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Research Article

DEVELOPMENT AND TESTING OF A FOOD FREQUENCY QUESTIONNAIRE FOR USE IN SLUM AREAS IN VARANASI BY A PILOT VALIDATION STUDY

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ABSTRACT

Food frequency questionnaires (FFQ) are important tool in estimating dietary intake in large nutritional epidemiological studies. Hence, this study aimed to develop and validate a food frequency questionnaire to assess the dietary intake of slum children of Varanasi. 10 categories of food with 33 food items were developed based on the food use of the study area. A pilot study was done on 50 slum children of Varanasi. The FFQ was tested for repeatability and validation against 24 hour dietary recall in 50 samples. The results of the validation study demonstrated good acceptance of the FFQ. Mean intake of macronutrients in FFQ1 and 24-h diet recall correlated well. Higher correlations were noted between the two methods in energy (0.60), fat (0.54) and carbohydrate (0.61) and moderate in protein (0.34). Pearson's correlation is also used to measure reproducibility between FFQ1 and FFQ2. These findings indicate that the FFQ is valid and reliable.

INTRODUCTION

Food frequency questionnaires (FFQ) are important research tool for dietary assessment in nutritional epidemiological studies. Dietary assessment done by using questions on dietary intake for nutritional epidemiological study play an important role in the discussion on chronic disease and public health issues (Bouvard *et al,* 2015, Joshi *et al*, 2015, Wolfram *et al* 2015, Sarich *et al* 2015 and Assmann *et al* 2015). Various methods have been used for assessing dietary intake at population level but still the accuracy and reliability of measuring diet is an ongoing challenge (Arab *et al* 2011, Hebden *et al* 2013 and Henriksson *et al* 2015). As we know childhood is a very crucial period because it's a period of rapid growth and during this period child eating habits are also formed (Mikkilal *et al* 2005). So, accurate dietary assessments of children are very important to show the effect of nutrition of growth and development of children. Relationship between nutrition and cognitive development of children is also highly depends on the proper assessment of dietary intake of children.
In epidemiological study FFQ is often used to assess long-term eating habits (Shahar *et al* 2003). FFQ is an inexpensive and more accurate tool to assess the habitual dietary patterns of large number of subjects in comparison to 24 hour diet recall and food records. It's a very practical and cost-effective approach for assessing dietary intake (Willett WC, 1998). FFQs are validated by comparing its results with reference methods such as 24-hour diet recall of dietary records (Kroke *et al* 1999). According to Bae *et al* (2010) Proper validation of FFQ is very important for collecting accurate diet records and in that way only we can provide a strong relationship between diet and disease or disease related markers. For proper validation of FFQ it is suggested that FFQ should be validated within the target population only (Cade *et al* 2002). So it is very important

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to develop the new FFQ according to the target population and the food items were used according to the eating habit of target population. Reproducibility of FFQ is also very important to assess and it can be done by administering it twice to the same group during review period (Bueno *et al* 1992).

Various literature searches were done by us but we didn't found any FFQ developed for assessing dietary intake of slum children of Varanasi. Hence, we develop and validate our own FFQ to assess regular dietary intake of slum children aged 5-12 years. The aim of this study is to describe the process of developing the FFQ its validation and reproducibility.

MATERIALS AND METHODS

This study was done in slum children of Varanasi. 50 children from Durgakund situated slum area were selected. The inclusion criteria were: children who were (a) Scheduled caste (b) aged 5-12 years and (c) mentally and physically healthy. Children with any genetic or physical disabilities and aged above 12 and below 5 were excluded. FFQ study was conducted prior to the data collection. After studying the target population an FFQ was developed. Written informed consent was obtained from the parents. During the study the Performa containing their general information, height, weight, 24 hour diet recall and FFQ were filled by us by taking information both from parents and children. Because of the fact that the study population was illiterate it's not possible for them to fill the FFQ and 24 hour diet record forms and also keeping food diaries wasn't an available option. The 24 hour record was an open-ended prompted interview conducted by us and the reference period for the 24 hour diet recall was the day prior to the day of the interview.

A total of 33 food items were determined from the analysis and organised into 12 main food groups: a) cereals & cereal products b) pulses & legumes c) vegetables d) fruits e) milk & milk products f) fats & edible oils g) meat, fish & poultry h) sweets i) beverage and j) fast food. Frequency of intake was evaluated based on habitual intake over the previous month. Food frequency consumption of each food items was evaluated using six categories: (a) never; (b) 1-2 times per month; (c) once a week; (d) 2-3 times per week; (e) 4-6 times per week and (f) daily. Each food item in the FFQ was assigned a portion size using natural units such as slices, number and pieces or other commonly used food measures (teaspoons (5ml), tablespoon (15ml), katori (bowl), tumbler). After completing the 24 h diet recall and FFQ Performa of the subjects for reproducibility again the administration of FFQ (FFQ2) was repeated to those subjects were first FFQ (FFQ1) was completed. FFQ2 was administered seven days after FFQ1.

To calculate the nutrient intake food items recorded in the 24 h diet recall were first converted to grams and then converted to total calorie, protein and fat intake with the help of book containing nutritive value of Indian food **(**Gopalan C, 1971**).** The amount of daily food intake was calculated from the FFQ according to the following formula: frequency of intake (conversion factor) × total no. of serving's ×weight of food in one serving. The conversion factor used to estimate food intake was based on the frequency of intake and the reference for this was taken from Fadil *et al* (2015). The conversion factors were shown in Table 1. With the use of the formula all food intake were converted into grams in the basic ten food groups (e.g. cereals, pulses, green leafy vegetables (GLV), roots and tubers, other vegetables, fruits, milk and milk products, fats and oils, sugar and jaggery and animal products). Then with the help of food exchange lists from the textbook of nutrition and dietetics (Khanna *et al*, 2005) all of these were converted in energy, protein, CHO and fat.

Table 1 Conversion factors for frequencies of intake reported in the food frequency questionnaires

Frequency of intake	Conversion factor (formula)
Per day	
1	1.00 (1.0/1)
Per week	
1	0.14 (1.0/7)
2-3	0.35 (2.5/7)
4-6	0.71 (5.0/7)
Per month	
1-2	0.05 (1.5/30)
Never	
0	0

RESULTS

For validation of FFQ 50 Performa of both FFQ and 24-h diet recall were successfully filled. For checking the reproducibility of FFQ again it was administrated in slum children. During the second administration of FFQ only 30 subjects Performa were successfully collected.

The characteristics of the 50 study participants are given in Table 2. Out of total 50 subjects 28 subjects were male and 22 were female. The overall mean of height and weight in male children aged 5 to 12 years is 119.35 and 20.60 respectively, whereas in female it is 121.09 and 20.07. The mean of BMI in male and female children is 14.30 and 13.54 respectively.

Table 2 Gender wise subject characteristics (n=50)

Gender	No. of Subject	Average of BMI	Average of height	Average of weight
Male	**28**	**14.30**	**119.35**	**20.60**
5	2	12.85	102	13.5
6	3	14.12	109.66	17
7	6	14.51	112.5	18.51
8	2	15.19	123	23.05
9	8	13.93	123	21.03
10	4	15.01	126.25	24.07
11	1	10.98	128	18
12	2	16.22	135.5	29.6
Female	**22**	**13.54**	**121.09**	**20.07**
5	1	13.02	96	12
6	3	12.31	103.66	13.33
7	3	13.92	118.66	19.66
8	6	13.79	119.5	19.5
9	3	14.15	125.33	22.23
10	4	13.51	129.5	22.5
11	1	13.85	137	26
12	1	13.24	153	31
Grand Total	**50**	**13.97**	**120.12**	**20.37**

Table 3 shows a comparison of energy, protein, fat and carbohydrate (CHO) in the FFQ1 and 24-hour diet recall and the correlations between the two methods. The FFQ1 produced a higher intake of energy, protein, fat and carbohydrate than 24-hour diet recall. Compared with the 24-hour diet recall, the most marked overestimation of nutrients observed in the FFQ1 was for protein (13.2%). On average, the Pearson correlation of absolute nutrient intake between the two dietary assessment

was r = 0.522, ranging from r = 0.34 (protein) to r = 0.61 (CHO).

Table 3 Comparison of means and correlations for intake of energy and macronutrients in the first administration of the food frequency questionnaire (FFQ1) and 24-h diet record (n=50).

Nutrients	Mean ± SD		MD	%MD*	Pearson correlation†
	FFQ1	24-h diet recall			
Energy (kcal/day)	1242.48±129.16	1113.65±129.29	128.8	11.6	0.60
CHO(g/day)	210.62±22.66	199.67±24.95	10.95	5.5	0.61
Protein(g/day)	31.39±4.31	27.74±5.59	3.65	13.2	0.34
Fat(g/day)	68.71±13.76	66.14±25.5	2.57	3.9	0.54

*Percentage mean difference was individually computed using the formula (FFQ1-24-h diet recall) / 24-h diet recall×100. †significance level for all four nutrients at p <0.0001. MD: mean difference; SD: standard deviation.

Table 4. shows the mean daily intake of energy, protein, fat and carbohydrate and the correlation between the two FFQs. The mean intake of all four macronutrients in FFQ1 was a little bit higher than FFQ2. Pearson correlation coefficients showed higher correlations between FFQ1 and FFQ2, ranging from r = 0.91 (fat) to r = 0.82 (CHO). There were significant differences between the intakes of all four macronutrients.

Table 4 Comparison of means and correlations for intake of energy and macronutrients in the administration of the first food frequency questionnaire (FFQ1) and second food frequency questionnaire (FFQ2) (n=30).

Nutrients	Mean ± SD		MD	%MD*	Pearson correlation†
	FFQ1	FFQ2			
Energy (kcal/day)	1242.48±129.16	1153.08±88.82	89.4	7.75	0.84
CHO(g/day)	210.62±22.66	199.43±17.16	11.19	5.61	0.82
Protein(g/day)	31.39±4.31	28.78±3.97	2.61	9.06	0.90
Fat(g/day)	68.71±13.76	62.44±6.06	6.27	10.04	0.91

*Percentage mean difference was individually computed using the formula (FFQ1-FFQ2) / FFQ2×100. †significance level for all four nutrients at p <0.0001. MD: mean difference; SD: standard deviation.

The internal consistency of the FFQ was also assessed by cronbach's alpha and had a value of 0.60.

Table 5 Showing Internal consistency of FFQ.

Reliability Statistics	
Cronbach's Alpha	N of Items
.606	33

DISCUSSION

This study focused on assessing relative validity of a paper form FFQ with a 24-h diet recall. The food list in our FFQ was developed specially for slum children and is more likely to provide representative dietary data for Varanasi slum children. The relative validity of the FFQ, compared to the 24-h diet recall varied among intake of energy and macronutrients (Table 3). The FFQ overestimated the absolute intake of various nutrients and foods. In our study we observed that frequently consumed foods tended to be overestimated in the FFQ compared to the 24-h diet recall in particular vegetables and fruits intake as reported in other FFQ validation studies (Hebden *et al*, 2013, Buch-Andersen *et al*, 2015). Daily consumed food items (e.g rice and wheat) are better estimated by the FFQ (Bountziouka V *et al* 2012 and Takachi R *et al* 2011). Percentages of mean differences were used to determine the agreements between FFQ and 24-h diet recall methods. According to Norimah and Margetts (1997), good agreements between two methods are achieved if the percentages of the mean differences are less than 10%. In our study, the mean differences of energy and protein was greater than 10 % showing a moderate agreement where as CHO and fat mean difference was smaller than 10% showing a significant agreement between the two methods.

In this study, overall correlations for energy and macronutrients between both FFQ1 and 24-h diet recall and FFQ1 and FFQ2 were considered fair. Hankin *et al* (1991) suggested that correlation coefficient between dietary methods should be considered poor if correlation coefficients in most dietary validations are less than 0.30, fair if they are over 0.50. The Pearson correlation coefficients obtained in this study showed a good correlation as the range of correlation in between all macronutrients were more than 0.50 except in one nutrient. Cronbach's alpha method is also used on FFQ to measure the scale reliability. The alpha coefficient for the thirty four items is .6, suggested that the items have good internal consistency. While determining FFQ reliability a very important factor is the time interval between the administrations of the FFQs. If the time interval is short, there are more chances that the subjects remember the first FFQ and thus overestimation of reliability may occur. However, if the time interval is too long, dietary patterns may change, affecting the study's reliability (Kusama *et al*. 2005). All the four macronutrients (energy, protein, fat and carbohydrate) were higher in FFQ1 compared to FFQ2. In general food intake during the first administration of an FFQ is higher than that during the second (McPherson *et al*. 2000). Moreover, children tended to report a higher frequency of intake in the first administration in comparison to the second administration of FFQ.

However, there are some limitations in this study. Firstly due to low literacy in study subject's food records was not an available option as food records were more accurate for validation of FFQ. The applied assessment tools contain several limitations. 24-hour diet recall is an invasive instrument which doesn't capture short-term dietary patterns well. The FFQ in contrast, captures food intake over longer time periods, and also faces the challenge of recall and difficulties in estimating portion size (Willett W. 1998). Another limitation of the study was the small sample size, which represents one of the most limiting factors of the study. A sample size of 100 or more is recommended for validation studies (Cade J *et al*. 2002).

CONCLUSION

In conclusion, a semi-quantitative FFQ consisting of 33 food items and 12 food groups was developed for slum children of Varanasi. The FFQ was found to be valid and reliable for measuring the average intake of energy and macronutrients among slum children aged 5-12 years. Therefore, it can be considered as an appropriate tool to assess and characterized the usual dietary intake of slum children in epidemiological studies.

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