

Development and use of an on-line semi-quantitative food-frequency questionnaire to evaluate calcium and iron intake

Abstract

Objective: The objective of this study was to develop an online semiquantitative food-frequency questionnaire for the evaluation of calcium and iron intake. **Methodology:** Research was conducted through the Folha newspaper online website. Thirty internet users, of both genders, aged 21 to 45 years, were selected. Information obtained from food records of 4 days (8RA) in two consecutive months was compared to that from an online QSFA filled out by participants in the third month. Pearson's correlation was used. Intake data was adjusted by energy and covariance. **Results:** The correlation of the results of intake obtained by both methods after adjustment and correction for variance was 0.52 for calcium and -0.02 for iron. **Conclusion:** Results showed that the Online Food Frequency Questionnaire could be considered a good method to evaluate average calcium intake in this group. Nevertheless, the conditions (n, intake levels) were not adequate to evaluate average iron intake.

Key Words: Calcium. Food intake. Iron. Semi-quantitative food-frequency questionnaire

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Introduction

Computerized programs provided by the World Wide Web may offer an innovative method to obtain relevant health data. This means of communication eases contact between people from different regions and processes the data obtained much faster. Most importantly, however, it goes beyond geographical frontiers because its only obstacle for use is the availability of internet access.^{1, 2, 3, 4}

The World Wide Web, when evaluated as a tool for individual data collection and nutritional education, proves to be as efficient as traditional paper versions.^{3, 4} Engle et al.⁵ and Boeckner et al.⁶ conducted methodological studies on the use and reproducibility of computerized questionnaires to evaluate food intake. They stated that when the programs developed provide individual answers, access to the Web is even greater, thus allowing the programs to be used as a promising innovation in the field of nutrition. Some authors emphasize the importance for nutrition professionals to explore this media in research aimed at obtaining health and nutritional education data; moreover, this media can be used to inform the population on health issues, focusing on healthy food.^{6, 7, 8, 9}

In Brazil, 16% of the population has access to the internet¹⁰, and there is an effort from the government to increase digital inclusion. Such an effort would increase internet access for the population in public schools, health centers and community centers.

The evaluation of dietary information is a challenge for researchers because the measuring processes related to dieting are hindered by random dietary intake.¹¹ According to Armstrong¹² and Slater et al.¹³, the choice of the method for this type of evaluation is not a simple task and depends on both theoretical considerations and practical experience. Thus, food intake evaluation is an important and crucial topic in studies that associate diet and illness. The reliability of the results will depend on the

quality and power of the tools selected to obtain the data.

The Semi-Quantitative Food-Frequency Questionnaire (SFFQ) is generally considered a practical method to evaluate food intake. Apart from being informative and relatively simple, it is also capable of distinguishing several patterns of food intake among individuals. The SFFQ requires little specialization of the interviewer and may also be self-administered. These advantages are mainly translated into low cost, which is the reason why this tool is widely used to evaluate food intake in epidemiological studies, mainly in those searching for an association between diet and illness.¹³

Another advantage of the SFFQ in epidemiological practice is its efficiency in identifying usual food intake. In contrast to tools like the 24-hour Recall (24hR) and the Food Record (FR), the SFFQ replaces food intake measurements at precise periods of time (present diet) for global intake information over a longer period of time.¹⁴ This method still offers the possibility of an exact quantitative stratification of the results of nutrient intake, aiming at an analysis of risk trends according to the degree of exposure, as well as the identification of differences between extreme levels of dietary intake.¹¹

Computerized questionnaires completed on the Web are user-friendly and present several advantages, such as immediate verification of inconsistencies or blank answers, immediate and personalized answers to the interviewee, as well as illustrations and sounds that may help the interviewee complete the process. Moreover, the answers are promptly received in an electronic format, allowing for fast verification. Thus, it becomes possible to avoid the stages of printing, mailing, interviewing, manual verification and retyping, and their possible errors. The cost of a computerized on-line SFFQ results from the development of the system and not from the number of participants in the research; therefore, the low cost allows the execution of nutritional epidemiological studies on a large scale.^{6, 7, 15, 16}

Several factors were taken into consi-

deration: a) the difficulty in obtaining food intake data in an accurate way, lower costs, and time spent for evaluation and data processing; and b) the difficulty in reaching calcium (Ca) and iron (Fe) recommendations, two nutrients of outstanding physiological importance. Additionally, both calcium and iron intake recommendations recently increased with the adoption of the Dietary Reference Intake (DRI). The objectives of the present study were to prepare an on-line Food-Frequency Questionnaire, to describe its impact and difficulties in its implementation and evaluation, and also to report its accuracy in individual adult internet users.

Methods

This was a cross-sectional study, and its design comprised the following steps:

Call: journalistic text inserted on the first page of *Folha Online* www.equilibrio-online.com.br with the objective of sample selection;

Confirmation: completion and approval of the on-line Informed and Written Terms of Consent. Registration was completed when tax identification and phone numbers were provided;

Certification: checking phone number provided;

Development: an image base made available on the *Folha Online* site containing photos illustrating portion sizes of the main food groups.

Application: dietary record forms, as well as instructions for its adequate completion, were sent on-line to interviewees;

Confirmation: personal interviews were conducted with participants, in a consulting room or by phone, to certify the information received.

Sample selection: casuistic

The study was advertised by *Folha Online* through a journalistic text and a link (connection) for the registration of interested individuals. Registrations were accepted for three days; people from all Brazilian regions enrolled.

Confirmation e-mails were sent to the first 160 individuals of both genders between the ages of 21 to 45 years who had enrolled; these individuals had a fixed residence in the State of São Paulo and the daily habit of accessing e-mail.

Data storage

The contents of the study (questionnaires, forms, Informed and Written Terms of Consent) were stored in a database with a copy on CD-ROM.

To guarantee the confidentiality of the information and the privacy of individuals, access to the communication tool was made available through an individual password, and data transmission was performed through personal e-mails.

Food Records (FR) and Semi-quantitative Food-Frequency Questionnaire (SFFQ)

Individuals were instructed to fill out the 4-day FR in two consecutive months, immediately after food intake, choosing three weekdays and one weekend day. The forms were sent to the interviewees and received by the interviewer via e-mail.

The on-line SFFQ was developed in a way to accept several web browsers, which means that the system was built to give access to all internet users, regardless of their operating system. Participants received a password and information on how to fill out the questionnaire. The results and a comment about dietary adequacy were supplied at the end of the study, based on the Ca and Fe intake results obtained from the 8 FR of each participant.

To help the completion of the questionnaires, a photo book containing food and kitchenware images was made available. Thirty-nine commonly consumed foods, representing the likely dietary habits of the Brazilian population, were presented in three different portions, as well as different dimensions of kitchenware and an explanatory text, all stored on *Folha Online*.¹¹ Among the photographed food, there were

fruits, vegetables, rice, beans, pasta, beef in pieces and slices, poultry, fish, and beverages, such as milk and juice.

The recently detailed methodology presented by Slater et al.¹³ for the construction and validation of the Food Frequency Questionnaire for Adolescents (FFQA) included a reliable evaluation of Ca and Fe. Based on the details of this methodology, the tool was adapted by considering the information obtained from food records used. From this information, 26 food items were suppressed from the original structure of the FFQA, and new items and portions, also defined based on the information from the FR, were added. The items maintained in the structure were compatible with the reports from the FR. The on-line SFFQ used a total of 79 food items.

Daily intake frequency was calculated based on the weekly and monthly intake frequency of each food (Table 1). The values, multiplied by the concentration of nutrients in the food, resulted in the daily intake value.¹³

Table 1. Frequency of daily food intake based on monthly and weekly intake. Internet users, n= 30. São Paulo, 2003.

Intake	Frequency of daily intake
Never	0
< 1/ month	0.03
1 to 3 / month	0.06
2 to 4/ week	0.43
1 / day	1
≥2 / day	3

Data processing

The Virtual Nutri software, fed with Ca and Fe data from foods analyzed in Brazilian studies, was used for the evaluation of the data from the dietary records.¹⁷

Interviews

The sample initially has 93 individuals

(58 women and 35 men). There was a 68% drop out; which resulted in a sample of 30 internet users of both genders.

At the beginning of data collection, the authenticity of the information in registrations was checked by a phone call to the participants of the study. At the end of the study, they were also invited to attend a personal interview, when they received individualized nutritional guidance based on all the information obtained in the 8 FR. Individuals who could not come to the consultation were interviewed by phone. Each participant was asked about his/her perception regarding the completion of the on-line SFFQ.

During data collection, interviewees did not have any information about the results from the analyses of their diets. As already mentioned, participants received dietary counseling only after data collection of the FR and SFFQ.

Statistical analysis

Histograms were made to show the distribution of nutrient intake. The normality of the distribution curves of the data obtained from both questionnaires was then tested, as the tests used here had this requirement.

Based on the data obtained from the 8 FR and SFFQ, the mean and standard deviations were obtained for both the absolute and the energy adjusted nutrient values.

Pearson's correlation coefficients between values obtained from the 8FR and SFFQ were calculated for both the absolute and adjusted energy data. Correlation coefficients were also corrected for the intrapersonal variance of the 8 FR, similar to the variance analysis with a classification factor.¹¹

The project was approved by the Ethics and Research Committee of the University of São Paulo, protocol # 195. Individuals could cancel their participation in the study at any time. It was possible for participants to ask questions by e-mail or phone at any time.

Table 2. Ca and Fe intake obtained from the SFFQ and the 8FR, before and after adjusting for energy. Internet users, n= 30. São Paulo, 2003.

Ca (mg/d)				Fe (mg/d)			
SFFQ		8FR		SFFQ		8FR	
Absolute	After adjustment	Absolute	After adjustment	Absolute	After adjustment	Absolute	After adjustment
940 (471)	936 (344)	770 (311)	768 (236)	13.3 (5.0)	13.3 (3.1)	11.6 (3.6)	11.3 (2.1)

n = 30; Results expressed as mean (standard deviation)

Results

From the sample of 30 internet users of both genders, there were 25 women and 5 men, and the level of schooling was 2 with junior high school, 3 high school, 18 with university degree, and 7 masters/doctorate degrees.

The personal interview was conducted with 12 participants, while the remaining participants were interviewed at the end of the study by phone, as described in the methods section.

The SFFQ overestimated the mean intake of Ca and Fe in relation to the 8 FR. After adjustment for energy, a reduction was observed in the standard deviation of the mean intake of Ca and Fe for both methods (Table 2).

After adjusting for energy and variance, the correlation between the methods decreased both for Ca and Fe data, as observed in Figure 1.

The analysis of Table 3 indicates that the results of Ca intake obtained from the 8 FR and SFFQ were correlated before and after the adjustment for energy and variance, while Fe intake was not.

To compare the correlation values corrected for energy and variance between data obtained from the 8 FR and SFFQ in the present study, an analysis of validation studies of the SFFQ conducted in Brazil and in other countries was conducted, as presented in Table 4.

Discussion

In this study, which analyzed the on-line

Table 3 – Correlation coefficients between intake values of Ca and Fe: Absolute, adjusted for energy and intra-personal variance, obtained from the 8FR and SFFQ. Internet users, n= 30. São Paulo, 2003.

Nutrients	r		
	Absolute	Adjusted ¹	Adjusted ²
Calcium (mg)	0.64*	0.51*	0.52
Iron (mg)	0.33	-0.02	-0.02

¹ Adjusted for energy

² Adjusted for intra-personal variance

* Significance p<0.05

Table 4 – Pearson's correlation coefficients for Ca and Fe adjusted for energy, found in other studies validated in the literature.

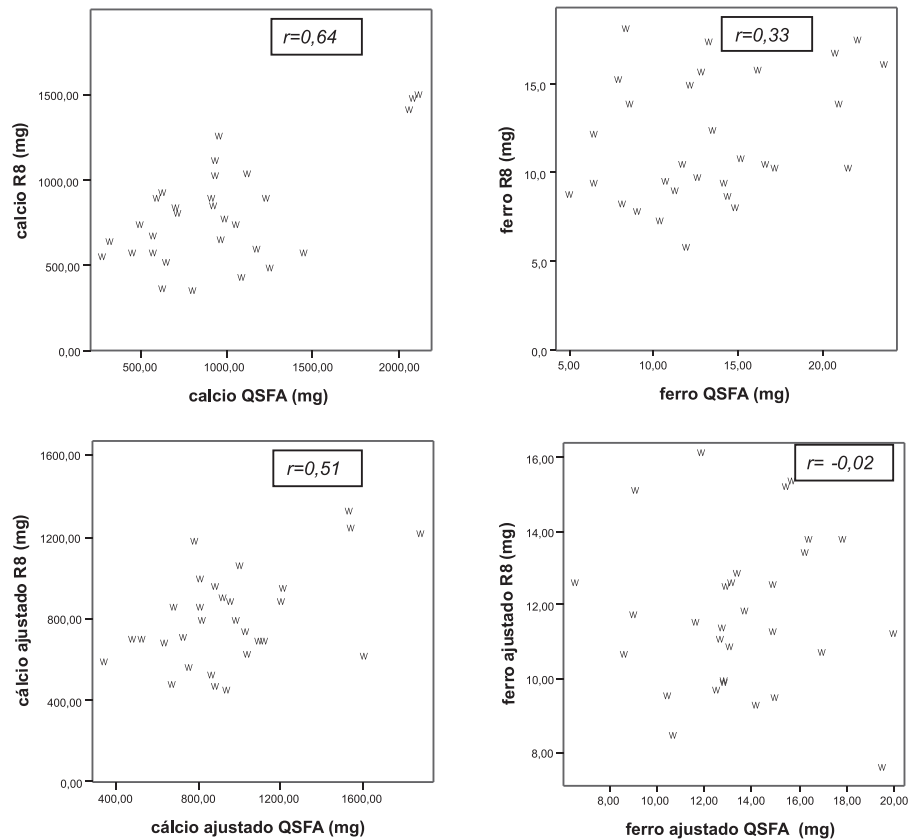
Author	Ca (mg)	Fe (mg)
Rohan and Potter (1984) ²²	0,78	0,38
Willett et al (1998) ¹¹	0,56	0,42
Sobell et al (1989) ²³	0,45	0,49
Sichieri et al (1998) ^{21*}	0,55	0,43
Slater et al (2002) ^{13*}	0,70	0,17
Ribeiro et al (2007) ^{24*}	0,52	0,58

Source: values obtained from the literature, with p<0.05

* Brazilian study

SFFQ accuracy to evaluate mean intake of Ca and Fe, the mean age (standard deviation) of the group studied was 30 (6) years old, which corresponds to the mean age of *Folha Online* readers.

The adherence to the present study was 32%. Individuals who quit the survey reported a lack of time and willingness to



Ca-adjusted QSFA (mg)

Fe-adjusted QSFA (mg)

Figure 1. Pearson's correlation coefficient between the two evaluation methods, for calcium and iron, before and after the adjustment for energy.

complete the 8 FR on paper and transcribe it onto the computer. However, the participants who surpassed these initial difficulties remained until the end of the study and completed the on-line SFFQ, emphasizing the ease and quickness of the self-administration of this type of questionnaire.

The final number of participants who completed the eight records and the SFFQ was lower than the 50 recommended for this type of study.¹² However, there are citations in the literature of dietary evaluations validated with a similar sample size.

A methodological aspect that promoted the quality of the information, compensating for and minimizing the effects of the high rate of drop-outs on the results, was the number of food records used as a

reference method. The knowledge of the percentage of drop-outs will be used as a reference to calculate the sample size in future studies.^{8, 18}

The studies that evaluated response rates to questionnaires sent by e-mail and traditional mail concluded that electronic questionnaires presented a higher return rate when compared to traditional mail; additionally, there was a higher rate of drop-outs among men.^{6, 15, 19, 20}

One observation that deserves to be highlighted in this study is the fact that the population evaluated used the internet daily. Participants did not report any difficulty in accessing the forms nor the image book, neither to understand the instructions for filling out the questionnaires. The images

made available were sufficient to answer possible questions. In interviews conducted in person and/or by phone, all participants reported that the questionnaires were easy to fill out, which certainly is related to age and schooling: 83% of the individuals had completed university and/or masters and doctorate degrees.

The results indicated that the SFFQ overestimated CA and Fe intake (Table 2), considering the obtained values from the 8 FR as reference. This overestimation of the intake of the two minerals was already expected and has been described in the literature as inherent to the SFFQ methodology, which focuses only on standard food source portions.^{8, 13, 21}

The values of the absolute correlations between the results obtained from the SFFQ and the mean obtained from the 8 FR are the first indication that the SFFQ is adequate to evaluate the Ca and Fe intake of the studied group. However, after adjustment for energy, the values of the correlation coefficients decreased both for Ca ($r=0.51$) and Fe ($r=-0.02$), maintaining statistical significance only for Ca. Thus, it is possible to conclude that the SFFQ developed is an adequate method to evaluate the mean Ca intake of the group but not the Fe intake (Table 3).

According to Willett¹¹, the adjustment for total calories decreases the correlation coefficient when the variability intake of nutrients was related to systematic errors of overestimation and/or underestimation, as observed for Fe. According to the same author, the acceptable correlation coefficients must be situated between 0.4 and 0.7.

The values of the coefficients corrected for energy were adjusted for variance. This adjustment removed the effects of the intrapersonal variance inherent to the energy and nutrient intake calculated from the eight records. After the adjustment, a significant correlation was observed for Ca, but not for Fe, indicating that the SFFQ has adequate performance to classify individuals in relation to their Ca intake. This Ca correlation coefficient value adjusted for energy and variance was within acceptable

values according to the literature, being similar to the ones obtained in other validation studies of SFFQ, both Brazilian and international (Table 4).

On the other hand, the correlation coefficient remained without statistical significance when comparing the Fe intake data. A validation of this SFFQ for Fe will demand a larger sample size and the re-evaluation of food sources and their portions.^{8, 11, 13}

Conclusion

Although the sample was comprised of a smaller number of individuals in relation to the n usually indicated for validation studies, we may consider that the questionnaire was accurate for obtaining mean Ca intake once this gap was compensated by the considerable amount of food records completed. The same did not occur with the Fe intake results. It is worth emphasizing that in the majority of studies, mainly the ones conducted in Brazil, there is great difficulty in obtaining repeated measures of a reference method, as was possible in this study.

Based on the speed in obtaining data from individuals and the ease of use that the internet offers, both for the researcher and the interviewees, we may consider that both the e-mail and the computerized questionnaire were adequate for obtaining information on individual food intake and should be more widely used in future studies.

Although the questionnaire was developed and validated in a specific sample and with distinctive characteristics of the general population, it is worth pointing out that the method is capable of evaluating food intake of adult individuals in an innovative way. This method can have structural changes according to the population to be studied, as long as it goes through the validation processes of the remaining nutrients or calibration for calcium and iron.

An article based on the Masters dissertation entitled "Relative validity of a semi-quantitative questionnaire of on-line food frequency to estimate the calcium and iron

intake” was presented to the Inter-unit Post Graduation Program in Applied Human Nutrition (PRONUT) of the University of São Paulo, 2004, 114p.

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