Original Article

# Development and Validation of a Short Food Frequency Questionnaire (SH-FFQ) in Iranian Adults: A Prospective Longitudinal Study


## Abstract

**Background:** An accurate assessment of food intake is necessary to monitor nutritional status. However, differences in cultures and dietary habits between communities make it necessary to create culturally specific tools to evaluate food intake. This study aimed to develop and validate a short food frequency questionnaire (SH-FFQ) in Iranian adults. **Methods:** This perspective longitudinal study was conducted during four months. A total of 135 healthy adults over 18 years (both of sex) were included. The 24-hour dietary recalls (24-HDRs) (three times per month: A total of 12 numbers) were collected as reference for validation of SH-FFQ. Participants completed two SH-FFQ, once at the end of the fourth month for validity, and the second one week after the first administration for reliability assessing. **Results:** Reliability analysis showed that the mean difference between the two SH-FFQs was not statistically significant ($P > 0.05$). None of the correlation coefficients ($r_s$) were less than 0.4. There was a substantial or perfect correlation ($r > 0.6$) in 85.1% and a moderate correlation ($r = 0.4–0.6$) in 14.9% of food items. For validity assessment, the average values of two SH-FFQ1 and SH-FFQ2 (SH-FFQ) were compared with the average values of 24-HDRs. All of the intraclass correlation coefficients (ICCs) of between SH-FFQ and 24-HDRs were equal to or greater than 0.4 (except one item). Moderate correlation (ICC = 0.4–0.6) and substantial or perfect correlation (ICC > 0.6) were observed in 38.3% and 59.6% of food items, respectively. **Conclusions:** The current study showed that the developed SH-FFQ is reliable and valid in Iranian adults. This developed SH-FFQ can be used in nutritional assessments.


**Keywords:** *Adult, dietary assessment, Iran, reliability, validity*

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## Introduction

Inadequate diet and inappropriate nutritional status are crucial modifiable risk factors for many chronic diseases.[1] Investigating and evaluating nutritional status plays an important role in the management of chronic diseases such as diabetes, hypertension, obesity, cancer, and even mental disease.[2,3] Nutritional assessment is the first step in dietary modification for community-based intervention programs.[4] An accurate assessment of food intake is necessary to monitor nutritional status and conduct epidemiological and clinical research.[5]

Many epidemiological studies have focused on investigating the relationship between diseases and foods, food groups, dietary patterns, nutrients, or indicators of healthy eating.[6,7] Clarifying the relationship between diet and diseases requires dietary assessment methods.[3] The food frequency questionnaire (FFQ) is one of the most common methods used to evaluate food intake among all age groups. In addition, the FFQ allows the estimation of an individual's usual food consumption over a long period of time, which has a low cost and a high ability to describe common food patterns.[8] However, the information collected by FFQs is usually less accurate compared to food records or dietary recalls. Hence, FFQs should be investigated for both reliability and validity.[8] One of the main weaknesses of the FFQ is that the standard version cannot be used in different regions of the world, even for different regions of the same country, due to the diversity of food, different eating habits, and food choices in different geographical regions, ethnic groups, and cultures.[9] So, it is necessary to prepare, modify, and adapt the questionnaire to cover and reflect the usual food intake of people in particular regions.[10] Since this method is affected by errors like other assessment methods, it is necessary to check its relative reliability and validity.[11] The validity and reliability



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of the FFQ are important and necessary to interpret the findings of studies to relate nutritional factors to diseases and to express these relationships for formulating dietary recommendations.[12] In studies that evaluate the nutritional status of a society, the use of the FFQ is a necessary and common method. Spending a long time to complete the FFQ is one of its main disadvantages.[13] Its length (168 food items) has caused people to get tired of answering and not providing correct information. So, the use of a short questionnaire in research whose validity and reliability have been confirmed is a necessity. Therefore, this study was designed for the first time with the aim of developing and validating of a short food frequency questionnaire (SH-FFQ) in Iranian adults.

## Methods

### Study design and sampling

This longitudinal study was conducted over four months on 135 healthy adults over 18 years old (both of sex) who were referred to health centers in Urmia city in the northwest of Iran. Participants were included using cluster sampling. So, firstly, the names of all the health centers in Urmia City were listed, and they were clustered based on geographical status into the north, south, west, and east regions. Then, the required number of centers was determined based on the ratio of the number of centers in each cluster to the total number of centers and they were selected randomly. Finally, the required samples were selected randomly based on the ratio of the total population in each center.

The sample size was calculated according to a correlation coefficient (r) of 0.58 in a previous study[13] with 95% CI ($\alpha$ = 0.05), design effect (DE) of 2, and precision (d) of 20%, to be 135 subjects based on below formula:

$$n = \frac{z^2_{1\text{-}\alpha/2} \times p(1-p)}{d^2} \times DE$$

The participant's demographic characteristics, including age, weight, height, education status, and job, were recorded on the checklist. Participants were stratified according to education level: high level (academic education) and low level (up to a high school degree). BMI was calculated based on the formula of weight (kg)/height ($m^2$).

This study was approved by the Ethics Committee of the Urmia University of Medical Sciences (ID: IR.umsu.rec. 1399.014). Also, informed consent was obtained from all participants.

### Short-food frequency questionnaire (SH-FFQ)

Participants were asked to fill the frequency of food intake over the past year. A designed semi-quantitative SH-FFQ with 47 food items was completed twice, once at the end of four months (SH-FFQ1) and another one week after SH-FFQ1 (SH-FFQ2). According to the opinions of two nutritionists, the food items were included in the newly designed questionnaire. These food items included bread, rice, fruits, fruit juice, dried fruit, raw vegetables, cooked vegetables, Milk, yogurt, cheese, poultry, beef, lamb meat, fish, eggs, corn and maize, barley or bulgur, lentils, beans, pea, broad bean, soya, mung bean, split peas, potato, almonds, hazelnut, pistachio, walnut, seed, olive oil, liquid oil, solid oil, butter, sausage, hamburger, pizza, pickle, sweets, biscuits, chocolate, cake, jam, soft drinks, delster, dough, and canned foods.

Food intakes were determined in grams based on the previously established weights of the used measure.[14] Participants were asked about the amount and frequency of consumption (daily, weekly, monthly, etc.) of each food item over the past year. The frequency classification of each food was as follows: occasionally or never, 1–3 numbers/month, 1–2 numbers/week, 3–4 numbers/week, 5–6 numbers/week, 1 number/day, 2 numbers/day, and 3 numbers/day. Then, the frequency classification of each food item was converted to daily intake. The daily intake of food items (gram per day) was calculated based on the reference book "Guides of Coefficients and Household Scales".[14] Therefore, the amount of daily intake (gram/day) for food items was calculated by multiplying the portion sizes by the consumption frequency. For the consumed food items, whether weekly or monthly, the product of multiplication (portion size by consumption frequency) is divided to seven or thirty, respectively.

### Three-Day of 24-hour dietary recalls (24-HDRs)

24-HDRs were used as a criterion reference method for the validation of the SH-FFQ. The 24-HDRs were administered for three days (two weekdays and one weekend day) at first (24-HDRs1), second (24-HDRs2), third (24-HDRs3), and fourth (24 HDRs-4) months (total 12 of 24-HDRs). All the questionnaires were completed by nutrition experts, who worked in the selected centers, after completing a training course.

### Statistical analysis

Descriptive statistics of food intakes calculated from the FFQs and 24-HDRs were presented as mean ± standard error (SE) and the other continuous variables as mean ± standard deviation (SD). Categorical variables were shown as *n* (%). An independent *t* test was used to compare the mean of age, height, weight, and body mass index (BMI) and a Chi-square test was used to compare the frequency of education level and job status between males and females.

The reliability analyses of the SH-FFQ were assessed by comparing the food intakes estimated by the SH-FFQ1 vs. SH-FFQ2 using the paired *t* test and Pearson correlation coefficients (r). Intraclass correlation coefficients (ICCs) were calculated for food intakes estimated by 24-HDRs1, 24-HDRs2, 24-HRs3, and 24 HDRs-4 to assess the reliability.

For validity analysis, the mean differences between food intakes obtained from SH-FFQ1/SH-FFQ2 and those obtained from 24-HDRs1/24-HDRs2/24-HRs3/24-HDRs4 were compared using repeated measures of ANOVA and ICCs were calculated. In addition, the validity of the SH-FFQ was assessed by comparing the food intakes using the mean of the two FFQs and the mean of twelve 24 HRs using the paired *t* test and ICCs. The values obtained for the Pearson correlation coefficients and ICCs were interpreted according to the cutoff points proposed by Landis and Koch.[15] Thus, values less than 0.21 indicated poor correlation, 0.21 to 0.40 fair correlations, 0.41 to 0.60 moderate correlations, 0.61 to 0.80 substantial correlations, and greater than 0.80 almost perfect correlations. Data analysis was performed using SPSS17 software, and a *P* value less than 0.05 was considered as significant level.

## Results

Demographic/anthropometric characteristics of the 135 participants are summarized in Table 1, of whom, 70.4% were female. Totally, the mean age and BMI were 39.77 ± 12.16 years and 26.27 ± 3.99 kg/m$^2$, respectively. 68.9% of participants had high-level education and 84.4% of them were employed.

Table 2 shows the mean difference and Pearson's correlation ($r_s$) of food intakes obtained using SH-FFQ1 and SH-FFQ2 for reliability analysis. The mean difference between the two SH-FFQs was not statistically significant (*P* values > 0.05). None of the correlation coefficients ($r_s$) were less than 0.4, while 59.6% (28 item/47) of food items had $r_s$ higher than 0.8 (perfect correlation) and 25.5% (12 item/47) had $r_s$ between 0.61–0.80 (substantial correlation), so there was substantial or perfect correlation (r > 0.6) in 85.1% (40/47) and moderate correlation (r = 0.4–0.6) in 14.9% (7/47) of food items.

In Table 3, the mean of food intakes estimated using the three days of 24-hour dietary recalls (24-HDRs) and intraclass correlation coefficients (ICCs) were assessed for reliability analysis. None of the ICCs were less than 0.2, and only two foods (cooked vegetables and pizza) had an ICC equal to 0.3 (4.25%). Substantial or perfect correlation (ICC > 0.6) was observed in 70.21% of food items (33/47) and there was a moderate correlation (ICC = 0.4–0.6) in 25.54% of foods (12/47).

For the validity assessment of two SH-FFQs, the mean differences between food intakes obtained from SH-FFQ1 or SH-FFQ2 and ones obtained from 24-HDRs1, 24-HDRs2, 24-HRs3, and 24 HDRs-4 were compared. In both SH-FFQ1 and SH-FFQ2, the mean difference of all values was not statistically significant compared to 24-HDRs1, 24-HDRs2, 24-HRs3, and 24 HDRs-4 except for yogurt, cheese, poultry, and beef. None of the ICCs were less than 0.4. Based on ICC, there was a substantial or perfect correlation (ICC > 0.6) in 68.08% of food items (32/47) and a moderate correlation in 31.92% (15/47) of items for both SH-FFQ1 and SH-FFQ2 compared to 24-HDRs [Tables 4 and 5].

Finally, the mean values of SH-FFQ1 and SH-FFQ2 (SH-FFQ) were compared with the mean values of 24-HDRs for validity assessment. The mean difference of all values was not statistically significant between SH-FFQs and 24-HDRs except yogurt, cheese, poultry, and beef. Only pizza had ICC = 0.3 (2.1%) and other ICCs were equal or greater than 0.4. Moderate correlation (ICC = 0.4–0.6) and substantial or perfect correlation (ICC > 0.6) were observed in 38.3% (18/47) and 59.6% (28/47) of items, respectively [Table 6].

## Discussion

In nutritional assessment, the use of a valid food frequency questionnaire is important. The length of this questionnaire has increased the possibility of people getting tired and not providing the correct information when completing the questionnaire. Therefore, it is very important to have a short food frequency questionnaire that has proven validity and reliability.[3,16,17] So, the current study aimed to develop and validate an SH-FFQ in Iranian adults for the first time.

In the current study, for validity assessment, the mean difference of food intakes between SH-FFQ1/SH-FFQ2 and the mean values of 24-HDRs1, 24-HDRs2, 24-HRs3, and 24 HDRs-4 was compared using repeated measures

**Table 1: Demographic characteristics of participants (*n*=135)**

| Characteristics | Total (*n*=135) | Males (*n*=40) | Females (*n*=95) | *P* |
|---|---|---|---|---|
| Age (years) | 39.77±12.16¶ | 40.1±13.2 | 39.63±11.7 | 0.84¥ |
| Weight (kg) | 73.07±12.69 | 79.83±12.29 | 70.22±11.8 | <0.001¥ |
| Height (cm) | 166.7±8.75 | 175.87±8.86 | 162.87±5.1 | <0.001¥ |
| BMI (kg/m$^2$) | 26.27±3.99 | 25.82±3.48 | 26.46±4.19 | 0.39¥ |
| Education, *n* (%) | | | | |
| Low level | 42 (31.1) | 15 (37.5) | 27 (28.4) | 0.42¶¶ |
| High level | 93 (68.9) | 25 (62.5) | 68 (71.6) | |
| Job, *n* (%) | | | | |
| Unemployed | 21 (15.6) | 5 (12.5) | 16 (16.8) | 0.52¶¶ |
| Employed | 114 (84.4) | 35 (87.5) | 79 (83.2) | |

¶Values are as Mean±SD. ¥Independent *t*-test was used to compare the difference between the sexes. ¶¶Chi-square test was used to compare the difference between the sexes

**Table 2: Comparing the mean difference and Pearson's correlation ($r_s$) of food intakes obtained using SH-FFQ1 and SH-FFQ2 (*n*=135)**

| Reliability analyses (FFQ1 vs. FFQ2) | | | | | |
|---|---|---|---|---|---|
| **Food items** | **Mean±SE** | | | **Pearson's correlation ($r_s$)** | **P¶** |
| | **FFQ1** | **FFQ2** | **Mean difference** | | |
| Bread | 170.50±9.24 | 167.18±8.88 | 3.32±3.77 | 0.91 | 0.38 |
| Rice | 105.56±9.73 | 106.80±9.72 | −1.24±2.08 | 0.98 | 0.55 |
| Fruits | 181.37±7.51 | 189.10±8.50 | −7.72±4.79 | 0.83 | 0.11 |
| Fruit juice | 20.36±2.46 | 21.36±2.63 | −1.002±1.1 | 0.90 | 0.38 |
| Dried Fruit | 2.00±0.15 | 2.09±0.17 | −0.08±0.11 | 0.75 | 0.47 |
| Raw vegetables | 14.19±1.14 | 12.94±2.34 | 1.25±2.23 | 0.85 | 0.58 |
| Cooked vegetables | 30.08±2.39 | 28.15±2.35 | 1.92±0.9 | 0.93 | 0.46 |
| Milk | 69.92±7.36 | 71.32±7.34 | −1.4±2.9 | 0.92 | 0.64 |
| Yogurt | 77.49±7.78 | 71.29±5.18 | 6.19±6.8 | 0.51 | 0.36 |
| Cheese | 25.90±2.14 | 26.33±2.15 | −0.42±1.45 | 0.77 | 0.77 |
| Poultry | 73.04±5.83 | 69.65±5.46 | 3.38±5.67 | 0.5 | 0.55 |
| Beef | 12.32±1.25 | 12.00±1.09 | 0.31±0.68 | 0.84 | 0.65 |
| Lamb meat | 7.20±0.91 | 7.45±0.92 | −0.25±0.21 | 0.97 | 0.25 |
| Fish | 12.29±1.93 | 14.44±2.83 | −2.14±1.5 | 0.87 | 0.16 |
| Egg | 26.04±1.51 | 26.03±1.55 | 0.003±0.7 | 0.88 | 0.99 |
| Corn and maize | 5.49±0.6 | 5.95±0.79 | −0.49±0.33 | 0.92 | 0.17 |
| Barley or bulgur | 10.82±0.76 | 10.69±0.92 | 0.12±0.65 | 0.71 | 0.84 |
| Lentils | 11.31±0.67 | 11.50±0.86 | −0.18±0.67 | 0.64 | 0.79 |
| Beans | 13.06±1.44 | 12.25±0.89 | 0.81±1.11 | 0.63 | 0.47 |
| Pea | 10.66±0.93 | 12.17±1.48 | −1.50±1.48 | 0.57 | 0.31 |
| Broad bean | 2.36±0.31 | 2.31±0.31 | 0.05±0.16 | 0.68 | 0.75 |
| Soya | 3.34±0.45 | 3.32±0.44 | 0.02±0.16 | 0.93 | 0.89 |
| Mung bean | 6.32±0.50 | 6.53±0.48 | −0.21±0.29 | 0.82 | 0.48 |
| Split peas | 10.13±0.65 | 10.58±0.69 | −0.45±0.45 | 0.77 | 0.32 |
| Potato | 66.75±4.64 | 67.35±3.84 | −0.59±3.6 | 0.65 | 0.87 |
| Almonds | 0.56±0.10 | 0.53±0.10 | 0.02±0.03 | 0.93 | 0.54 |
| Hazelnut | 0.24±0.05 | 0.21±0.3 | 0.02±0.4 | 0.68 | 0.55 |
| Pistachio | 0.69±0.14 | 0.76±0.17 | −0.07±0.6 | 0.92 | 0.31 |
| Walnut | 3.86±0.36 | 3.85±0.37 | 0.008±0.17 | 0.98 | 0.96 |
| Seed | 2.19±0.18 | 2.23±0.19 | −0.03±0.09 | 0.86 | 0.73 |
| Olive oil | 3.68±0.58 | 3.80±0.61 | −0.11±0.21 | 0.94 | 0.58 |
| Liquid oil | 24.05±1.51 | 23.93±1.42 | 0.11±0.73 | 0.88 | 0.87 |
| Solid oil | 7.81±0.93 | 7.51±0.88 | 0.29±0.54 | 0.82 | 0.59 |
| Butter | 6.27±0.71 | 7.06±1.32 | −0.79±1.10 | 0.56 | 0.47 |
| Sausage | 4.08±0.87 | 3.39±0.58 | 0.69±0.82 | 0.42 | 0.39 |
| Hamburger | 2.69±0.33 | 3.21±0.57 | −0.52±0.48 | 0.54 | 0.28 |
| Pizza | 11.53±1.53 | 13.84±1.79 | −2.31±1.3 | 0.71 | 0.08 |
| Pickle | 18.80±2.69 | 17.76±2.29 | 1.03±1.30 | 0.87 | 0.43 |
| Sweets | 9.61±1.72 | 9.48±2.17 | 0.12±0.93 | 0.91 | 0.89 |
| Biscuits | 9.35±1.39 | 9.51±1.24 | −0.15±1.22 | 0.58 | 0.89 |
| Chocolate | 5.49±0.49 | 6.19±0.62 | −0.69±0.45 | 0.68 | 0.13 |
| Cake | 14.59±1.62 | 15.16±1.55 | −0.57±0.65 | 0.92 | 0.38 |
| Jam | 1.93±0.18 | 1.80±0.16 | 0.13±0.08 | 0.89 | 0.11 |
| Soft drinks | 46.94±6.07 | 52.13±8.89 | −5.18±6.24 | 0.71 | 0.41 |
| Delster | 33.37±6.07 | 34.78±7.01 | −1.40±2.55 | 0.93 | 0.58 |
| Dough | 4.49±0.25 | 4.52±0.24 | 0.027±0.13 | 0.86 | 0.84 |
| Canned foods | 6.22±0.83 | 6.58±0.88 | −0.36±0.24 | 0.96 | 0.15 |

¶Mean difference was compared using a paired *t*-test

of ANOVA, and ICCs were calculated. The reliability analyses of the SH-FFQ were assessed by comparing the food intakes estimate from SH-FFQ1 vs SH-FFQ2 in 1-weak interval.

**Table 3: Mean±SE of food intakes obtained using the three days of 24-hour dietary recalls (24-HDRs) and intraclass correlation coefficients (ICC) (*n*=135)**

| Reliability analyses (24-HDRs1, 24-HDRs2, 24-HRs3, and 24 HDRs-4) | | | | | | |
|---|---|---|---|---|---|---|
| Food items | Mean±SE | | | | ICC | 95% CI |
| | 24-HRs1 | 24-HRs2 | 24-HRs3 | 24-HRs4 | | |
| Bread | 184.31±10.63 | 176.56±9.56 | 181.97±10.58 | 188.26±10.86 | 0.81 | 0.74–0.85 |
| Rice | 113.84±6.06 | 103.75±5.37 | 107.11±5.35 | 101.80±8.62 | 0.67 | 0.55–0.74 |
| Fruits | 188.49±8.02 | 181.59±8.09 | 183.29±7.39 | 182.65±7.72 | 0.92 | 0.89–0.94 |
| Fruit juice | 16.04±3.64 | 19.94±4.39 | 21.15±4.35 | 23±4.63 | 0.67 | 0.56–0.75 |
| Dried fruit | 2.35±0.76 | 2.74±0.81 | 2.78±0.75 | 2.82±0.86 | 0.83 | 0.77–0.87 |
| Raw vegetables | 16.02±1.57 | 15.65±1.68 | 15.61±1.84 | 14.29±1.36 | 0.72 | 0.64–0.79 |
| Cooked vegetables | 30.03±2.83 | 34.52±3.31 | 25.02±2.22 | 32.37±3.02 | 0.32 | 0.11–0.49 |
| Milk | 64.34±8.48 | 62.66±7.33 | 60.79±7.79 | 66.04±7.96 | 0.56 | 0.043–0.67 |
| Yogurt | 41.72±4.67 | 63.80±5.25 | 61.11±5.41 | 51.16±5.55 | 0.82 | 0.76–0.86 |
| Cheese | 21.22±1.28 | 18.84±1.25 | 17.94±1.23 | 15.81±1.28 | 0.81 | 0.76–0.86 |
| Poultry | 41.65±4.78 | 28.75±3.81 | 44.08±4.41 | 35.21±4.27 | 0.8 | 0.74–0.85 |
| Beef | 32.71±2.54 | 33.23±2.81 | 30.61±2.69 | 29.25±3.2 | 0.64 | 0.53–0.73 |
| Lamb meat | 10.23±1.9 | 9.94±1.81 | 8.16±1.39 | 10.08±1.5 | 0.68 | 0.58–0.76 |
| Fish | 8.95±2.26 | 10.18±2.08 | 8.76±1.74 | 9.87±2.75 | 0.56 | 0.42–0.67 |
| Egg | 30.32±1.85 | 29.06±1.92 | 29.49±1.83 | 28.79±2.14 | 0.58 | 0.45–0.68 |
| Corn and maize | 4.81±1.47 | 5.92±1.66 | 3.51±1.21 | 3.14±1.27 | 0.75 | 0.68–0.82 |
| Barley or bulgur | 12.43±2.69 | 11.01±2.65 | 16.13±2.88 | 11.54±2.74 | 0.92 | 0.9–0.94 |
| Lentils | 10.56±1.86 | 11.31±1.65 | 12.7±1.88 | 10.37±1.74 | 0.52 | 0.4–0.64 |
| Beans | 14.85±1.81 | 15.87±1.78 | 10.77±1.41 | 11.91±1.78 | 0.65 | 0.54–0.74 |
| Pea | 12.80±1.42 | 13.04±1.56 | 11.07±1.48 | 10.61±1.35 | 0.67 | 0.57–0.75 |
| Broad bean | 1.28±0.55 | 1.13±0.44 | 2.12±0.64 | 1.38±0.7 | 0.42 | 0.2–0.51 |
| Soya | 0.79±0.36 | 2.12±0.72 | 1.58±0.72 | 0.88±0.4 | 0.4 | 0.21–0.55 |
| Mung bean | 6.59±1.61 | 7.63±1.62 | 7.09±1.78 | 6.94±1.62 | 0.91 | 0.88–0.93 |
| Split peas | 11.66±1.86 | 11.07±1.73 | 13.48±1.93 | 10.26±1.75 | 0.82 | 0.77–0.87 |
| Potato | 60.15±5.73 | 72.39±6.06 | 57.88±5.66 | 63.75±4.64 | 0.85 | 0.8–0.89 |
| Almonds | 0.76±0.15 | 0.43±0.09 | 0.23±0.06 | 0.12±0.04 | 0.51 | 0.36–0.63 |
| Hazelnut | 0.17±0.05 | 0.17±0.07 | 0.12±0.04 | 0.11±0.05 | 0.4 | 0.2–0.54 |
| Pistachio | 1.27±0.34 | 0.67±0.15 | 0.38±0.1 | 0.75±0.24 | 0.49 | 0.34–0.62 |
| Walnut | 3.06±0.4 | 2.4±0.31 | 2.91±0.33 | 2.72±0.34 | 0.68 | 0.58–0.76 |
| Seed | 0.87±0.14 | 1.34±0.29 | 0.85±0.21 | 0.95±0.3 | 0.84 | 0.79–0.88 |
| Olive oil | 3.13±0.62 | 2.75±0.58 | 3.26±0.63 | 2.59±0.56 | 0.6 | 0.48–0.7 |
| Liquid oil | 21.11±0.93 | 20.13±0.99 | 19.81±0.94 | 20.43±1.005 | 0.91 | 0.89–0.94 |
| Solid oil | 6.22±0.75 | 7.13±0.74 | 7.14±0.75 | 6.51±0.77 | 0.98 | 0.96–0.98 |
| Butter | 3.51±0.56 | 4.09±0.67 | 3.71±0.57 | 3.58±0.6 | 0.87 | 0.82–0.9 |
| Sausage | 5.48±1.16 | 3.68±0.95 | 2.96±0.86 | 2.12±0.63 | 0.5 | 0.35–0.63 |
| Hamburger | 3.79±0.78 | 3.44±0.75 | 2.01±0.54 | 1.82±0.56 | 0.45 | 0.28–0.56 |
| Pizza | 10.81±2.85 | 12.55±3.17 | 11.31±2.99 | 18.89±4.54 | 0.3 | 0.05–0.45 |
| Pickle | 16.04±3.22 | 12.34±3.01 | 14.07±2.77 | 14.07±2.92 | 0.76 | 0.69–0.82 |
| Sweets | 8.43±1.63 | 8.47±1.96 | 7.03±1.31 | 7.78±1.52 | 0.8 | 0.73–0.84 |
| Biscuits | 8.87±1.02 | 8.94±1.2 | 7.38±0.95 | 8.01±1.07 | 0.79 | 0.79–0.84 |
| Chocolate | 7.66±1.21 | 7.22±1.09 | 5.69±1.03 | 6.27±1.14 | 0.83 | 0.78–0.87 |
| Cake | 17.88±2.29 | 19.79±2.82 | 16.17±2.17 | 18.98±2.41 | 0.75 | 0.67–0.81 |
| Jam | 1.75±0.33 | 2.006±0.34 | 2.23±0.41 | 1.49±0.31 | 0.4 | 0.21–0.54 |
| Soft drinks | 46.99±7.11 | 43.3±6.77 | 50.99±7.45 | 55.22±8.89 | 0.76 | 0.69–0.82 |
| Delster | 32.65±8.99 | 28.25±6.01 | 28.82±8.09 | 27.54±6.81 | 0.87 | 0.83–0.9 |
| Dough | 3.54±0.4 | 3.93±0.66 | 3.57±0.46 | 3.58±0.37 | 0.74 | 0.66–0.81 |
| Canned foods | 8.88±2.99 | 5.92±1.66 | 4.88±2.09 | 3.63±1.66 | 0.7 | 0.61–0.78 |

The mean difference between the two SH-FFQs was not statistically significant. None of the correlation coefficients ($r_s$) were less than 0.4. Overall, there was a substantial or perfect correlation (r ≥ 0.6) in 85.1% and a moderate correlation (r = 0.4–0.6) in 14.9% of food items, respectively. The mean ICC of 0.67 (range: 0.4–0.95)

**Table 4: Comparing the difference between SH-FFQ1 and the mean of 24-hour dietary recalls (24-HDRs) and Intraclass correlation coefficients (ICC) (*n*=135)**

| Validity analyses (SH-FFQ1 vs. 24-HDRs) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Food items** | **Mean difference** | | | | ***P*** | | | | **ICC** | **95% CI** |
| | **24-HDRs-1** | **24-HDRs-2** | **24-HDRs-3** | **24-HDRs-4** | **P1** | **P2** | **P3** | **P4** | | |
| Bread | −13.81±11.5 | −6.05±11.09 | −11.5±11.9 | −17.7±12.1 | 0.23 | 0.59 | 0.34 | 0.15 | 0.79 | 0.73–0.84 |
| Rice | −8.27±9.5 | 1.80±8.7 | −1.55±9.7 | 3.75±11.7 | 0.39 | 0.84 | 0.87 | 0.75 | 0.68 | 0.58–0.76 |
| Fruits | −7.11±6.4 | −0.21±7.33 | −1.91±6.7 | −1.27±6.7 | 0.27 | 0.98 | 0.78 | 0.85 | 0.92 | 0.89–0.94 |
| Fruit juice | 4.32±3.2 | 0.41±4.3 | −0.79±4.1 | −2.63±4.4 | 0.18 | 0.92 | 0.85 | 0.55 | 0.71 | 0.63–0.78 |
| Dried Fruit | −0.35±0.7 | −0.73±0.8 | −0.77±0.7 | −0.82±0.8 | 0.64 | 0.36 | 0.29 | 0.33 | 0.79 | 0.72–0.84 |
| Raw vegetables | −1.83±1.4 | −1.45±1.5 | −1.42±1.88 | −0.09±1.3 | 0.22 | 0.36 | 0.45 | 0.94 | 0.78 | 0.71–0.83 |
| Cooked vegetables | 0.04±2.7 | −4.44±3.1 | 5.05±2.69 | −2.29±2.57 | 0.98 | 0.15 | 0.6 | 0.37 | 0.78 | 0.71–0.83 |
| Milk | 5.57±6.02 | 7.25±7.05 | 9.13±7.03 | 3.87±6.34 | 0.35 | 0.3 | 0.2 | 0.54 | 0.91 | 0.88–0.93 |
| Yogurt | 35.76±8.06 | 13.69±7.63 | 16.38±8.21 | 26.33±7.87 | <0.001 | 0.07 | 0.05 | 0.001 | 0.77 | 0.7–0.83 |
| Cheese | 4.68±2.39 | 7.06±2.31 | 7.96±2.26 | 10.09±2.19 | 0.07 | 0.06 | 0.06 | <0.001 | 0.52 | 0.4–0.62 |
| poultry | 31.39±7.60 | 44.28±7.01 | 28.95±7.14 | 37.83±7.44 | <0.001 | <0.001 | <0.001 | <0.001 | 0.63 | 0.53–0.72 |
| Beef | −20.47±2.35 | −20.99±2.65 | −18.37±2.5 | −17.02±2.7 | <0.001 | <0.001 | <0.001 | <0.001 | 0.69 | 0.59–0.76 |
| Lamb meat | −3.03±1.74 | −2.73±1.84 | −0.95±1.37 | −2.88±1.56 | 0.08 | 0.14 | 0.48 | 0.07 | 0.7 | 0.61–0.77 |
| Fish | 3.33±2.45 | 2.11±2.39 | 3.52±2.12 | 2.41±2.74 | 0.18 | 0.37 | 0.1 | 0.38 | 0.65 | 0.54–0.73 |
| egg | −4.27±2.17 | −3.01±2.01 | −3.45±2.05 | −2.74±2.21 | 0.05 | 0.13 | 0.1 | 0.22 | 0.58 | 0.45–0.68 |
| Corn and maize | 0.67±1.39 | −0.43±1.3 | 1.97±1.25 | 2.34±1.12 | 0.63 | 0.76 | 0.12 | 0.05 | 0.77 | 0.7–0.82 |
| Barley or bulgur | −1.61±2.57 | −0.27±2.5 | −5.31±2.67 | −0.71±2.61 | 0.53 | 0.91 | 0.05 | 0.78 | 0.88 | 0.85–0.91 |
| Lentils | 0.75±1.82 | −0.002±1.6 | −1.38±1.86 | 0.93±1.73 | 0.68 | 0.99 | 0.47 | 0.59 | 0.54 | 0.4–0.65 |
| Beans | −1.78±2.32 | −2.81±2.27 | 2.29±1.73 | 1.15±2.26 | 0.44 | 0.22 | 0.19 | 0.61 | 0.59 | 0.47–0.69 |
| Pea | −2.13±1.61 | −2.37±1.76 | −0.4±1.72 | 0.06±1.54 | 0.19 | 0.18 | 0.82 | 0.97 | 0.63 | 0.52–0.72 |
| broad bean | 1.08±0.61 | 1.22±0.42 | 0.24±0.61 | 0.98±0.74 | 0.08 | 0.05 | 0.69 | 0.19 | 0.44 | 0.3–0.58 |
| Soya | 2.55±0.58 | 1.22±0.73 | 1.76±0.71 | 2.46±0.57 | 0.05 | 0.1 | 0.09 | 0.05 | 0.5 | 0.35–0.62 |
| Mung bean | −0.27±1.5 | −1.31±1.52 | −0.76±1.75 | −0.61±1.55 | 0.86 | 0.39 | 0.66 | 0.69 | 0.87 | 0.83–0.9 |
| split peas | −1.52±1.81 | −0.94±1.71 | −3.35±1.88 | −0.13±1.76 | 0.4 | 0.58 | 0.08 | 0.94 | 0.79 | 0.73–0.84 |
| Potato | 6.59±9.08 | −5.64±6.57 | 8.87±5.73 | 2.99±6.72 | 0.27 | 0.39 | 0.12 | 0.66 | 0.83 | 0.78–0.87 |
| Almonds | −0.2±0.17 | 0.12±0.11 | 0.33±0.11 | 0.43±0.1 | 0.23 | 0.26 | 0.09 | 0.07 | 0.54 | 0.41–0.65 |
| Hazelnut | 0.06±0.07 | 0.06±0.09 | 0.11±0.05 | 0.13±0.07 | 0.35 | 0.46 | 0.06 | 0.08 | 0.4 | 0.21–0.54 |
| Pistachio | −0.58±0.34 | 0.01±0.17 | 0.31±0.13 | −0.05±0.24 | 0.09 | 0.94 | 0.05 | 0.81 | 0.57 | 0.45–0.68 |
| Walnut | 0.79±0.44 | 1.46±0.42 | 0.94±0.45 | 1.13±0.43 | 0.2 | 0.07 | 0.15 | 0.05 | 0.71 | 0.62–0.78 |
| Seed | 1.32±0.21 | 0.85±0.33 | 1.35±0.25 | 1.24±0.35 | 0.07 | 0.1 | 0.05 | 0.08 | 0.45 | 0.3–0.58 |
| olive oil | 0.55±0.48 | 0.92±0.41 | 0.42±0.46 | 1.09±0.39 | 0.25 | 0.17 | 0.36 | 0.06 | 0.95 | 0.94–0.96 |
| Liquid oil | 2.95±1.39 | 3.92±1.4 | 4.25±1.39 | 3.62±1.48 | 0.16 | 0.05 | 0.047 | 0.06 | 0.88 | 0.84–0.91 |
| Solid oil | 1.58±0.79 | 0.67±0.74 | 0.66±0.8 | 1.29±0.78 | 0.05 | 0.36 | 0.41 | 0.1 | 0.94 | 0.92–0.95 |
| Butter | 2.76±0.81 | 2.18±0.9 | 2.55±0.82 | 2.69±0.9 | 0.05 | 0.14 | 0.09 | 0.07 | 0.78 | 0.71–0.83 |
| Sausage | −1.4±1.3 | 0.4±0.97 | 1.12±1.2 | 1.96±1.08 | 0.28 | 0.68 | 0.33 | 0.07 | 0.56 | 0.43–0.67 |
| Hamburger | −1.09±0.77 | −0.75±0.77 | 0.67±0.56 | 0.86±0.66 | 0.16 | 0.34 | 0.23 | 0.19 | 0.48 | 0.33–0.61 |
| Pizza | 0.73±3.04 | −1.01±3.14 | 0.23±3.21 | −07.35±4.1 | 0.81 | 0.75 | 0.94 | 0.08 | 0.4 | 0.21–0.54 |
| Pickle | 2.75±3.41 | 6.45±3.5 | 4.72±3.31 | 4.72±3.55 | 0.42 | 0.07 | 0.16 | 0.19 | 0.75 | 0.68–0.81 |
| sweets | 1.17±2.12 | 1.13±2.38 | 2.57±1.98 | 1.83±2.02 | 0.58 | 0.63 | 0.2 | 0.37 | 0.74 | 0.67–0.81 |
| Biscuits | 0.48±1.44 | 0.41±1.61 | 1.97±1.44 | 1.34±1.41 | 0.74 | 0.79 | 0.17 | 0.35 | 0.64 | 0.53–0.73 |
| Chocolate | −2.16±1.19 | −1.72±1.12 | −0.19±1.04 | −0.77±1.14 | 0.07 | 0.13 | 0.85 | 0.5 | 0.8 | 0.74–0.85 |
| Cake | −3.29±2.07 | −5.2±2.95 | −1.58±2.33 | −4.39±2.59 | 0.11 | 0.08 | 0.49 | 0.09 | 0.75 | 0.68–0.81 |
| Jam | 0.18±0.32 | −0.07±0.36 | −0.3±0.41 | 0.43±0.21 | 0.58 | 0.85 | 0.47 | 0.21 | 0.45 | 0.3–0.58 |
| Soft drinks | −0.049±5.9 | 3.64±5.94 | −4.05±6.84 | −8.28±7.35 | 0.99 | 0.54 | 0.55 | 0.26 | 0.82 | 0.77–0.86 |
| Delster | 0.72±6.82 | 5.12±4.64 | 4.55±6.28 | 5.83±4.34 | 0.92 | 0.27 | 0.47 | 0.18 | 0.9 | 0.87–0.92 |
| Dough | 0.95±0.38 | 0.56±0.67 | 0.91±0.46 | 0.91±0.36 | 0.05 | 0.4 | 0.5 | 0.06 | 0.51 | 0.37–0.63 |
| Canned foods | −2.66±2.95 | 0.3±1.78 | 1.34±1.98 | 2.59±1.59 | 0.37 | 0.86 | 0.5 | 0.1 | 0.69 | 0.6–0.77 |

P1, P2, P3 and P4: the mean difference between SH-FFQ1 values and 24-HDRs-1, 24-HDRs-2, 24-HDRs-3, and 24-HDRs-4 was compared using Repeated measures of ANOVA, respectively

in this study compared to those reported in some studies was the most attainable and favorable one.[13,18-21] Current study showed that SH-FFQ is well reliable and valid for all food items except for yogurt, cheese, chicken, and meat.

**Table 5: Comparing the difference between SH-FFQ2 and the mean of 24-hour dietary recalls (24-HDRs) and Intraclass correlation coefficients (ICC) ($n$=135)**

| Validity analyses (SH-FFQ2 vs. 24-HDRs) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Food items | Mean difference | | | | *P* | | | | ICC | 95% CI |
| | 24-HDRs-1 | 24-HDRs-2 | 24-HDRs-3 | 24-HDRs-4 | P1 | P2 | P3 | P4 | | |
| Bread | −17.13±11.41 | −9.37±10.83 | −14.79±11.58 | −21.08±11.82 | 0.14 | 0.39 | 0.2 | 0.08 | 0.79 | 0.73–0.84 |
| Rice | −7.04±9.5 | 3.05±8.58 | −0.31±9.58 | 4.99±11.53 | 0.46 | 0.72 | 0.97 | 0.67 | 0.69 | 0.59–0.77 |
| Fruits | −0.13±7.35 | 7.51±8.13 | 5.81±7.94 | 4.96±7.55 | 0.99 | 0.36 | 0.47 | 0.51 | 0.9 | 0.88–0.93 |
| Fruit juice | 5.32±3.38 | 1.42±4.41 | 0.21±4.22 | −1.63±4.62 | 0.12 | 0.74 | 0.96 | 0.72 | 0.71 | 0.62–0.78 |
| Dried Fruit | −0.26±0.74 | −0.65±0.81 | −0.68±0.73 | −0.74±0.86 | 0.72 | 0.42 | 0.35 | 0.39 | 0.78 | 0.72–0.84 |
| Raw vegetables | −3.08±2.46 | −2.71±2.55 | −2.67±2.81 | −1.35±2.55 | 0.21 | 0.29 | 0.34 | 0.59 | 0.68 | 0.59–0.76 |
| Cooked vegetables | −1.87±2.85 | −6.39±3.07 | 3.13±2.65 | −4.21±2.48 | 0.51 | 0.05 | 0.24 | 0.09 | 0.78 | 0.72–0.83 |
| Milk | 6.98±5.99 | 8.66±6.74 | 10.53±6.92 | 5.28±6.14 | 0.25 | 0.2 | 0.13 | 0.39 | 0.91 | 0.89–0.93 |
| Yoghurt | 29.6±5.21 | 7.49±5.24 | 10.18±5.37 | 20.13±5.56 | <0.001 | 0.16 | 0.06 | <0.001 | 0.84 | 0.79–0.88 |
| Cheese | 5.1±2.35 | 7.48±2.31 | 8.39±2.34 | 10.51±2.16 | 0.09 | 0.07 | 0.06 | <0.001 | 0.55 | 0.43–0.61 |
| poultry | 28.04±7.33 | 40.89±6.85 | 25.56±7.39 | 34.44±6.48 | <0.001 | <0.001 | 0.001 | <0.001 | 0.64 | 0.54–0.73 |
| Beef | −21.04±2.36 | −21.34±2.59 | −18.91±2.48 | −17.24±2.73 | <0.001 | <0.001 | <0.001 | <0.001 | 0.69 | 0.6–0.77 |
| Lamb meat | −2.78±1.73 | −2.48±1.85 | −0.71±1.34 | −2.63±1.58 | 0.11 | 0.18 | 0.6 | 0.1 | 0.7 | 0.61–0.77 |
| Fish | 5.48±2.88 | 4.25±2.93 | 5.67±2.75 | 4.56±3.26 | 0.06 | 0.15 | 0.05 | 0.16 | 0.66 | 0.56–0.74 |
| egg | −4.27±2.3 | −3.02±2.02 | −3.45±2.23 | −2.75±2.03 | 0.07 | 0.14 | 0.12 | 0.18 | 0.6 | 0.44–0.67 |
| Corn and maize | 1.14±1.42 | 0.03±1.34 | 2.44±1.37 | 2.81±1.14 | 0.42 | 0.98 | 0.08 | 0.05 | 0.77 | 0.71–0.83 |
| Barley or bulgur | −1.73±2.63 | −0.4±2.56 | −5.43±2.75 | −0.85±2.7 | 0.51 | 0.88 | 0.05 | 0.75 | 0.88 | 0.84–0.91 |
| Lentils | 0.93±1.9 | 0.18±1.79 | −1.2±2.03 | 1.12±1.81 | 0.62 | 0.92 | 0.56 | 0.54 | 0.52 | 0.38–0.64 |
| Beans | −2.59±1.99 | −3.62±2.01 | 1.48±1.56 | 0.34±1.92 | 0.19 | 0.07 | 0.34 | 0.86 | 0.61 | 0.49–0.7 |
| Pea | −0.63±2.08 | −0.87±2.18 | 1.11±2.14 | 1.56±2.04 | 0.76 | 0.69 | 0.61 | 0.45 | 0.54 | 0.4–0.65 |
| broad bean | 1.03±0.6 | 1.17±0.42 | 0.19±0.64 | 0.93±0.73 | 0.09 | 0.07 | 0.77 | 0.21 | 0.43 | 0.3–0.57 |
| Soya | 2.53±0.56 | 1.2±0.7 | 1.74±0.71 | 2.43±0.56 | 0.05 | 0.09 | 0.06 | 0.08 | 0.52 | 0.4–0.64 |
| Mung bean | −0.06±1.53 | −1.1±1.53 | −0.55±1.74 | −0.41±1.55 | 0.97 | 0.47 | 0.75 | 0.79 | 0.87 | 0.83–0.9 |
| split peas | −1.08±1.88 | −0.49±1.76 | −2.9±1.94 | 0.32±1.75 | 0.57 | 0.78 | 0.14 | 0.86 | 0.78 | 0.72–0.84 |
| Potato | 7.19±5.11 | −5.04±5.84 | 9.47±5.24 | 3.59±6.05 | 0.16 | 0.39 | 0.07 | 0.55 | 0.85 | 0.8–0.88 |
| Almonds | −0.23±0.18 | 0.1±0.11 | 0.3±0.12 | 0.41±0.11 | 0.2 | 0.34 | 0.1 | 0.09 | 0.53 | 0.4–0.65 |
| Hazelnut | 0.04±0.05 | 0.04±0.07 | 0.09±0.05 | 0.11±0.06 | 0.42 | 0.58 | 0.06 | 0.09 | 0.42 | 0.25–0.56 |
| Pistachio | −0.51±0.35 | 0.08±0.2 | 0.38±0.17 | 0.01±0.22 | 0.15 | 0.67 | 0.12 | 0.95 | 0.59 | 0.47–0.69 |
| Walnut | 0.78±0.45 | 1.45±0.42 | 0.94±0.48 | 1.12±0.43 | 0.09 | 0.05 | 0.06 | 0.09 | 0.7 | 0.61–0.77 |
| Seed | 1.36±0.21 | 0.89±0.33 | 1.38±0.25 | 1.28±0.34 | 0.07 | 0.1 | 0.05 | 0.08 | 0.48 | 0.32–0.6 |
| olive oil | 0.67±0.48 | 1.04±0.41 | 0.54±0.45 | 1.21±0.38 | 0.36 | 0.17 | 0.24 | 0.05 | 0.95 | 0.94–0.97 |
| Liquid oil | 2.83±1.29 | 3.81±1.22 | 4.13±1.28 | 3.5±1.31 | 0.17 | 0.05 | 0.047 | 0.07 | 0.9 | 0.87–0.92 |
| Solid oil | 1.29±0.63 | 0.38±0.63 | 0.36±0.67 | 0.99±0.61 | 0.05 | 0.54 | 0.58 | 0.1 | 0.96 | 0.95–0.97 |
| Butter | 3.56±1.24 | 2.97±1.15 | 3.35±1.29 | 3.48±1.4 | 0.05 | 0.14 | 0.08 | 0.07 | 0.75 | 0.67–0.81 |
| Sausage | −2.09±1.09 | −0.29±0.83 | 0.43±0.96 | 1.27±0.85 | 0.06 | 0.72 | 0.66 | 0.14 | 0.58 | 0.46–0.69 |
| Hamburger | −0.57±0.83 | −0.23±0.83 | 1.2±0.63 | 1.39±0.72 | 0.49 | 0.78 | 0.06 | 0.06 | 0.56 | 0.43–0.67 |
| Pizza | 3.03±3.1 | 1.29±3.23 | 2.53±3.5 | −5.05±4.5 | 0.34 | 0.69 | 0.47 | 0.27 | 0.35 | 0.16–0.51 |
| Pickle | 1.71±3.1 | 5.42±3.17 | 3.69±2.97 | 3.69±3.12 | 0.58 | 0.09 | 0.22 | 0.24 | 0.77 | 0.7–0.83 |
| sweets | 1.04±2.53 | 1.01±2.76 | 2.45±2.38 | 1.7±2.48 | 0.68 | 0.71 | 0.31 | 0.49 | 0.7 | 0.61–0.77 |
| Biscuits | 0.64±1.26 | 0.57±1.39 | 2.13±1.15 | 1.5±1.12 | 0.61 | 0.68 | 0.07 | 0.18 | 0.71 | 0.63–0.78 |
| Chocolate | −1.46±1.22 | −1.03±1.15 | 0.49±0.103 | −0.07±1.1 | 0.23 | 0.37 | 0.63 | 0.95 | 0.8 | 0.74–0.85 |
| Cake | −2.72±2.08 | −4.62±2.85 | −1.01±2.41 | −3.82±2.6 | 0.19 | 0.11 | 0.67 | 0.14 | 0.75 | 0.67–0.81 |
| Jam | 0.05±0.33 | −0.2±0.34 | −0.43±0.41 | 0.31±0.35 | 0.88 | 0.56 | 0.3 | 0.38 | 0.44 | 0.3–0.58 |
| Soft drinks | 5.13±8.9 | 8.82±8.03 | 1.13±7.5 | −3.09±8.25 | 0.57 | 0.27 | 0.88 | 0.71 | 0.82 | 0.76–0.86 |
| Delster | 2.13±7.38 | 6.53±5.36 | 5.96±6.33 | 7.24±5.29 | 0.77 | 0.23 | 0.35 | 0.17 | 0.9 | 0.87–0.92 |
| Dough | 0.98±0.38 | 0.59±0.66 | 0.94±0.46 | 0.94±0.37 | 0.12 | 0.38 | 0.11 | 0.11 | 0.51 | 0.4–0.63 |
| Canned foods | −2.29±2.95 | 0.66±1.82 | 1.7±2.01 | 2.96±1.62 | 0.44 | 0.72 | 0.4 | 0.07 | 0.69 | 0.6–0.77 |

P1, P2, P3 and P4: the mean difference between SH-FFQ2 values and 24-HDRs-1, 24-HDRs-2, 24-HDRs-3, and 24-HDRs-4 was compared using Repeated measures of ANOVA, respectively

It seems that the lack of validity of four food items in the FFQ (yogurt, cheese, chicken, and meat foods) is not only due to the possibility of memory error in this questionnaire but also to the increasing inflation and prices of these

**Table 6: Comparing the difference between SH-FFQs and the mean of 24-hour dietary recalls (24-HDRs) and Intraclass correlation coefficients (ICC) (*n*=135)**

| Validity analyses (SH-FFQ vs. averaged 24-HDRs) | | | | | | |
|---|---|---|---|---|---|---|
| Food items | Mean±SE | | | $P^{¶}$ | ICC | 95% CI |
| | SH-FFQ [(SH-FFQ1 + SH-FFQ2)/2] | 24 HR [(24HDR1 + 24HDR2 + 24HDR3 + 24HDR4)/4] | Difference (SH-FFQ – 24 HDR) | | | |
| Bread | 168.84±8.87 | 182.78±8.28 | −13.94±9.47.9 | 0.14 | 0.56 | 0.38–0.69 |
| Rice | 106.18±9.67 | 106.62±4.57 | −0.45±8.7 | 0.96 | 0.5 | 0.3–0.64 |
| Fruits | 185.23±7.65 | 184.56±6.94 | 0.67±5.93 | 0.91 | 0.8 | 0.72–0.86 |
| Fruit juice | 20.86±2.48 | 20.03±3.02 | 0.83±2.75 | 0.76 | 0.67 | 0.54–0.77 |
| Dried Fruit | 2.05±0.16 | 2.67±0.65 | −0.63±0.62 | 0.32 | 0.76 | 0.72–0.84 |
| Raw vegetables | 13.57±1.47 | 15.4±1.24 | −1.83±1.51 | 0.23 | 0.69 | 0.59–0.76 |
| Cooked vegetables | 29.12±2.33 | 30.49±2.14 | −1.37±1.95 | 0.48 | 0.76 | 0.67–0.83 |
| Milk | 70.63±7.20 | 63.46±6.94 | 7.16±5.13 | 0.16 | 0.85 | 0.79–0.89 |
| Yoghurt | 74.39±5.68 | 54.45±4.21 | 19.94±4.97 | <0.001 | 0.67 | 0.54–0.77 |
| Cheese | 26.12±2.02 | 18.46±1.01 | 7.66±2.04 | <0.001 | 0.48 | 0.35–0.51 |
| poultry | 71.34±4.89 | 37.42±3.44 | 33.92±6.03 | <0.001 | 0.4 | 0.29–0.44 |
| Beef | 12.07±1.11 | 31.45±1.95 | −19.37±1.1 | <0.001 | 0.58 | 0.42–0.7 |
| Lamb meat | 7.33±0.92 | 9.61±1.18 | −2.28±1.15 | 0.06 | 0.71 | 0.59–0.79 |
| Fish | 13.37±2.31 | 9.44±1.47 | 3.92±1.98 | 0.05 | 0.64 | 0.5–0.74 |
| egg | 26.04±1.48 | 29.41±1.21 | −3.37±1.45 | 0.05 | 0.61 | 0.43–0.71 |
| Corn and maize | 5.72±0.68 | 4.35±1.07 | 1.37±0.92 | 0.14 | 0.65 | 0.51–0.75 |
| Barley or bulgur | 10.76±0.78 | 12.8±2.47 | −2.04±2.33 | 0.38 | 0.87 | 0.83–0.92 |
| Lentils | 11.41±0.7 | 11.24±1.14 | 0.17±1.16 | 0.89 | 0.56 | 0.4–0.62 |
| Beans | 12.66±1.06 | 13.35±1.09 | −0.69±1.51 | 0.65 | 0.65 | 0.49–0.72 |
| Pea | 11.42±0.99 | 11.88±1.033 | −0.46±1.41 | 0.75 | 0.74 | 0.62–0.78 |
| broad bean | 2.34±0.3 | 1.48±0.34 | 0.86±0.36 | 0.62 | 0.6 | 0.4–0.69 |
| Soya | 3.34±0.44 | 1.34±0.35 | 1.99±0.44 | 0.07 | 0.58 | 0.4–0.69 |
| Mung bean | 6.42±0.47 | 7.07±1.47 | −0.64±1.38 | 0.65 | 0.85 | 0.73–0.9 |
| split peas | 10.35±0.63 | 11.62±1.47 | −1.26±1.44 | 0.38 | 0.77 | 0.72–0.86 |
| Potato | 67.05±3.86 | 63.54±4.98 | 3.5±4.57 | 0.44 | 0.64 | 0.5–0.74 |
| Almonds | 0.55±0.1 | 0.39±0.06 | 0.16±0.1 | 0.13 | 0.55 | 0.45–0.6 |
| Hazelnut | 0.23±0.04 | 0.15±0.03 | 0.08±0.05 | 0.09 | 0.43 | 0.3–0.48 |
| Pistachio | 0.73±0.16 | 0.77±0.14 | −0.04±0.15 | 0.78 | 0.63 | 0.48–0.74 |
| Walnut | 3.85±0.36 | 2.78±0.26 | 1.08±0.36 | 0.09 | 0.48 | 0.3–0.63 |
| Seed | 2.22±0.18 | 1.003±0.15 | 1.21±0.21 | 0.06 | 0.44 | 0.34–0.53 |
| olive oil | 3.75±0.59 | 2.93±0.56 | 0.81±0.37 | 0.34 | 0.88 | 0.83–0.91 |
| Liquid oil | 23.99±1.42 | 20.37±0.91 | 3.62±1.25 | 0.06 | 0.62 | 0.46–0.73 |
| Solid oil | 7.66±0.87 | 6.75±0.73 | 0.91±0.63 | 0.15 | 0.82 | 0.75–0.87 |
| Butter | 6.67±0.91 | 3.72±0.51 | 2.94±0.88 | 0.08 | 0.45 | 0.23–0.61 |
| Sausage | 3.74±0.62 | 3.56±0.58 | 0.17±0.64 | 0.79 | 0.61 | 0.45–0.72 |
| Hamburger | 2.95±0.4 | 2.77±0.41 | 0.19±0.44 | 0.67 | 0.58 | 0.41–0.7 |
| Pizza | 12.84±1.54 | 19.21±6.13 | −6.37±6 | 0.29 | 0.3 | 0.2–0.42 |
| Pickle | 18.28±2.41 | 14.13±2.27 | 4.14±2.56 | 0.11 | 0.57 | 0.4–0.7 |
| sweets | 9.55±1.91 | 7.93±1.28 | 1.62±2.07 | 0.44 | 0.63 | 0.52–0.75 |
| Biscuits | 9.44±1.17 | 5.91±0.53 | 3.52±1.11 | 0.05 | 0.4 | 0.3–0.57 |
| Chocolate | 5.84±0.51 | 6.71±0.92 | −0.87±0.91 | 0.34 | 0.77 | 0.63–0.85 |
| Cake | 14.87±1.55 | 18.21±1.84 | −3.33±1.91 | 0.08 | 0.54 | 0.36–0.67 |
| Jam | 1.86±0.17 | 1.87±0.21 | −0.003±0.22 | 0.99 | 0.45 | 0.25–0.61 |
| Soft drinks | 49.53±6.94 | 49.13±4.79 | 0.41±4.6 | 0.93 | 0.85 | 0.79–0.89 |
| Delster | 34.08±6.43 | 29.31±6.43 | 4.76±4.15 | 0.25 | 0.88 | 0.84–0.92 |
| Dough | 4.51±0.24 | 3.65±0.29 | 0.85±0.28 | 0.32 | 0.61 | 0.46–0.72 |
| Canned foods | 6.41±0.85 | 5.83±1.57 | 0.57±1.54 | 0.71 | 0.41 | 0.2–0.58 |

The mean difference was compared using paired *t*-test

foods during the study period, which has caused a reduced consumption in households compared to usual intake. Therefore, the intake of some foods has been replaced with other foods. These changes from usual intakes are detected in the 24-hour recall method, but they were not shown in SH-FFQ, and it seems that in the lack of significant price fluctuations, the SH_ FFQ can be trusted for all food items.

The fact that, in the current study, the correlation coefficients were above 0.4, for most of the items, may be attributed to the synergistic effect of the complete and precise food list and distance between the two SH_FFQs. According to some studies, correlation coefficients tended to be lower when FFQ was repeated after a long time interval compared with a shorter time interval, which could be explained by the variation in dietary habits due to longer time laps.[3,16]

Indeed, this interval should not be too short or too long, because in a short period of time, subjects may remember and repeat the answers. On the other hand, a long time interval can be influenced by dietary changes, for example, changes due to seasonality.[17,22]

Although there is no consensus on this matter, previous studies have evaluated reliability at the same 2-week interval.[21-23]

The average time interval between administering the two SH-FFQs in this study is considered adequate because it is not likely to influence eating habits. While in other research, this distance has reached 30–40 days.[13,15,21]

Finally, validity assessment was done by comparing the mean values of SH-FFQ1 and SH-FFQ2 (SH-FFQ), and the mean values of 24-HDRs and ICCs were calculated. In the current study, to reduce people's need for long reminders, food intake was investigated prospectively with a 24-hour reminder for three days every month. A total of 12, 24-HDRs were collected during four months, and this number has increased the accuracy of the data collected in this research. While in other studies, the number of 24-HDRs has been limited between 1 and 3 questionnaires during the study.[3,13,15,21]

The current study showed that the mean difference of all values of food items was not statistically significant between SH-FFQ and 24-HDRs except for yogurt, cheese, poultry, and beef, and all the ICCs were equal to or greater than 0.4 except one food item. Moderate correlation (ICC = 0.4–0.6) and substantial or perfect correlation (ICC ≥ 0.6) were observed in 38.3% and 59.6% of values, respectively. The correlation coefficients ranged from 0.3 to 0.98 for reliability analysis, and the ICCs ranged from 0.3 to 0.88 for validity analysis of SH-FFQ. In this study, the correlation coefficient was higher than the mean values found by other studies.[16,19] In addition, the validity correlation coefficient of SH-FFQ was higher than the reported values in other studies of the Iranian population.[13,24]

Since correlation coefficients above 0.30 are considered as acceptable in FFQ validation studies.[25,26] In this sense, the developed SH-FFQ in the current study shows acceptable validity in adults.

The 24-hour diet recalls were chosen as the reference method for the assessment of FFQ validity because they were expected to have a high response rate and good quality of response.[27] Because a single administration of a 24 HR is unable to account for day-to-day variation, two or more nonconsecutive recalls are required to estimate usual dietary intake distributions. Multiple administrations are also recommended when 24 HRs are used to examine diet and health or other variables. The reliability of the recall methods is very dependent on the shortness and length of the recall questionnaires. The reliability of the studies increases with the shortness of the questionnaires, and a study that can prove the validity and reliability of a short FFQ can play an important role in these studies. Therefore, in this study, due to the predominance of literate subjects in this study, 24 recall methods had more value and validity compared to equivalent methods such as food record, and we were able to compare a 4-month reminder method with a 24-hour reminder method over time.

To our knowledge, the present study is the first one that proposes the reliability and validation of an SH-FFQ in West Azerbaijan in the north of Iran. The most important advantage of the current study is its prospective nature, which raises the accuracy of the study to an acceptable level and introduces a practical tool for checking food consumption in nutritional studies. Also, this study had some strengths, such as measuring 12 times of 24-HDRs (four consecutive months and three times every month) and measuring twice of the SH-FFQ at an interval of one week at the end of four months, which has increased the accuracy of the data collected in this research.

Given that both the FFQ and the 24 HR rely on respondents' ability to accurately recall the past, some degree of measurement error due to under- or over-reporting of consumption is inevitable. Nevertheless, in this study, an attempt has been made to optimize the data collection process to reduce measurement errors. The limitations of this study are the small number of samples and relatively short duration of the study, so it is recommended to conduct a study with a larger number of samples with high reliability and a long duration to cover seasonal variation in food intake.

## Conclusions

In conclusion, based on our knowledge, this is the first study that has evaluated the reliability and validity of an SH-FFQ in Iranian adults. The results of this study have shown that the SH-FFQ has acceptable validity and reliability. Therefore, this SH-FFQ will be a useful assessment tool in future researches, particularly in studies on the relationship between dietary intake and chronic diseases. In addition, this tool provides valuable assistance to health policymakers as it may be useful in evaluating interventions or policies to improve community nutrition.

## Abbreviations

SH-FFQ: Short food frequency questionnaire.

24-HDRs: Twelve 24-hour dietary recalls.

DE: Design effect.

SE: Standard error.

BMI: Body mass index.

ICC: Intraclass correlation coefficients.

## Ethical approval

This study was approved by the ethics committee of Urmia University of Medical Sciences with number IR.UMSU.REC.1399.014. All participants signed a consent form—consent for publication.

## Data availability statement

All data relevant to the study are included in the article.

## Authors' contributions

It is to certify that this study has been planned, organized, and conducted by SNS and MA, and the manuscript has been prepared by the same ones. SNS contributed to the interpretation of the data and writing of the manuscript. Data analysis was done by *P* A. Critical revision of the manuscript for important intellectual content was done by all authors. All authors read and approved the final manuscript.

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## Conflicts of interest

There are no conflicts of interest.

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