



# Assessment of dietary calcium intake of university students: a pilot study in Turkey

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## Abstract

**Summary** The aim of this study was to adapt the rapid assessment method (RAM) and International Osteoporosis Foundation Food Frequency Questionnaire (IOF FFQ) tools, used for the assessment of daily calcium intake in university students, and to compare the data obtained using 24-h recall (24-HR) data. There was a moderate positive correlation between the RAM and IOF.

**Purpose/introduction** Calcium is an essential mineral that plays vital roles in metabolism and it is very important to accurately assess the amount of calcium intake on the diet. It was aimed to assess the daily calcium intake of university students by two different food frequency questionnaires (FFQs) developed specifically for evaluating calcium intake, and 24-h recall method.

**Method** The study was conducted with a total of 183 female university students aged 18–31. In the study, a questionnaire including sociodemographic information, a calcium calculator, IOF FFQ, prepared in seven different languages, and RAM was applied. In addition, 1-day food consumption records were obtained using 24-HR method.

**Results** The daily average calcium intakes of individuals according to two different food frequency questionnaires (RAM FFQ and IOF FFQ) and 24-h food consumption records are respectively  $1594.2 \pm 810.9$ ,  $897.9 \pm 368.4$ , and  $605.6 \pm 278.3$  mg. When the daily average calcium intake was compared with the other two methods, RAM was found to be statistically higher ( $p < 0.001$ ). There was a moderate positive correlation between the RAM and IOF FFQ methods (Pearson  $r = 0.528$ ,  $p < 0.01$ ) and the intra-class correlation coefficient between these two methods was found to be significant and moderate (ICC  $r = 0.452$ ,  $p < 0.01$ ).

**Conclusion** In terms of protecting and improving health, it is important to make suggestions using fast and short tools to ensure adequate calcium intake from young age. It is thought that FFQs are the most appropriate methods in assessing daily calcium intake for this study group because it is observed that the list of foods and the amount of portions in FFQs reduce the problem of remembering at 24-h method to a great extent.

**Keywords** Calcium intake · Food frequency questionnaire · Young adults · 24-h dietary recall method · Rapid assessment method

## Introduction

Calcium is an essential mineral that plays an important role in blood clotting, in the activation of many enzymes, and in neuromuscular functions and provides skeletal rigidity [1, 2]. Calcium is being investigated in the pathogenesis and treatment of osteoporosis, hypertension, obesity, and many other diseases [2–5]. In these studies, using the methods of assessment and determining the amount of calcium intake in the diet are very essential [3–5].

Food consumption data can be collected using a wide variety of methods and procedures. Twenty-four-hour dietary recall (24-HR) method is the most commonly used assessment tool in children and adults in large cross-sectional surveys. This method has many advantages even if it does not provide nutritional safety and the changes in nutritional habits. One of the

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advantages of 24-HR method is the ability to seek in detail and check to ensure the correctness of the responses [6, 7]. Hence, 24-HR or more daily recording methods can be used to determine the validity of other food consumption record tools [8, 9]. Otherwise, food frequency questionnaires (FFQs) have been developed to quickly detect food consumption. These questionnaires can be used to assess the intake of a single food or nutrient as well as the total diet [10–12]. Block et al. [5] and Willett et al. [6] have established and validated FFQs for evaluation of the entire diet; besides, different FFQs have been designed to identify only one nutrient dietary intake [9, 12–14]. Among frequency questionnaires designed specifically for single nutrient intake, there are several FFQs for assessing approved calcium intake to be used in some population subgroups [15–18]. In that respect, FFQs are considered to be quite suitable for the assessment of dietary calcium intake [15–18].

A calcium-specific FFQ (IOF FFQ) has been developed by the International Osteoporosis Foundation (IOF) for the assessment of dietary calcium intake in the general population and is available online [19]. This questionnaire can be used as a rapid method for the assessment of calcium intake in large epidemiological studies or clinically. In addition, it can distinguish between inadequate and high levels of calcium intake. One of the commonly used FFQs for assessing dietary calcium intake in clinical trials is rapid assessment method (RAM). A variety of studies have been conducted to determine whether RAM is reliable and valid in adults [20–24].

Although 24-HR is the most commonly used diet assessment tool in validation studies, using 24-HR is time-consuming and often requires expertise and special software for analysis. On the other hand, FFQs can be implemented quickly and easily. The aim of this study was to adapt the RAM and IOF FFQ tools used for the assessment of daily calcium intake in university students and to compare the data obtained using 24-HR data.

## Method

### Participants and procedure

The study was conducted with 183 females aged 18–31 years who were studying at Gazi University, Department of Nutrition and Dietetics. G Power 3 program was used to determine the number of samples. According to the results of this analysis, when the reference values in the studies that are closest to the design of the study are taken into consideration, it is determined that it is sufficient to reach 159 individuals in the 80% confidence interval [12, 18, 25].

Body weight and height were recorded according to the statements of the individuals participating in the study and body mass index (BMI) was calculated. A questionnaire including the sociodemographic information and IOF FFQ and

RAM form was applied to the individuals in the study. In addition, 1-day food consumption record was taken from individuals by using 24-h recall (24-HR) method. Individuals with a daily energy intake of < 600 or > 3500 kcal were excluded from the study due to very low or extremely high levels [25]. Moreover, if the individual's FFQ data were missing, they were excluded.

Ethical approval was obtained from the ethics commission of Gazi University (12/09/2016, no: E.149482).

### Instruments used to assess calcium intake

#### Rapid assessment method

The rapid assessment method (RAM) is an assessment tool that was comprised using the Second National Health and Nutrition Examination Survey data and involves basic calcium sources in the American diet [20]. Similar foods are listed in groups to facilitate the record of foods. These groups are milk-yoghurt-cheese, fruit-vegetables, bread-cereals, meat-fish-chicken-legumes, and fat-sugar-alcohol. This questionnaire asks to quantify the servings of food consumed in the previous 7 days. Household measures (cups, slices, etc.) are used to allow participants to more easily estimate portion sizes. In this study, RAM was used with a modification. Buttermilk and kefir, bulghur, cheese/kashar cheese pita, and pita/lavash/flatbread/yufka were added to the list of foods that are commonly consumed in Turkey. In addition, walnut, hazelnut, halvah, and sesame were added to the questionnaire. Besides, subgroups were formed in some food groups. For example, in the cheese group, hard cheese, white cheese, and soft cheeses were questioned separately. Similarly, the vegetables were divided into subgroups as cooked and raw; fruits were divided as berries, other fresh fruits, dried figs, and other dried fruits. Calcium-enriched orange juice, bread, and quiche were removed from the survey because they were not consumed in Turkey. In addition, quantities of both home measurements and grams were provided for more convenient determination of portion sizes of foods. The Turkish Nutrition Guidelines 2015 was used in determining the portion sizes [26]. To determine the calcium content of foods, Nutritional Information Systems (BeBiS) program developed specifically for Turkish foods was used [27].

#### International Osteoporosis Foundation Food Frequency Questionnaire

International Osteoporosis Foundation Food Frequency Questionnaire (IOF FFQ) is an assessment tool that asks how often the stated foods in the questionnaire are consumed within a week [19]. In this tool, the frequency of the intake of calcium supplements and 78 foods are questioned. It is possible to reach it online and it has seven different language translations. In this

study, strained yoghurt, airan, probiotic yoghurt, kefir, labne cheese, mineral water, and soda which were not included in IOF FFQ but consumed frequently in Turkey were added to the questionnaire. Calcium contents of these added foods were obtained from the BeBiS program [27].

## 24 h recall

On the day the FFQ questionnaires were applied, dietary records were obtained using 24-HR method from all participants through experienced dietitians. Subjects were asked to recall everything consumed (including foods, beverages, sauces, and condiments) the day prior to the interview. The contents of the dishes consumed by the individuals were calculated using the book *Examples from Turkish Cuisine* [28]. The data were analyzed using the BeBiS program for total energy intake and nutrient intake [27]. Furthermore, the daily calcium intake of individuals was compared to the Dietary Reference Intake (DRI) for three methods [29].

## Statistical analysis

SPSS 22.0 program was used for statistical analysis. The normal distribution suitability of variables was examined by visual and analytical methods. Descriptive analyzes were expressed as means and standard deviations for continuous variables with symmetrical distribution; other variables were expressed as medians with interquartile ranges. The relationship between daily calcium intake, calculated by 24-HR, RAM, and IOF FFQ questionnaires, was assessed by the Pearson and intra-class correlation coefficient (ICC). The maximum ICC value is 1.00 and ICC values close to 1.00 indicate that the reliability is high. If correlation coefficient is 0.05–0.30, it indicates low/insignificant correlation, 0.30–0.40 low middle correlation, 0.40–0.60 medium correlation, 0.60–0.70 good correlation, 0.70–0.75 very good correlation, and 0.75–1.00 excellent correlation. Statistical significance was assessed using the Friedman test, as it was determined that the calcium intake values determined by the 24-HR, IOF, and RAM FFQ did not meet the parametric test assumptions. Statistical significance was assessed at  $p < 0.05$ .

## Results

Table 1 shows the demographic characteristics of the individuals. All of the individuals participating in the study are women. The average age of the individuals is  $20.2 \pm 1.8$  years.

The daily average calcium intakes of individuals according to two different food frequency questionnaires (RAM FFQ and IOF FFQ) and 24-h food consumption records are respectively  $1594.2 \pm 810.9$ ,  $897.9 \pm 368.4$ , and  $605.6 \pm 278.3$  mg, and the amount of calcium they consume per 1000 kcal per

**Table 1** Characteristics of the participants ( $n = 183$ )

|                                                   |             |
|---------------------------------------------------|-------------|
| Age (years) <sup>a</sup>                          | 20.2 ± 1.8  |
| Weight (kg) <sup>a</sup>                          | 56.7 ± 7.9  |
| Height (cm) <sup>a</sup>                          | 164.2 ± 5.9 |
| Body mass index (kg/m <sup>2</sup> ) <sup>a</sup> | 21.0 ± 2.5  |
| Body mass index classification (%)                |             |
| Underweight                                       | 26 (14.2)   |
| Normal weight                                     | 131 (71.6)  |
| Overweight                                        | 14 (7.7)    |
| Dietary supplementation (%)                       |             |
| Yes                                               | 14 (7.7)    |
| No                                                | 169 (92.3)  |
| Commonly used supplements (%) <sup>b</sup>        |             |
| Calcium                                           | 1 (7.1)     |
| Fish oil                                          | 1 (7.1)     |
| Probiotic                                         | 1 (7.1)     |
| Multivitamin                                      | 1 (7.1)     |
| Vitamin D                                         | 3 (21.4)    |
| Iron supplement                                   | 7 (50.2)    |

<sup>a</sup> Mean ± standard deviation

<sup>b</sup> Percentages were taken over 14 participants using supplements

day was  $964.1 \pm 560.7$ ,  $549.5 \pm 277.4$ , and  $348.7 \pm 136.8$  mg, respectively. When the daily average calcium intake was compared with the other two methods, RAM FFQ was found to be statistically significantly higher ( $p < 0.001$ ) (Table 2).

The agreements between the data derived from the 24-h recall and the RAM, or the IOF, are evaluated using the Pearson correlation coefficients ( $r$ ) and intra-class correlation coefficients (ICC) in Table 3. There was a moderate positive correlation between the RAM and IOF FFQ methods (Pearson  $r = 0.528$ ,  $p < 0.01$ ), and the intra-class correlation coefficient between these two methods was found to be significant and moderate (ICC  $r = 0.452$ ,  $p < 0.01$ ).

It was determined that 24-h recall (91.3%) and IOF FFQ method (67.2%) could not meet daily calcium intake according to DRI recommendations in most of the individuals. However, in the RAM FFQ method, a large proportion of individuals (74.3%) met the daily recommendations (Table 4).

## Discussion

Calcium is the most abundant mineral in the body and has many important functions. Calcium insufficiency causes many medical problems such as kidney stones, breast and colon cancers, hypertension, and osteoporosis. Inadequate intake of calcium on a diet is a global health problem [30]. It is suggested that the increase of dietary calcium intake decreases the risk of chronic diseases in the general population [31].

**Table 2** The mean, standard deviation (SD), median, interquartile range (IQR), and minimum and maximum values of the individuals' daily calcium intake ( $n = 183$ )

| Variables                         | Mean $\pm$ SD      | Median $\pm$ IQR    | Min-max      |
|-----------------------------------|--------------------|---------------------|--------------|
| Daily calcium intake              |                    |                     |              |
| 24-h recall (mg/d)                | 605.6 $\pm$ 278.3  | 570.9 $\pm$ 331.1   | 112.4–1869.1 |
| IOF FFQ (mg/d)                    | 897.9 $\pm$ 368.4  | 831.2 $\pm$ 403.0   | 256.0–2629.0 |
| RAM FFQ (mg/d)                    | 1594.2 $\pm$ 810.9 | 1416.4 $\pm$ 1004.0 | 207.0–4205.0 |
| <i>p</i>                          | < 0.001            | < 0.001             |              |
| Daily calcium intake per 1000 cal |                    |                     |              |
| 24-h recall (mg/d)                | 348.7 $\pm$ 136.8  | 336.1 $\pm$ 178.0   | 96.0–817.0   |
| IOF FFQ (mg/d)                    | 549.5 $\pm$ 277.4  | 521.3 $\pm$ 297.5   | 116.0–2178.3 |
| RAM FFQ (mg/d)                    | 964.1 $\pm$ 560.7  | 831.6 $\pm$ 714.9   | 121.3–3753.0 |
| <i>p</i>                          | < 0.001            | < 0.001             |              |

In a study conducted in Spain, the mean daily calcium intake values obtained by using 2-day 24-HR recall and FFQ in healthy adolescents were  $564.6 \pm 232.0$  and  $895.9 \pm 343.1$ , respectively [32]. In another study, the calcium intakes obtained using 24-HR recall and FFQ were  $949 \pm 384$  mg and  $1141 \pm 387$  mg, respectively [33]. In studies, the mean calcium intake of participants showed many different results. The variety between the results of calcium intake in different studies may be due to differences in the populations. Foodways and cultures of different nations may have diversified daily calcium intake in study groups. In another study, 3-day 24-HR recall and FFQ were performed to Danish adolescents. The daily mean calcium intakes were found to be 867 and 873 mg/d, respectively [34]. Similarly in this study, the daily mean calcium intake of the participants according to the RAM and IOF FFQ was found higher than the 24-h food consumption records. Generally, studies have shown that FFQs tend to predict more calcium intake than the 24-HR recall [12, 35, 36]. Food frequency questionnaire may have led to more markings of consumption by facilitating the selection of nutrients in the list [37]. Also, when conducting 24-HR recall method, participants sometimes may have forgotten their consumption of food and made a false statement unintentionally. In the study group, it is observed that the list of foods and the amount of portions in these FFQs reduce the problem of

**Table 3** The agreements between the data derived from the 24-h recall and the RAM, or the IOF, are evaluated using the Pearson correlation coefficients ( $r$ ) and intra-class correlation coefficients (ICC)

| Dependent variable | Independent variable | Pearson  |          | ICC      |          |
|--------------------|----------------------|----------|----------|----------|----------|
|                    |                      | <i>r</i> | <i>p</i> | <i>r</i> | <i>p</i> |
| 24-h recall        | RAM FFQ              | 0.044    | 0.557    | 0.019    | 0.393    |
| 24-h recall        | IOF FFQ              | 0.121    | 0.103    | 0.127    | 0.098    |
| RAM FFQ            | IOF FFQ              | 0.528    | < 0.01   | 0.452    | < 0.01   |

**Table 4** Adequate/inadequate calcium intake according to Dietary Reference Intakes

| Variables          | Adequate ( $\geq 1000$ mg/d) |      | Inadequate ( $< 1000$ mg/d) |      |
|--------------------|------------------------------|------|-----------------------------|------|
|                    | <i>n</i>                     | %    | <i>n</i>                    | %    |
| 24-h recall (mg/d) | 16                           | 8.7  | 167                         | 91.3 |
| IOF FFQ (mg/d)     | 60                           | 32.8 | 123                         | 67.2 |
| RAM FFQ (mg/d)     | 136                          | 74.3 | 47                          | 25.7 |

remembering at 24-h method to a great extent. Also, household measures (cups, slices, etc.) in FFQs are used to allow participants to more easily estimate portion sizes. It was assessed only for 24 h in 24-HR recall method, while FFQs were used for the last 7 days. In assessing calcium intake, it may be more beneficial to use FFQs, which can detect longer consumption habits than 24-HR recall method. It was determined that most of the participants could not meet DRI daily calcium intake recommendations derived from data of 24-HR recall (91.3%) and IOF FFQ (67.2%). According to RAM, 74.3% of participants met the daily recommendations at a high rate. That contradicts the other two methods. This can be explained by the differences in declarations of the participants. The RAM and IOF FFQ methods have a moderate positive correlation and it was found to be significant but moderate. In these two methods, correlation is higher than 24-HR because the participants may be helped to remember because the nutrients are listed in both methods.

In a postmenopausal women study, the correlation between FFQ and 24-HR was investigated and found moderate [15]. In another study, the agreement between 7-day FFQ and 24-HR recall was examined and a moderate positive correlation was found [38]. On the contrary, in the study, intra-class correlation coefficient between calcium intakes calculated by IOF FFQ and 24-HR recall was low and statistically not significant. In addition, in the present study, there was no significant relationship between the RAM and 24-HR recall. However, there are some studies that an agreement between these two scales was found [21, 22, 35]. In a study conducted on female athletes, the 6-day 24-HR recall and the RAM were performed and a moderate agreement was found [22]. In another study on athletes using calcium supplements, the RAM and a 3-day 24-HR recall were recorded. A strong positive correlation was found between the two methods and the interclass correlation coefficient was found to be good [21]. A study conducted on adolescents showed a significant moderate correlation between the RAM and 24-HR recall [35]. In this study, when Bland-Altman analysis was used to determine the agreement of the methods, no agreement was found between these three methods. Similarly in a study, when Bland-Altman analysis was used, no agreement was found between the methods that were used [36]. It should be taken into consideration that these

different results may occur because of the differences of the FFQs and the groups in which the studies are conducted. In the IOF and the RAM FFQs, the calcium consumptions of the participants within the last 7 days are questioned. However, in the study, 24-HR recall may not accurately reflect general food consumption and do not provide changes in nutritional habits because the recording was taken only for 1 day. A longer record of the 24-HR recall up to 7 days may further increase the agreement with IOF and RAM FFQs.

There are few limitations in the study. One of these is that methods of food intake determination have not been associated with a biochemical parameter related to calcium. Other limitation is the sample consists of only women and sample size would be larger.

In conclusion; this descriptive study evaluated calcium intake using two FFQs and 24-h recall in female university students in Turkey. There was a moderate positive correlation between the RAM and IOF FFQs. However, it is thought that FFQs are the most appropriate methods in assessing calcium intake for this study group because it is observed that the list of foods and the amount of portions in these FFQs reduce the problem of remembering. There is a need for further studies with males and larger sample size for this young study group in Turkey to explore the effectiveness of the IOF and RAM FFQ methods.

### Compliance with ethical standards

Ethical approval was obtained from the ethics commission of Gazi University (12/09/2016, no: E.149482).

**Conflicts of interest** None.

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