

Reliability and validity of a semi-quantitative FFQ for sodium intake in low-income and low-literacy Brazilian hypertensive subjects

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Abstract

Objective: To assess the reliability and validity of an FFQ to evaluate dietary patterns of Na consumption among low-income and low-literacy Brazilian hypertensive subjects.

Design: The initial FFQ was submitted to content analysis with the pre-test administered to fifteen subjects. Reliability was evaluated according to the reproducibility criterion, with interviewer administration of the FFQ twice within a 15 d interval. Validity was assessed against a 24 h recall (132 subjects), a 3 d diet record (121 subjects) and a biomarker (24 h urinary Na; 121 subjects). To test the correlation with the biomarker, discretionary salt was added to the FFQ Na values.

Setting: A large urban teaching hospital in south-eastern Brazil.

Subjects: The study was based on 132 randomly selected subjects (eighty-three women and forty-nine men) aged 18 to 85 years.

Results: Kappa coefficients ranged from 0.79 to 0.98, confirming the reproducibility of the FFQ. There was no correlation between urinary Na excretion, the FFQ and the 24 h recall for the general sample, although significant correlations had been observed when methods were summed up (24 h recall + discretionary salt + FFQ; 0.32, $P=0.01$). The addition of discretionary salt significantly improved the biomarker-based FFQ validity, with correlation coefficients varying from 0.19 (general sample) to 0.31 (female sub-sample).

Conclusions: The developed FFQ demonstrated satisfactory evidence of validity and reliability and can be used as an important complementary tool for the evaluation of Na intake among Brazilian hypertensive subjects.

Keywords
Sodium intake
Questionnaire
Reproducibility
Validity
Biological markers
Hypertension

Hypertension is recognized as the number one attributable risk for death from CVD around the world⁽¹⁾. Diet and lifestyle strongly influence all causes of mortality throughout the life span⁽²⁾, and dietary patterns play a major role in the development of CVD, especially hypertension^(2,3). Evidence shows, however, that Na restriction is associated with a reduction in the risk of CVD death while high Na intake increases that risk^(4,5).

Despite medical recommendations, Na intake is still extremely high in many cultures and populations⁽¹⁾. In the USA, the mean Na intake is approximately 4100 mg/d for men and 2750 mg/d for women, 75 % of which comes from processed foods^(1,6,7). However, the lack of tools to evaluate Na intake is still a problem in clinical practice⁽⁸⁾.

The multidisciplinary team approach is effective mostly when the professionals can provide orientation based on individual needs and lifestyle⁽⁹⁾, but an accurate assessment of the Na intake of free-living persons remains a difficult and labour-intensive process. The routine assessment of the diet of a large number of individuals from a range of socio-economic backgrounds requires a quick and simple method of estimating the intake of specific nutrients. The FFQ has been proposed as a precise measure for the evaluation of the intake of nutrients, and it has been used extensively for various purposes^(10,11). Nevertheless, few FFQ assess Na intake, and none has yet been developed and validated for the Brazilian population^(12,13). Therefore the aim of the present study was to develop and validate an FFQ for the

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evaluation of Na intake among low-income hypertensive Brazilian patients; this Brazilian version was called the Questionário de Frequência Alimentar de alimentos com alto teor de sódio (QFASÓ).

Study population and methods

Study population

One hundred and thirty-two hypertensive subjects over 18 years of age, seen as outpatients in a large urban teaching hospital in south-eastern Brazil, were recruited during regular appointments. Subjects with diabetes, identifiable causes of secondary hypertension and inability to read and write were eliminated from the study, although illiterate individuals who could depend on a specific family member to register salt intake were retained. The study was performed according to university ethical committee policy, and all subjects signed a consent form.

Development of the FFQ

The FFQ was developed as recommended in the literature⁽¹⁰⁾. A fifty-item list of high-Na foods frequently consumed by the target population of low-income Brazilians with little education was compiled from previous surveys of dietary habits of such individuals and a consultation of the literature in relation to the Na content of the identified items (i.e. those supplying at least 200 mg Na/100 g)⁽¹⁰⁾. This pre-version was evaluated by two expert dietitians to determine content validity. These experts were asked to evaluate and rank the fifty-item list of foods in relation to: (i) importance as a source of Na; and (ii) relevance for the targeted population. Items revealing disagreement were discussed by the two experts until agreement was reached. After this analysis, six items were excluded because they were not commonly consumed by the target population; the result was the first forty-four-item version of the FFQ. This was pre-tested among fifteen patients from the targeted population and proved to be comprehensible and applicable to the studied group. The forty-four items consisted mostly of industrialized foods such as canned dairy and meat products, condiments, snacks and fast food. Participants were asked how frequently each food was consumed during the last year, with responses ranging from 1 = 'never' up to 7 = 'twice or more per day'. For each food on the list, an Na conversion factor was derived from food composition tables. The conversion factor was a number between 0.01 and 1.00 and represented the amount of Na in 1 g of the food⁽¹⁴⁾. For each participant, the Na content of the average portion consumed was calculated by multiplying the weight of the portion (in grams) by the conversion factor. Finally, the number of milligrams of Na in the usual serving size was multiplied by the frequency of intake, corrected for the frequency of monthly consumption (0 for the score of 1, representing never; 0.5 for the score of 2, representing less

than once monthly; 2 for a score of 3, representing a frequency of 1–3 times monthly; 4 for a score of 4, representing once weekly; 12 for a score of 5, representing a frequency of 2–4 times weekly; 30 for a score of 6, representing a frequency of once daily; and 60 for a score of 7, representing a frequency of twice or more daily); the result was the monthly Na consumption for each item.

For foods with no published Na data available, the Na content was estimated by using known amounts in similar foods. Regional recipes were used to determine the Na content of frequently served dishes combining various ingredients with variable amounts of Na. The Na content of the recipes was estimated by a third expert dietitian using the TACO list for the ingredients commonly used in regional recipes⁽¹⁵⁾. The following procedures were adopted to define the items to be eliminated from the final FFQ: (i) elimination of foods never consumed by more than 50% of the sample population; (ii) calculation of the sum of the scores of all subjects for the frequently consumed food items; and (iii) exclusion of those foods receiving an average score of 2 or less (total less than 264 points). Those foods retained were then tested for their contribution to overall Na consumption, and those not contributing more than 20% of the final Na intake were also excluded. The final instrument used for all analyses thus comprised fifteen items considered to be representative for the population studied.

Data collection

Participants were recruited during regular doctor visits. The administration of the FFQ was preceded by the asking of a series of questions assessing social and demographic variables; questions involving the 24 h recall measure were then asked. These interviews were based on meal sequence and involved a detailed assessment and description of the food consumed. Afterwards, the participants were asked about the use of discretionary salt in the household and instructed to fill out a 3 d dietary record starting on the fourth day after the interview; the 24 h urine sample was to be collected on the sixth day. For all self-report measures, the usual amount of food consumed was assessed on the basis of known home portion sizes^(16,17). On the seventh day, the patient returned for another doctor's visit at the hospital and brought the completed 3 d record and the 24 h urine sample. From the 132 subjects initially recruited, thirteen did not return the 3 d diet record and the 24 h urine sample (attrition rate of 9.8%). A sub-sample of thirty-eight subjects with similar sociodemographic and clinical characteristics to those of the targeted population was submitted to a second interview within a 15 d interval to test the stability of the FFQ.

Discretionary salt

Patients were asked to rate the usual monthly salt consumption (number of 1 kg packages of salt consumed per month), as well as the number of persons in the household who ate at least five meals per week at home (in order to

correct the salt consumption per person). Computation of the data from the 24 h recall and 72 h inventory measures included only the Na intrinsic in the foods. Added salt was computed using only the data from the discretionary salt. The US Department of Agriculture reference (1 g salt = 400 mg Na) was used to obtain the monthly and daily average of number of milligrams of Na per person⁽¹⁸⁾.

24 h urinary Na

Na excretion was measured spectrophotometrically and converted to mEq/l. Na intake was estimated by assuming that about 86% of the total Na consumption of the day is excreted in the urine⁽¹⁹⁾. Subjects were carefully instructed to collect all urine produced during the 24 h period and to continue to drink water normally throughout the day. The percentage of Na intake accounted for by each self-report measure was calculated as the ratio of total dietary Na reported by each measure to that of the total assessment estimated from the 24 h urine sample, multiplied by 100.

24 h recall

This measure was assessed in a face-to-face interview in which the participants were asked to describe in as much detail as possible all the food and beverages consumed over the past 24 h period, including the usual portion size of these foods; they were asked to report these amounts using regionally typical utensil sizes (cups, glasses, spoons, slices and pieces)⁽²⁰⁾.

72 h register

This measure was self-administered. To maintain control of the quality of this home register, the participants were asked to record the items consumed within 30 min of the termination of the meal and then to record the sizes of the portions using the same measures used for recording what had been eaten when recalling consumption during the past 24 h.

Nutrient database

Energy and nutrient intakes for both dietary assessments were calculated using the Nutwin[®] database software developed by the Federal University of São Paulo.

Statistical analyses

Means and standard deviations of Na determined using the different measures (FFQ, 24 h dietary recall, 3 d diet record, urinary Na excretion) were calculated. The reproducibility of the FFQ was assessed by using the kappa coefficient to test the agreement between the first and second applications of the instrument. The overall validity of the FFQ was assessed by Spearman correlation coefficients relating self-reports of salt consumption with Na excretion obtained from a 24 h urine sample; the latter was also used for the correlation of all of the items of the FFQ. A Mann-Whitney test was used to determine significant gender differences between means of salt

consumption provided by the self-report methods and the 24 h urinary Na. Results were considered statistically significant at a two-tailed level of 0.05. Statistical analysis was performed by using the SAS statistical software package release 6.12 (SAS Institute Inc., Cary, NC, USA).

Results

The mean age of the 132 participants was 55.5 (SD 13.3) years. Most of them were white (78%); the mean number of years of formal education was 5.6 (SD 4.0) and the mean monthly income was \$US 516.2 (SD 442.8). Of these 132 individuals, thirteen did not return the urinary sample (9.8%) and twenty-two (16.7%) did not return the complete 72 h register. Nevertheless, data regarding the FFQ, the 24 h recall and discretionary salt were used in the analysis for the 132 subjects. There were no significant differences in sociodemographic and clinical variables between the final sample and those who dropped out. Furthermore, the 132 subjects were not different in terms of age, gender and schooling when compared with the whole population attending the ambulatory clinic (*n* 396) during the period of the research.

The sociodemographic and clinical characteristics of the participants are summarized in Table 1. The Na intake assessed by the FFQ and the reference measures was higher for men than for women ($P < 0.05$). No difference in discretionary salt was ascertained between genders (Table 2).

Reliability

The reliability of the FFQ was assessed according to the criterion of reproducibility. Thus, stability in relation to frequency of consumption was tested. Kappa coefficients ranged from 0.79 to 0.98, confirming the stability of the FFQ.

Table 1 Sociodemographic and clinical characteristics of the low-income Brazilian hypertensive patients

	<i>n</i>	%		
Gender				
Female	83	62.9		
Male	49	37.1		
Race				
White	103	78.0		
Non-white	29	22.0		
	Mean	sd	Median	Range
Age (years)	55.5	13.3	56.0	18–85
Education (years)	5.6	4.0	4.5	0–17
Monthly income (\$US)	516	442.8	397.5	0–2623.5
BMI (kg/m ²)	29.4	4.8	28.9	17.7–39.6
Male	29.2	5.0	29.3	19.5–38.1
Female	29.5	4.6	28.9	17.7–39.6
WC (cm)	96.5	12.5	95.5	60–129
Male	99.2	12.7	98.0	77–127
Female	94.8	12.2	94.0	60–129
SBP (mmHg)	147.0	24.0	142.5	99–220
DBP (mmHg)	86.9	13.9	87.0	53–135

WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 2 Dietary intake of sodium from the FFQ and self-report methods, biological marker of sodium intake, and mean differences in intake between men and women among the low-income Brazilian hypertensive patients

	Mean	SD	Median	Range	Men		Women		P value*
					Mean	SD	Mean	SD	
Na consumption from 24 h urinary Na [†] (mg Na/d)	5384	2402	5086	734–12 756	6125	2636	4917	2131	0.02
Discretionary salt (mg Na/d)	2902	1882	2444	740–13 333	2740	1451	2998	2098	NS
FFQ (mg Na/d)	2191	2681	1175	78–12 237	3111	3328	1648	2048	0.007
+ discretionary salt added‡ (mg Na/d)	5093	267	4117	1047–15 568	5851	3419	4646	2772	0.05
24 h recall (mg Na/d)	1052	926	779	50–6475	1297	1186	907	700	0.05
+ discretionary salt added‡ (mg Na/d)	3954	191	3582	1113–15 398	4037	2184	3905	2219	NS
72 h register (median of 3 d; mg Na/d)	1048	679	895	22–5061	1141	628	991	707	NS
+ discretionary salt added‡ (mg Na/d)	3859	1856	3378	1343–13 846	3967	1763	3793	1921	NS

*Mann–Whitney test.

†Na consumption estimated from the urinary Na excretion⁽¹⁷⁾.

‡Discretionary Na summed to the Na given by the specific method.

Validity

There was no correlation between urinary Na excretion, the FFQ and the 24 h recall for the general sample, although significant correlations had been observed when methods were summed up (24 h recall + discretionary salt + FFQ; 0.32, $P=0.01$). Spearman correlation coefficients with the 72 h register + discretionary salt+FFQ (first and second day) were 0.19 and 0.20 ($P<0.05$) for the sample as a whole and, for the second day, 0.27 ($P=0.03$) for the sub-sample of women. The FFQ alone, as well as the other self-reported measures, revealed no significant correlations with 24 h urinary Na; however, when discretionary salt was added, the correlations were significant for the 24 h recall in the sub-sample of women. Furthermore, for the sample as a whole, Spearman correlation coefficients were significant when the FFQ was included with the self-report measures already corrected for discretionary salt (Table 3).

The percentage of total Na intake provided by each of the self-report measures was calculated on the basis of the 24 h urinary Na, as shown in Table 4. The 24 h recall and the FFQ alone provided a low estimation of the Na intake (23.9% and 48.9%), but inclusion of discretionary salt improved this to 87.2% and 112.2% of the value registered by the assessment of 24 h urinary Na.

The correlation of each of the final fifteen items of the FFQ was tested against the total Na consumption estimated by the instrument. Three items were found to correlate significantly with total Na intake: chicken sausage (0.32, $P=0.02$), type one seasoning (industrialized blend of seasonings of salt and added spices; 0.95, $P<0.001$) and type two seasoning (beef flavour bouillon tablet; 0.51, $P<0.001$).

Discussion

Data are lacking about the sources of Na in the Brazilian diet. Na intake by hypertensive subjects, however, is a cause of major concern among health professionals; moreover, there is a lack of validated instruments and

Table 3 Spearman correlation coefficients of the FFQ and the self-report methods against urinary sodium excretion for the general sample, women and men sub-samples of the low-income Brazilian

	General sample	Women	Men
Discretionary salt	NS	0.30 0.02	NS
FFQ	NS	NS	NS
24 h recall	NS	NS	NS
+ discretionary salt	0.18*	0.32	NS
+ discretionary salt + FFQ	0.06†	0.01	NS
	0.23	0.31	NS
	0.02	0.01	
72 h register – day 1	NS	NS	NS
+ discretionary salt	NS	NS	NS
+ discretionary salt + FFQ	0.19	0.23	NS
	0.05	0.06	
72 h register – day 2	NS	NS	NS
+ discretionary salt	NS	0.23	NS
+ discretionary salt + FFQ	0.20	0.27	NS
	0.04	0.03	
72 h register – day 3	NS	0.22	NS
+ discretionary salt	NS	0.80	NS
+ discretionary salt + FFQ	NS	NS	NS
	NS	NS	NS
72 h register	NS	NS	NS
+ discretionary salt	NS	NS	NS
+ discretionary salt + FFQ	NS	0.25	NS
		0.05	

*Correlation coefficient.

†P value.

measures for the assessment of habitual dietary Na intake, which hinders the evaluation of individual dietary Na patterns in clinical practice^(21,22). Development and validation of tools to assess Na consumption is still a challenge. Assessing Na intake more accurately implies identification of the sources of Na in the standard diet, yet this is different from the situation for other nutrients which are supplied largely by intrinsic nutrients in specific foods⁽⁸⁾. Na constitutes a part of almost all fresh foods, and it is a major component of industrialized,

Table 4 Percentage of consumption given by the self-reported methods with and without the addition of discretionary salt in relation to the consumption estimated by urinary sodium excretion among the low-income Brazilian hypertensive patients

Method	% of Na intake estimated by urinary Na		
	Mean	SD	Median
Discretionary salt	63.3	48.4	51.7
FFQ	48.9	72.4	19.3
+ discretionary salt	112.2	101.6	82.6
24 h recall	23.9	24.7	15.2
+ discretionary salt	87.2	63.7	72.4
+ discretionary salt + FFQ	136.1	114.2	104.9

canned and pre-prepared foods. Moreover, table salt and that added when preparing foods are also an important source of Na in the individual diet^(1,6,8). Therefore, in order to estimate Na consumption, it is necessary to consider all different sources of dietary Na. In the present study, we have developed and evaluated the validity of an FFQ (QFASó) to provide an instrument to furnish rapid information about the consumption of foods known to be sources of large amounts of Na and which cannot be assessed by other measures.

The questionnaire was validated using the self-report measures of 24 h recall and 72 h register (both alone and corrected with the inclusion of discretionary salt), as well as a biomarker (24 h urinary Na). The method of 24 h recall is simple and easy to use, and can be administered by the researcher; it can provide results of great accuracy in relation to frequency and portions consumed. However, an individual's memory is limited. The 72 h record tends to be more accurate because it is based on immediate registration of consumption, thus eliminating the memory bias⁽¹⁷⁾, but depends on the commitment of the subject as well as requiring a certain level of literacy^(13,19). Urinary Na is considered to be the ideal measure for estimation of Na consumption although it does not provide information about the quantity of nutrients consumed, nor what dietary habits are involved, so it is of less help in planning educational intervention^(23,24).

In this matter, the FFQ was a useful tool to highlight the contribution of some items such as seasonings, whose information is not accessed by any other method and was found to be a major source of Na for these Brazilians. The higher correlations involved for the subset of women reflects the results of various studies which have shown FFQ to correlate with the food habits of women^(25–27); this may be due to the fact that women are generally responsible for the purchase of food and the preparation of meals, which may make them more likely to be able to estimate their consumption and dietary habits than are men.

A significant correlation between self-report measures and urinary Na was obtained only when discretionary Na was included. This can be explained by the fact that the 24 h and 72 h measures do not consider the salt added to food,

neither before nor after preparation, yet for this population discretionary salt is an important source of dietary Na.

Furthermore, our data suggest that the various measures used (24 h recall, 72 h register, FFQ, discretionary salt) may tap different dimensions of the actual total intake of Na, since the sum of the three measures correlated better with 24 h urinary Na than did any of them alone. The 24 h recall and the 72 h register evaluated the intake of participants in just a brief period of time, and it did not include some of the sources of Na assessed with the FFQ, nor did it evaluate the regular use of discretionary salt.

Various studies have limited the evaluation of diet to one or two methods of assessment⁽²⁸⁾, and this may introduce a critical bias when evaluating Na intake. The use of three measures has proved more efficient for the triangulation of Na intake^(29,30).

Another contribution of the present study was the inclusion of low-income individuals of marginal literacy, as such people tend to face greater difficulty in filling out questionnaires⁽¹¹⁾. Even though limited literacy was included as a criterion for the elimination of potential subjects, we were able to collect information from a sample with very low literacy levels, with 50% of them having only 4.5 years or less of formal education. Such a group truly represents the population of low income and marginal literacy targeted here.

We conclude that the FFQ developed is a reliable and valid method for assessing Na intake, even though it should not be used alone to assess overall Na intake. The application of this validated FFQ, when used in conjunction with other measures such as 24 h recall and the use of discretionary salt, can be extremely helpful in epidemiological studies evaluating Na consumption and its relation to disease in low-income Brazilians.

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