

Original Article

Dietary calcium intake in postmenopausal Malaysian women: comparison between the food frequency questionnaire and three-day food records

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The objective of this study was to compare the dietary calcium intakes assessed by a quantitative food frequency questionnaire (FFQ) and the three-day food record method in 230 Chinese postmenopausal women aged 50–65 years in Kuala Lumpur. The results showed that the mean calcium intake from the dietary records was 447 ± 168 mg/day and 499 ± 211 mg/day from the FFQ. The mean difference in intake by the two methods was 51.3 mg (95% CI = $-30.8 - 77.9$; SD = 181.2, $P > 0.05$), which did not differ significantly from zero. Pearson's correlation coefficient of 0.56 was obtained between the two methods. Ninety-five percent of the individuals classified by food records fell into the same or within-one-quartile category when classified by FFQ. Forty-eight percent were classified into the same quartile by both methods. No subjects were grossly misclassified by the FFQ. The FFQ correctly identified subjects with calcium intakes below the Malaysian recommended daily allowance (450 mg/day) with 60% specificity and with 92% specificity for women consuming less than 800 mg calcium/day. In conclusion, the FFQ developed was a useful, rapid clinical tool for assessing calcium intake and identifying postmenopausal Chinese women with low calcium intakes in Malaysia.

Key words: calcium, China, diet, food frequency questionnaire, food records, Malaysia, menopause, women.

Introduction

In Malaysia, osteoporosis is beginning to receive attention as a public health problem. In 1997, the incidence of hip fractures among individuals over 50 years of age was reported to be 0.90 per thousand people,¹ and this is expected to increase in view of the country's rapidly 'ageing' population. Statistics show that the percentage of the Malaysian population in the age group over 65 years grows annually at a rate of 3%, and the elderly will make up 7% of the population by the year 2020.² Being a multiethnic nation, the incidence of hip fractures has been found to be higher among Chinese women than among other races.³

The cause of osteoporosis is multifactorial.⁴ Besides genetic differences and endocrine factors, lifestyle behaviour such as physical activity level and dietary composition, especially calcium intake, plays an important role in preventing osteoporosis. In the absence of a national dietary survey, data available from several general dietary studies among Malaysians of different age categories often show calcium intakes below 500 mg/day.^{5–8} Low calcium has been found to be one of the risk factors for osteoporosis amongst Asian

women.⁹ Assessing the calcium intake of Malaysians would be important to identify individuals at risk so that appropriate intervention programs can be targeted.

There remains no 'gold standard' for the assessment of dietary intakes. In Malaysia, the food record method has been more widely used than weighed intakes as it is less tedious to carry out and less demanding on the individuals studied. However, data analysis is no simple task and consumes much time and cost. In epidemiological surveys, a dietary assessment tool that is simple to administer, less demanding on the subjects and less tedious to analyse is often required. The food frequency questionnaire (FFQ) appears to provide the advantage of fulfilling these criteria in

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assessing nutrient intakes. The objective of this study was to compare the dietary calcium intakes assessed by a semi-quantitative FFQ and the three-day food record method.

Methods

Subjects

Subjects were participants of a study to assess the effects of calcium supplementation on bone density in postmenopausal women. Volunteers were invited by advertisements and screening exercises carried out in various senior citizens clubs, residential areas and religious centres within a 50 km radius of Kuala Lumpur. All participants were healthy, free-living, Chinese postmenopausal women aged between 50 and 65 years. Exclusion criteria were women with a history of bone disease, medical conditions that affect bone metabolism, calcium supplementation above 500 mg/day for longer than a month and women on hormonal/oestrogen replacement therapy. A total of 250 women were recruited for this FFQ study. This study obtained ethical approval by the Research Ethics Committee of Universiti Kebangsaan Malaysia.

Measurements

Food frequency questionnaire. The FFQ contained 78 food items commonly eaten in the Malaysian diet. The food list was derived from 478 food records collected previously in a study to assess the food intake of adult Malaysians in four selected regions in the country.⁵ The FFQ was constructed using the methodology described by Block *et al.*,¹⁰ whereby the foods that contributed 95% of the total calcium intake of the population were included in the list. The portion sizes were divided into small, medium and large as follows: small = $0.5 \times$ standard/medium portion size; medium = $1.0 \times$ standard/medium portion size; and large = $1.5 \times$ standard/medium portion size.

Trained dieticians administered the FFQ by interviewing the subjects. Serving sizes were given in common household measures. Local household measurements (e.g., bowls, cups and spoons), food photographs and matchboxes of different sizes were shown to the subjects. Subjects were required to indicate the serving sizes eaten for each food item listed. They were also required to give the number of times they consumed each food item daily, weekly or monthly. They could also answer 'never or rarely' for foods consumed infrequently. The subjects were requested to give their answers based on their usual diet for the last three month period.

Three-day food records. Subjects were asked to record their food intake for three days (two weekdays and a weekend) after administration of the FFQ. The subjects were instructed to record all foods at the time of eating in local household measurements (i.e., bowls, cups, glasses, teaspoons and tablespoons). Food photographs and matchbox sizes were used to better quantify food portion sizes. Written instructions in English and Mandarin were also given to the subjects. All completed records were checked immediately for clarity and understanding of portion sizes. Home recipes

for dishes not included in the Malaysian food composition table were also obtained.

Calculation of nutrient intakes. The household measurements recorded by the subjects in the three-day food record forms were converted into food weights in grams based on a list of food weights that had been compiled. The compilations of weights of common food portion sizes were adapted from the *Nutrient Composition of Malaysian Foods*¹¹ and the researchers also weighed foods that were frequently eaten by subjects.

The calcium content of the diets was calculated using computer software and data from the *Nutrient Composition of Malaysian Foods*. As for foods not found in that reference, common recipes were obtained from standardized recipes and calculated for nutrient content. These nutrient values were then used to analyse the subjects' nutrient intake. The manufacturer's data were also used for some processed foods that did not have analytical data.

In the FFQ, the calcium content of the foods listed was obtained from the *Nutrient Composition of Malaysian Foods*. The total calcium intake for the day was calculated by multiplying the consumption frequency, portion sizes and calcium content of the foods.

Data analysis

Means, standard deviations and ranges were calculated for calcium intakes measured by the FFQ and food records methods. Mean differences and standard deviations of the differences were calculated to assess the agreement between the two methods, as recommended by Bland and Altman.¹² Pearson's correlation coefficient was calculated between the calcium estimates from the two methods as well. To evaluate the ability of both methods to classify individuals similarly in categories of calcium intake, quartile categories were assigned for both assessment methods separately. The overall percentage of women classified into the same, the adjacent and extreme quartile category was determined. Specificity¹³ was defined as the proportion of women with a daily intake below the Malaysian recommended daily allowance (RDA)¹⁴ of 450 mg, on the basis of the three-day records that also fell below 450 mg on the FFQ. Sensitivity¹³ was the proportion of those with a daily calcium intake above 450 mg, on the basis of the food records that also fell above 450 mg on the FFQ. Analysis was performed by use of SPSS version 10.0 (SPSS, Chicago, IL, USA).

Results

Out of a total of 250 women recruited, 230 women (participant rate 92%) successfully completed both the three-day food records and FFQ. Twelve subjects failed to complete the diet records and another eight subjects were excluded on the basis that their dietary records were unlikely to represent habitual intake.¹⁵

Physical characteristics

Table 1 shows the physical characteristics of the subjects. The subjects had a mean age of 59 ± 3 years. The duration of

menopause was 9.5 ± 4.2 years. The mean weight of the women was 56.5 ± 8.7 kg, mean height was 1.54 ± 0.05 m and the mean body mass index (BMI) was 23.9 ± 3.6 kg/m². The majority of the women were of normal weight while 3.5% were underweight (BMI < 18.5 kg/m²), 28.7% were overweight (BMI = 25.0–29.9 kg/m²) and only 5% were obese (BMI > 30.0 kg/m²).

Mean dietary intake and food sources of calcium

The mean energy intake reported from the diet records (Table 2) was 6.65 ± 1.27 MJ/day, with an energy distribution of 53% carbohydrates, 17% protein and 30% fat. These figures were typical of the Malaysian dietary pattern reported in other studies.^{5–8} The reported calcium intake from the food records was 447 ± 168 mg/day. Fifty-six percent of these women failed to meet the Malaysian RDA for calcium (450 mg/day), while only 3.9% of the women had intakes above 800 mg/day. The percentage calcium intake from various food sources is shown in Figure 1. Most of the calcium was from vegetables and bean sources (32%), dairy products (26%), eggs, meat and seafood (16%) and cereals (12%).

Comparison of calcium intakes from FFQ and diet records

In Table 3, the mean calcium intakes calculated from the dietary records and FFQ are presented. The mean calcium intake from the dietary records was 447.4 ± 168 mg/day and from the FFQ it was 498.7 ± 211 mg/day. There was no significant difference between the mean intakes by paired *t*-test. A significant ($P < 0.001$) Pearson's correlation coefficient of 0.563 was obtained. A scatter plot is shown (Fig. 2) with details of the regression line.

The mean difference in intake by the two methods was 51.3 mg (95% CI = -30.8 – 77.9; SD = 181.2, $P > 0.05$),

Table 1. Physical characteristics of subjects

	Mean \pm SD	Range
Age (years)	59 ± 3	50–66
Years after menopause	9.5 ± 4.2	5–25
Weight (kg)	56.5 ± 8.7	36.5–62.3
Height (m)	1.54 ± 0.05	1.41–1.65
BMI (kg/m ²)	23.9 ± 3.6	15.6–40.3

Table 2. Daily intake of nutrients from three-day food records

	Mean \pm SD
Energy	
kcal	1591 ± 305
MJ	6.65 ± 1.27
Energy distribution	
% protein	17
% carbohydrate	53
% fat	30
Protein (g)	67 ± 16
Fat (g)	54 ± 15
Carbohydrate (g)	212 ± 43
Calcium (mg)	447 ± 168

which did not differ significantly from zero. The percentage mean difference between the two methods was 11%. When individual diets were examined, differences in estimates were mainly between 0 and 300 mg and did not exceed 500 mg.

Classification of calcium intakes, specificity, sensitivity and predictive value

Table 4 shows that 95% of the individuals classified by food records fell into the same or into the within-one-quartile category when classified by FFQ. This was significantly higher than the expected 62.5% correct cross classification to within one quartile, due to chance alone. Forty-eight percent were classified into the same quartile by both methods, compared with 33% expected by chance alone. No subjects were grossly misclassified by the FFQ.

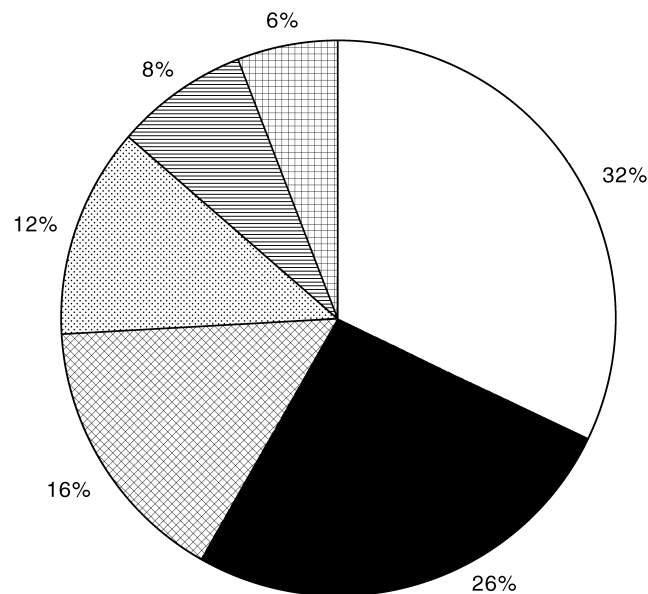


Figure 1. Percentage of calcium intake from various food sources for postmenopausal Malaysian women. (□) vegetables and beans; (■) dairy products; (▨) egg, meat and seafood; (▩) cereals; (▧) beverages; (▦) fruits.

Table 3. Comparison of calcium intake assessed by three-day food records and food frequency questionnaire

	Mean \pm SD (mg)	Range (mg)
Three-day food records (DR)	4474 ± 168	143–1056
FFQ	498.7 ± 211	128–1198
Mean difference (FFQ – DR)		51.3 (11.5%)
Differences	No. subjects	Percentage subjects
Individual intakes (mg)		
0–100	104	45.2
101–300	100	43.5
301–500	26	11.3

Calculated as $(\text{mean FFQ} - \text{mean DR}) / \text{mean DR} \times 100\%$. DR, diet record; FFQ, food frequency questionnaire.

Of those 129 women whose recorded intakes contributed less than the current Malaysian RDA of 450 mg calcium per day, 77 also had FFQ estimates below this level. This gave a specificity of 60%. The sensitivity of the questionnaire was 70%; that is, of those 101 women whose recorded intakes were more than 450 mg calcium per day, 71 also had FFQ estimates above this level. If the intakes were instead compared to 800 mg/day, the FFQ gave a specificity value of 92% and sensitivity value of 33%. The low sensitivity value is attributed to the fact that only nine women recorded intakes above 800 mg/day.

Discussion

This study further substantiates the current evidence available that calcium intake is low among Malaysian women. This could be attributed to low consumption of dairy products among these women, as it is indisputable that milk and milk products are rich sources of calcium. Dairy products contributed 26% of the total calcium intake in this study, which is much lower than the 50% reported in Western diets.^{16–18} This study found that the main calcium sources were from vegetables and beans, which may have poor bio-availability of calcium, depending on the oxalate and phytate

contents.¹⁷ The low dietary consumption of calcium in these postmenopausal women has important implications for their risk of developing osteoporosis. There arises a need for nutritionists and dietitians in the country to place emphasis on adequate calcium intake within the population.

The correlation coefficient obtained from calcium intakes assessed by FFQ and food records ($r = 0.56$) was somewhat lower than those obtained for other calcium FFQ that generally fell around 0.65–0.85.^{18–21} The limitation of the present study is that the three-day records used as a reference may be of insufficient length to reliably assess calcium intake. Potosky *et al.*²² had shown that the validity of dietary questionnaires is influenced by the number of diet-record days used for comparison, preferably with two or more four-day records. However, a longer recording period may also cause a decline in accuracy and potential alterations to dietary habits,²³ especially among older adults and the elderly. Nevertheless, the mean difference between the two methods in the present study was non-significant.

The FFQ was found mostly to overestimate the calcium intakes of the individuals studied. A reason for the discrepancy was that the women included foods high in calcium when responding to the FFQ but failed to eat those same foods during the three-day recording period. In a review on the use of FFQ in minority populations, it was reported that mean intakes were generally higher from FFQ than those estimated from reference methods, although this varied according to the population, questionnaires and nutrient being assessed.²⁴ The long list of food items and food groups is also likely to cause overestimation of nutrient intakes. Clearly, the FFQ developed could not replace the food records in assessing absolute calcium intakes of individuals.

In epidemiological and clinical settings, the usefulness of the FFQ would be in its ability to classify individuals into categories of nutrient intake.²⁵ A high degree of cross-classification agreement was found between the two methods in this study. An important purpose of the FFQ would be to correctly identify women with low intakes to target intervention strategies.²⁶ In this case, the FFQ correctly identified subjects with calcium intakes below the Malaysian RDA (450 mg/day) with 60% specificity, and with 92% specificity for women consuming less than 800 mg calcium/day.

We conclude that while the FFQ developed could not assess calcium intake accurately, it is a useful clinical tool for

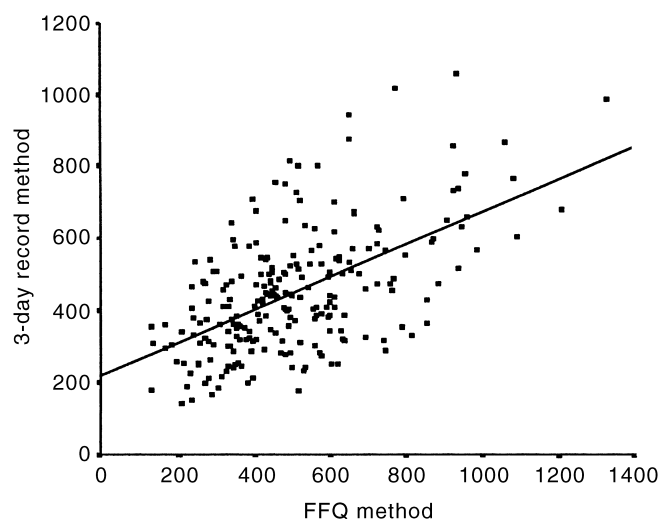


Figure 2. Plot of calcium intake from three-day food records vs food frequency questionnaire (FFQ) with regression line ($y = 0.708x + 185.12$ mg; $r^2 = 0.317$).

Table 4. Joint classification of calcium intake assessed by the three-day food records and food frequency questionnaire (number of subjects)

DR quartiles	FFQ quartiles				Total
	< 10	10–50	50–90	> 90	
< 10	8	12	6	0	26
10–50	12	46	33	0	91
50–90	2	37	48	7	94
> 90	0	3	8	8	19
Total	22	98	95	15	230

DR, diet record; FFQ, food frequency questionnaire.

the rapid evaluation of calcium intake to identify postmenopausal Chinese women in Malaysia with low calcium intakes for intervention and counselling purposes. Its usefulness in other ethnic groups in Malaysia, however, remains to be studied.

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