Original Article

Food Frequency Questionnaire-Based Estimates of Compliance to ATP III (National Cholesterol Education Programme) Recommended Diets in a Middle-Class Adult Population of Bangalore City

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Abstract

Objective: To assess the extent of compliance to recommended diets of the ATP III (National Cholesterol Education Programme) in adults across a wide age range.

Methods: A cross-sectional survey of dietary intake assessed by a 108 item food frequency questionnaire (FFQ) in a convenience middle-class adult population sample (n=302) of Bangalore city. The FFQ was tested for repeatability and validated against multiple 24 hour dietary recalls in a smaller sample (n=55).

Results: Repeatability of nutrient estimates was high with correlations between two FFQ administrations of r=0.529 to r=0.732, all P < 0.01. Relative validity of nutrient estimation was also high (correlations 0.43 to 0.753, all P <0.05; FFQ vs 24 hour recalls). The percentage of people across age stratified groups who had adverse dietary intakes in relation to recommended norms were 3.7% to 28.9% for total fat, 94.1% to 100% for saturated fat, 36.3% to 49.1% for cholesterol and 67.6% to 88.9% for fibre.

Conclusions: The FFQ that was developed has comparable repeatability and relative validity with other published FFQs. A large proportion of middle-class individuals across a wide age range have adverse dietary profiles. There is a need to develop effective strategies to tackle this.

Introduction

Increasing life-spans throughout the world, and an even more striking demographic and lifestyle shift in the developing world, has increased the focus on diseases of aging. While many of these diseases are, in part, genetically determined, lifestyle factors also play an important role. Thus, diet-disease relationships have been described for coronary artery disease, diabetes and cancer among others.[1] One method that has been used extensively in epidemiological research to assess diet-disease relationships is the food frequency questionnaire (FFQ).[3] In India, diet-disease relationship in chronic disease like coronary artery disease have conventionally been studied using other methods of food intake, most notably the 24 hour recall method without or with weighment.[4] or an assessment of categorical variables.[5] While it might be argued that 24 hour dietary recalls are adequate in circumstances where the diet is relatively unchanging, the socio economic group in India that has been most affected by coronary heart disease is the urban group[4] which is likely to have a considerable varied diet. There have been few validated food frequency questionnaires that have been developed in India,[6,7] and these have been developed for rural populations, a group that is relatively less affected by chronic diseases of aging. Not surprisingly, therefore, the development of rapid and cost-effective methods for collecting and analyzing food intake data has been listed as a research priority area in developing countries.[8]

In this study, we developed a food frequency questionnaire for use in the middle-class population of Bangalore city in south India. This group would be expected to be part of an unfavourable nutritional transition, described in most parts of the developing world.[9] The repeatability of the FFQ was tested, as was its 'relative validity'. The FFQ was then applied to a population to establish the extent to which dietary patterns fell within the Therapeutic Lifestyle Changes (TLC) diet designed as part of the ATP III recommendations of the National Cholesterol Education.[10]

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Methods

Study design: This is a cross-sectional survey of dietary intake assessed by a 108 item food frequency questionnaire (FFQ) in a convenience, middle-class adult population sample (n=302) of Bangalore city. The FFQ was tested for repeatability and validated against multiple 24 hour dietary recalls in a smaller sample (n=55). Details of the subjects involved in both these studies are given below.

Construct an analysis of the food frequency questionnaire: The FFQ was specifically aimed at urban middle-class residents of Bangalore city. Bangalore city is a cosmopolitan city in South India in which people consume a wide variety of foods including traditional South Indian preparations, North Indian Mughlai preparations, Chinese cuisine and Continental food, among

others. The food frequency questionnaire was thus required to reflect the broad range of food choices available to a typical middle class individual. To this end, a list of food items was drawn up utilizing data from (i) a food database developed over a period of many years from studies conducted at the Division of Nutrition, and (ii) 180 days of diet records collected during a more recent study (unpublished data).

The food list had 11 categories with 108 items: Cereals=15, Vegetarian dishes=19, Chutneys=3, Soups=2, Salad=2, Non-vegetarian dishes=19, Snacks=10, Dessert=8, Beverages and milk products=7, Fruits=15, Miscellaneous/Others=8. The food frequency questionnaire identified portion sizes of the various cooked food items based on standard food measures. These included either natural units such as slices, number, and pieces, or other commonly used food measures (teaspoons (5 ml), tablespoons (15 ml), katori (bowl), tumbler). Choice of frequencies included rarely or never, 1-3 times a month, weekly once, 2-4 times a week, 5-6 times a week, daily once, 2-3 times a day, 4-5 times a day and greater than or equal to six times a day. The food-frequency questionnaire was developed to ascertain dietary intakes over the previous one month.

Recipes for the food items were tested in the laboratory. Raw ingredients for each recipe were weighed, and volume to weight conversions measured for the cooked food item. Nutrient composition of the food item was done using standard food conversion tables for the ingredients.[11] Where Indian data of nutrient composition were not available, United States Department of Agriculture (USDA) data in the public domain were used.[12] For a rapid analysis of the data, information from the FFQ was entered into a customized Microsoft Excel spreadsheet.

Repeatability and relative validity of the FFQ: Sixty five subjects of the central government office of the "Employees Provident Fund" situated in Bangalore city agreed to participate in the study; 10 were lost to follow up and the analyses in this manuscript are thus for the remaining 55 subjects (23 women). All FFQs were interviewer-based and administered by three trained research assistants. In order to facilitate recall of portion sizes, the standard measures were placed before the respondent at the start of the interview and identified by the names given to them in the questionnaire. Repeatability of the FFQ was assessed by comparing two FFQs administered 4 weeks apart. Relative validity was tested between the second FFQ and the mean of four 24-hour dietary recalls (3 week day and 1 weekend) administered over the 4 week period prior to the second FFQ. As an independent measure of relative validity, the daily energy intake from the second FFQ was also compared with the daily energy expenditure for the same period using a previously described physical activity questionnaire.[13]

Dietary patterns in a middle-class population: A convenience sample of 302 people between the ages 20 and 88 years (men = 156, women = 146) was obtained. Subjects were recruited from students and faculty of colleges, banks, other offices, software companies and recreational centres for the elderly. 71.4% of the sample was Hindu and 41.4% of subjects were vegetarian. Of the vegetarians, 88% were lacto-vegetarians and 12% lacto-ovo vegetarians. There were no vegans in the sample.

Statistical analysis: Statistical analyses were performed using SPSS for Windows, Version 10.1. All data are presented as mean ± SD. Comparisons between the two FFQs for repeatability, and between the second FFQ and the mean of the four 24-hour dietary recalls for relative validity, were assessed using Pearson's correlations and a paired 't' test. Since in certain analyses, it is desirable to employ a measure a nutrient intake that is independent of energy intake, 'energy-adjusted' nutrient intakes were also computed for the assessment of relative validity of the FFQ, using Willett's residual method'.[14] In all instances the null hypothesis was rejected at $P<0.05$.

Table 1 : Repeatability of the Food Frequency Questionnaire: Comparison of two questionnaires administered 4 weeks Apart

Nutrient	FFQ 1	FFQ 2	Correlation between FFQ 1 and FFQ 2
Energy (kcal/day)	2784 ± 1208	2235 ± 853*	0.682*
Carbohydrate (gm)	435.5 ± 195.1	340.2 ±124.1*	0.697*
Fat (gm)	81.4 ± 38.0	67.6 ± 32.9 *	0.582*
Protein (gm)	78.1 ± 33.0	64.8 ± 26.4*	0.664*
Fibre (gm)	14.2 ± 8.6	10.9 ± 4.8*	0.732*
Saturated fat (gm)	30.0 ± 13.4	25.1 ± 10.8*	0.676*
Monounsaturated fat (gm)	22.4 ± 13.2	18.4 ± 12.8*	0.529*
Polyunsaturated fat (gm)	21.6 ± 11.5	17.6 ± 9.5*	0.549*
Cholesterol (mg)	149.6 ± 100.3	113.2 ± 79.9 *	0.699*

Data presented as mean ± SD
Comparison between FFQ 1 and FFQ 2 using a paired 't' test.
* = $P < 0.01$.

Table 2 : Relative validity of the Food Frequency Questionnaire comparison between food frequency data and the mean of four 24-hour dietary recalls

Nutrient	FFQ	24 hr recall	Correlation between FF Q 1 and 24 hr recall	Energy adjusted correlations
Energy (kcal/day)	2235 ± 853	1716 ± 736**	0.726**	
Carbohydrate (gm)	340.2 ± 124.1	266.2 ± 101.5**	0.701**	0.630**
Fat (gm)	67.6 ± 32.9	48.3 ± 30.4 **	0.700**	0.647**
Protein (gm)	64.8 ± 26.4	51.8 ± 23.6**	0.753**	0.499**
Fibre (gm)	10.9 ± 4.8	7.8 ± 4.5**	0.745**	0.738**
Saturated fat (gm)	25.1 ± 10.8	17.9 ± 9.8**	0.614**	0.338**
Monounsaturated fat (gm)	18.4 ± 12.8	13.3 ± 11.2**	0.684**	0.381**
Polyunsaturated fat (gm)	17.6 ± 9.5	12.1 ± 7.9**	0.648**	0.685**
Cholesterol (mg)	113.2 ± 79.9	81.32 ± 59.9 **	0.434**	0.319*

Data are mean ± SD. Comparison between FFQ2 and 24-hour recalls analysed using a paired 't' test. * = $P < 0.05$, ** = $P < 0.01$.

Table 3 : Age-stratified percentages of nutrient intakes that fall outside of standard ATP III dietary recommendations

	Age g8roups		
	20-40 yrs	41-60 yrs	>60 yrs
Samples	173	102	27
Total fat intake (% of daily calories)			
25-35%	57.8	58.8	81.5
> 35%	28.9	17.6	3.7
Saturated fat intake (% of calories)			
7-10%	23.7	25.5	29.6
>10%	74.0	68.6	70.4
Cholesterol (>200mg/day)[a]	49.1	36.3	37.0
Fibre (<20gm/day)[a]	69.4	67.6	88.9

The Therapeutic Lifestyle Changes (TLC) Diet recommends total fat between 25 to 35% of calories, saturated fat < 7% of total calories, polyunsaturated fat up to 10% of total calories, monounsaturated fat up to 20% of total calories, carbohydrate between 50 to 60% of calories, fibre 20-30 gm/day, Protein approximately 15% of total calories and cholesterol < 200 mg/day.

Results

The repeatability of the FFQ was assessed by comparing FFQ1 with FFQ2 (Table 1). In absolute terms, estimates of energy, macronutrient and micronutrient intake from FFQ1 were significantly higher than those obtained from FFQ2. The absolute energy intake was strongly correlated with the number of food items consumed (FFQ1: r = 0.559, FFQ2: r = 0.509, both P< 0.01). In general, there were high correlations between the nutrient intakes of FFQ1 and FFQ2. The strength of the correlations ranged from 0.53 for monounsaturated fat intake to 0.73 for fibre intake. There was also a high correlation of the number of items consumed in the two FFQs (r=0.69, P<0.01), indicating that subjects with more varied food intakes continued this during the second administration of the FFQ.

The relative validity of the FFQ was assessed by comparing FFQ2 with the mean of the four 24-hour dietary recalls (Table 2). In absolute terms, the FFQ significantly overestimated the energy and macronutrient intakes that were obtained from the 24-hour dietary recalls. In general, the unadjusted correlations between the nutrient intakes obtained from the two methods were high and significant. When the nutrient intakes were adjusted for energy, the correlation coefficients generally fell, but remained high for the bulk of the nutrients. There was also a strong correlation between the daily energy intake obtained from FFQ2 and the daily energy expenditure obtained from the physical activity questionnaire over the same period (r = 0.49, P<0.01).

Table 3 summarises the dietary patterns of the sample of urban middle-class subjects stratified by age. For the middle-age group (41-60 yrs) 17.6% of subjects reported higher than recommended daily fat intakes, while the figures for saturated and polyunsaturated fats intake were 94.1 and 16.7% respectively. Total fat intake had a significant correlation with variability in the diet using the total number of food items consumed in the FFQ as a surrogate (r=0.37, P<0.01). 36.3% of the middle-age group had higher that recommended cholesterol intakes and about two-thirds (67.6% had lower than recommended fibre intakes. All subjects across all age groups fell within the <20% of total calorie intake from monounsaturated fats while the bulk of subjects across all age groups had less than the recommended 15% of their daily calories from protein. The proportion of individuals who obtained greater than 60% of their calories from carbohydrates ranged from 30.6% in the youngest age group to 43.1% in the middle aged group.

Discussion

While developing the FFQ we were acutely aware of the wide range of food choices that it would need to represent. The final food list of 108 items is in the mid range of FFQ lengths. Some FFQs that have assessed a single nutrient contain as few as 12 items,[15] while others, which aim to provide broader nutritional information contain as any as 350 items.[16] The duration for which food questionnaires assess nutrient intake in published literature is also quite variable. Some assess food intakes for as short as a week,[17] while many assess food intakes for the duration of an entire year.[18] We devised our FFQ for a month, since pilot questionnaires that we administered suggested that a month was the duration for which most people felt they could truly recall their food intakes.

Our data shows that the FFQ provides repeatable data when it is re-administered one month later. Since the FFQ was designed to access intakes over the duration of one month, the differences between the two FFQs are likely to represent true changes in diet as well measurement errors. The strength of the correlations between the first and second FFQ, for the range of nutrients, was generally in keeping with published literature reviewed recently.[19] The first FFQ recorded higher values for energy and nutrients than the second FFQ. This has been noted earlier.[20] It is possible that there is a 'learning effect' with the second FFQ,[21] or that subjects tend to modify their diets after the administration of the first FFQ. Repeatability studies are important while describing FFQs since they help to assess within-subject errors; this is important because high random and systematic within-subject errors would tend to bias relative risks towards the null value of 1,[22] during an evaluation of diet-disease relationships.

Estimates of validity are intended to assess the measured food intake against the 'true' intake. However, when the instrument of validity has it own bias in estimation, true validity cannot be established, and the term 'relative validity' is used. Instruments of validity that have been used in the validation of other published FFQs included repeated 24 hour dietary recalls,[6,7] weighed intakes,[16] food records,[23] and the doubly labeled water technique for energy balance.[24] The ideal validating instrument should be independent of the FFQ.[25] Thus, in the present study we compared the energy intake from the FFQ with the energy expenditure from the physical activity questionnaire as part of the validation process, assuming weight stability. The correlation that we obtained is comparable with other 'energy balance' studies comparing questionnaire based energy intake and energy measurements.[26, 27] Nutrient and energy intakes obtained from the FFQ were significantly higher than those obtained as the mean of four 24-hour dietary recalls. This is a common finding with FFQs, and while the cause for this has not been clearly ascertained, it may partly result from issues intrinsic to the use of food lists.[28] The unadjusted and energy-adjusted correlations obtained in this data set were comparable with other published studies.[19,28]

The data indicate that while a relatively low percentage of the study population had higher than recommended daily total fat intakes, the vast majority of them had higher than recommended saturated fat intakes. Fibre intakes were low in approximately two-thirds of the study population. In urban high-income groups in India, visible fat intake in the form of oil, ghee, vanaspati

and butter can account for about 18% of energy intake, while invisible intake include milk, eggs and animal food contribute about 12% of energy intake.[29] The trends of increased fat intakes are synonymous with the nutrition transition of developing economies, including India.[30] The data indicate a need for concerted efforts to promote healthy eating practices. This must be considered in the background of various issues that have been reviewed earlier;[31] first, food choice is not only influenced by health considerations; second, people can be ambivalent about foods and about healthy eating, and this factor might impact on the translation of beliefs and attitudes into behaviour; and third, individuals may be influenced by "optimistic bias", where they believe themselves to be at less risk from various hazards than is the average person and may pay less attention to health education messages. Nevertheless, a major barrier to healthy dietary change is the lack of knowledge among the public, even in developed countries with wide knowledge dissemination programmes.[32] In addition, medical practitioners often have difficulty advising people about food habits and have tendency to focus more on pharmacological interventions than on diet, in part, because of the perceived quality of the underlying clinical research.[33] Improving the nutritional knowledge of the general population and enhancing medical practitioners to be effective agents of healthy dietary change may help to stem the current shift towards unhealthy nutritional profiles.

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