A food frequency questionnaire for use in Chinese populations and its validation

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There is no gold standard in the assessment of individual dietary intake methodology. The choice of dietary method to estimate individual intake depends upon the study objectives for the assessment of individual intake. We adopted a food frequency questionnaire and modified it for use in a study of food habits and cardiovascular health status in adult Chinese living in Melbourne, Australia. This is a semi-quantitative questionnaire (MCHS-FFQ) and is designed to estimate past food intake. It consists of 220 foods and beverages. A reference portion is given to obtain a quantitative estimate of the usual intake portion. Various internal validation tests were performed. The MCHS-FFQ, being a food frequency dietary method, does not provide a good estimate of nutrients in foods which are not served in standard portions, such as sodium. The MCHS-FFQ offered a good estimate for potassium and protein intake when compared to estimates derived from a single 24-h urine collection. Finally, the MCHS-FFQ was predictive of plasma cholesterol levels. We conclude that the MCHS-FFQ is adequate for the assessment of individual usual food and nutrient intakes in a representative sample of adult Melbourne Chinese. For foods that are not served in a standard portion or quantifiable addition, an alternative more reliable method would be required for quantitative purposes. The method is, however, likely to be useful for the appraisal of overall food patterns in Chinese populations.

Introduction

Studies of food-health relationships require a dietary method with the capacity to estimate usual or past intake so as to make comparisons in time or to deal with the variability of dietary intake. On the other hand, current or short-term dietary methods may provide a better intake estimate in an intervention study where the compliance with dietary modification for a particular nutrient intake needs to be closely monitored over a short period[1].

There is no gold standard in the assessment of individual dietary intake methodology[2,3]. Up to the 1960s, food records for a few days or 24-h recalls were the two methods commonly used by researchers to estimate short-term or current food intake of individuals. These methods are expensive and unrepresentative of usual intake and therefore are not appropriate for the assessment of long-term or past food intake[4]. With the development of computer techniques for nutrient database management and statistical analysis, the food frequency questionnaire has become more widely used in large scale epidemiological studies[5]. Twenty-four recalls are still being used, with interest developing in their repeated application so that several days of information over an extended period of time can be obtained prospectively. The choice of dietary method to estimate individual intake thus depends upon the study objectives for the assessment of individual intake: particularly in reference to duration upon which intake estimates are based.

In the Melbourne Chinese Health Study, we are interested in relationships between food habits and cardiovascular health status in adult Chinese Australians living in Melbourne, Australia. In order to assess long-term food habits, we have adapted a food frequency questionnaire developed by Record and Baghurst[6] for use in Australian populations. We have modified this semi-quantitative questionnaire so that eating practices pertaining to Chinese food culture are embraced. We present here the development of a food frequency questionnaire for use in a Melbourne Chinese population, its application and potential for generalization.

Methods

We took the CSIRO food frequency questionnaire (FREQPAN)[6] as the basis for our modified Chinese food frequency questionnaire. The CSIRO FREQPAN questionnaire covered foods and beverages commonly used by Australians and was designed to assess usual intake rather than short-term intake. It consisted of 179

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Table 1. The Melbourne Chinese Health Study food frequency questionnaire: sample pages: Chinese text opposite English.

FOODS/BEVERAGES	Reference Portion	Usual time of day eaten	NUMBER OF TIMES EATEN: Per day	Per week	Per month	Per year	Never or rarely
			(put a number in appropriate column)				(tick please)
Rice vermicelli/noodles	1 bowl						
Mungbean thread	1 bowl						
Gluten roll/ball	3 big 5 small						
Steak (grilled)	1 medium						
Steak (pan-fried)	1 medium						
Roast beef/veal	2 slices						
Crumbed veal/schnitzel (deep-fried)	1 large						
Lean beef/veal in other dishes (stir-fried)	5 cut pieces or 1/2 bowl						
Pork chop (grilled)	1 chop						
Pork chop (pan-fried)	1 chop						
Roast pork	2 slices						
Lean pork in other dishes (stir-fried)	5 cut pieces or 1/2 bowl						

B: Breakfast M: Morning L: Lunch A: Afternoon D: Dinner S: Supper

Table 1. English text opposite Chinese.

食物與飲料	參考用量	日常進食時間	進食次數					
			每天	每星期	每月	每年	不用少用	
			請在適當的空格內寫下次數				請打✓	
米粉/河粉類	1碗							
粉絲/冬粉	1碗							
麵筋(球)	3大 5小							
炙燒牛扒(肉) 【火來自上方】	1塊中							
油煎牛扒(肉) 【鍋放少許油】	1塊中							
焙烤(烘)牛肉/ 牛仔肉【烤箱內】	2切片							
炸沾粉牛仔肉	1塊大							
炒瘦牛肉(柳)/ 牛仔肉	5切塊 或半碗							
炙燒豬扒 【火來自上方】	1扒							
油煎豬扒 【鍋放少許油】	1扒							
焙烤(烘)豬肉 【烤箱內】	2切片							
炒瘦豬肉	5切塊 或半碗							

B: 早餐 M: 早茶 L: 午餐 A: 下午茶 D: 晚餐 S: 宵夜

Australian foods and beverages with identified standard portion size. Foods and beverages were expressed in serving sizes or natural units. Subjects were asked to select either per day, per week or per month as a denominator and then to enter frequency of use. Subjects could write down S alongside the frequency of use to indicate a seasonal use for that particular food. In addition, there was a comment column for usual serving size, if different from the questionnaire standard.

Food and beverage list. The main task in developing a food frequency questionnaire for use in an adult Melbourne Chinese population was to compile a food list that was cross-culturally robust. For the European type foods, the FREQPAN food list was used. The Chinese food list was compiled using information collected at various Chinese grocers, markets and restaurants. Foods were photographed at stores and Chinese kitchens to record the way in which food was prepared or served.

Denominators for frequencies. Subjects were asked to estimate the intake frequency for each food or beverage based upon one of the usual time frame, namely per day, per week, per month or per year. In doing so, subjects referred to our 'reference portion' listed alongside each food or beverage.

Reference portion. The Chinese rice bowl is a common household measure. It is used to serve rice, a staple in the traditional Chinese meal setting. For each food or beverage, we used a 'Chinese rice bowl (approximately 300 ml)' as a reference portion to estimate usual intake. Reference portion replaced the 'standard serving size (a correct and recommended amount for consumption)' in the Melbourne Chinese Health Study Food Frequency Questionnaire (MCHS-FFQ). Subjects referred to their consumption of each food item in the MCHS-FFQ in terms of a fraction of a rice bowl, eg 1/2 bowl of beef, 1/2 bowl of bean sprouts, etc. The identification of foods was facilitated with the use of colour food photographs at interview.

In a traditional Chinese meal setting, members of the family usually share *ts'ai* (dishes) from the centre of the dinner table, while *fan* (staple) is served in individual rice bowls. In such a setting, table manners emphasize taking food pieces 'equally amongst members', though men and young adults generally consume a greater portion than women and the aged. Perhaps, to facilitate the *ts'ai* sharing practices, Chinese dishes are usually diced, or sliced before they are cooked. Thus, in addition to 'portion of a rice bowl', food pieces were also used where appropriate as a reference portion. Rice bowl equivalents for food pieces were also used. For example, a 1/2 bowl of stir-fried chicken is equivalent to about 5 chicken (cut) pieces. There was also a need to use standard household measures like tea cups, glasses and spoons.

All food intake was ultimately expressed in numbers of Chinese rice bowls, pieces, or household measures. However, conversion factors allowed the intake of almost all items to be expressed in terms of rice bowl equivalents.

Time of intake (meal pattern). The usual times of the day for food/beverage consumption were also recorded.

Applications

One of the objectives of the development of the MCHS-FFQ was to assess an individual's usual intake in the 12 months prior to interview. Subjects were given descriptions of all parameters (eg the food and beverage list, frequency of intake, reference portion and time of intake) included in the questionnaire and instructions to fill out the questionnaire. MCHS-FFQ is bilingual (Chinese and English). Subjects were encouraged to report foods or beverages that were frequently consumed and not listed in the MCHS-FFQ. Extra spaces were provided for additional food items.

Self-administration. The MCHS-FFQ is a self-administered questionnaire with Chinese and English set side by side. A one-to-one interview could be arranged for those who were illiterate or less educated. The interview was conducted in the language spoken at home, which included Mandarin, Cantonese and Teochew dialects. Whether or not the subject needed a one-to-one interview was generally established prior to the interview.

Time taken. The self-administered questionnaire took about 45 min to one hour to complete. In the case where a one-to-one interview was required, interview would take up to 2½ hours.

Role of interviewer. Because the questionnaire was designed for self-administration, the role of interviewer was to ensure all food items in the questionnaire were answered. The interviewer would go through the questionnaire item by item and check at random the denominator for the frequency of use. The interviewer would also use the response to the 'usual time of day eaten' to verify 'portion size' or the 'frequency of use'. Although it rarely happened, the interviewer might decide to perform a one-to-one interview in light of doubts about the completeness of the questionnaire. Where the questionnaire as a whole appeared to be misunderstood, the interviewer would immediately offer another one-to-one interview or ask that the questionnaire be repeated. There were only a few subjects (less than five) who required the additional interview procedures.

Validation

We used several internal mechanisms to validate the MCHS-FFQ. These considered whether or not the questionnaire (1) covered foods likely to be consumed by the Melbourne Chinese, (2) adequately estimated the energy intake in terms of minimal energy requirement, (3) provided comparable nutrient intake estimates for appropriate biochemical markers, and (4) had ability to predict health outcomes.

Percentage of total food intake accounted for by the MCHS-FFQ. We classified food items into four categories: category 1 was food and beverages consumed by more than 75% of the study population (frequently consumed foods); category 2 was those consumed by 50 to 75% of the study population (commonly consumed foods); category 3 was foods and beverages consumed by 25 to 50% of the study population (less commonly consumed foods); category 4 was foods and beverages consumed by less than 25% of the study population (rarely consumed foods). We then calculated the number of foods and beverages in each category.

Additionally, for each subject, we calculated the percentage food items reported for intake during the 12-month period. This is called 'intake index' hereafter. Linear relationships between 'intake index' and estimates for daily total energy intake and daily intakes for protein, total carbohydrates and total fats were examined using simple regression analyses. The relationships between 'intake index' and the expected basal metabolic rates were also examined.

Nutrient intakes were estimated using the Australian Food Composition Table, 1990 edition[7]. Detailed methodology for nutrient conversion has been reported elsewhere[8].

Total energy intake and estimated BMR by weight. A dietary method is regarded as invalid if the population habitual energy intake is less than 1.4 times the expected basal metabolic rate (BMR)[9]. In other words, if the expected BMR accounted for more than 71.5% of the estimated energy intake, then the dietary method which produced the energy intake estimates would not likely be valid, discounting a 12.5% coefficient of variation in BMR.

Basal metabolic rate (BMR) is a measurement of the energy expended for maintenance of normal body functions and homeostasis, plus a component for activation of the sympathetic nervous system. BMR is the greatest contributor to total energy expenditure. Allowing for inter-individual variation and the effects of other component of energy expenditure, BMR accounts for 60 to 75% of total energy expenditure. The second largest component of energy expenditure is the thermic effect of exercise (TEE). TEE represents the cost of physical activity above basal levels and ranges from 15 to 30% of total energy requirements in a moderately active individual. It is highly variable. The thermic effect of food (TEF) is the result of energy expended to digest, transport, metabolize, and store food. It accounts for about 10% of daily energy expenditure[10]. BMR, TEE and TEF are major components of energy requirements. Energy expenditure may also be modulated by, or adapt to, for example, climatic change.

We used the Schofield equations to estimate BMR[11]. The equations employed body weight to estimate BMR for three age categories, ie (1) 18 to 30 years old, (2) 30 to 60 years old, and (3) 60 years. Assuming that 70% of the total energy intake is expended for BMR, we then calculated the expected energy intake. Student's *t*-test was performed to examine whether or not mean total energy intake estimated by the MCHS-FFQ was the same as that of the expected total energy intake.

Urinary sodium and potassium excretion. We collected single 24-h urine random specimens from 97 subjects. Urine specimens were collected using a cylinder sampler which exacts 1/50 portion of the voided urine. The 24-h volume was then estimated, multiplying the 1/50 specimens by 50. One ml was used to measure urinary sodium, potassium and creatinine concentrations. Urine specimens were analysed at Prince Henry's Hospital (now Monash Medical Centre), Department of Chemical Pathology (now Department of Clinical Biochemistry). Sodium and potassium excretion levels are products of urinary concentrations and volume estimated for 24 h.

The expected sodium intake was calculated based upon the urinary sodium excretion, allowing for 5% faecal and skin losses. Similarly, we assumed that 86% of the potassium intake was excreted through urine[12] and calculated the expected potassium intake. Student's *t*-test was performed to test whether the expected urinary sodium and potassium intakes were significantly different from estimates derived from the MCHS-FFQ.

Total nitrogen output. Urinary total nitrogen was analysed by the Kjeltec Kjeldahl technique[13]. Aliquots of urine specimens were stored in −20°C for two years prior to analysis. Single measurements were performed at the Monash Medical Centre, Department of Clinical Biochemistry.

We used estimates by Bingham and Cummings[14] that urine nitrogen accounted for 81% of the dietary nitrogen and calculated the expected nitrogen intake. The expected nitrogen intake was compared with the nitrogen intake estimates derived from the MCHS-FFQ, using Student's *t*-test.

Subjects were categorized into two groups; those whose nitrogen intake estimate derived from the MCHS-FFQ were higher than the expected value being derived from the urinary nitrogen, and those who had a lower estimate. Differences in total energy and nitrogen intakes, as derived from MCHS-FFQ, and the urinary nitrogen output were tested.

Ability to predict outcomes. One of the main objectives of our study was to identify changes in food habits in relation to cardiovascular risk factor prevalence in Melbourne Chinese. Multiple finger pricks were applied to collect capillary blood samples. Plasma total cholesterol and HDL-C were analysed using the KONE 'Progress' Selective Chemistry Analyser. LDL-C level was calculated based on the Friedewald formula[15]. We calculated Pearson's correlation coefficients to examine whether or not univariate relationships exist between nutrient intakes and plasma cholestrol levels. Plasma total cholestrol, high density lipoprotein cholesterol (HLD-C) and low density lipoprotein cholestrol (LDL-C) levels were examined and treated as outcomes.

Stastical methods

All statistical procedures were performed using SAS (Statistical Analysis System)[16]. The significance level was set at 5%. Student's *t*-test was performed to assess differences between two population means and Pearson's correlation coefficient was calculated to test whether linear trends exist between two continuous variables. Population means and standard deviations (in parentheses) were reported where appropriate.

Results

The MCHS-FFQ

Table 1 gives sample pages selected from the Melbourne Chinese Health Study Food Frequency Questionnaire. This questionnaire begins with an introduction. Parameters required to estimate the frequency of usual food intake were stated. A stepwise instruction on how to fill out the questionnaire was also given. There were 220 foods and beverages, each in a reference portion attached to it. Denominators for the frequency of use were per day, per week, per month and per year. 'The usual time of day eaten' was also requested for each item.

The complete questionnaire can be obtained from the first author.

Validation

Percentage of total food intake accounted for by the MCHS-FFQ. We found that 48 (22%) items were reported for consumption by less than 25% of the study population (rarely consumed foods) and 44 (20%) items were reported for regular consumption by more than 75% of the population (frequently consumed foods) (Table 2).

Table 2. Foods and beverages reported for frequent and rare consumption in the 12 months prior to interviews.

Items frequently consumed	Items rarely consumed
Steamed rice	Raw bran
Sliced bread	Crumpet and muffin
Rice vermicelli	Gluton roll
Lean beef, stir-fried	Schnitzel
Lean pork, stir-fried	Dried pork
BBQ pork	Lamb chop, pan-fried
Spare ribs	Lamb, stir-fried
Boiled chicken	Pigeon
Chicken breast, stir-fried	Pork sausages, pan-fried
Chinese sausages	Beef sausages, grilled
Fried egg	Beef sausages, pan-fried
Fresh fish	Salami and mettworst
Crab, prawns and lobster	Cottage cheese
Abalone and scallops	Pure cream
Dried shrimps	Yoghurt
Lettuce	Boiled quail egg
Cabbage	Eel
Spinach	Skimmed milk
Broccoli	Flavoured milk
Celery	Milk shake
Cauliflower	Thick shake
Chinese cabbage	Canned carrots
B.ai-choi	Dried Chinese radish
Choi-sum	Mashed potato
Fried onion	Potato packet
Cucumber	Broad beans
Tomato	Tau-miu
Fresh carrots	Soybeans
Green peas	Papayas
Snow peas	Fruit fritters
Beancurd	Preserved plums
Bean sprouts	Olives
Chinese dried mushrooms	Gherkins
Orange, mandarin and grapefruits	Hamburger without bun
Apple and pear	Meat pie – homemade
Banana	Savoury pies and pastries
Watermelon	Packet soup
Mango and nectarines	Ginseng tea
Fresh grapes	Cider
Dim sim – steamed varieties	Walnut shortcake and biscuits
Curry	Rice pudding
Homemade soup	Milk pudding
Chinese tea	Custard
Water	Vegemite
	Thick sauces
	Sherry
	Port
	Light beer

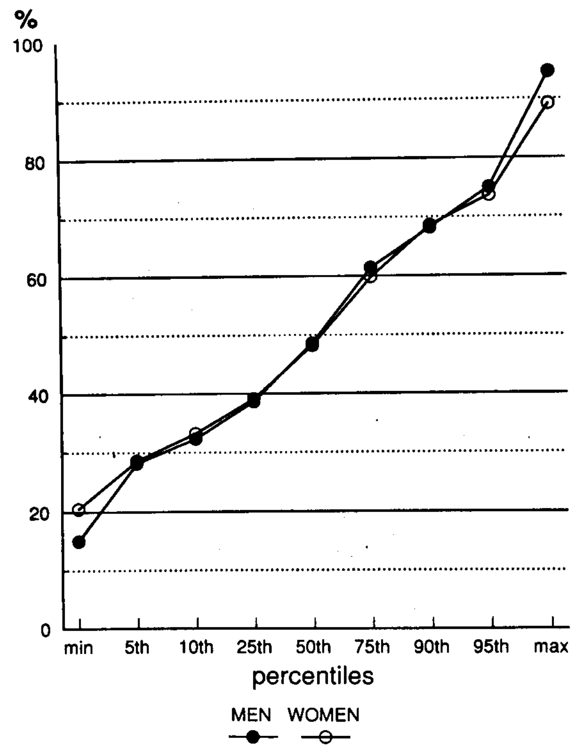

Fig. 1. Percentile distribution for total food intake index, by gender.

On average, responses were obtained for 110 items in the MCHS-FFQ, ranging from 33 items to 208 items. Figure 1 shows percentiles for 'intake index' in men and women. There is no difference in intake index between men and woman.

Figure 2 shows macro-nutrient intake estimates by tertiles of the intake index. Macro-nutrient intake estimates were significantly higher among those in the higher tertiles compared to the lowest. There was a positive linear trend between macro-nutrient intake estimates and intake indices, expect for total carbohydrates in men. Similarly, there was a positive linear trend between total energy intake estimates and intake indices. The same trend was not significant for the estimate BMR. (Figure 3).

Total energy intake and estimated BMR. The mean expected total energy intake from BMR was 9.37 (±1.13) MJ/d for men and 7.49 (±0.51) MJ/d for women. The expected total energy intakes derived from BMR did not differ from those estimated from the MCHS-FFQ [9.21 (±2.90) MJ for men and 7.57 (±2.37) MJ for women] (Figure 4).

Urinary sodium excretion. On average, the urinary sodium excretion was 181 (±86) mmol/d for men and 154 (±74) mmol/d for women. This was equivalent to 10.6 g/d of salt intake for men and 9.0 g/d for women. The expected sodium intake [191 (±91) mmol/d for men and 162 (±74) mmol/d for women] was significantly higher than the estimate derived from the MCHS-FFQ. The mean sodium intake for those who collected the urine sample did not differ from the population mean (Figure 5).

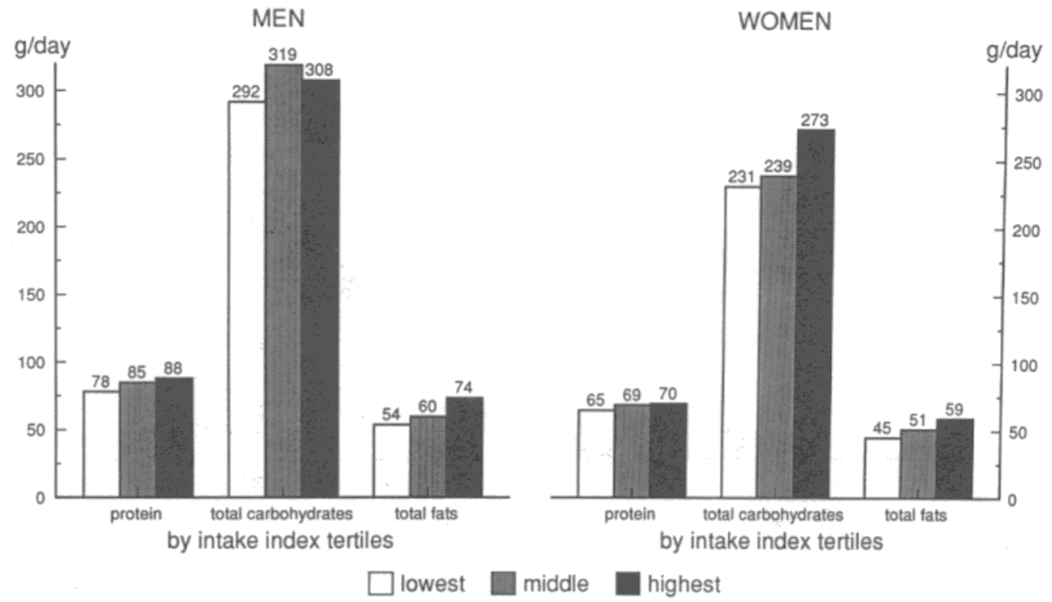

Fig. 2. Macro-nutrient intake estimates by tertiles of the intake index, by gender.

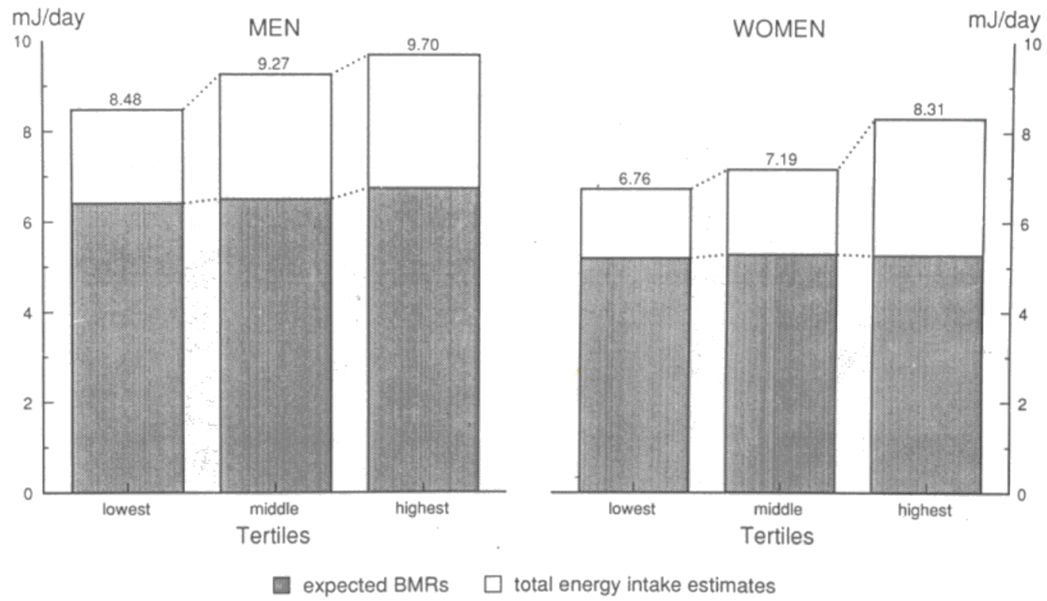

Fig. 3. Total energy intake estimates and the expected basal metabolic rates by tertiles of the intake index, by gender.

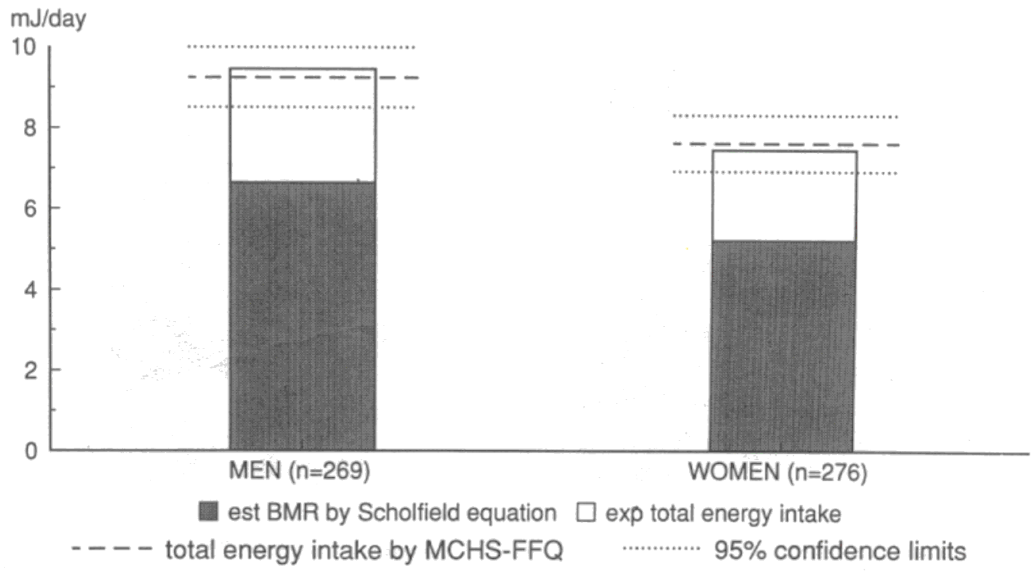

Fig. 4. The expected total energy intake derived from the estimated BMR and the mean and 95% confidence limits for total energy intake derived from MCHS-FFQ.