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Calibration of the food list and portion sizes of a food frequency questionnaire applied to free-living elderly people

Karina Pfrimer Ph.D. [a,c,*], Daniela Saes Sartorelli Ph.D. [b], Flavia Troncon Rosa M.Sc. [e], Cristina Maria Mendes Resende M.Sc. [c], Daniela Vieira Pallos Viera M.Sc. [d], Estela Iraci Rabito Ph.D. [e], Fernanda Baeza Scagliusi Ph.D. [f], Eny Kiyomi Uemora Moriguti [g], Jaqueline Pontes Monteiro Ph.D. [c], Eduardo Ferriolli M.D., Ph.D. [a]

[a] Division of General Internal and Geriatric Medicine, School of Medicine of Ribeirao Preto, University of São Paulo, Brazil
[b] Department of Social Medicine, School of Medicine of Ribeirao Preto, University of São Paulo, Brazil
[c] Department of Pediatrics, School of Medicine of Ribeirao Preto, University of São Paulo, Brazil
[d] School of Nursing of Ribeirao Preto, University of São Paulo, Brazil
[e] Division of Clinical Nutrition, School of Medicine of Ribeirao Preto, University of São Paulo, Brazil
[f] Department of Health Sciences, Institute of Health and Society, Federal University of São Paulo, Santos, Brazil
[g] Division of Clinical Nutrition, Clinics Hospital, School of Medicine of Ribeirao Preto, University of São Paulo, Brazil

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ABSTRACT

Objective: To calibrate the food list and relative portion sizes of a food frequency questionnaire (FFQ) for application to a free-living, healthy, elderly population.
Methods: Cross-sectional study. One hundred free-living, healthy participants, aged from 60 to 75 y, randomly selected from among individuals in the area served by the Family Health Program, School of Medicine of Ribeirao Preto, University of São Paulo. A Food Frequency Questionnaire (FFQ) and a Diet History Questionnaire (DH) were applied by trained dietitians. Each food item of the FFQ had its portion size recalculated according to the percentiles referenced by the volunteers in the DH (25th = small, 50th = medium, and 75th = large). The list of foods and portion sizes of the original FFQ and those obtained by the application of the DH were compared. The percent contribution of energy, protein, fat, carbohydrate, folic acid, vitamin C, calcium, and fiber of each food item mentioned in the FFQ was determined from the data obtained by the application of the DH.
Results: FFQ, as compared with the DH, provided good estimation of the intake of protein, calcium, folic acid, and fiber (paired t test $P < 0.05$). Portion sizes of the FFQ differed from those obtained by the application of the DH (−23% to 300%).
Conclusions: Adjustments to the FFQ in particular, new portion sizes and a reduction of the food list were found to be appropriate for application to healthy, urban, free-living elderly people in Ribeirao Preto, Brazil.

Introduction

The Brazilian population is aging fast. The number of Brazilians aged 60 y or more is 20 million, or 10.5% of the total population, of which 82% live in urban areas [1]. As a consequence, the pattern of diseases is also changing, with the prevalence of chronic disabling diseases increasing sharply and the prevalence of infectious diseases decreasing. As diet patterns are clearly involved in the pathogenesis of age-associated chronic diseases [2], the development and validation of accurate methods for the assessment of food intake is important for a reliable evaluation of local dietary patterns. Moreover, studies on the impact of diet on the health status of older populations have shown that a better evaluation of the methods used for the assessment of food intake is clearly needed [3].

The Food Frequency Questionnaire (FFQ) is considered a useful tool for the evaluation of the intake of food and nutrients. Epidemiology studies show important associations between diet, as assessed by this method, and chronic diseases. However, FFQs are frequently applied to different populations without

* Corresponding author. Tel.: + 55 16 3602 3370; fax: +55 16 36336695.
E-mail address: karinapfrimer@uol.com.br (K. Pfrimer).

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adequate adaptation. Adjustments to the FFQ improves the accuracy of nutrition research studies [4,5].

The determination of the food list is one of the main components of the adjustment of the FFQ for a given population. When the list is well defined, the length of the interview and the participant burden are reduced, as a long interview may be tiresome for some interviewees. Also, a food list that does not include items usually consumed by the studied population may lead to underestimation of food intake.

Another important component is the portion size, defined as the weight and unitary size that best represent the usual intake [6]. Portion sizes that are not adequate for a given population lead to significant inaccuracy in the estimation of food intake. Also, the use of pictures showing the different portion sizes of a food item during the application of the questionnaire may improve the accuracy of the quantification of intake, especially when the participants are older [7].

This research was aimed to calibrate and evaluate the adequacy of the food list and portion sizes of a FFQ, originally designed for use in an adult Brazilian population, when applied to an elderly population.

Materials and methods

Patients and study design

One hundred persons aged from 60 y to 75 y, living in the area served by the Family Health Program of the School of Medicine of Ribeirao Preto, São Paulo, Brazil, participated in this research. The area is medium-to-low income, with about 2,000 inhabitants aged 60 y or more. The selection of participants covered all the census areas of the neighborhood (2000 census). Houses were randomized, and persons living in the selected houses were invited to participate. Inclusion criteria were being free-living, independent, and ages 60 y to 75 y. Exclusion criteria were being bed-ridden or dependent, having severe health impairment due to cerebrovascular and other chronic diseases, having uncontrolled chronic diseases, undergoing weight gain or loss, and being under prescribed diet restrictions. The study was approved by the local Human Research Ethics Committee, and all participants signed an informed consent before participating.

Anthropometric assessment

Volunteers had their weight measured on a Filizola ID 1500 scale with precision of 0.1 kg (Filizola, Brazil) and their height measured to the nearest centimeter by a stadiometer at head level with the subject standing barefoot, with feet together. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2).

Assessment of food intake

The food intake of each volunteer was assessed by the application of a DH and a FFQ by trained dietitians during a single interview session. For the application of the DH, volunteers were asked to refer to a usual day within the last year. They were asked to list the foods they usually consumed (more than four times a week) from the first meal of the day until the last.

The FFQ applied in the present study was originally developed and validated for Japanese-Brazilian adults [8,9]. The Japanese foods were excluded from the original food list, as they were not usually consumed by the population involved in this study [10]. The FFQ included the specification of the habitual intake frequency of each food item (daily, weekly, or monthly), and the usual portion sizes, classified as small, medium, and large. The FFQ included 120 food items, but the interviewer was allowed to add foods that the interviewee consumed at least once a month but were not mentioned in the original FFQ. The questionnaire also included questions about the intake of supplements.

During the application of the FFQ, a book with pictures showing the different portion sizes was used to avoid bias and facilitate the classification of the portion sizes [11]. Before data collection, the dietitians were trained in order to standardize the application of the FFQ and the DH.

A complete recheck of codes was performed before the registration of data and double keying was used for data entry. Food intake, when assessed by the application of the FFQ, was analyzed with the DietSys 4.02 software (1999; HHHQ DietSys Analysis Software, National Cancer Institute, Bethesda, MD, USA) and, when assessed by the application of the DH, with the Dietpro 4.0 software (São Paulo, Brazil, 2004). Data were always typed in by the same dietitian. The Food Composition Tables from the United States Department of Agriculture [12] and from the official Brazilian Food Composition Data [13] were used for analysis.

Table 1
Characteristics of the volunteers

Gender	Number	Age (y)		Weight (kg)		BMI (kg/m^2)	
Female	59	66.2	3.7	66.9	10.7	28.2	4.7
Male	41	66.5	4.4	74.6	12.7	26.7	3.8
Total	100	66.3	3.9	70.0	12.1	27.6	4.4

Data are presented as mean and standard deviation

The intakes of energy and nutrients (protein, fat, carbohydrate, calcium, fiber, vitamin C, and folic acid) obtained by the application of the FFQ and DH were compared.

The percent contribution of energy, protein, fat, carbohydrate, folic acid, vitamin C, calcium, and fiber [14,15] of each food item mentioned in the FFQ was determined by comparison with the data obtained by the application of the DH. To identify the contribution of each nutrient of the different food items, the method proposed by Block et al. [16] was used, according to the following equation:

% contribution of nutrient k by food item i = amount of nutrient k supplied by food i × 100/amount of nutrient k supplied by all food intake

Portion sizes were determined according to the weights obtained by the application of the DH. Small, medium, and large sizes were defined, respectively, as the 25th, 50th, and 75th weight percentiles. If the person ate more than one food item of the same group, the portion size was determined by the food item most frequently consumed.

The adequacy of the food list of the FFQ was evaluated by comparison with the food items referred during the application of the DH.

Statistical analysis

Mean and standard deviation (SD) were calculated for the total nutrient intake obtained by the FFQ and DH. The Shapiro-Wilk test was used to verify normality. Because the distribution of most nutrients was skewed towards higher values, all variables were log (natural) transformed before statistical analysis. The Student's *t* test for paired samples was used to compare the results of the application of the FFQ and DH.

All statistical analyses were performed using the SPSS software version 16.0. *P* values ≤ 0.05 were considered significant.

Results

Fifty-nine volunteers were women, mean age was 66.3 y, and BMI was 27.6 kg/m^2 (Table 1). There were no significant differences between genders, so the results shown represent the whole population.

The mean consumption of energy and nutrients (excluding supplements) estimated by the FFQ and the DH is shown in Table 2. There were significant differences in the estimated consumption of almost all nutrients, except for protein, calcium, fiber, and folic acid.

Table 3 shows the distribution, in percentiles, of the weight of the portion sizes of all foods listed in the FFQ, according to the sizes obtained by the application of the DH.

Table 2
Mean intake of energy and nutrients as estimated by the Food Frequency Questionnaire (FFQ) and the Diet History (DH) in elderly volunteers (n = 100)

Nutrients	FFQ		DH		*P* value
	Mean	SD	Mean	SD	
Energy (kJ)	7824.0	3090.7	6711.5	2956.4	<0.005
Protein (g)	71.3	29.3	69.5	35.3	0.082
Fat (g)	60.6	25.4	50.5	31.8	<0.005
Carbohydrate (g)	253.9	112	215.0	94.4	<0.005
Calcium (mg)	607.4	315.2	607.0	321.0	0.981
Fiber (g)	17.3	9.3	16.4	11.7	0.055
Vitamin C (mg)	215.1	147.4	153.1	170.7	<0.005
Folic acid (mg)	226.5	121.8	259.6	163.0	0.132

Table 3
Distribution in percentiles (P) of the serving sizes obtained by the DH

Groups/Food	P25 (g or ml)	P50 (g or ml)	P75 (g or ml)
Dairy			
Milk	165	240	330
Low fat Milk	161	210	362
Yogurt	82.5	157	176
Low fat cheese	20	30	40
Yellow cheese	16.3	20	38.8
Cottage cheese	6	14	32.5
Fat			
Butter	5.7	8	16
Bread, cereals, and pasta			
Bread	50*	50*	100
Sweat bread	38	40	139
Cookie	16	25	42
Rice	82.5	125	200
Potatoes	50	80	230
Pasta	120	200	220
Fruits and juice			
Orange	180*	180*	360
Banana	40	70*	70*
Apple	130*	130*	200
Papaya	132.2	155	300
Mango	140	180	220
Other fruits	75	240	480
Orange juice	202	240	420
Other fruits juice	165	300	400
Vegetables			
Beans	40	100	157.5
Lettuce	30	45	80
Cabbage	25	40	45
Carrot	25	50	60
Tomato	33.7	60	100
String bean	50	90	120
Okra	42.5	73	80
Soup	397	520	798
Meat			
Cattle meat	73.5	125	200
Chicken	66.2	110	146.5
Fish	24.5	75	175
Sausage	50	60	105
Eggs	36	47.5	50
Ham	22.5	47.5	50
Drinks			
Coffee without sugar	52.5	71.5	84.5
Coffee with sugar	50	100	170
Coffee with sweetener	50	100	200
Green tea	191	220	376
Beer	360	1050	1800
Artificial juice	172	240	380
Soft drink	360	420	480
Diet soft drink	202	330	665
Sweets			
Cake	30	60	90
Chocolate	10	20	30
Honey	5	12.5	30.7
Pudding	32	170	260
Stewed Fruit	40	80	125

DH, diet history
* Median of the portion sizes have the same weight.

Figure 1 shows the differences between the portion sizes reported by adults (previously published data from Ribeiro & Cardoso [10]) and by the elderly volunteers (new data).

Table 4 shows the contribution (in percentage) of each food item mentioned in the FFQ for the total intake of the main nutrients. The total percent contribution of the food items ranged from 86% (folic acid) to 99% (fiber). The ten foods that contributed most for the total consumption of energy were rice (14%), meat (12%), beans (10%), French bread (10%), whole milk (6%), oranges (3%), chicken (3%), soup (3%), cream cracker biscuits (3%), and bananas (2%).

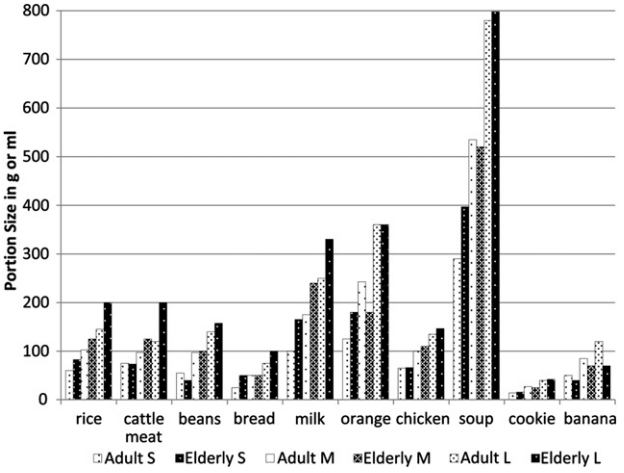

Fig. 1. Differences in portion sizes for adults and elderly persons. Portion size for adults came from the original to calibrate Food Frequency Questionnaire (FFQ), and portion size for the elderly came from the Diet History Questionnaire to original the new FFQ (calibrate). S, small; M, median; L, large. (Original FFQ data reprinted from Ribeiro & Cardoso [10] with permission from Revista de Nutriçaõ [Brazilian Journal of Nutrition]).

Discussion

In the present study, we evaluated the food list and portion sizes of a FFQ regarding the intake of energy, protein, fiber, calcium, and other nutrients considered important for the elderly. The food list obtained by the application of the DH was much shorter than that of the original FFQ. The values obtained by the application of the DH for protein, calcium, fiber, and folic acid were similar to those obtained by the application of the original FFQ. However there were differences in the values obtained for other important nutrients as fat, energy, carbohydrate, and vitamin C.

The assessment of the percent contribution of different foods to the total intake of nutrients showed that at least 86% of the total intake of all nutrients had their quantification guaranteed by the application of the FFQ. For some nutrients (i.e., fiber, protein, and calcium), the percent contribution reached 98%, a very high level of detection.

The analysis of the food list showed that the diet of the elderly volunteers was more monotonous than that of previously studied younger adults [16]. The energy percent contribution of the ten foods most frequently reported by our volunteers was 66.3%, in opposition to 56.8% reported by the volunteers studied by Tomita and Cardoso [16]. A similar finding was reported by Freitas et al. [17]. The diet reported by our elderly volunteers was so monotonous that some foods were considered the only relevant source of a given nutrient. Cooked beans, as an example, was the main contributor for fiber intake, although it is known that raw vegetables, fruits, and whole cereals are also usually listed as food sources of fiber.

To minimize errors, we used pictures showing different portion sizes of all foods to help the volunteers when they seemed to be in doubt [18]. Robson et al. [19] refer that the use of pictures may be a useful tool to improve the accuracy of nutrient intake estimation at the individual level.

Another important aspect of assessing dietary patterns is the adequacy of portion sizes (small, medium, and large). This study showed that some portion sizes of a FFQ validated for an adult Brazilian population were inadequate for free-living elderly people. Comparison with the DH showed that from the 15 food

Table 4
Main contributors of nutrients, in the FFQ, in relation to the total nutritional values evaluated by the DH

Food	Energy (Kcal)	Carbohydrate (g)	Fat (g)	Protein (g)	Calcium (mg)	Vitamin C (mg)	Fiber (g)	Folic acid (mg)
Dairy								
Whole Milk	5.71	3.5	10.0	7.6	26.6	2.8	0.0	3.3
Milk low fat	1.32	1.3	0.3	2.8	9.3	0.9	0.0	1.5
Yogurt	0.24	0.3	0.0	0.3	0.8	*	*	*
Yogurt with fruits	0.13	0.2	0.0	0.2	0.6	*	*	*
Fresh cheese	0.78	0.0	1.8	1.3	4.8	*	*	*
Yellow Cheese	0.7	0.0	1.7	1.2	2.51	0.0	0.0	0.1
Cream cheese	0.22	0.0	0.8	0.3	1.2	*	*	*
Bread, cereals, and pasta								
French bread	9.94	14.2	4.3	8.3	7.7	0.0	12.5	7.3
Sweet bread	1.10	1.4	0.3	0.7	0.1	*	0.4	*
Cream cracker	2.79	3.4	3.2	1.6	0.9	*	0.4	*
Rice	14.06	22.7	1.3	7.2	3.5	0.0	5.6	2.6
Potato cooked	0.70	1.1	0.0	0.4	0.2	1.2	2.0	0.6
Fried potato	0.09	0.1	0.1	0.1	0.0	0.1	0.0	*
Pasta	1.50	2.0	0.8	1.4	0.7	0.0	*	0.9
Kibe[†]	0.04	0.0	0.0	0.1	*	*	0.0	*
Boast-flour	0.29	0.4	0.2	0.3	0.1	0.0	1.0	0.3
Pizza	0.48	0.42	0.66	0.8	0.7	0.5	*	0.7
Fats								
Margarine	1.80	0.0	5.9	0.0	0.2	0.0	*	0.0
Butter	0.45	0.0	1.5	0.1	0.0	0.0	0.0	0.0
Mayonnaise	0.45	0.0	1.5	0.1	0.0	0.0	0.0	0.0
Fruits and juice								
Orange	3.34	5.7	0.5	1.8	7.2	24.5	13.7	11.2
Banana	2.11	3.7	0.3	0.8	*	*	4.8	*
Apple	1.08	2.2	0.3	0.1	0.4	2.9	4.8	0.4
Papaya	0.59	1.0	0.1	0.3	0.8	7.4	2.4	2.9
Mango	0.59	1.0	0.1	0.3	0.8	7.4	2.4	2.9
Avocado	0.08	0.0	0.2	0.0	0.0	0.0	0.2	0.1
Watermelon	0.08	0.1	0.0	0.0	0.0	0.5	0.1	0.0
Orange juice	0.79	1.3	0.1	0.3	0.5	5.7	0.4	2.7
Other fruits juice	0.65	1.1	0.2	0.3	0.6	4.0	0.5	3.0
Vegetables								
Beans	9.99	10.6	12.8	9.5	12.6	4.7	33.4	20.0
Lettuce	0.42	0.6	0.3	1.1	2.8	7.8	3.5	14.5
Oat	0.03	0.1	0.0	0.0	0.0	0.0	0.1	0.0
Cabbage	0.12	0.2	0.1	0.2	0.7	1.9	2.2	2.1
Carrot	0.23	0.4	0.0	0.2	0.4	0.0	1.9	0.6
Tomato	0.40	0.7	0.2	0.4	0.3	9.6	2.3	1.9
Cauliflower	0.00	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Cooked aubergine	0.12	0.2	0.0	0.1	0.1	0.4	1.2	0.4
Okra	0.09	0.2	0.0	0.1	0.4	1.1	0.8	0.8
Eggplant	0.08	0.1	0.0	0.1	0.5	0.7	0.7	0.8
Soap	2.95	2.5	3.9	2.3	1.5	5.9	1.9	*
Meat								
Beef	12.44	0.0	21.5	30.6	1.1	0.0	0.0	3.1
Pork	0.94	0.0	2.6	0.4	0.5	0.0	0.0	0.0
Bacon	0.06	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Chicken	2.98	0.0	5.0	9.1	0.7	0.0	0.0	0.9
Fish	0.45	0.0	0.7	1.3	0.2	*	*	*
Sausage	0.78	0.0	1.8	1.2	0.2	0.1	0.0	0.4
Eggs	0.44	0.0	1.0	0.9	0.4	0.0	0.0	0.9
Ham	0.27	0.0	0.6	0.4	0.0			
Drinks								
Coffee with sweetener	0.05	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Coffee with sugar	1.31	2.3	0.0	0.0	1.2	0.0	0.0	0.0
Green tea	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Black tea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Beer	1.20	1.0	0.0	0.2	0.5	0.0	0.9	1.5
Juice artificial	0.87	1.5	0.0	0.0	0.2	6.0	0.0	0.0
Soft drink	0.55	0.1	*	*	*	*	*	*
Diet soft drink	*	*	*	*	*	*	*	*
Wine	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweets								
Cake	1.10	1.2	1.3	0.6	*	*	*	*
Honey	0.21	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Pudding	0.57	0.7	0.4	0.4	*	*	*	*
Stewed fruit	0.99	2.0	0.0	0.0	0.0	0.3	0.2	*
Popcorn	0.06	0.1	0.1	0.0	0.0	0.0	0.2	0.0
Cucumber	0.01	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Sugar	0.16	0.3	0.0	0.0	0.1	0.0	0.0	0.0
Ice-cream	0.13	0.1	0.2	0.1	0.1	0.0	*	*

(*continued on next page*)

Table 4 (*Continued*)

Food	Energy (Kcal)	Carbohydrate (g)	Fat (g)	Protein (g)	Calcium (mg)	Vitamin C (mg)	Fiber (g)	Folic acid (mg)
Chocolate	0.10	0.1	0.2	0.0	0.0	*	0.0	*
Powder chocolate	0.3	0.1	0.1	0.2	0.6	0.0	0.1	0.0
Nut	0.10	0.0	0.3	0.2	0.1	0.0	0.1	0.3
Total	91.9	92.1	88.3	97.9	95.1	90.0	99.5	86.5

Data are presented as percentages

* Data not available.

† meat and wheat mixed ball, arabic original recipe.

items most consumed by the elderly volunteers, only oranges had the same weight per portion of the original questionnaire, and that only for the large portion size. Nine items presented small and large portion sizes varying from 1% to 300% bigger than the original questionnaire, and five varied from 23% to 1% smaller.

There were no significant differences in the portion sizes for different genders, in opposition to the results published by Carlos et al. [20]. Those authors studied 779 Brazilian elderly persons and reported gender-related differences in the intake of rice, juice, cheese, soft drinks, beans, and chicken. Some portion sizes reported by them also differed from those found in the present study. The differences may be partially explained by the population studied, as their study included the general population and our study included only healthy independent elderly people.

This study has some limitations that must be considered. There is no gold standard method for the measurement of food intake, so there may be inaccuracies in the measurement of the portion sizes and food contribution as assessed by the DH. Multiple 24-h recalls and dietary records are usually used for the adjustment of FFQ but a single DH was used in this study. However, the assessment of older persons with low levels of education and potential memory impairments justify the adoption of the DH as reference. Changes in the pattern of food intake during the last year could affect the results, but those were not reported by any of the participants.

Conclusions

This study showed that in an elderly population the portion sizes of a FFQ questionnaire were different from those report for a younger population. The food list of the FFQ was adequate regarding the sources of food in the elderly group, but it could be shortened. Further studies are needed to validate and calibrate dietary assessment methods for elderly groups.

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