

Validation of a Food Frequency Questionnaire for Assessing Macronutrient and Calcium Intake in Adult Pakistani Population

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ABSTRACT

Objective: To develop and validate a food frequency table (FFQ) for use in urban Pakistani population.

Study Design: A validation study.

Place and Duration of Study: The Aga Khan University, Karachi, from June to November 2008.

Methodology: Healthy adult females, aged ≥ 18 years who consented to be included in the study were inducted, while males, unhealthy females, aged below 18 years or who did not consent were excluded. The FFQ was administered once while 4, 24 hours recalls spread over a period of one year were administered as the reference method. Daily intakes for energy, protein, fat, and calcium intake were estimated for both the tools. Crude and energy adjusted correlations for nutrient intakes were computed for the FFQ and mean of 4, 24 hours recalls and serum N-telopeptide of type-I collagen (NTx).

Results: The correlation coefficients for the FFQ with mean of 4, 24 hours recall ranged from 0.21 for protein to 0.36 for calcium, while the correlation for nutrient estimates from the FFQ with NTx ranged from -0.07 for calcium to 0.01 for energy.

Conclusion: Highly significant correlations were found for nutrient intakes estimated from the FFQ vs. those estimated from the mean of 4, 24 hours recalls but no correlations was found between nutrient estimates from the FFQ and serum NTx levels. FFQ was concluded to be a valid tool for assessing dietary intake of adult females in Pakistan.

Key Words: Food frequency questionnaire. Females. Macronutrient intake. Calcium. N-telopeptide of type-I collagen. Bone turnover.

INTRODUCTION

Evaluation of nutritional adequacy of diets can be performed by various dietary data collection techniques. Currently, such collection techniques include interviewer-administered 24 hours recalls, self-administered food records and food frequency questionnaires (self or interviewed administered). In a 24-h recall, the interviewer through probing questions ask the respondent to list detail for the description and amounts of all food and beverages consumed during the previous day, while food records require the respondent to provide a written description of the types and amounts of food eaten. On the other hand, FFQs provide a list of foods and respondents are asked how often they eat each item on the list.¹⁻³ FFQ can assess dietary intake in a way that is valid, easy and inexpensive to administer and can be easily utilized in studies for promoting health and assessing intake. Validation of these tools enhances their utility and influence.

Calcium intake has received increased attention in the last decade because of its role in bone health. With a pandemic of vitamin-D deficiency (VDD); newer strategies and recommendations have been put forward for dietary and supplementation intake of vitamin-D and calcium. Accurate assessment of calcium is critical in evaluating bone health risks and addressing calcium needs helps to optimize bone health by improving deposition in early adolescents and teenage, maintaining bone density in adults, and minimizing bone loss in older patients.

There is total paucity of research specially targeting calcium intake and food source in our population. One of the reasons is lack of availability of tool for assessing calcium intake. This study was undertaken with the aim to develop and validate a FFQ for assessing macronutrient and calcium intake in adult Pakistani population.

METHODOLOGY

To develop the list of food items to be used in the FFQ for assessing the nutrient intake, 24-h dietary recall data was collected from individuals attending the Aga Khan University's Laboratory Collection points in various parts of the city. Based on the results of the 24-hour (h) recalls and experiences from the authors other work, the list of foods was developed on the FFQ. This FFQ has 64 food items which are categorized into 8 food groups. A food

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composition table for all the food items on the list was also being developed so that the dietary intake could be converted into nutrient estimates. The food frequencies were reported as never, several times per year, 1 - 3 times/month, once a week, 2 - 3 times/week, 4 - 6 times/week, once a day, 2 - 3 times/day and ≥ 4 times/day.

To estimate nutrient intake, the reported intake frequency of each food on the FFQ was multiplied by reported portion size and its respective nutrient composition, summing over all foods. The composition of raw food items was determined from the USDA.⁴ In certain cases where this information was not available from the USDA, other local food composition tables were consulted.^{5,6} The study was approved by the ERC via 811-Pat/ERC-07.

Two hundred apparently healthy adult females, aged ≥ 18 years, were recruited through convenient, non-purposive sampling. Subjects were contacted through two different approaches. A door-to-door approach was exercised in community residents in district Karachi East. AKU hospital employees and their relatives residing in any part of Karachi were also approached.

Information regarding patients' name, age and ethnicity was collected by research officer through face-to-face interviews using a structured questionnaire and parameters of weight and height were measured. At this time, the participants were administered the FFQ and one 24-hour (h) recall. The interview and blood was taken after informed consent at a phlebotomy center of AKU laboratory at Shakra-e-Faisal, Karachi, and main Clinical laboratory at the Aga Khan University situated in district East. Furthermore, these participants completed 3, 24-h recalls more, over a period of one year via telephone calls. Out of the 200 recruited, only 144 provided complete information, consequently our final sample size for analysis was 144 participants.

Eight milliliters of blood was drawn from the antecubital vein in the fasting state for biochemical analysis. All blood samples were centrifuged. Required serum and plasma stored at -70°C until assayed.

Bone turnover was assessed by measuring N-telopeptide of type-I collagen (NTx) using an ELISA kit OsteomarkNTx from Ostex International, Inc., Seattle, WA. For quality control, low and high controls were run. Inter-assay and intra-assay variability for serum NTx assays are 6.9% and 4.6% respectively. Results are expressed as nanomoles of bone collagen equivalents per liter of serum (nMBCE/L). The range of serum NTx levels in healthy females is taken from 6.2 to 19.0 nMBCE/L with a mean of 12.6 nMBCE/L. Serum NTx levels > 19 nMBCE/L was taken as high bone turnover.

Mean nutrient intakes with their standard deviations were computed for the FFQ and the mean of the 4, 24-h recalls nutrient estimates. Nutrient estimates were

log transformed as they were skewed positively. Pearson product -moment correlations between intakes estimated by the FFQ and those calculated from the recalls were computed as shown in Table III. The crude as well as energy adjusted correlations were assessed for the nutrient estimates between those obtained from the FFQ versus those taken from the 24-h recalls as well as NTx, where level of significance was taken to be 0.05 two sided.

Statistical Package for Social Sciences (SPSS) 17 was used for all statistical analysis.

RESULTS

The mean age of the participants was 32.8 ± 11.4 years. The mean BMI was 23.8 ± 4.8 kg/m², height being 156.5 ± 5.4 cm and weight being 58.3 ± 11.3 kg. The mean NTx level was 19.0 ± 8.7 nMBCE/L and the mean serum PTH level was 73.7 ± 34.7 pg/ml (Table I). Further results are shared in Table I.

Intake of energy and macronutrients were similar using the FFQ and 24-h recalls, but higher for FFQ (Table II). Mean usual daily energy estimated from the FFQ was Kcal 1643.5 ± 703.1 kcal; daily protein intake was 55 ± 23.3 g, fat 61.7 ± 29.4 g, and calcium 610.7 ± 306.3 mg. While the mean usual daily energy intake estimated from the mean of 4, 24-h recalls was 1391.8 ± 365.3 , daily proteins intake was 45.4 ± 13.9 g, fat 52.0 ± 17.9 g, calcium 462.1 ± 175.7 mg (Table II).

Comparing mean nutrient estimates from the FFQ with 4, 24-h recalls, the correlation coefficient ranged from 0.21 for protein to 0.36 for calcium, while the correlation for nutrient estimates from the FFQ with NTx ranged from -0.07 for calcium to 0.01 for energy. The energy adjusted correlation between mean nutrient estimates of FFQ with 4, 24-h recall ranged from 0.03 for protein to 0.32 for calcium. The energy adjusted correlation

Table I: Sociodemographic characteristics of the study participants.

| Characteristic | Mean | SD |
|-------------------|-------|------|
| Age (year) | 32.8 | 11.4 |
| Height (cm) | 156.5 | 5.4 |
| Weight (kg) | 58.3 | 11.3 |
| BMI | 23.8 | 4.8 |
| NTx (number/L) | 19.0 | 8.7 |
| Serum PTH (pg/ml) | 73.7 | 34.7 |

SD = Standard Deviation; BMI = Body Mass Index; NTx = N-telopeptide of type-I collagen; PTH = Parathyroid hormone.

Table II: Mean daily nutrient intakes estimated by the FFQ as the 24-h recalls.

| Variables | FFQ | | Mean of 4, 24-h recalls | |
|---------------|--------|-------|-------------------------|-------|
| | Mean | SD | Mean | SD |
| Energy (kcal) | 1643.5 | 703.2 | 1391.8 | 365.3 |
| Protein (g) | 55.0 | 23.3 | 45.4 | 13.9 |
| Fat (g) | 61.7 | 29.4 | 51.9 | 17.9 |
| Calcium (mg) | 610.7 | 306.4 | 462.1 | 175.7 |

FFQ = Food Frequency Questionnaire; SD = Standard Deviation.

Table III: Crude and energy adjusted correlations between nutrient estimates from FFQ and mean of 4, 24-h recalls and serum NTx values.

| Nutrient | Mean of 4, 24-h recalls | | | | NTx | | | |
|----------|-------------------------|---------|-----------------|---------|--------|---------|-----------------|---------|
| | Crude | p-value | Energy adjusted | p-value | Crude | p-value | Energy adjusted | p-value |
| Energy | 0.248 | < 0.001 | ----- | ----- | 0.010 | 0.912 | 0.031 | 0.724 |
| Protein | 0.213 | 0.002 | 0.029 | 0.682 | -0.002 | 0.986 | 0.019 | 0.831 |
| Fat | 0.323 | < 0.001 | 0.116 | 0.104 | -0.043 | 0.629 | -0.019 | 0.835 |
| Calcium | 0.363 | < 0.001 | 0.315 | < 0.001 | -0.069 | 0.438 | -0.055 | 0.534 |

NTx = N-telopeptide of type-I collagen.

between means estimates of FFQ with serum NTx ranged from -0.02 for fat to 0.03 for energy (Table III).

DISCUSSION

In epidemiological studies of chronic diseases, the understanding of the usual diet is of sheer importance in the progression and development of disease, as compared to the clinical setting where the dietary intake is titrated as per the requirement of the condition.⁷ Epidemiological studies conducted all over the world employ FFQ as a standard method to acquire a sense of the day-to-day nutrient consumption of the population. In this study, the authors have described the development and validation of a food frequency questionnaire to assess the dietary intake of adult Pakistani population residing in Pakistan.

A food composition table was developed, which was largely based on US Department of Agriculture nutrient database, to estimate the nutrient intake from the FFQ. There are several advantages of using the USDA nutrient data base as the standard. USDA is considered as the most comprehensive nutrient data base in the world. The USDA nutrient data base has the largest number of nutrient reported, and is constantly updated with the nutrient estimation assays conducted in a standardized manner. There are over 150 food composition tables used around globally and their values are primary derived from USDA.⁸⁻¹⁰ Moreover, comparable methods have been carried out by other investigators as well.^{7,12} However, other local food composition tables were also consulted where USDA fell short.

The mean nutrient intake estimated by the FFQ were similar to those obtained from the 24-h recall and within the range reported by others in South Asia.^{13,14} In an Indian investigation, mean usual daily energy intake was observed to be 1749 kcal and 1910 kcal in the urban and rural population, respectively.¹⁵ Likewise in a study conducted in South India, the mean daily energy intake was 2066 ± 437 kcal for men and 1745 ± 343 kcal for women.¹⁶ Similar to other studies, energy intake estimated from the FFQ were higher than those obtained by the 24-h recall.¹⁷

Mean nutrient estimates from the 24-hour recalls were used as reference method for comparing the nutrient intakes from the FFQ. The correlations of nutrient

estimates from the FFQ vs. the 24-hour recalls were highly significant and moderate (0.21-0.36). Adjustment for energy lowered the correlations. Similar correlations have also been reported by Huang and Kim.^{18,19}

This study's correlations of nutrient estimates from the FFQ with serum NTx levels were extremely low and not significant. The author was expecting that the intake estimates from the FFQ and serum NTx would be highly correlated. This lack of correlation may be due to the difference in intake of calcium.^{20,21} The age of female participants, bone formation and the presence of other nutrients and factors that affects bone formation.^{22,23}

Some limitations of this study merit consideration. The correlations observed in the present study were in general lower than those reported by others who compared FFQ data to several weeks of diet records but similar to estimates comparing FFQ data to multiple 24-h recalls generally and to studies done in the subcontinent in particular.^{24,25} A possible reason why this study's correlations are lower than those reported for FFQ validated against diet records may be that the data was from only 4, 24-h recalls as a reference method, as opposed to estimates from several days considered by others.²⁵ Another limitation that needs to be highlighted is that the age groups represented by the sample are mostly < 50 years, and hence the dietary intake is skewed toward the younger age group. Moreover, all the participants were females and hence the nutrients consumed and the bone turnover of males may be underestimated. The way to make it more accurate is to repeat the study, include more participants from the > 50 age group and male gender.

CONCLUSION

Highly significant correlations were found for nutrient intakes estimated from the FFQ vs. those estimated from the mean of 4, 24-hour recalls but no correlations between nutrient estimates from the FFQ and serum NTx levels. It was concluded that this FFQ is a valid tool for assessing dietary intake of adult females in Pakistan.

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