Short Communication

Food frequency questionnaire is a valid tool in the nutritional assessment of Brazilian women of diverse ethnicity

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The objective of this study was to validate a food frequency questionnaire (FFQ) used to estimate energy and selected nutrient intake in a Brazilian population with various ethnic backgrounds. Validity of intake estimated using the FFQ was tested among 55 Brazilian women, namely 26 Caucasians, 15 of Japanese descent, and 14 others. The FFQ was originally developed for use in a case-control study of breast cancer conducted in São Paulo. Dietary records (DRs) recorded in two seasons were used as references. Intake of energy and 24 nutrients were calculated using the USDA and Japanese food composition tables. Validity and reproducibility were evaluated using Spearman's correlation coefficients. Results showed that intake of chicken/poultry, eggs and legumes were overestimated by the FFQ compared to the DR, whereas that of pork and fat was underestimated. Further, intake of folate, fiber and isoflavones was overestimated by the FFQ whereas that of energy, fat, carbohydrate alpha-carotene and lycopene was underestimated. Energy-adjusted correlation coefficients between nutrient intakes estimated with the FFQ and DR were high for isoflavones (0.76), calcium (0.50), and vitamin C (0.49). In contrast, validity varied from moderately high to low for energy and other nutrients. In conclusion, validity of the FFQ for estimation of the intake of selected nutrients among Brazilian women with varied ethnic background was moderately high.

Key Words: FFQ, ethnicity, reproducibility, validity, nutritional assessment

INTRODUCTION
Thanks to their ease of administration and low burden on the subject, food frequency questionnaires (FFQs) are commonly used to assess dietary intake in epidemiological studies.[1] When used to assess intake in a population, however, it is necessary to validate that the instrument includes a sufficient number of foods to ensure accurate assessment at the population level.

A multi-institutional hospital-based case-control study was conducted to investigate the epidemiologic and molecular aspects of breast cancer among Brazilians with and without Japanese ancestry living in São Paulo. The study aimed to determine the risk factors associated with breast cancer, focusing on the role of diet in the etiology of this disease. When assessing dietary intake among population with such diverse cultural background, FFQs need to include various type of food items which represents dietary intake of each population. For above-mentioned case-control study, a semi-quantitative FFQ was carefully developed with consideration of estimating dietary intake among Brazilian population with various ethnic backgrounds. To ensure that the FFQ was able to estimate the accurate dietary intake among the population, a validation study needed

to be conducted among subsample of the main study. The objective of our study was to evaluate the validity of this FFQ using dietary records (DRs) as a reference method.

MATERIALS AND METHODS
Study Subjects
The FFQ was originally developed to estimate dietary intake among individuals in a multi-institutional hospital-based case-control study aimed at identifying risk factors associated with breast cancer among Brazilians with and without Japanese ancestry living in São Paulo, focusing on the role of diet in the etiology of this disease.[2] We validated the FFQ in a subsample of subjects from the

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main study. A total of 55 Brazilian women were recruited starting January, 2002 from among the controls of the main study at four hospitals in São Paulo (Pérola Byingnton Hospital, A. C. Camargo Hospital, Instituto Brasileiro de Controle ao Câncer, SBC Hospital). These women had not been diagnosed with breast cancer and had lived in São Paulo for at least 10 years. The study protocol was approved by CONEP (Comissão Nacional de Ética em Pesquisa), Brasília, Brazil, and by the institutional review board of the National Cancer Center, Tokyo, Japan.

Data collection
Each subject completed the semi-quantitative FFQ twice at a one-year interval, and a 4-day DR in each of two seasons. The first FFQ, administered between January, 2002 and August, 2003 to assess exposure information for the main study, provided data for comparison with the second FFQ to evaluate reproducibility in the present validation study. The second FFQ was used to obtain data for the evaluation of validity by comparison with the DRs.

The FFQ inquires about the habitual intake of the subjects during the 1-year period preceding the diagnosis or development of symptoms of disease. It included 118 food items in 8 frequency categories (less than once a month, 1-3 times/month, 1-2 times/week, 3-4 times/week, 5-6 times/week, once a day, 2-3 times/day, 4-6 times/day,

Table 1. Subject characteristics (n=55)

Characteristic	n	%
Ethnic background		
Caucasian	26	47
Mulatto (mixed)	10	18
Black	4	7
Japanese	15	27
Age (year-old)		
30s	6	11
40s	14	25
50s	16	29
60s	15	27
70s	4	7
Marital status		
Single	5	9
Married	35	64
Widowed	8	15
Divorced	7	13
Frequency of alcohol consumption		
Almost never	43	78
1-3 times/month	11	20
1-2 times/week	1	2
Smoking status		
Never smoker	36	65
Current smoker	3	5
Past smoker	16	29
Education		
Uneducated	3	5
< 8 y. education	3	5
Primary	26	47
< 11 y. education	8	15
High school	11	20
University	4	7
Body mass index [weight(kg)/height(m)^2]		
<18.5	1	2
18.5-25	31	56
25-30	22	40
>=30	1	2

7 times/day or more). Portion sizes relative to the reference standard portion size in grams were also classified in three categories (small, half the standard size; medium, same as the standard size; and large, 1.5 times or more the standard size). The FFQ was administered in personal interviews conducted by trained interviewers.

Dietary records were collected over four consecutive days (Wednesday, Thursday, Friday and Saturday) once each in winter (July, August or September 2002) and summer (December 2002, or January or February 2003). Each participant was instructed to record all foods and beverages consumed on the four consecutive days in a specially designed form provided by a dietitian. Forms were collected one week after distribution. A dietitian reviewed all DRs for completeness, and when necessary questioned the participants to clarify the foods and amounts consumed.

Statistical analysis
Energy and nutrient intakes according to the FFQs and DRs were calculated using the food composition database of the USDA National Nutrient Database for Standard Reference, Release 18.[3] For Brazilian- and Japanese-specific mixed dishes, a dietitian (CMK) identified and quantified ingredients and weights according to commonly used recipes. The Japanese Standardized Tables of Food Composition, 5th ed.[4] was used for some Japanese-specific foods. daidzein and genistein intake was calculated using a previously developed food composition table for isoflavones[5,6]. Intake values of nutrients and food groups were adjusted for energy using the residual method.

Mean standard deviation and median intakes were calculated for all nutrients in the DRs and FFQs. Validity and reproducibility between the DR and second FFQ were evaluated using Spearman's rank correlation coefficients (CCs), and between the first FFQ and second FFQ for crude intake and energy-adjusted intake.

RESULTS
Characteristics of the study participants are shown in Table 1 Approximately half of the 55 participants were Caucasians, while those of Japanese descent and other ethnic backgrounds accounted for about 25% each. Age varied from 33 to 72 years, with most subjects in their 40s to 60s (median=55). More than half of the participants were married, and had less than 11 years of education. Very few were smokers or consumed alcohol, or were obese or underweight.

Daily intake of energy and nutrients as assessed by the DRs and FFQs is shown in Table 2. Intake of folate, fiber and isoflavones was overestimated by the FFQs whereas that of energy, fat, carbohydrate, alpha-carotene and lycopene was underestimated. Intake of chicken/ poultry, eggs and legumes were overestimated more than 1.5 times by the FFQ compared to the DR whereas that of beef, pork, vegetables and fat were underestimated.

Spearman's CCs between nutrient intake according to the second FFQ and DR were calculated to check the validity of the FFQ, and those between nutrient intake according to the first and second FFQs for reproducibility of the FFQ (Table 2). Among results, the CC between en-

Table 2. Energy, nutrients and food group intake from the second FFQ and 8-day DR, and validity and reproducibility of the FFQ compared to the DR (n=55)

		FFQ			DR			Validity [†]		Reproducibility [‡]	
		Median	Range	Interqurtile range	Median	Range	Interqurtile range	Crude	Energy-adjusted [§]	Crude	Energy-adjusted [§]
Nutrient											
Energy	kcal	1497	902-2864	1239-1811	1846	1047-2652	1497-2118	0.31	-	0.63	-
Protein	g	64	35-148	53-83	65	31-92	55-72	0.15	0.03	0.48	0.46
Total fat	g	49	20-122	35-65	65	37-116	54-75	0.37	0.33	0.61	0.30
Carbohydrate	g	200	127-341	167-249	246	111-409	205-283	0.35	0.17	0.63	0.36
Calcium	mg	594	227-1340	483-762	567	338-1199	446-768	0.50	0.50	0.54	0.62
Retinol equivalent	mg	539	152-2239	419-818	406	121-3051	357-526	0.42	0.41	0.66	0.52
Vitamin D	IU	91	0-265	82-201	79	8-169	56-110	0.36	0.37	0.61	0.60
Vitamin E	mg	5	2-9	4-6	5	2-9	4-6	0.19	0.24	0.67	0.67
Vitamin B_1	mg	1.3	0.7-2.7	1.1-1.6	1.1	0.6-1.8	0.9-1.3	0.40	0.08	0.52	0.29
Vitamin B_2	mg	1.6	1-3.5	1.5-2.1	1.4	0.9-3.2	1.2-1.7	0.09	0.12	0.67	0.49
Vitamin B_6	mg	1.6	0.8-3.7	1.2-2	1.4	0.6-2.1	1.3-1.6	0.25	0.38	0.69	0.40
Vitamin B_{12}	μg	4.8	1.5-25.1	3.4-7	3.2	1.5-35.5	2.4-4.2	0.34	0.33	0.69	0.65
Vitamin C	mg	132	19-355	75-194	81	12-346	49-153	0.46	0.49	0.72	0.71
Folate	μg	411	180-845	337-646	300	168-565	239-350	0.41	0.30	0.51	0.47
Saturated fatty acids	g	15	6-38	11-20	18	9-37	16-22	0.41	0.45	0.59	0.40
Monounsaturated fatty acids	g	17	7-44	12-23	22	12-48	19-26	0.43	0.36	0.59	0.32
Cholesterol	mg	183	46-657	131-230	172	80-461	132-222	0.09	0.11	0.41	0.16
Total fiber	g	22	7-40	15-34	15	7-33	13-18	0.20	0.21	0.64	0.43
Retinol	mg	268	79-2038	212-567	200	64-2961	136-269	0.27	0.35	0.60	0.53
Alpha-carotene	mg	191	4-587	124-284	201	4-842	44-382	0.43	0.37	0.30	0.22
Beta-carotene	mg	2239	187-8674	1353-3258	2020	247-6800	1184-2715	0.41	0.42	0.47	0.42
Lycopene	mg	404	43-2449	226-925	2019	0-15281	836-3210	0.03	0.02	0.62	0.59
Daidzein	mg	0.0	0-13.1	0-2.3	0.0	0-19.2	0-0.5	0.76	0.76	0.80	0.80
Genistein	mg	0.0	0-35.3	0-3.7	0.0	0-35	0-0.9	0.76	0.76	0.80	0.79
Food group											
Meat	g	79	13-406	62-119	96	20-187	76-123	0.26	0.24	0.26	0.17
Red meat	g	46	0-204	30-73	70	6-168	51-104	0.29	0.24	0.55	0.55
Beef	g	36	0-167	17-43	56	6-129	28-79	0.20	0.25	0.58	0.57
Pork	g	0	0-23	0-4	3	0-38	0-13	0.29	0.31	0.54	0.55
Processed meat	g	9	0-54	2-19	8	0-49	0-20	0.46	0.42	0.66	0.59
Chicken/Poultry	g	34	0-241	20-46	20	0-72	6-40	0.16	0.18	0.10	0.08
Fish	g	8	0-90	0-26	0	0-88	0-25	0.30	0.28	0.66	0.63
Egg	g	11	0-118	3-12	6	0-44	0-13	0.22	0.25	0.62	0.59
Legumes (excl. soy)	g	144	11-416	69-350	58	0-219	30-109	0.47	0.45	0.66	0.60
Soy	g	0	0-150	0-2	0	0-192	0-6	0.51	0.49	0.75	0.75
Cereal	g	213	43-319	115-213	130	64-341	97-180	0.00	-0.06	0.10	0.20
Vegetables	g	76	5-204	41-111	107	40-226	85-148	0.38	0.37	0.46	0.41
Fat	g	5	0-20	3-5	24	11-48	19-31	0.18	0.17	0.67	0.62
Fruit	g	221	8-977	111-389	183	8-848	92-306	0.43	0.47	0.69	0.70
Milk and dairy	g	220	0-606	200-500	219	26-642	153-272	0.71	0.71	0.68	0.67
Bread	g	56	9-145	50-73	75	20-172	58-93	0.32	0.23	0.52	0.51

[†]Spearman's rank correlation coefficients between the second FFQ and mean value of the 8-day DR
[‡]Spearman's rank correlation coefficients between the first and second FFQ
[§]Energy-adjusted value was calculated using the residual model

ergy intake estimated with the FFQ and DR was 0.31. Energy-adjusted CC for validity of the FFQ was high for isoflavones (daidzein and genistein, 0.76), calcium (0.50), and vitamin C (0.49), but low (less than 0.20) for lycopene, protein, carbohydrate, vitamins B_1 and B_2, and cholesterol. Validity for the other nutrients was moderate. Validity for intake of foods by food group was moderate except for chicken/poultry, cereal and fat. CC for reproducibility varied from low for cholesterol to moderate to very high for other nutrients (0.80 for daidzein). Reproducibility for intake of foods by food group was moderate except for total meat and chicken/poultry. Analysis by ethnicity (Japanese descent, Caucasian and other) showed that validity for food groups frequently consumed within

the ethnicity was high. Among Japanese-descended Brazilians, for example, validity was high for fish (0.82), whereas among Caucasian and others it was high for legumes (0.48 and 0.50, respectively). We also evaluated the validity of the FFQ using a 4-day DR from one season only (winter or summer) as a reference, but found that validity was not influenced by the seasonality of the reference method.

DISCUSSION

In this study, we evaluated the validity of an FFQ developed to estimate the habitual dietary intake of Brazilians, who have various ethnic backgrounds, in a case-control study aimed at determining the risk factors associated

with breast cancer. Results showed that the validity of the FFQ in estimating dietary intake in these Brazilian women varied depending on food groups and nutrients. Validity for specific food groups such as dairy products and soy products was high. In contrast, validity for legumes and processed meat was moderate, and the relatively poor validity for the meat group, especially for chicken/poultry, apparently lowered validity for protein. Moreover, the poor validity for chicken/poultry in turn caused poor validity for total meat.

FFQs used in epidemiological studies must be evaluated to ensure they include an adequate number of foods, and thus the ability to assess dietary intake among the study population. This evaluation is particularly important when the population is composed of immigrants of different ethnic backgrounds, because the diet usually contains foods from the originating cultures. A number of studies have evaluated the validity of FFQs in immigrants[7-9]. Cardoso and colleagues reported that the validity of their FFQ in women of Japanese ancestry living in São Paulo, Brazil ranged from 0.27 for sodium to 0.68 for dietary fiber [8]. The validity of our FFQ was slightly lower, possibly owing to our inclusion of a variety of ethnicities. In addition to their study variables, we also evaluated the intake of isoflavones, a phytoestrogen with potential effects on breast cancer consumed in relatively large amounts by Japanese via soy products; although the food sources were different, validity in estimating isoflavones was reasonably high for Brazilians of both Japanese and non-Japanese descent.

One of the strengths of our study was the variability of the reference data. In Brazil, the availability of fruits and vegetables is seasonal. We used a 4-day DR in two seasons, which should have ensured capture of the seasonality of intake. Our FFQ can be easily used to compare dietary intake in Brazilians of various ethnic backgrounds, and was the same instrument used to estimate diet in the main study. In contrast, a limitation of the study is selection bias, as participants were not a randomly selected sample, and indeed required high motivation to complete the 8-day DRs.

In conclusion, we verified the validity of an FFQ in estimating the intake of selected nutrients, such as isoflavone, calcium and vitamin C, which may have a preventive effect on breast cancer among Brazilian females. Validity was moderately high for energy and other nutrients.

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食物頻率問卷對於不同種族的巴西婦女是一種具有效度的營養評估工具

本研究目的為確認食物頻率問卷(FFQ)作為多種族背景的一巴西族群之熱量及選出的營養素攝取評估的效度。FFQ 攝取量評估的效度是測試 55 名巴西婦女，包括 26 名白人、15 名日本裔及 14 名其他種族。此套 FFQ 原本是為 Sao Paulo 的一個乳癌病例對照研究而發展出來的。以兩季的飲食紀錄(DRs)當作參考值。使用 USDA 及日本食物組成表計算熱量及 24 種營養素的攝取量。使用斯皮爾曼相關係數評估效度及信度。結果顯示 FFQ 比起 DR，在雞肉/家禽類、蛋類及豆類是高估，反之豬肉及脂肪是低估。再者，FFQ 高估葉酸、纖維素及異黃酮的攝取，反之熱量、脂肪、碳水化合物、α-胡蘿蔔素及蕃茄紅素是低估。經過熱量校正後，FFQ 與 DR 對營養素攝取量的評估，在異黃酮(0.76)、鈣質(0.50)及維生素 C(0.49)有高的相關係數。相反地，對熱量及其他營養素的效度並不一致，從適度地高到低。總之，對有多種族背景的巴西婦女，FFQ 在評估某些營養素攝取量的效度是適度地高。

關鍵字：食物頻率問卷、種族、信度、效度、營養評估