

**Table 4 Use of fat spreads reported by the short food frequency questionnaire and percentages of subjects reporting use of the same fat spread by both the short food frequency questionnaire and the weighed records, n=108**

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Percentage correctly classified</th>
</tr>
</thead>
<tbody>
<tr>
<td>User of fat on bread</td>
<td>81</td>
<td>96$^a$</td>
</tr>
<tr>
<td>Non-user of fat on bread</td>
<td>27</td>
<td>86$^a$</td>
</tr>
<tr>
<td>Butter</td>
<td>3</td>
<td>0$^b$</td>
</tr>
<tr>
<td>Hard margarine</td>
<td>28</td>
<td>61$^b$</td>
</tr>
<tr>
<td>Soft margarine</td>
<td>47</td>
<td>28$^b$</td>
</tr>
<tr>
<td>Low-fat margarine</td>
<td>21</td>
<td>42$^b$</td>
</tr>
<tr>
<td>Other types of margarine</td>
<td>28</td>
<td>70$^b$</td>
</tr>
</tbody>
</table>

a: The number of subjects being a user or non-user from both methods as a percentage of the subjects actually being a user or non-user according to the weighed records.

**DISCUSSION**

The FFQ seems to be able to identify individuals with low intake of vegetables and fruit and to identify those using or not using fat on bread. Moreover, the FFQ produced valid estimates of the amount of fat used on bread and type of fat spread used.

**Methodological limitations**

We are aware that the men included in this paper are a selected group of the population and not a population-based random sample. Furthermore, 29 (21%) men who originally were included in the study did not complete the short questionnaire. As such, it is likely the study population is a highly motivated group. However, the age distribution in the study population was similar to the age distribution in the general population of Norwegian men between 20 and 55 years.

In a validation study the reference method should be as accurate as possible. In the present study 14 men had a ratio of energy intake from weighed records to BMR below 1.12 and it is most likely that these persons underreported their habitual intake. We have not evaluated if this was caused by omitting some food items or a general underreporting of the amount of food eaten. The 14 men were included in our analysis. The association between frequency of intake reported by the FFQ and amount of food eaten by records was similar if the 14 men were included or not (data not shown).

When using relative validation the sequence of the dietary assessment methods is of concern since the applications of methods used may affect the results. The best design is to distribute the reference method after the method you want to validate. In the present study the FFQ was administered 1.5–2 months after the recording period. This recording of foods before filling
in the questionnaire may sensitize subjects to their food habits and artificially improve the accuracy in completing the FFQ. The relative large time lag (1.5–2 months) between the recording period and filling in the FFQ was chosen to reduce that problem.

This study was performed only during autumn and winter; spring and summer was not included. It could be argued that this is a problem because of seasonal variations in vegetables and fruit intake. A nationwide study in Norway from 1993–94 did not show variations in intake of fruits and vegetables between the four seasons (winter, fall, summer, autumn), except for citrus fruit.\textsuperscript{23} Intake of citrus fruits showed a significantly higher intake during winter and fall.\textsuperscript{23} Even though the FFQ in the present study asked about the usual intake it is possible that the predominant food choice at the time of the survey could influence the respondents memory. This means that since the data in the present study was collected during the main season for citrus intake the correlation observed for citrus fruit may not be representative of summer and autumn.

**Fruit and vegetables**

A few comparable studies have been found evaluating short FFQs according to food intake level.\textsuperscript{11–13} Serdula et al.\textsuperscript{11} validated a six-item FFQ about intake of fruit and vegetables against different reference methods (diet records, diet recalls and extensive FFQ) and Ling et al.\textsuperscript{12} validated a 16-item FFQ about intake of cereals, fruit and vegetables against three 24-h recalls. A 26-item FFQ evaluated by Osler and Heitman\textsuperscript{13} included several of the same food items as our FFQ and they validated their FFQ against a diet history interview. The correlations found for vegetable ($r=0.46$) and fruit ($r=0.66$) in our study were similar to those reported by Serdula et al.\textsuperscript{11} and Osler and Heitman,\textsuperscript{13} while the correlations observed by Ling et al.\textsuperscript{12} were higher than observed in the present study. We also evaluated an extensive FFQ (including 180-food items) in the same group of men.\textsuperscript{16} The correlation coefficients between fruit and vegetable intake (gram per day) from the extensive FFQ and from the 14-day weighed records were similar to those presented in this paper between the short FFQ and 14-day records.\textsuperscript{24}

The weak correlations observed for ‘cauliflower, broccoli, cabbage’, ‘other vegetables’ and ‘other fruits’ may be explained by a rather high within-person variation for these food items. Furthermore, combining several food items into single questions may weaken the correlation observed for ‘cauliflower, broccoli, cabbage’, ‘other vegetables’ and ‘other fruits’, because it requires individuals to consider many contributors.

From a public health point of view the short FFQ may be a valuable screening tool. The high specificity of the FFQ would mean that almost all individuals identified by the FFQ as having less than the recommended intake of fruits and vegetables, actually require advice. Only a small proportion who actually had an intake beyond the recommendation, were not identified by the FFQ. The sensitivity error is quite high for our FFQ, especially for total intake of potatoes, vegetables and fruits. However, that the FFQ has less possibility to identify subjects who have reached the recommendation may be a minor problem, even if this means that it is difficult to use the FFQ to say anything about how many achieved the goal. The specificity observed in our study was similar to that found by Ling et al.\textsuperscript{12}, while the sensitivity found by Ling et al.\textsuperscript{12} was much higher than observed in the present study.

**Fat intake**

The FFQ was good at identifying subjects using fat spread on bread or not. Furthermore, the ability of the FFQ to identify type of fat spread was good, except for butter. The low value for butter may be due to the fact that butter often is used occasionally for instance at the weekend, but in the FFQ we asked for the type of fat spread usually used. The ability of the FFQ to assign the subjects to the same quartile of the distribution for intake of fat spread by the diet records was high.

We wanted to investigate if the questions about milk intake (whole fat and low fat milk) and fat spread from the FFQ could be used as an indicator of total fat intake, saturated fat intake and percentage of energy intake from fat. In a nationwide study among Norwegian men ($n=1291$) the Pearson correlation coefficient observed between fat on bread and intake of total fat was 0.63 ($p<0.001$) (data not published). Furthermore, the study showed that fat and saturated fat from fat spreads and milk (whole fat and low fat milk) accounted for 40% and 30%, respectively, of the total fat intake and the total saturated fat intake among users of fat spread. In the present study, we found that the fat and saturated fat calculated from the FFQ accounted for only 22% and 27% respectively, of the total fat intake and the total saturated fat intake reported by weighed records among users of fat spread. The highest correlations were observed between the amount of fat and saturated fat calculated from the FFQ and the weighed records among users of fat spread compared to the total sample of men. While the correlation between intake of fat from the FFQ and the percentage of energy intake of fat calculated from the weighed records was higher in the total sample than among the users of fat spread. Our correlations among users of fat spread were similar to those observed by Neuhauser et al.\textsuperscript{25} using a 13-item dietary screener developed to identify groups of individuals with high (or low) fat intake. They found a correlation between the 13-item screener and multiple 24-hour recalls of 0.48 for total fat and 0.53 for saturated fat.

**CONCLUSION**

On the basis of results from the present study, we conclude that the short FFQ was able to identify those not consuming the recommended portions of fruit, vegetables and potatoes, and to identify those using or not using fat on bread. The FFQ’s capability to classify subjects according to total intake of fat, saturated fat intake and percentage of energy from fat was not good. To increase the value of the FFQ as a screening tool for high (and low) consumers...
of fat we have to include more food items important for the total fat intake, e.g. cheese, meat, cakes. The relevance of this FFQ to other Norwegian populations needs to be established by other validation studies. Future validation studies should include a design where the short FFQ is distributed before the reference method.

REFERENCES