



VALIDITY AND REPRODUCIBILITY OF A FOOD FREQUENCY QUESTIONNAIRE DESIGNED TO CHARACTERIZE THE DIET OF WOMEN OF CHILDBEARING AGE

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Abstract

Objectives: To test the validity and reproducibility of a food frequency questionnaire (FFQ) administered by interview, consisting of 127 items, developed to characterize the food intake of women of fertile age, in comparison with the method of the 24 hours diet recall (24 HDR). **Design:** The FFQ assessment study was conducted on 47 women aged between 19 and 43 years old. The food frequency questionnaire was administered twice to the same subject at a period of three months. To test the validity, the diet was assessed by three 24 HDR, two applied at the same time with the FFQ and a third one a month after the first test. The reproducibility was tested by comparing the average nutrient intake and the food consumption in grams of the food divided into food groups of the two FFQ. The validity was assessed by comparing the average nutrient intake and the food consumption in grams of the food divided into food groups of the two food frequency questionnaires, with the average of the nutrient input of the three 24 HDR ones. **Results:** The reproducibility was assessed using the Pearson correlation, the correlation coefficients range between 0.615 for cholesterol and 0.863 for the energy application. The strongest connection was recorded for fruit (0.960) and the lowest for soups (0.637). The Pearson correlation coefficients to test the validity ranged between 0,051 for cholesterol and 0.829 for the energy application. In testing the validity by comparing the food groups the lowest correlation is recorded for vegetables (0.35) and the highest for beverages (0.72). **Conclusions:** The results indicate a favourable reproducibility and validity of the FFQ developed.

keywords: food frequency questionnaire, 24 hours diet recall, validity, reproducibility, nutrients, fertile age women

Background

The fundamental ways of assessing the food intake is rendered by such means as follows: the food record; the 24-hour diet recall; the food frequency questionnaire and dietary history [1].

As most personalised diets normally vary on a daily basis, it is therefore advised against gathering all data of a single 24-hour diet recall interview to conclude upon one's habitual diet. Due to the high intra-individual variability, a more accurate evaluation of one's diet is recommended to be performed throughout several days of questioning. The purpose of doing that is to conceive a generalized data of the population although it demands specific statistical methods [2].

Diet records commonly provide exact data on the food consumption as observed throughout the intended time period (1 – 7 days). Keeping a record of the food as it is progressively consumed can be contributory to a decreased omission rate and it reveals the benefit of tracking the complete amount of food intake [3]. The inconvenient resulted in applying the method of a diet record is conveyed by the fact that one's choices of food and its ingested quantities are consequently influenced. It also requires a collaborative relationship with individuals being well-motivated and having the necessary educational background [3].

The food frequency questionnaire stands for a method of assessing the food intake per population by way of estimating the general food frequency within a limited period of time. The data selection is performed depending on the frequency and the occasional size of the food portion but there is little information on the specifications of the

ingested food meaning no reference is made to the preparation methods or the combined food of a meal. The relative or absolute nutrient intake can be evaluated by conceiving several questions addressing the issue of portion sizes or demanding for the exact portion size to be mentioned with every given question. The common nutrient intake is calculated by summing up the food frequency and the amount of nutrient in a food product [4]. Operating with FFQs can be considered beneficial as it facilitates the assessment of a regular food intake per individual or population over an extended period of time. As a rule, the food frequency questionnaires are widely applied in valuable epidemiological studies in order to measure the regular food intake as a consequence of the low costs involved in collecting and processing the specific data as well as its much simpler information completion as opposed to the 24-hour diet recalls or the serial food records [3].

Material and methods

The targeted population segment

The group of attendees was made of 55 women residing in Iasi County. The data selection was carried out from March till May 2008, 5 women were unavailable and failed to take part in the second 24-hour diet recall and three of them similarly missed the second FFQ. All 47 women having undertaken the complete number of stages included in the food frequency questionnaire inhabit a urban environment by 51,1% and a rural one by 48,9%, are aged between 19 to 43 years old (the average value is of 25,22 years) and also observed with a median value of about 23, 24 kg/ m² BMI. The study was conducted according with the Declaration of Helsinki and

all subjects gave written informed consent before taking part.

The idea of developing a food product list based on the food frequency questionnaire was initiated when examining the composition tables of the food range available nationwide [2] as well as the data base belonging to USDA

(www.nal.usda.gov/fnic/foodcomp/search/) in order to distinguish the nutrient rich foods in view of which FFQ validation was undertaken: protein, fat, cholesterol, carbohydrate, total fibre, calcium, iron and magnesium. The final list was, however, limited after having previously conducted a 24-hours diet recall and a stepwise multiple regression procedure so as to identify the food types that are fundamentally instrumental in achieving the nutrient intake [5]. The FFQ under validation analysis consisted of 127 food products divided into 14 different groups: bread and cereals, dairy products, meat, fish, fat, eggs, vegetables, soup, fruit, seeds and oleaginous fruit, fast-food products, alcoholic beverages and soft drinks. The food frequency questionnaire was administered by an interviewer having an open debate with the participant being examined.

Data Collection

FFQ was preceded by an introductory questionnaire regarding demographic information of the individuals under examination and identify the following anthropometric parameters: weight, height and BMI. The regular food frequency was retrospectively analysed over a 12-month period of time. Along with the 24-hours diet recall, it was accomplished on two occasions three months away one from the other while

the third 24-hours diet recall was applied one month after the first test. The FFQ inquired women about their average food consumption over the last year. As for the assessment of the quantities associated with the food portions, the reference was made to the standard portion by the cooking measurements to follow: mugful, spoonful, scoopful or pinch and to the medium size when dealing with fruit. The food frequency was measured in such indicators as follows: 0/month, 1/month, 2-3/month, on a weekly basis (number of days per week). In view of establishing the food intake, it was agreed upon tracking the daily frequency of the food portion consumption. The nutrient proportion and the caloric intake of every person were calculated by means of Excel 2007 programme that also proved helpful in conceiving a centralized database.

Statistical Analysis

A numeric description of the mean, median and dispersal variables was done for each type of nutrient and food group. In order to evaluate the reproducibility of the FFQ, the Pearson's correlation coefficients and the intra-class correlation coefficients (ICC) were measured between the medium energy intake, nutrients and food groups of both frequency questionnaires. The validity status was verified by calculating the Pearson's correlation coefficients and the intra-class correlation those between the average energy intake, nutrients and food groups of the two FFQs and the three 24-hour diet recalls. The correlations were considered to have attained their significance level when reaching $p \leq 0.05$. The statistical data processing was performed by way of SPSS 16 version programme.

Results

The average intake of protein, fat, carbohydrate and total fibre revealed as a consequence of the food frequency questionnaire proved to be much higher than

the one attested by the average of the three 24-hour diet recalls. The medium intake of cholesterol, iron, calcium and magnesium had a lower value than the one indicated by the reference method (table 1).

Table 1. The average and standard deviation of nutrient intake of the FFQ and 24 HDR

	FFQ 1		FFQ2		24 HR	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Calories	2094,42	788,53	2119,09	923,74	2138,69	643,08
Protein g	89,35	38,00	90,03	38,44	87,18	31,12
Total Fat g	85,98	38,78	90,23	50,03	84,86	29,2
Cholesterol mg	215,64	153,00	207,97	142,00	261,87	164,48
Carbohydrate g	306,74	142,43	308,48	149,35	295,88	99,09
Celulosis g	12,76	8,16	11,95	7,47	12,40	8,61
Iron mg	11,79	6,52	11,56	4,95	13,58	4,92
Calcium mg	550,98	269,95	577,98	331,36	579,27	259,67
Magnesium mg	231,26	101,93	226,63	101,37	247,16	89,56

As a result of the statistical descriptive analysis, it can be noticed that, as far as the food groups are concerned, we are presented a sub-reported intake dairies, fats, vegetables and alcoholic beverages altogether with an over-reported consumption of soup, fruit, seeds, sweets, fast-food products and soft drinks of the FFQ by comparison to the average of all three 24-hour diet recalls (table 2).

Reproductibility

As for the nutrients having been examined, the Pearson's correlation coefficients ranged from 0,616 for cholesterol and 0,888 for fat while the median variable

showed a 0,803 value. The caloric intake had a Pearson's correlation coefficient of 0,863. The intra-class correlation coefficients varied between 0,617 for cholesterol and 0,889 for fat while the medium value of the correlation coefficients was that of 0,794 and the median variable – 0,791. The caloric intake revealed an ICC value of 0,855 (table 3).

As concerns the food groups, all intra-class correlation indicators are observed with significant values ($p < 0,05$). The highest correlation is recorded in fruit (0,960) while the lowest correlation is registered in soup (0,637) (table4). The average value of the intra-class correlation coefficient was of 0,747, the median variable being of 0,747.

Table 2. The average intake by food groups (grams) observed in FFQ and 24 HD

Food Group	FFQ ₁		FFQ ₂		%	The average FFQ		24H	
	The mean, median and the standard deviation		The mean, median and the standard deviation			The mean, median and the standard deviation		The mean, median and the standard deviation	
Dairies	143,887 (135,95)	(78,58)	250,73 (166,88)	(103,46)	105	198,47 (179,63)	(134,43)	212,66 (146,15)	(187)
Fats	18,13 (10,56)	(16,59)	18,58 (14,52)	(17,02)	102	18,36 (12,48)	(16,58)	23,81 (180,4)	(23,38)
Meat	124,52 (61,14)	(107)	138,88 (80,9)	(123,7)	111	125,77 (62,24)	(118,20)	134,71 (68,97)	(134)
Eggs	24,54 (18,04)	(20,42)	27,72 (19,91)	(24,49)	112	26,13 (18,13)	(21,37)	28,18 (25,38)	(21,66)
Fish	15,83 (12,78)	(13,33)	16,08 (14,52)	(12,66)	101	15,96 (12,48)	(14,75)	25,88 (0,00)	(44,95)
Vegetables	306,17 (163,76)	(250,93)	295,86 (126,64)	(255,75)	96	301,01 (133,11)	(249,03)	354,79 (180,4)	(333,33)
Soup	128,66 (83,21)	(116)	119,42 (66,12)	(106,66)	93	124,04 (67,98)	(113,52)	121,48 (75,59)	(133,33)
Fruit	321,18 (322,65)	(246,32)	331,34 (317,06)	(295,12)	103	322,74 (305,44)	(275,48)	233,74 (145,69)	(200)
Seeds and oleaginous fruit	44,24 (27,92)	(37,53)	38,15 (27,69)	(30,87)	86	37,80 (25,99)	(30,62)	16,84 (0,00)	(23,49)
Sweets	82,29 (48,46)	(68,59)	84,59 (59,65)	(65,45)	103	83,44 (51,22)	(74,81)	71,31 (0,00)	(23,49)
Drinks	17,82 (26,95)	(16,66)	20,84 (10)	(43,91)	117	19,33 (13,33)	(35)	22,77 (0,00)	(52,77)
Fastfood	29,82 (21,59)	(23,13)	29,08 (26)	(24,77)	98	29,45 (21,27)	(25,56)	24,27 (0,00)	(43,86)
Bread	220,70 (118,54)	(191,22)	188,62 (131,22)	(155,19)	85	204,67 (117,17)	(197,08)	210,44 (105)	(192,38)
Juice and other soft drinks	101,04 (96,96)	(59,52)	93,29 (98,98)	(59,52)	92	97,16 (91,32)	(59,52)	82,22 (115,49)	(0,00)

Table 3. FFQ1-FFQ2 Correlation Coefficients and 24 HDR Comparative

Nutrients	Pearson's Correlation			Intra-class correlation coefficient		
	FFQ1 vs. 24 HDR	FFQ 2 vs. 24 HDR	FFQ1 vs. FFQ2	FFQ1 vs. 24 HDR	FFQ 2 vs. 24 HDR	FFQ1 vs. FFQ2
Calories	0.829	0.814	0.863	0.814	0.767	0.855
Protein	0.656	0.634	0.880	0.647	0.623	0.882
Carbohydrate	0.733	0.719	0.801	0.647	0.623	0.882
Cholesterol	0.051	0.316	0.615	0.049	0.299	0.617
Fat	0.699	0.644	0.888	0.653	0.591	0.889
Celulosis	0.403	0.191	0.769	0.407	0.192	0.766
Iron	0.571	0.557	0.865	0.529	0.518	0.836
Calcium	0.385	0.371	0.805	0.387	0.365	0.789
Magnesium	0.388	0.537	0.727	0.384	0.526	0.730

Validity

In order to verify the validity, for nutrients, both FFQs were compared to the average of the three 24 HDR. Except from the

correlation for cellulosis (questionnaire 2 vs 24h) and cholesterol (questionnaire 1 vs 24h), all of the other correlation coefficients indicate significant values (table 3). While testing FFQ1 by comparison to 24 HDR average, the

Pearson's correlation coefficients varied between 0,051 for cholesterol and 0,829 for energy intake(mean variable: 0,523, median variable: 0,547 and a FFQ2 vs. 24 HDR

between 0,191 for fibre and 0,814 for energy intake (mean variable: 0,531, median variable: 0,547) (table 3).

Table 4. The correlation coefficients between FFQ1-FFQ2 food group consumption

Food group	FFQ ₁ Average	FFQ ₂ Average	The value of the intra-class correlation coefficient	p
Dairies	143,887	150,73	0,641	0,000
Fat	18,13	18,58	0,776	0,000
Meat	124,52	138,88	0,702	0,000
Egg	24,54	27,72	0,822	0,000
Fish	15,83	16,08	0,667	0,000
Vegetables	306,17	295,86	0,654	0,000
Soup	128,66	119,42	0,637	0,000
Fruit	321,18	331,34	0,960	0,000
Seeds and oleaginous fruit	44,24	38,15	0,811	0,000
Sweets	82,29	84,59	0,777	0,000
Drinks	17,82	20,84	0,846	0,000
Fastfood	29,82	29,08	0,676	0,000
Bread	220,70	188,62	0,756	0,000
Juice and soft drinks	101,04	93,29	0,738	0,000

The intra-class correlation coefficients varied between 0,049 (for cholesterol FFQ1 vs 24 HR) and 0,814 for energy intake (FFQ1 vs 24 HR), higher values than the second FFQ being noticed when comparing the first FFQ with the the outcomes of 24 HDR analysis. The average value of ICC in the comparative study of FFQ1 with the average of the three 24-hour diet recall during the last 24 hours was of 0,508 while the median variable was of 0,518. In the second FFQ, the ICC value was of 0,500 and the median variable of 0,522 (table 3).

A for the food groups, a comparison was performed between the average of the two food frequency questionnaires and the average of the three HRD. The highest correlation was observed in bread (0,597) and the lowest correlation indicated towards dairies (0,38), the average value of these ones being of 0,484 and the median variable of 0,484. All

correlation coefficients show significant values ($p < 0.05$) (table 5).

Discussions

The regular food intake is necessary to be measured in order to determine the correlation between diet and sickness. The food frequency questionnaire stands for a helpful working instrument in the epidemiological studies as it facilitates a long-term diet evaluation of the studied population segment. So as to assess the effectiveness of the food frequency questionnaires, two different approaches were undertaken:

1. Comparing the averages
2. Determine the proportion of the overall food intake comprised in the the questionnaire.
3. Validation (comparison to a standard reference method)
4. Reproducibility

5. Comparison to the biochemical markers
6. Correlate the data with a physiological answer
7. Ability to predict certain affections [5].

Table 5. The Pearson's correlation coefficients in the comparison of the food intake in FFQ with the 24 HR

Food Groups	FFQ Average	24H Average	Pearson's correlation coefficient	p
Dairies	198.47	212.66	0,38	0,01
Fat	18.36	23.81	0,389	0,008
Meat	125.77	134.71	0,532	0,000
Eggs	26.13	28.18	0,52	0,000
Fish	15.96	25.88	0,653	0,000
Vegetables	301.01	354.79	0,306	0,041
Soup	124.04	121.48	0,431	0,003
Fruits	322.74	233.74	0,403	0,006
Seeds and oleaginous fruit	37.80	16.84	0,389	0,008
Sweets	83.44	71.31	0,357	0,016
Drinks	19.33	22.77	0,725	0,000
Fastfood	29.45	24.27	0,535	0,000
Bread	204.67	210.44	0,597	0,000
Juice and soft drinks	97.16	82.22	0,563	0,000

The validity study was undertaken by a group of women residing in Iasi County, the reproduction component in the general population or other groups of individuals demanding an additional validation and prospective changes depending of the characteristics observed in the tested groups [6].

On the purpose of evaluating the nutrient intake, it is therefore necessary to make use of the tables indicating the nutrient intake of the food being reported by the participants as part of the 24-hour diet recall of the last 24 hours as well as in FFQ. The nutrient composition table can constitute a major source of variation in the evaluation run by means of FFQ. As the available databases in our country lack complete information, we operated with the database of US Department of Agriculture. The food composition in USDA database is

likely to be the most comprehensive worldwide, the assessment of the nutrient intake being performed by standard methods and continuously updated. Furthermore, there are about 150 tables referring to the composition of current foods in the entire world with values mainly relying on USDA [7].

FFQ validation carried out by means of 24 serial HRs does not represent the best method as the errors of the two food inquiries can be correlated (both of them demand memorizing skills and an evaluation of the portion sizes). However, 24 HR is preserved as a justifiable alternative when dealing with a decreased motivation of the participants being tested [5].

Regardless of the comparison approach selected in view of the validation, it is essential to take into consideration the time period FFQ is addressed to. Since the „real”

food intake normally stands for the average long-term intake, the comparison method ought to indicate this time period. The comparative testing of FFQ with serial food records is motivated by the wide diversity of an individual's daily food intake [5]. Although the time periods in testing the reproducibility varied between 2 up to 15 years [8], its selection still proved to be fundamental. A time period that is too short especially when testing the reproducibility can overestimate the outcomes while another one that is too long can underestimate the results due to the changes having appeared in personalised diets [9]. Given the influence of the time period between different testing proceedings, we considered a three-month period of time as being sufficiently long for its respondents not to recall the questions but also short enough not to face changes of the food patterns.

The seasonal diversity of the food intake in fruit and vegetables constitutes an elaborate issue concerning the data adjustment due to the fact that the majority of them are ingested throughout the entire year while others mostly in summertime. To help clarify this matter, the period of time referred to in the frequency questionnaire was that of one year.

When testing the reproducibility and validity of the food frequency questionnaires, multiple studies operated Spearman, Pearson, Kappa concordance coefficient and Bland Altman method to compare the averages and standard deviations. Making use of the correlation coefficients in testing proceedings can be disadvantageous as it can be influenced by the inter-personal variation noticed in the studied population segment and the exactitude of the questionnaire as well. These inconveniences are counter-balanced by the

fact that they can be considered useful to differentiate between individuals, thus being explained why Pearson's coefficient is used in testing our questionnaire validity [5]. Nonetheless, it is recommended that we took into account the fact that the scores achieved can be correlated but their accordance needs to be decreased. In order to rule out this perspective, we examined the intra-class correlation coefficients as they point towards an index of the rating reliability formulated by a typical singular evaluator. The average value of the correlation coefficients for nutrients in FFQ reproducibility testing within frequent studies applied every 1 to 10 years varied between 0,5 and 0,7. A 227-case validation analysis undertaken by Cade et al. revealed a 45% frequency of the reproducibility testing, the correlation coefficients of the two questionnaires applied at a time period of up to 6 months being of 0,6-0,7[8] on average but higher in this particular case (0,8). As for validity, the value of the correlation coefficients in the specialised literature varied between 0,82 and 0,1 but averagely between 0,5-0,7[5]. Pearson's correlation coefficient indicated a medium nutrient value of 0,523 and 0,531 that was comparable to that shown in other validation studies.

Conclusion

The food frequency questionnaire that was undertaken is observed with a notable reproducibility and validity in the assessment of the energy and nutrient intake but a still debatable validity of the cholesterol and fibre consumption. The questionnaire under validity analysis can represent a beneficial instrument in investigating the nutrient intake and the food groups for young women. Further studies

are necessary in testing the population response to the questionnaire and also in

evaluating the intake of other nutrient categories.

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