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Calibration of a food frequency questionnaire developed for the South Asian community in the United Kingdom

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ABSTRACT

An interview administered food frequency questionnaire (FFQ) consisting of 75 food items was developed and calibrated against a four day weighed record (WR). The FFQ was also calibrated against a proxy for biomarker, the energy intake/basal metabolic rate ratio (EI/BMR). A total of 58 subjects (35 women, 23 men) aged between 19 and 76 years of Pakistani and Indian origin in Southampton, United Kingdom (UK) participated in this calibration study. The results for men and women combined together suggested reasonable agreement between FFQ and WR estimates of intake with Spearman rank correlation coefficient ranging between 0.26 and 0.38 (energy unadjusted). Gender specific agreement was however, poor. The percent mean difference between nutrient estimates by FFQ and WR was in general within 10% for energy, fat and protein in women while in the range of 11% to 25% in men. The percent mean difference for other nutrients such as sugar and dietary fibre ranged between 18% and 99% in men and women; while was 9% and 6% for starch in men and women respectively. The ranking of subjects into the thirds of distribution was poor with gross misclassification in the range of 5% to 14% in men and 15% to 29% in women. Comparison of both FFQ and WR with EI/BMR ratio showed that there were more underreporters of energy intake when reporting intake using WR than FFQ in both men and women. Based on these results, it was concluded that further development of the FFQ was needed before the FFQ could be used to evaluate the usual dietary intake in the South Asian population.

INTRODUCTION

Food frequency questionnaire (FFQ) is the preferred method to evaluate long-term usual dietary intake in population based epidemiological studies because it is simple, easy to administer and requires minimal effort from the subjects (Boeing *et al*, 1989). In our effort to study the relationship between diet and diabetes in the South Asian population in Southampton, UK, a FFQ was developed for this population. To our knowledge, at present, no FFQ has been designed and calibrated specifically for use in the South Asian population (peoples from the Indian subcontinent and East Africa). It is important that to be able to evaluate the usual dietary intake of a population to be studied, the food items included into the FFQ should reflect the food consumption of the population (Nelson, 1991).

In calibration studies, the test method (FFQ) is usually compared with a reference method (another dietary method), which from previous research has been considered to provide more accurate measures (Margetts, 1991). However, in the past decade the use of biomarkers to calibrate dietary methods have been carried out. In comparing the dietary assessment method with a biomarker, it would be possible to evaluate the quality of the dietary measurement used. In the present study, the assumption of the biomarker is to act as an estimate of dietary intake (Bates *et al*, 1991). Therefore in this paper, we evaluated the validity of the South Asian FFQ with the WR as the reference method and EI/BMR ratio as a proxy of a biomarker.

METHODS

Development of the FFQ

In the development of the FFQ, the food list to be included into the FFQ was identified. The food list was determined based on the results of a preliminary survey, in which 62 subjects were interviewed (24 hour recall) to evaluate their meal pattern and sources of energy and macro-nutrients in the South Asian diet. From this survey, the mean intake of each food item consumed by the subjects was determined . The energy, fat, carbohydrate and protein contributed by each food were calculated. The cumulative percent distribution of energy and macronutrients were then calculated for each food list until at least 90% of the total energy, fat, carbohydrate and protein respectively had been included. Generally the number of foods which contributed to 90% of total energy, fat, carbohydrate and protein were 19, 12, 15 and 9 respectively. The food list which consisted of 75 food items were included in the FFQ. Incidently these foods were also the foods commonly eaten by the majority of South Asians.

The frequency responses included in the FFQ were spread into seven responses ranging from rarely or never to two or more times per day. The available standard portion for each food and the number of portions consumed were also included. This FFQ was then administered by interview.

Subjects

In this calibration study, male and female patients and their relatives attending a General Practitioner in Southampton were invited to participate. A total of 100 subjects of Pakistani, Punjabi and Gujerati origin agreed to take part in the calibration study. However, only 58 subjects (35 women, 23 men) completed the interview administered FFQ and WR (respondents), 34 subjects completed only the FFQ (non respondents) while the remaining eight subjects did not complete both the FFQ and the WR.

Study design

The calibration study was carried out over a 14 months period (December 1993 to February 1995). A verbal consent was requested when approaching the subjects for his or her participation in the calibration study. Once the consent was granted, an appointment was then set up for the FFQ interview. A second appointment was then made up for a demonstration of usage of dietary

scale in the subjectís home; usually two to three weeks after the FFQ interview. The subjects were then given a demonstration on how to weigh and record their foods for four days, three week days and one week end. To be certain that each subject understood the weighing procedure, he or she was asked to repeat the demonstration to the researcher before a dietary scale (Soehnle) and a food diary were left with them.

The weight and height of the subjects for the calculation of the basal metabolic rate (BMR) were taken at the subject's home during visits to administer the FFQ or to collect the WR. The weight of the subjects was taken with the subjects wearing light clothing and without shoes. The weight was recorded to the nearest ± 0.1 kg using the Soehnle weighing scale (max weight 150 kg). The height of the subjects was measured with the Harpenden pocket stadiometer to the nearest ± 0.1 cm. The BMR of the subjects was calculated using the equation of Henry and Rees (1991). As a check for under-reporters or overreporters of energy intake, a cut off point of < 1.2 BMR and > 1.8 BMR as suggested by Bingham (1994a) was used.

Analysis of dietary data

The dietary data were converted to nutrient intake using the commercially available software package (Compeat Version 4) for WR and a software package for FFQ developed at the Wessex Institute of Public Health Medicine, University of Southampton. Each computer software package used a separate but similar nutrient database developed from food composition tables and their supplements (Holland *et al,*1988; Holland *et al,*1989; Holland *et al,* 1991a; Holland *et al* 1991b). The nutrient intakes estimated by each dietary method were then compared against each other.

Statistical Analysis

The means and 95% confidence interval (CI) for energy and selected nutrients were computed for the WR and the FFQ. Mean nutrient difference (MD) between the WR and FFQ was calculated by subtracting the WR from the FFQ (FFQ-WR). The ability of the FFQ to correctly rank individuals as the WR was assessed by the Spearman rank correlation coefficient. In addition, the Spearman rank correlation coefficient were also calculated using energy adjusted nutrient intakes. Energy adjusted nutrients were computed as residuals from the regression model, with the total energy intake as the independent variable and absolute nutrient intake as the dependent variable (Willett, 1990). The nutrient estimates of both the FFQ and WR were divided into thirds of distribution to examine their joint classification.

RESULTS

Background information about location and subjects of study

Southampton is a city situated about 120 km from London, United Kingdom. In the UK, there is an estimated one and a half million South Asians who originated from the main subcontinent of India or from East Africa (Uganda and Kenya) (OPCS, 1991). South Asians comprise 2.7% of the total UK population. Similarly in Southampton, where the calibration study is carried out,

South Asians make up 2.8% of the city population.

Description of subjects

Table 1 shows the demographic characteristics of subjects who completed (respondents) and dropped out (non respondents) of the calibration study. There were more female respondents (60%) compared to males (40%). The mean ages of the male and female respondents were 46 years and 45 years respectively. In the non respondents, the mean age was 44 years for male while 31 years for female.

The Pakistanis represented the majority of the respondents followed by the Gujeratis and Punjabis. The non respondents were mainly Punjabis. More than 90% of the respondents and non respondents were married and had five children or less. A majority of both respondents and non respondents had lived in the UK for more than 15 years and had more than six years of formal education, in India or in UK.

Comparison of intake estimates for FFQ and WR

The comparison of the mean daily nutrient intake estimates between the FFQ and WR for men and women are tabulated in Table 2 and Table 3. Generally the FFQ tended to give higher estimates than WR for energy, fat, carbohydrate and protein as well as for other nutrients such as sugar, starch and dietary fibre in both men and women. The percent mean difference between the two measures was in general within 10% for energy (10%), fat (7%), protein (4%) and starch (-6%), while in the range of 13% to 74% for carbohydrate, dietary fibre and sugar in women. The percent mean difference for sugar in men was 99%. However, other nutrients, the mean difference between measure ranged between 11% to 31%.

Spearman rank correlation coefficient

The Spearman rank correlation coefficient to determine the ability of the FFQ to rank correctly as the WR was calculated for both energy adjusted and energy unadjusted intake (Table 4). Rank correlation coefficient for energy unadjusted were statistically significant for energy, fat, carbohydrate and protein only when the data for men and women were pooled together. The correlation for energy adjusted ranged between 0.25 to 0.36 and only significant for carbohydrate and protein. The correlation ranged between 0.26 to 0.38 for energy unadjusted. The correlation of the selected nutrients analyzed, except for carbohydrate, were negative in women for the energy unadjusted, but the correlation for all the nutrients were positive in men. However, none of the correlation were significant in either men or women separately in the energy unadjusted nutrients.

The ranking of the subjects into the thirds of the distribution was also evaluated. Table 5 shows the percent of subjects who were correctly classified and grossly misclassified between the two measures. Subjects are categorized as correctly classified if they are ranked in the same third of the distribution by both measures, while they are defined as grossly misclassified if they are ranked in the opposite third of the distribution by both measures. Based on this criteria, 15% to 29% of women were grossly misclassified in their ranking while the percentage was lower (5%

to 14%) in men.

Table 1. Demographic characteristics of respondents in the calibration study

		Respondents	Non respondents
Sex	Male	23 (40%)	25 (74%)
	Female	35 (60%)	9 (26%)
Marital status	Married	53 (91%)	31(91%)
	Single	3 (5%)	2 (6%)
	Divorced	2 (4%)	1 (3%)
No. of children	0 - 5 children	52 (90%)	32 (94%)
	6 - 10 children	6 (10%)	2 (6%)
No. in household	0 - 5 person	40 (69%)	18 (53%)
	6 - 10 person	18 (31%)	16 (47%)
Ethnic	Gujerati	17 (29%)	7 (21%)
	Pakistani	26 (45%)	9 (26%)
	Punjabi	15 (26%)	16 (47%)
Live in UK	<5 years	7 (12%)	2 (6%)
	6-10 years	5 (9%)	3 (9%)
	11 - 15 years	2 (3%)	4 (12%)
	>15 years	44 (76%)	25 (73%)
Education	0 - 6 years	10 (17%)	6 (18%)
	>6 years	48 (83%)	28 (82%)

Table 2. Comparison of mean (95% CI) daily energy and nutrient intakes between WR and FFQ in men (n = 23)

Nutrient	Mean WR (95% CI)	Mean FFQ (95% CI)	MD	% MD
Energy, kcal	2202 (1901, 2502)	2604 (2280, 2928)	402	18%
Fat, g	98.98 (82.46, 115.51)	109.93 (89.89, 129.96)	12.0	11%
CHO, g	272.19 (234.29, 310.08)	339.02 (305.93, 373.24)	66.8	25%
Protein, g	67.32 (57.38, 77.25)	78.36 (67.73, 88.99)	11.0	16%
Sugar, g	68.79 (53.16, 84.41)	137.14 (114.46, 159.81)	68.4	99%
Starch, g	182.96 (155.67, 210.25)	199.07 (180.42, 217.72)	16.1	9%
Dietary fibre, g	25.52	33.47	7.95	31%

MD, mean difference, (FFQ-WR)
% MD, percent mean difference, (mean FFQ — mean WR/mean WR)* 100
CI, confidence interval

Table 3. Comparison of mean (95% CI) daily energy and nutrient intakes between WR and FFQ in women (n = 35)

Nutrient	Mean WR (95% CI)	Mean FFQ (95% CI)	MD	% MD
Energy, kcal	1647 (1487, 1808)	1803 (1639, 1967)	156	10%
Fat, g	70.95 (59.24, 82.66)	75.81 (61.17, 84.44)	4.86	7%
CHO, g	210.82 (191.9, 229.8)	239.02 (215.5, 262.5)	28.2	13%
Protein, g	54.77 (48.09, 61.44)	56.88 (51.98, 61.02)	2.09	4%
Sugar, g	59.28 (47.23, 71.4)	103.08 (88.50, 117.67)	44.6	74%
Starch, g	140.80 (130.1, 151.5)	133.10 (119.4, 146.8)	-6.8	-6%
Dietary fibre, g	20.60 (18.33, 22.86)	24.42 (22.38, 26.45)	4.13	18%

MD, mean difference, (FFQ-WR)
%MD, percent mean difference, (mean FFQ - mean WR/mean WR)* 100
CI, confidence interval

The cut-off point of < 1.2 BMR was used as the indication of underreporters while > 1.8 BMR was used as the indication for overreporters (Bingham, 1994a). In women, 48% underreported their energy intake when reporting using the WR, while only 7% underreported when using the FFQ. In men, 41% underreported energy intake with the WR while 6% underreported with FFQ. However, more than two thirds of men and women reported their energy intake with the FFQ within an acceptable EI/BMR ratio. On the other hand, only half of the men and women recorded their energy intake with the WR within the acceptable EI/BMR ratio.

Table 4. Spearman rank correlation coefficient[a] for energy and macronutrients in the food frequency questionnaire and weighed record.

Nutrient	All (n = 58)		Men (n = 23)		Women (n = 35)	
	unadj[1]	adj[2]	unadj	adj	unadj	adj
Energy	0.29[a]		0.39		-0.16	
Fat	0.26[a]	0.25	0.46	0.10	-0.05	0.29
CHO	0.38[a]	0.36a	0.20	0.23	0.28	0.36
Protein	0.27[a]	0.36a	0.55	0.44[a]	-0.17	0.23

[a] Two tailed tests for significance $p < 0.05$
[1] energy unadjusted nutrients
[2] energy adjusted nutrients (by method of Willett, 1990)

Table 5. Percentage of agreement (%) in ranking between WR and FFQ for selected nutrients

Nutrients	Men		Women	
	%GM	%CC	%GM	%CC
Energy	14	38	27	21
Fat	9	41	29	26
CHO	9	41	15	49
Protein	5	52	29	27

GM, grossly misclassified
CC, correctly classified

Table 6. Underreporters and overreporters of energy intake by dietary methods

	Women			Men		
Dietary method	Henry & Rees BMR			Henry & Rees BMR		
	<1.2	1.2-1.8	>1.8	<1.2	1.2-1.8	>1.8
FFQ	3 (7%)	30 (70%)	10 (23%)	1 (6%)	12 (70%)	4 (24%)
WR	16 (48%)	16 (48%)	1 (5%)	7 (4 1%)	9 (53%)	1 (6%)

DISCUSSION

The objective of developing the FFQ was to use it as a dietary tool to evaluate the usual dietary intake of the South Asian community in the UK. The FFQ could then be used to determine the relationship between diet and diabetes in this community. Thus it was expected that the FFQ could rank intake of energy and macronutrients and should be able to differentiate those who have high or low intakes.

In the present study, the FFQ (test method) was calibrated against a four day weighed record (reference method). A proxy of a biornarker (EI/BMR ratio) was used to check the relative validity of the energy intake estimated by the FFQ as well as the WR. The WR was used as the reference method because theoretically weighed record has been regarded as the best method to collect nutrient intake information (Bingham *et al,* 1994b; Willett *et al,* 1985).

The demographic information collected showed that there were some differences in the demographic characteristics between the respondents and non respondents. This was evident in the gender and ethnic criteria. There were more women who were respondents (60%) compared to men. A possible reason for this drop out among men was the weighing of food that was required in the calibration study. South Asian men were not involved in the preparation and serving of foods in their homes. As a result, many men who initially agreed to participate did not complete the study protocol.

The gender difference between the respondents and non respondents could have made a difference in the calibration study. These differences included how well men and women weighed and recorded their food intake as well as how they could remember and could estimate their usual intake when responding to the FFQ.

In the present study, there was language barrier between the subjects and the researcher especially among women. Some of the South Asian women were illiterate in both their native and English language. This problem was not as serious among men. Therefore it would be likely that those men who completed the study protocol weighed and recorded better than those men who dropped out and the women respondents. On the other hand, eventhough the women were sincere in their participation in the study, the language problem which they had could undermined the way they recorded their food intake. Many subjects found it very difficult to complete the WR because of the technical aspect of the weighing.

In the responding of the FFQ, some subjects had difficulty in estimating the portion size of the foods. This could be due to the absence of a standard portion size for a lot of South Asian foods. Therefore it would be likely that many subjects overestimated or underestimated their portion size when responding to the FFQ.

The FFQ generally gave higher estimates than the WR for almost all nutrients analyzed. This was expected as the comparison of energy estimates with the EI/BMR ratio indicated that a high percentage of underreporters when subjects reported their dietary intake with WR. However, our findings were in agreement with various other studies which compared the FFQ with the WR (Bingham *et al,* 1994b; Rothenberg, 1994). Despite the high underreporting by the WR, the higher nutrient estimates derived from the FFQ could possibly be due to the overestimation of portion size. Overestimation of frequency of intake and portion of intake was also shown by others (Flegal et al, 1988; Bingham *et al,* 1994).

The percent mean difference between the FFQ and WR were greater than 10% for all nutrients except starch in men. However, in women, the percent mean difference were within 10% for energy, fat, protein and starch. Although the cut off point of less than or equal to 10% mean difference had been used as an indicator of a good agreement between measures, it did not appear such when ranking between measures was evaluated.

The ability of the FFQ to rank individual correctly as the WR was determined using the Spearman rank correlation coefficient. The ranking showed reasonable agreement between methods only when the data for both men and women were analyzed together. The correlation broken down by gender were lower than those reported by others (Rothenberg, 1994; Goldbohm *et al,* 1994; Thompson and Margetts, 1993). However, comparison with other studies must be made with caution because of large differences between FFQs and in the population in which they are applied.

The percent of agreement in ranking of subjects between WR and FFQ was poor. In the present study, between 5% to 14% of men and 15% to 29% of women were grossly misclassified. This implied that many subjects were incorrectly placed in the proper thirds of the distribution by both the WR and FFQ. This misclassification of ranking by the dietary methods could be attributed to the underreporting of dietary intake by the WR method, while overreporting of dietary intake by the FFQ method. Other studies reported gross misclassification of subjects between 0% to 10% (illett et al, 1985; Tjonneland *et al,* 1991; Bingham *et al,* 1994b).

CONCLUSION

We conclude that this food frequency questionnaire which was designed for the South Asian community in the UK needs further development before it can be used to evaluate the usual dietary intake of this community. Subject recruitment and completion of the study protocol were major problems which undermined the confidence with which one can interpret the results.

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