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Development and Validation of a Semi-Quantitative Food Frequency Questionnaire to Assess Dietary Intake of Turkish School-Aged Children

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Key words: validation, food frequency questionnaire, nutritional assessment, school-aged children, dietary intake

The aim of this study was to develop and validate a food frequency questionnaire (FFQ) on the dietary intake of Turkish school-aged children. Fifty randomly selected students aged 7–12 from urban areas of Istanbul were included in this study. An FFQ, containing a list of 138 frequently consumed foods was developed. Dietary records (DRs) including three days, and FFQs were collected during autumn and spring. Daily consumption of each food group was assessed and the nutrient compositions of diet were calculated. The Pearson correlation coefficient, weighted kappa, the Bland--Altman scatter plots between averages of the reported (FFQ) and the references method (DR) were used as validity coefficient.

The Pearson correlation, energy adjusted and attenuation coefficients of nutrient intake were calculated for energy (0.29; 0.11), protein (0.36–0.32; 0.21), carbohydrate (0.25-0.09; 0.15), fat (0.25-0.05; 0.13), and as for food groups, for meat group (0.29–0.21, 0.09), oil and margarine groups (0.21–0.02, 0.08), dairy group (0.52–0.58, 0.31), vegetable group (0.14–0.11, 0.09), fruit group (0.31–0.40, 0.09) and cereal group (0.33–0.34, 0.10), respectively. According to the kappa values, there is moderate and fair agreement between two methods. The Bland-Altman scatter plots showed an acceptable level of agreement between the two methods that DRs may be replaced with FFQ.

The performance of the FFQ is likely to allow detection and sufficient assessment of nutritional status. The developed FFQ had validity coefficients similar to those of FFQs in previous studies.

INTRODUCTION

Investigation of childhood diet is today's popular topic for most of the epidemiological researches and its relation to the onset of diet-related diseases as well [Lanfer *et al*., 2011]. Although dietary records (DRs) and 24-hour recalls have been used, economic constraints and the time of these methods make them unsuitable for most large scale studies [Buzzard, 1998]. Because of their cost-effectiveness and ease of application, food frequency questionnaire (FFQ) is more preferable than weighed dietary records (WDRs) or 24-hour recall.

Components of a basic FFQ are a food list and a response section eliciting how often each item was eaten in a given time interval. However validity is a prime concern [Willett, 1998], which is the effectiveness degree of the method and actually assesses the usual intake of subjects. It is essential to ensure that a FFQ is validated in a group of representative population before using it. For the fact that there is no perfect measurement of diet, the relative validity of an FFQ is often compared with another dietary survey method such as the daily food record [Preston *et al*., 2011].

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Although FFQ might be less accurate when it is compared with a WDR and a 24-h recall, it can assess the habitual dietary patterns of many subjects [Kobayashi *et al*., 2010]. Some of FFQ tools were developed for adults and used to assess their dietary intakes [Kowalkowska *et al*., 2013; Liu *et al*., 2013; Vioque *et al*., 2013]. However when an FFQ originally developed for adults is used to assess the diet of children, intake is overestimated [Wilson & Lewis, 2004; Fumagalli *et al*., 2008]. Difficulties of applying FFQs in children are: remembering quantities, describing the eaten foods in details, the concept of time and estimation of mean frequency of food intake [Kobayashi *et al*., 2010; Lillegaard *et al*., 2012; Eck *et al.*, 1989]. Therefore it would be useful to develop a specific FFQ for children [Kobayashi *et al*., 2010]. Frequency data can present much of the variation in dietary intake and FFQs provide sufficient accuracy to relate individual diets in childhood to subsequent health outcomes [Watson *et al*., 2009]. Because foods are cultural dependent, FFQ validated for one population cannot be used for another population [Cade *et al*., 2004].

The aim of this study was to develop and validate a food frequency questionnaire (FFQ) on the dietary intake of Turkish school-aged children, which is designed for typical Turkish cuisine.

SUBJECTS AND METHODS

Development of the FFQ

In order to form an FFQ, trained interviewers obtained food records from 30 volunteers (30 children with mothers) living in Istanbul to determine the most frequently consumed foods by Turkish population. Participants recorded food consumption over a period of consecutive three days, including two weekdays and one weekend. The pre-tests were undertaken to develop a comprehensive food list and to refine the format of the FFQ with this group. Based on these records and expert opinion, the FFQ was created, which contained 138 foods and those foods were classified under 7 food groups (dairy group, meat group, cereal group, sweet group, oil and margarine group, fruit group and vegetable group) (Table 1).

Classification of the mixed dishes into food groups was done according to source of most abundant energy content of the ingredients. Frequency of food consumption was recorded in nine different categories (>6/day, 4–5/day, 2–3/day, 1/day, 5–6/week, 2–4/week, 1/week, 1–3/month, 1-none / month). The portion sizes of the consumed foods were determined by using food atlas.

A food atlas, containing most frequently consumed foods, beverages and some Turkish dishes was used [Gunes & Imeryuz, 2008]. Eventually, a colored picture of each portion of foods or beverages were shown to the participants [Gunes & Imeryuz, 2008]. Each food had different portion sizes and participants would identify the appropriate portion size (small, medium, large). Food intake was calculated as the frequency and the portion size of the product.

Demographic characters of participants

The study population included 60 healthy children aged between 7 and 12 who lived in the urban areas of Istanbul. After performing the first FFQ and the first record, 7 participants left the study due to unwillingness (4 children), disease (2 children), address change (1 child). Three children were excluded from the study due to the food intake of extremely low or high in calories (less or higher than the 98%). The study was completed with a total of 50 participants comprising 27 males and 23 females with mean age of 10.26 (±1.58) years. The students were randomly selected from three schools with low, medium and high socioeconomic levels, according to region of residence. Afterwards they were divided into two groups, which were consistent with two main socioeconomic levels, *i.e.* low and medium-high socioeconomic levels. The approval was taken from their families and school. All of participants were native Turkish speakers and no ethnical differences were observed. Students had not been using any vitamin and mineral supplements. Children's weights and heights were measured by using TANITA Digital Scale and Seca Stadiometer in order to calculate their Body Mass Indexes (BMIs) according to CDC Growth Charts. Childhood overweight is defined as a BMI-for-age ≥CDC 95 percentile, ≥85-<95 percentile is at risk of overweight, <85-≥5 percentile is normal and <5 percentile is underweight [CDC, 2000].

The surveyed students included 54 % of boys and 46 % of girls. The demographic characteristics of participants are shown in Table 2.

TABLE 1. Description of food groups.

Food group	Description
Cereal group	Bread, rice, macaroni, wheat, patty, biscuits, cereals, semolina, pasta, bulgur, cookies
Dairy group	Milk, sweeted milk, butter, cheese, cheese with fruit, yogurt, yoğurt with fruit, buttermilk, sour cream, ice-cream, kefir
Vegetable groups	Raw vegetables, salad, cooked vegetables
Meat group	Red meat, poultry, fish, eggs, beans, meat varieties, sausages, salami and Turkish sausage
Fruit groups	Fresh and dried fruit, fruit juice
Oil and margarine group	Olive oil, nut oil, sunflower oil, corn oil, margarine, sesame oil
Sweet group	Sugar, sugar in beverages, candy, jam, honey, molasses, chocolate, dairy desserts, pastry, fruit dessert, wafer

TABLE 2. Demographic characteristics of study participants in whole group.

Demographic characteristics	Whole group (n:50)
Age (years)	10.2±1.5
Weight (kg)	35±10.7
Height (cm)	139.6±9
Socio-demographic status, n (%)	
Low	30 (60)
Middle and High	20 (40)
Gender, n (%)	
Girl	23 (46)
Boy	27 (54)
Body mass index, kg/m^2	17.67±3.77
BMI percentile**, n (%)	
≥95 percentile: Overweight	5 (10)
≥85-<95 percentile: At risk of overweight	4 (8)
<85-≥5 percentile: Normal	37 (74)
<5 percentile: Underweight	4 (8)

**: BMI was evaluated according to the CDC (Centers for Disease Control and Prevention) BMI Growth Chart.

FFQ administration

Data collection, timetable and study design were presented in Figure 1.

The purpose and the method of the investigation including the frequency of intake and portion sizes of foods were explained both to the mothers/caregivers and to the children. The developed FFQ was applied face to face to student twice in a year at an interval of 6 months by a dietitian to represent both autumn and spring in 2010 – 2011 with the help of their teacher. To determine amount of the consumed food precisely in a standardized way, pictures of 3 different sizes of each item on the FFQ were shown to the participant. All children could report portion sizes well because food atlas generally contains food and portion sizes clearly. Afterwards their decisions on the portion size and the frequency of consumption were recorded.

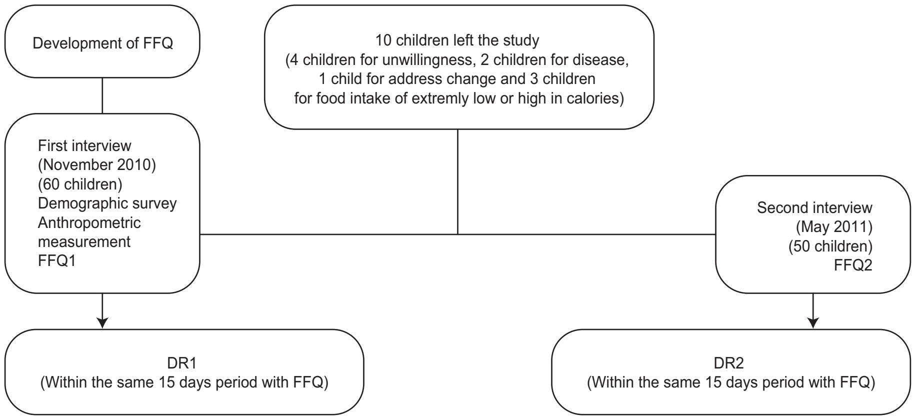

FIGURE 1. Protocol for data collection, timetable and study design.

Dietary Records collection

During data collection visits, empty forms of the DRs were distributed to participants at school. The students were asked to complete the DRs for the following day (or the day after if it was on Sunday) with the help of their families. The DRs were completed for weekdays (2 days) and weekends (1 day) In both cases, DRs were collected within the same 15-day period with FFQ. Oral and written instructions on how the diet should be recorded were given by a dietitian to each class and were explained to their families by phone. All participants were phoned on the second day of their recording period to encourage participation and provide answers to questions. Participants were instructed to call the responsible dietitian at any time if they had questions.

When teachers were visited by the researchers after two days, the completed DRs were interviewed individually with the participants to clarify all food types and quantities. To standardize the amounts of consumed food, every participant was interviewed face to face by a dietitian to determine the amount of the consumption by using the same food atlas with the help of their teacher.

Calculation of nutrient intake

Daily nutrient intake was calculated by using computer software (Ebispro, Stuttgart, Germany; Turkish version: BeBiS, Vers. 6.1). Data source of this software was 97% Bundeslebensmittelschluessel; German Food Code and Nutrient Data Base; Version II.3 and 3% USDA. In the food composition table, local standard recipes have been used as sources for typical Turkish cuisine. By using the same software, daily consumption of each food group (g) was assessed and the nutrient compositions of diet were calculated.

Statistical analyses

Data is expressed as mean and standard deviation. If some data was not normally distributed, it was log-transformed for energy, vitamin E, vitamin B6, vitamin C, sodium, calcium, sweet group. Unpaired t-test was used to compare independent groups. Paired t-test was used to compare estimated daily nutrient intakes by FFQs and DRs. Correlations between estimated macro and micro-nutrients by FFQs and DRs were investigated by Pearson correlation coefficient and attenuation coefficient, which were calculated by correlation test and simple linear regression, respectively. With correction for attenuating effects due to random errors in the reference measurements, the correlation between the questionnaire long-term intake of micronutrients measurement and the true is estimated from the observed correlation with mean reference measurements. Therefore, deattenuated correlations were assigned a higher rating than crude or adjusted correlations [Serra-Majem *et al*., 2009; Fumagalli *et al*., 2008]. To compare two methods of assessments, Bland and Altman plots were used. The average proportions of classifications into the same quartiles, adjacent quartiles and distant quartiles between DRs and FFQs were calculated and compared by weighted kappa statistics. Ninety-five percent confidence intervals (95% CI) were calculated. Bland-Altman plots were used for any acceptable consistency between the present FFQ and DRs. All statistical analyses of study data were performed using SPSS 16.0 (SPSS Inc., Chicago, IL, USA) program and Medcalc program. P values less than 0.05 were considered statistically significant.

RESULTS

Daily macro and micro-nutrient intakes of participants assessed by FFQ and DR are shown in Table 3.

Table 3 also demonstrates the attenuation coefficient which is calculated by simple linear regression analyses, Pearson's correlation coefficients and energy adjusted that are performed with the mean values of FFQ and DRs. Moderate and statistically significant correlations were found for energy (0.29), carbohydrate (0.25 - 0.09), fat (0.25 - 0.05), protein (0.36–0.32). Attenuation coefficients were 0.11; 0.15; 0.13; 0.21, respectively. Among micronutrients, correlation was fair but positive and still statistically significant for vitamin B2, vitamin B6, folic acid, sodium, potassium, calcium and phosphorus ($P < 0.05$).

Table 4 summarizes the mean daily intake of food groups and correlations between methods used to detect food intake. Correlation, energy adjusted and attenuation coefficient of food groups were between for meat group (0.29 – 0.21, 0.09), oil and margarine groups (0.21 – 0.02, 0.08, dairy group (0.52 – 0.58, 0.31), vegetable group (0.14 – 0.11, 0.09), fruit group (0.31 – 0.40, 0.09) and cereal group (0.33 – 0.34, 0.10), respectively.

TABLE 3. Comparison of mean values of daily intake of nutrients detected by FFQ and DRs, Pearson correlation, energy adjusted correlation and attenuation coefficient between the mean values of FFQs and the mean values of DRs.

	The mean of values of FFQs±SD	The mean of values of DRs±SD	Pearson Correlation r	Energy adjusted correlation r	Attenuation coefficient r	P*
Energy (kcal)**	2948±994	1617±530	0.29*	-	0.11*	*0.045
Protein (g)	98±33	59±19	0.36*	0.32	0.21*	*0.011
Fat (g)	127±47	65±24	0.25	0.05	0.13	0.080
Carbohydrate (g)	342±117	192±69	0.25	0.09	0.15	0,083
Fiber (g)	32±10	15±7	0.21	0.07	0.15	0.136
Cholesterol (mg)	458±255	255±110	0.44*	0.45	0.24*	*0.001
Vitamin A (μg)	1448±631	981±496	0.20	0.12	0.16	0.166
Vitamin E (mg)**	28±12	13±7	0.19	0.03	0.21	0.185**
Vitamin B1 (mg)	1.1±0.3	0.6±0.2	0.23	0.06	0.14	0.110
Vitamin B2 (mg)	1.9±0.5	1.1±0.4	0.36*	0.41	0.26*	*0.010
Vtamin B6 (mg)**	2±0.6	1±0.3	0.29*	0.31	0.28*	*0.043
Folic acid (mg)	363±108	207±73	0.32*	0.240	0.22*	*0.024
Vitamin C (mg)**	184±70	98±68	0.11	0.061	0.11	0.546**
Sodium (mg)**	4770±1820	3090±1193	0.41*	0.444	0.35*	*0.003**
Potassium (mg)	3521±1073	1861±686	0.28*	0.273	0.18*	*0.049
Calcium (mg)**	1081±343	659±293	0.39*	0.408	0.46*	*0.005**
Magnesium (mg)	407±127	208±70	0.23	0.302	0.13	0.102
Phosphorus (mg)	1711±526	993±340	0.34*	0.460	0.22*	*0.014
Iron (mg)	16±5	8±2	0.21	0.020	0.11	0.153
Zinc (mg)	14±4	8±2	0.25	0.169	0.16	0.077

*Statistically significant Pearson correlation.**log transformation was done.

TABLE 4. Comparison of mean values of daily intake of food groups detected by FFQ and DRs, Pearson correlation, energy adjusted correlation and attenuation coefficient between the mean values of FFQs and the mean values of DRs.

Food groups	The mean of values of FFQs±SD	The mean of values of DRs±SD	Pearson Correlation r	Energy adjusted correlation r	Attenuation coefficient r	p
Meat group (g)	416±178	123±56	0.29*	0.21	0.09	0.212
Sweet group (g)**	121±63	24±19	-0.03	-0.01	-0.05	-0.125
Oil-margarine group(g)	77±32	23±12	0.21	0.02	0.08	0.024
Dairy group (g)	743±278	256±164	0.52*	0.58	0.31	0.582
Vegetable group (g)	260±113	125±68	0.14	0.11	0.09	0.108
Fruit group (g)	1075±467	201±136	0.31*	0.40	0.09	0.396
Cereal group (g)	890±335	298±103	0.33*	0.34	0.10	0.342

**log transformation was done.

Average values of FFQ and DR values were divided into quartiles, then weighted kappa statistics were calculated for agreement of method. The same, adjacent or opposite quartiles were also determined in Table 5.

Percentages of classifying together the same quartiles with adjacent quartiles were 96, 94, 94, 94%, respectively for energy, fat, protein and carbohydrate,. The highest figures were 98% for vitamin B2, 98% for vitamin C, 98% for cholesterol, 96% for sodium and the lowest value was 86% for magnesium. The percentage of classifying together the same quartiles with adjacent quartiles was in between those percentages for the other micronutrients.

Moderate agreement between two methods (FFQ and DR), which was defined as weighted kappa value of 0.6–0.4, was

TABLE 5. Average values of FFQs and DRs for energy and nutrients were divided into quartiles, and weighted kappa values.

	Weighted kappa	95% Cl	The same quartile n(%)	Adjacent quartile n(%)	Opposite quartile n(%)
Energy (kcal)	0.19	-0.06–0.44	13 (26)	35 (70)	2 (4)
Protein (g)	0.34	0.08–0.59	15 (30)	32 (64)	3 (6)
Fat (g)	0.21	-0.05–0.46	11 (22)	36 (72)	3 (6)
Carbohydrates (g)	0.24	-0.01–0.48	12 (24)	35 (72)	3 (6)
Fiber (g)	0.04	0.22–0.31	14 (28)	32 (64)	4 (8)
Cholesterol (mg)	0.44	0.22–0.66	20 (40)	29 (58)	1 (2)
PUFA (mg)	0.13	-0.14–0.40	11 (22)	35 (70)	4 (8)
Vitamin A (μg)	0.14	-0.14–0.42	16 (32)	29 (58)	5 (10)
Folic acid (mg)	0.14	-0.13–0.41	14 (28)	32 (64)	4 (8)
Vitamin E (mg)	0.16	0.12–0.43	13 (26)	33 (66)	4 (8)
Vitamin B1 (mg)	0.11	-0.16–0.38	16 (32)	31 (62)	3 (6)
Vitamin B2 (mg)	0.20	-0.04–0.45	14 (28)	35 (70)	1 (2)
Vitamin B6 (mg)	0.12	-0.16–0.40	16 (32)	30 (60)	4 (8)
Vitamin C (mg)	0.34	0.10–0.58	17 (34)	32 (64)	1 (2)
Sodium (mg)	0.39	0.15–0.63	18 (36)	30 (60)	2 (4)
Potassium (mg)	0.24	-0.04–0.52	17 (34)	29 (58)	4 (8)
Calcium (mg)	0.30	0.04–0.56	19 (38)	28 (56)	3 (6)
Magnesium (mg)	0.06	-0.24–0.35	13 (26)	30 (60)	7 (14)
Phosphorus (mg)	0.26	0.01–0.51	14 (28)	33 (66)	3 (6)
Iron (mg)	0.16	-0.12–0.43	13 (26)	33 (66)	4 (8)
Zinc (mg)	0.17	-0.10–0.45	15 (30)	31 (62)	4 (8)

TABLE 6. Average values of FFQs and DRs were divided into quartiles, then weighted kappa values for food groups.

Food groups	Weighted kappa	95% Cl	The same quartile n(%)	Adjacent quartile n(%)	Opposite quartile n(%)
Meat group(g)	0.21	-0.06–0.47	14 (28)	33 (66)	3 (6)
Sweet group (g)	0.11	-0.17–0.39	14 (28)	31 (62)	5 (10)
Oil and margarine group (g)	0.17	-0.11–0.44	16 (32)	29 (58)	5 (10)
Dairy group (g)	0.47	0.28–0.66	17 (34)	33 (66)	0 (0)
Vegetable group(g)	0.07	-0.17–0.32	9 (18)	37 (74)	4 (8)
Fruit group (g)	0.19	-0.09–0.47	17 (34)	29 (58)	4 (8)
Cereal group (g)	0.34	0.11–0.57	14 (28)	35 (70)	1 (2)

obtained in cholesterol (0.44). The fair agreement, defined as weighted kappa values of 0.2–0.4 (Table 5), was obtained in protein (0.34), fat (0.21), carbohydrate (0.24), vitamin B2 (0.20), vitamin C (0.34), sodium (0.39), potassium (0.24), calcium (0.30), phosphorus (0.26). There was no agreement on consumption of other nutrients.

Food groups had good agreement, which percentage of classifying together the same quartiles with adjacent quartiles were 100% dairy product, 98% cereal group, but the lowest values were 90% for sweet group and oils and margarine group.

In terms of food groups, dairy group (0.47) consumption showed moderate degree of agreement. Meat group (0.21) and cereal group (0.34) had fair degree of agreement (Table 6).

To illustrate the limits of agreement between two methods, the Bland-Altman scatter plots, were used for daily energy, protein, fat and carbohydrate intakes (shown in Figure 2).

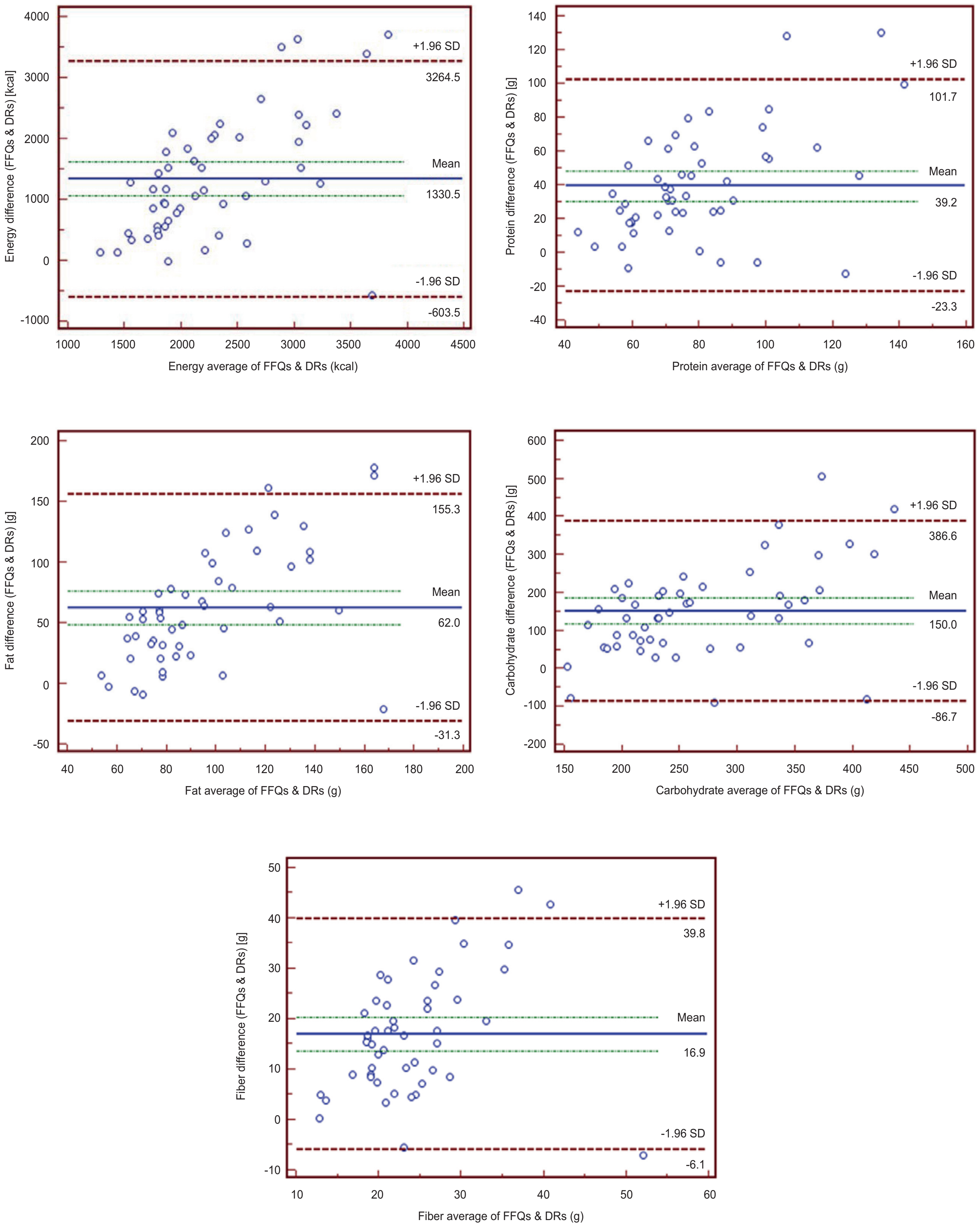

FIGURE 2. Bland-Altman plots comparing the difference and means of food contents measured by FFQ and DRs. The central solid horizontal line indicates the mean difference between the two methods, and the dashed lines above and below it indicate ±1.96 SDs.

Different values of two measurements (FFQ and DRs) were plotted against the average then the mean± 1.96 SD for each subject, accepted as agreement limits. It was expected that all subjects fall between these agreements limits. All plots showed an acceptable level of agreement between the two methods, showing that DRs may be replaced with FFQ.

DISCUSSION

This was the first FFQ, which was an important indicator for the performance of validity in school-aged children for large-scale epidemiological studies that were investigating the assessment of the dietary intake in Turkey. In present study, compared to mean of DRs, mean of FFQs overestimated energy and macronutrients; DRs 1617.78±530.72, FFQ 2948.30±994.97 respectively. Kaskoun *et al*. [1994] reported that the Willett's FFQ overestimated energy intake by 813 kcal/d when compared with doubly labeled water in 4 to 7-y-old children. As a comparison between FFQ and DRs, FFQ shows the mean intake of foods particularly for longer period of time, *i.e.* one year, but DR provides the information about the recent food intake [Willet 1998; Van Dongen *et al*., 2011; Sahashi *et al*., 2011; Dehghan *et al*., 2012].

Validity was evaluated by Pearson correlation and by simple linear regression in that analyses DRs accepted as reference method. Correlation has been defined as poor if $r<0.2$, moderate if correlation varied between 0.2 and 0.6 and high if $r > 0.6$ [Block *et al*., 2006; McNaughton *et al*., 2007]. In the present study, Pearson's correlation coefficients and energy adjusted were between 0.08 – 0.52; 0.02 – 0.58 and attenuation coefficients of regression were between 0.10 – 0.45. Our new developed FFQ was accurate to measure especially, protein, cholesterol, calcium, vitamin D, vitamin B2, sodium, phosphorus, fruits and cereal groups intake in comparison with the DRs. And similarly as in Szymelfejnik study, it was accurate to measure dairy groups [Szymelfejnik *et al*., 2006]. The Pearson correlation coefficients of a food frequency questionnaire for youth ranged from 0.26 for protein and iron to 0.58 for calcium [Rockett *et al*., 1995]. In other studies with a two-week interval between applications of the questionnaire, the correlations ranged from 0.08 to 0.76 [Speck *et al*., 2001] and with a one-year interval correlations were from 0.18 to 0.47 [Field *et al*., 1999].

Both vitamin C and vitamin A were indicated by the poor correlation between the FFQ and DRs [Chen *et al*., 2004; Barrat *et al*., 2012]. In other study, the time reference can also reflect changes in intake due to seasonality, so that lowering the true correlations of fruits and vegetables which are the main source of vitamins like vitamin C and caretonoids [Marchioni *et al.,* 2007]. Nelson and colleagues have addressed how to calculate the number of days of recording required to estimate intakes of individual nutrients for children aged 2–17 years [Nelson *et al*., 1989]. The time between two DRs was 20 days in the study conducted by Navarro *et al*. [2001] whereas in the present study, DRs were performed at six-month intervals. Although seasonality in calculations was taken into consideration, diet influenced by real changes increasing with time, it was to be expected as reporting errors and general variability in diet.

Although the correlation coefficient has been questioned as an indicator of validity, because it measures association instead of agreement between two measurement methods, its use in our analysis can be justified if the FFQ is designed to rank individuals according to nutrient intakes instead of quantifying the absolute level of intakes [Masson *et al*., 2003]. As well as correlation analysis, the cross-classification can indicate differential under and over reporting [Friis *et al*., 1997]. In the present study, agreement in terms of classification was good. More than 90% of participants were classified in the same or adjacent quartiles which is similar to other studies [Deschamps *et al*., 2009; Pakseresht *et al*., 2010].

In a similar study, a good agreement was determined with dairy group [Roumelioti *et al*., 2009]. The children's questionnaire responses relating to dairy group [Szymelfejnik *et al*., 2006] such as milk, yoghurt and cheese consumption were in almost perfect agreement because most children were likely consume dairy group in daily routine and at standard time frames within a day. This also makes it easier to determine the amount and frequency of dairy group consumption.

Bland-Altman analyses showed that there is an acceptable consistency between the present FFQ and DR, which was used as the reference group [Bland & Altman, 1986]. Bland--Altman plots comparing the difference and means of food contents measured by FFQ and DRs. The Y axis is the difference between data intake (energy, carbohydrate, fat, protein and fiber) measured by FFQ (average of FFQ1 and FFQ2) and DRs (average of the two DRs). The axis is the mean of this data intake of the two methods. The central solid horizontal lines indicate the mean difference between the two methods, and the solid lines above and below indicate ± 1.96 SDs. These findings were consistent with the results reported in other studies [Deschamps *et al.,* 2009; Zhuang *et al*., 2012].

The strengths of the present study are that we used a food atlas which shows the amount of consumed foods, thus the amount of consumed foods could be assessed in accordance with the true intake. Some other studies on the tools of dietary assessment are reference books with full-size photographs of portions which have been credited as being both easy and accurate group [Nelson *et al*., 1996; Faggiano *et al*., 1992; Stout 1997; Zhang & Ho 2009]. Another advantage of our questionnaire is that besides the food consumption items, it also contains common special dishes in Turkish cuisine.

The limitations of this study is questionnaire's inability to represent those under the age of 12 years included in the study. And this study has limited sample size and some of the participants quited during the study. Other limitations were biomarkers, which could not be introduced to validate food intake measurements. The FFQ was applied to children in average of 45 minutes.

CONCLUSIONS

In conclusion, the developed FFQ had validity coefficients similar to those FFQs in previous studies, it has been the first questionnaire developed in Turkish children. This FFQ appears to be a useful tool for estimation of dietary intakes for research, especially for epidemiological studies of diet as a risk factor for diseases, and for dietary surveillance in Turkey. And it would make considerable contribution to further studies.

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