The Design, Analysis and Evaluation of a Food Frequency Questionnaire for Assessing the Nutrient Intake of New Zealand Adults

Ross Marshall

A thesis submitted in partial fulfilment
of the requirements for the degree of

Master of Science

at the University of Otago, Dunedin,
New Zealand.

1994

Abstract

A food frequency questionnaire was designed to assess the usual nutrient intake of New Zealand adults. National diet survey data was used as a basis for compiling the food list.

The optimal design and analysis of the 132 item food frequency questionnaire was determined by a series of analyses using diet intake data from a sample of 101 female undergraduate Nutrition students (mean age 21 years).

The performance of the food frequency questionnaire was assessed by comparison with seven-day diet records. The nutrients used in this comparison were ones of special consideration for New Zealanders according to the Nutrition Taskforce (1991), i.e carbohydrate, starch, sugars, fat, saturated fat, polyunsaturated fat, protein, dietary fibre, calcium, iron, zinc, thiamin and ascorbic acid.

The comparison methods used were mean difference, standard deviation of the difference, classification into the same or adjacent quintile, gross misclassification, correlation coefficients and actual values for surrogate categories.

There is a need for further investigation into the sensitivity of the 'classification into the same of adjacent quintile' method for assessing the ability of the food frequency questionnaire to classify subjects. The use of a statistical test to assess the significance in changes in classification is necessary. The use of more than five categories, e.g. 7 or 9, requires consideration for a more sensitive measure of the food frequency questionnaire's ability to classify individuals.

General principles were formulated according to the effect of the design and analysis issues on the food frequency questionnaire's performance.

The food frequency questionnaire's ability to estimate the group mean intake was enhanced through use of a categorical response scale format (rather than an open-ended scale), age and sex specific serving

sizes (rather than common standard measures) and adjustments for the total servings of fruit, vegetables and meat.

The food frequency questionnaire's ability to classify individuals was enhanced through use of a categorical response scale format (rather than an open-ended scale), use of common standard measures as serving sizes, and asking the respondent to specify small, medium or large serving sizes.

Acknowledgements

Many thanks to
Caroline Horwath
& Jim Mann
for their input and support.

Heaps of thanks to
Alex Chisholm
Jane Upritchard
Mikel Packer
Susan Shackleton
Mum & Dad
for their encouragement.

Thanks everyone!
Cheers,
Ross.

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1 Introduction

Food frequency questionnaires were first developed during the 1960's in response to a need for new methods for determining dietary intake in large population studies. The diet history method and diet record methods, which are so useful with individuals or in small group studies, were too time-consuming and demanding of interviewer skills and subject cooperation to be suitable for large scale dietary and epidemiological studies (Wiehl 1960).

Food frequency questionnaires elicit information concerning the frequency of consumption of each of a list of foods and drinks. Their advantages over other methods include: comparatively low burden to respondents, high response rates in random population studies, the ability to be administered by non-professionals or to be self-administered, low cost, the production of standardised results and a direct assessment of usual intake (Block 1982; Dwyer 1988; Horwath 1989).

The food frequency method has been hotly debated over the past decade (Bingham 1987; Briefel et al 1992; Horwath 1990; Rimm et al 1992; Sempos 1992). Questions concerning validity and the most appropriate design such as whether to include estimations of serving size and optimal response scales for specifying frequency of consumption have been of major concern. The development of reliable, valid food frequency questionnaires for assessment of usual dietary intake is central to many areas of nutrition and epidemiological research.

The objective of this study was to determine the optimal design and analysis of a food frequency questionnaire to assess the usual intake of New Zealand adults.

In order to achieve this objective, several major design and analysis issues were investigated for their role in enhancing the performance of the food frequency questionnaire. The performance was judged by the ability of the food frequency questionnaire to classify individuals into high and low intakes of nutrients and to estimate group mean intakes.

The following questions were addressed:

Which of the two predominant response scale formats result in enhanced performance of the food frequency questionnaire?

- An 'Open' format requiring the subject to respond with the number of times the food is consumed within a time period (day, week or month).
- A 'Closed' format consisting of a fixed number of broad frequency categories (e.g. daily, two to three times per week, monthly).

Does the use of age and sex specific serving sizes derived from 24-Hour Recalls and Seven Day Diet Records enhance the performance compared to the use of common standard measures of the foods?

Do questions asking the subject to specify serving size as small, medium or large, given a description of a medium serving, enhance the performance of the food frequency questionnaire?

Do questions asking for total number of servings of a food type per day or per week to adjust the frequency of consumption of the individual food items of that type enhance the performance of the food frequency questionnaire? For example, using the total number of servings of fruit per day or per week to proportionally increase or decrease the individual frequency of consumption of the individual fruit items.

To gauge the effect of these issues on the performance of the food frequency questionnaire, several techniques for comparison against the reference method were utilised. It is crucial that the sources of error in the reference method are as independent as possible from the sources of error in the food frequency method. Seven day diet records were used as they are open-ended, do not depend on memory and are of sufficient number of days to represent an average intake for most nutrients.

These comparisons were made for energy and a subset of those nutrients of special consideration for New Zealanders according to the Nutrition Taskforce (1991). The nutrients were carbohydrate, starch, sugars, fat, saturated fat, polyunsaturated fat, protein, dietary fibre, calcium, iron, zinc, thiamin, and ascorbic acid.

2 Literature Review

A food frequency questionnaire consists simply of a list of food items. The questionnaire respondents report how often they usually consume each food item. Additional data, such as usual serving size and cooking methods, may be collected to aid the estimation of nutrient intakes.

The calculation of nutrient intake from a food frequency questionnaire involves the multiplication of consumption frequency of a food item per day, serving size of the food item, and the nutrient composition of the food item. The sum of all the food items calculated in this way results in an estimation of nutrient intake per day.

2.1 Origin of the Food Frequency Method

The growing awareness of the role of diet in the aetiology of disease (particularly cardiovascular disease) in the 1960's brought about a need for development of new methods for assessing the diets of large groups.

The usual method of evaluating diets in this era was to compute the total amount of each nutrient. This approach was paramount in identifying those nutrients more likely to be deficient in the diet and providing this information for nutrition programs addressing this deficiency problem. However, the possible association between diet and cardiovascular disease did not relate to deficiency but possibly to excessive intakes or other dietary patterns (Wiehl 1960). Rather than focusing on the levels of nutrient intakes, consideration needed to be given to analysis of other parameters of food intake including frequency of consumption of foods (Stefanik and Trulson 1962).

The shift in emphasis from intensive collection of data from individuals or small populations to the need for large scale epidemiological studies required an inexpensive, time-saving method of assessing usual diet.

Wiehl and Reed (1960) developed a schedule of simple questions to gain information to classify individuals according to dietary practices such as use or non-use, frequent or infrequent use of selected foods. This classification of individuals was then used for tests of association with disease.

At this stage of the development of the food frequency method no attempt was made to quantify the subjects' responses in terms of nutrient intake. The inability of the food frequency method to provide data on nutrient intake was noted by Abramson et al (1963). Although differences in dietary patterns could be demonstrated by the food frequency method, definite conclusions about the existence, nature and magnitude of differences in nutrient intake could not be made. The qualitative analysis of food frequency questionnaires may be a valuable tool in studies of groups consuming widely differing types of foods, however, in groups with similar food choices it may not yield as useful information as would an analysis of nutrient intake. The variability in the amount of food, i.e. serving size, may be as important in the heterogeneity of diets as the choice of food (Baghurst and Baghurst 1981).

These limitations of the food frequency method have led to the development of 'semi-quantitative' and 'quantitative' variations of the method.

2.2 Types of Food Frequency Questionnaires

2.2.1 Qualitative Food Frequency Questionnaires

Qualitative food frequency questionnaires request information only on the frequency of consumption of food items. This is the questionnaire in it's earliest form of development.

2.2.2 Semi-Quantitative Food Frequency Questionnaires

Semi-quantitative food frequency questionnaires incorporate questions about the frequency of consumption of specified amounts of food items. For example, the number of slices of bread eaten is requested rather than just the frequency of eating bread. This question type is only useful for food items that can be easily quantified, that is, consumed in discrete portions.

2.2.3 Quantitative Food Frequency Questionnaires

Quantitative food frequency questionnaires request information on amounts of all food items in the questionnaire. This information can be elicited by several methods. The subjects can be asked to estimate their usual serving size with the aid of visual cues such as food models, household utensils and photographs. A medium serving may be given in the questionnaire as a reference for the subject to either estimate their own serving amount or to indicate that their serving is small or large in comparison to the stated reference.

An alternative approach to asking the subject to estimate their serving size, is to ask the respondent to report frequency of intake in terms of the standard serving sizes presented in the questionnaire (Willett et al 1987).

2.3 Advantages and Disadvantages of the Food Frequency Questionnaire

Each method of assessing dietary intake has advantages and disadvantages; it is the balance and nature of these factors which determine the usefulness and appropriate application of each method. Several reviews have been published discussing the advantages and disadvantages of dietary assessment methods (Baghurst and Baghurst 1981; Bingham 1987; Bingham 1991; Dwyer 1988; Horwath 1990). The strengths and limitations of the food frequency questionnaire can be summarised under several headings. Firstly, the development of the questionnaire; secondly, the administration of the questionnaire and thirdly, the questionnaire's ability to assess dietary intake.

2.3.1 Development of the Questionnaire

The 'open-ended' methods of assessing dietary intake, such as diet records, involve comparatively little work in the preliminary stages. The food frequency method, however, requires considerable effort in the preliminary stage. The design process involves analysis of large samples of dietary intake data from other methods to determine the food list and serving sizes.

The derivation of the food list from existing dietary data means that the questionnaire is applicable only to same population group as the existing data. A food frequency questionnaire that is applicable to the general population may not include foods specific to subgroups of the population. These subgroups may be cultural, socioeconomic or groups with different dietary habits such as vegetarians.

The food frequency questionnaire has to be pre-tested and validated against another method of assessing diet. The sample used for the validation of a food frequency questionnaire should represent the food habits of the group for which the questionnaire is ultimately intended (Sempos 1992)

The limitations in the design of a questionnaire can essentially be bypassed by using a questionnaire that has already been designed and validated elsewhere, assuming the food frequency questionnaire is applicable to the population being studied. There is widespread use of food frequency questionnaires developed by Block (1986) and by Willett (1985).

The foods that are consumed by a population are constantly changing. The food list in a food frequency questionnaire will over time become obsolete and require revision. This revision would necessitate another validation of the questionnaire (Sempos 1992).

The fact that food frequency questionnaires are a series of predetermined questions has the advantage of allowing other specific information to be determined within the same instrument. For example, questions about cooking practices can be seamlessly incorporated into a food frequency questionnaire.

2.3.2 Administration of the Questionnaire

The food frequency questionnaire demonstrates several advantages in its administration to, and interaction with, the respondents.

The food frequency questionnaire is relatively rapid to administer. It does not require highly trained interviewers and in some cases can be self-administered and used in mail surveys.

The comparatively short time required to complete a food frequency questionnaire reduces the burden on the respondent. The number of food items and additional questions relating to serving sizes and other factors such as cooking methods relate to the length of time taken to complete and therefore the burden on the respondent. The diet record method, depending on the number of days required, can involve a substantial time commitment by the respondent. The food frequency questionnaire requires, at most, a matter of hours of the subjects time whereas the diet record method requires their cooperation over a period of days. The food frequency questionnaire does not alter the usual diet of the respondents whereas the use of recording methods is likely to affect the subjects usual intake (Mertz 1992).

The food frequency questionnaire is subject to the possibility that respondents will forget how often they usually consume a food item. Foods can be under- and over-reported by the respondents. The extent to which this occurs may vary between food items. The amount and frequency with which a food item is consumed may influence the errors in estimation. Staple foods and those consumed in large quantities are better estimated than items eaten less frequently and/or in smaller amounts (Dwyer 1988).

The cost of data-entry of a food frequency questionnaire is comparatively low per subject. This allows much larger samples to be studied compared to sample sizes using other methods. The data can be entered directly from the questionnaire by data entry personnel whereas diet records require a certain degree of expertise in interpretation and making substitutions for foods eaten that are not included in the food composition database. Precoding and direct entry of some food frequency questionnaires further decrease cost and time for administration. Computer administered food frequency questionnaires decrease these factors even further.

There is cost incurred using the food frequency method which is not incurred for other methods. Specific software has to be written to analyse the food frequency questionnaires. If modifications are made to an existing food frequency questionnaire beyond the scope of the software's capabilities, the software needs to be modified by the programmer.

The advantages in administration of the food frequency method permit investigators in large epidemiologic studies to obtain dietary information that would not be possible with other methods.

2.3.3 Ability of the Questionnaire to Assess Dietary Intake

The third aspect of the strengths and limitations of the food frequency method is the ability of the instrument to assess usual dietary intake.

The food frequency questionnaire obtains data on how often foods are eaten from which can be derived food intake patterns. The food intake information is useful when the purpose is to study the associations of specific foods and risk of disease.

The food frequency questionnaire lacks the ability to monitor short-term changes in diet as the time period is usually quite long (i.e.

one month, one year). The responses are based on the subjects' memory making it difficult to measure the exact time period covered.

The usefulness of food frequency questionnaires for providing nutrient intake data for individuals is limited, however, it does provide useful data at the group level. The nutrient analysis of a food frequency questionnaire can be used to provide an estimate of the group mean and/or a relative ranking of individuals, as discussed in the next section.

2.4 Purpose of Nutrient Analysis of the Food Frequency Questionnaire

In a review of dietary assessment methods Bingham (1987) concluded that 'food frequency questionnaires are in fact unable to fulfil the epidemiological purposes for which they were intended, i.e. to classify individuals into extremes of a population distribution'. There is, however, accumulating support for the food frequency questionnaire's role in nutrition and health research. The food frequency questionnaire has been compared to multiple days of diet record in many recent studies (Block et al 1992; Pietinen et al 1988; Willett et al 1987). The food frequency method has been shown in these studies to be capable of classifying individuals into extremes of nutrient intake and to provide estimates of mean nutrient intake for populations. Examples of each of these findings are presented below.

2.4.1 Classification of Individuals

The ability to categorise individuals according level of nutrient intake is often the primary aim of using food frequency questionnaires in epidemiological studies.

Pietinen et al (1988) tested the ability of a qualitative food frequency questionnaire to classify subjects into broad categories of intake. They used, as a comparison, classification into quintiles by twenty-four days of diet record.

On average, 72% of subjects were classified into the same or adjacent quintiles by the two methods. These values varied from 64% to 80% for the nutrients reported.

The classification results found by Pietinen et al were slightly lower than those reported by Willett et al (1985). Willett et al evaluated the reproducibility and validity of a 61 item semiquantitative food frequency questionnaire using, as a reference method, four one-week diet records. They found that 74% of the subjects in the lowest diet record quintile were in the lowest one or two quintiles according to the food frequency questionnaire. Seventy seven percent of the subjects in the highest diet record quintile were in the highest one or two quintiles according to the questionnaire.

Horwath (1993) validated a semiquantitative food frequency questionnaire using five two-day diet records. For most nutrients, at least 70% of the subjects were classified into the same or within one quintile by the two methods.

2.4.2 Estimate of Mean Nutrient Intake

Pietinen et al (1988) found that there was some agreement between the absolute nutrient intake values produced by the food frequency questionnaire and the diet records. The mean intakes from the food frequency questionnaire ranged from about 66% of the diet record values, for energy, total fat and saturated fat, up to 100% for polyunsaturated fat, vitamin E and selenium.

Willett et al (1985) noted that the mean daily intakes from their questionnaire and the diet records were 'roughly comparable'. The distribution of the questionnaire values were wider than those obtained from the four one-week diet records.

The semiquantitative food frequency developed by Horwath (1993) produced mean intakes that were less than 5% different, for most nutrients, from five two-day diet records.

Block and Subar (1992) used a 60 item food frequency questionnaire administered to 22,080 individuals as part of the 1987 National Health Interview Survey. This method was used to provide estimates of mean intake and the distribution of intakes. The questionnaire was a subset of Block's validated 100 item food frequency questionnaire (Block et al 1992; Sobell et al 1989). In the validation studies of the full questionnaire it has been shown to produce accurate estimates of mean nutrient intake. The results of the 60-item questionnaire were, however, subjected to adjustments to achieve mean values similar to those of traditional dietary recall or record methods.

2.5 Food Frequency Questionnaire Design and Analysis

2.5.1 Foods Included in the Questionnaire

Willett (1990) lists three general characteristics of a food for it to be of value in the questionnaire.

1. the food must be consumed reasonably often by a significant number of individuals.
2. the food must have a substantial nutrient content especially of the nutrient or nutrients of interest.
3. the consumption of the food must vary from person to person in order to discriminate between individuals.

Apart from these considerations a food may be included on the basis of epidemiologic information that an association may exist between the food item and a condition of interest.

Willett (1987) followed these steps to select foods for a questionnaire. The help of an experienced dietitian was used to identify potentially important sources of the specified nutrients. Those foods that were consumed infrequently were eliminated. In a pilot study of 1742 women, stepwise regression was used to identify those foods that did not add appreciably to the between-person variation in nutrient intake. Approximately 6000 days of diet records were used to identify any additional foods that might contribute appreciably to the nutrient intake. Some foods were then added to the food list that were of special interest with respect to cancer epidemiology but were not necessarily important nutrient contributors.

Block (1986) described the development of the food list using NHANES II data. The 2,244 foods reported by the respondents in this survey were grouped into 147 conceptually similar food items. For example, the 11 green bean codes were all grouped under one item – green beans. The following criteria were used for this grouping of food items:

1. The individual food items had to be conceptually similar.
2. The respondents need to be able to distinguish between the food items.
3. The similarity in nutrient content per usual serving was considered.

4. The importance of the food item to the ability to correctly classify an individual by nutrient intake and the approximate number of persons at risk of any misclassification.

The NHANES II survey included data on energy and 17 nutrients. The percentage of energy and the nutrient contribution was calculated for each food item. The foods were then ranked in order of their contribution. The contribution calculated in this way is related to the nutrient composition, the typical serving size and the frequency of consumption by the population. These factors led to the detection of some foods, such as liver, which are sometimes overlooked as important contributors.

The food list was then modified to ensure adequate assessment of dietary fibre, include major cruciferous vegetables, include foods with suspected health implications, e.g. tea, coffee, artificial sweeteners. Foods that were important in some geographic and ethnic subgroups were included. Some foods, e.g. winter squash, that were consumed by relatively few people were included to ensure these individuals were not misclassified. Further changes were made after a pretest of the questionnaire. An open-ended question was also added to questionnaire to enable the respondent to report any other frequently consumed foods.

The grouping or separation of food items into groups is further detailed by Block (1992) describing the development of the University of Michigan Food Frequency Questionnaire. The foods included were derived from foods eaten by adults aged 23 to 74 in the USDA's Nationwide Food Consumption Survey.

Foods were listed together as a single item if they were similar in nutrient composition, serving size and were consumed in a similar manner, e.g. pancakes and waffles.

Food items that were used in different ways were listed separately, e.g. eggs in salads, eggs in casseroles and eggs eaten by themselves.

Food items that were consumed in different portions were also separated into different items, e.g. beef in stew and roast beef.

Foods that were used as additions to other food items, such as milk on cereal, were asked about in reference to the primary food item.

Other major food frequency questionnaire development and validation studies have also used national dietary survey data, either for the general population (Pietinen et al 1988), or for a population subgroup such as the elderly (Horwath 1993).

Eck and Willett (1991) have advised caution when modifying an existing food list. Deletion of food items must be clearly justified as information collected by the original questionnaire will be eliminated. Additions are of less concern although care needs to be taken to prevent the introduction of redundant items. Redundancy occurs when the same food item is included in different forms, for example, a mixed dish containing a meat item and the meat item by itself.

2.5.2 Frequency Response Scale

Flegal et al (1988) partitioned the energy estimates from a food frequency questionnaire into its two separate determinants: the reported frequency and the reported serving size. The low correlation coefficients and poor agreement in classification when compared to 16 days of diet record were attributed to the frequency estimates. This study suggests that improving the accuracy of the frequency estimate is essential in increasing the relative validity of the food frequency questionnaire for epidemiologic uses.

A key element in aiding the accuracy of the frequency estimates is the frequency response scale.

In a review of 'measurement of past diet', Friedenreich et al (1992) assessed nine food frequency questionnaires. The frequency response scale varied considerably. Four of the questionnaires used an 'absolute' estimate of frequency, where the subject reported frequency as an exact number per day, week or month. Five of the food frequency questionnaires used a 'categorical' response scale, with the number of categories ranging from five to ten.

Willett (1990) suggests that five options are likely to be too few and result in loss of information. The use of a small number of broad frequency categories decreases the capacity of the question to discriminate between consumption frequency. Stefanik and Trulson (1962) in one of the original food frequency questionnaires used a scale of ten categories ranging from 'once a month or less' through to 'over six times per day'. The frequency scale needs to have the greatest detail and thus greatest sensitivity at the high frequency end. Foods consumed less than once per week make relatively little contribution to the overall nutrient intake.

The alternative to the 'categorical' or 'closed' response scale is the 'absolute' or 'open-ended' response type. This continuous scale, in theory, should provide higher precision compared to the 'category' scale (Willett 1990). This is unlikely, however, as the potential increase in precision may be small considering that the subject's estimate of frequency is only an approximation.

There is some mixing of the two approaches to gaining frequency information. Some questionnaires use the 'categorical' format for most food items but use the 'absolute' response method for food items that are easily quantified and/or consumed very frequently. For example the consumption of bread, coffee, tea and drinks were assessed with the 'absolute' format in the questionnaire used by Pietinen (1988) while the frequency of all other food items were assessed with an eight option 'category' scale.

2.5.3 Collection of Serving Size Information

"...questions still exist concerning the respondent's ability to provide, as well as the researcher's need to collect, the portion size of the food consumed." (Clapp et al 1991)

The ability of subjects to accurately describe the amount of food eaten has been investigated by several researchers. Rapp et al (1986) assessed the amount of error when individuals were asked to estimate serving sizes without measuring devices. They found that errors varied both in amount and direction depending on the food item being measured. Guthrie (1984) suggests the need to provide respondent's with help in estimating servings or development of methods not requiring accurate description of serving size. Hunter et al (1988) suggested that the large within-person variance in portion sizes makes it very difficult for subjects to specify their 'usual' portion size.

Numerous studies have addressed the issue of whether to collect data on amounts eaten. There has been a large variation in the methodology of the studies assessing the impact of serving size information on the food frequency questionnaire. This variation in methodology leaves many unanswered questions and confusion in this area of food frequency questionnaire design.

The studies concerning the collection of serving size information can be divided into two groups.

The first group of studies have compared the performance of a food frequency questionnaire using standard serving sizes with the same instrument using reported estimates of serving size.

The second group of studies compared the performance of a food frequency questionnaire using standard serving sizes with the same instrument using the subjects responses as to whether they consume a small, medium, or large serving size (in relation to a stated serving size).

2.5.3.1 Standard serving sizes versus reported estimates of serving size

The first group of studies compare the performance of a food frequency questionnaire using standard serving sizes with that of the same instrument using reported estimates of serving size.

Tjønneland et al (1992) reported correlation coefficients and quintile classifications of 144 subjects, aged 40 to 64 years, for foods and nutrients analysed from a semiquantitative food frequency questionnaire with and without individually estimated serving sizes. The serving sizes were estimated by the subjects with the aid of photographs of four options of serving sizes. The questionnaire without estimated serving sizes used median serving sizes from the 1985 Danish National Dietary Survey data. The food frequency questionnaires were compared to two seven day weighed diet records. Tjønneland et al reported that the mean correlation coefficients for men decreased slightly from 0.51 for the questionnaire including estimated serving sizes to 0.49 with standard serving sizes. For women, there was a slight increase from 0.39 with estimated serving sizes to 0.40 without. The classification of subjects into quintiles showed only minor differences. It was concluded that the inclusion of estimated serving sizes provided little gain in the questionnaire's performance. The reasons presented for this were that either the serving sizes are a minor influence on the analysis compared to the frequency of consumption, or the estimated serving sizes were subject to large errors.

Hernandez-Avila et al (1988) used personal interviews with food models to obtain serving sizes for a food frequency questionnaire. When compared to a one week diet record the questionnaire with estimated serving sizes resulted in a mean correlation coefficient of 0.54. The same questionnaire without the serving size estimates resulted in a correlation with the diet records of 0.53.

Hankin et al (1975) compared a food frequency questionnaire that used photos of serving sizes and the same questionnaire without estimated serving sizes against a seven day diet record. The mean correlation coefficient for the questionnaire with serving sizes was 0.59, compared to 0.55 for the questionnaire with frequency alone.

Cohen and Laus (1990) administered to 399 University students, in randomised order, a food frequency questionnaire requiring estimates of serving sizes, a food frequency questionnaire without the serving size component and two sets of three day diet records. When the nutrient intakes were energy-adjusted, the food frequency questionnaire with serving size estimates was reported as 'marginally closer' to the diet record than the food frequency questionnaire without serving size information.

Jackson et al (1990) compared a food frequency questionnaire with individual portion estimates, and a food frequency questionnaire using standard portions with a diet history interview. Only fat, calcium and dietary fibre intakes were analysed. The use of individual portion estimates increased the correlation coefficients for fat and calcium compared to the questionnaire with standard serving sizes. However the correlation coefficient for dietary fibre decreased slightly.

A few studies have investigated the issue of serving size information through comparison of the food frequency questionnaires against each other but have not compared to another dietary assessment method.

Samet et al (1984) compared vitamin A intakes in 439 subjects from a food frequency questionnaire estimating individual portions using food models with intakes calculated from frequency alone. They found that the relative ranking of subjects remained stable when the individual serving sizes were added to the frequency only analysis.

Chu et al (1984) compared a food frequency questionnaire requesting frequency alone to a full quantitative food frequency questionnaire. Regression analysis showed the results of each method were not identical and therefore could not be interchangeable.

Clapp et al (1991) obtained results for retinol, carotene, vitamin C and folate from a food frequency questionnaire that used reported serving sizes and compared them to results using standard serving size information. The correlation between the two analyses ranged from 0.73 (carotene) to 0.92 (folate). The mean, median, and standard deviation of nutrient intake were smaller for the analysis using standard serving sizes. There was some difference in classification of subjects between the two analyses. The estimation of disease–risk factor association through calculation of odds ratios for cervical dysplasia differed for only one nutrient (vitamin C) between the two analyses.

2.5.3.1 Standard serving sizes versus responses of small, medium or large serving size

The second group of studies elicit serving size information, not by requesting estimates, but by collecting responses as to whether the subject consumes a small, medium or large serving size (in relation to a stated serving size).

Block et al (1986) derived median serving sizes from dietary survey data (NHANES II). Small and large serving sizes were determined from the distribution of serving sizes within the survey data. A considerable degree of judgement was used in this method. This process was repeated for six age and sex groups. A food frequency questionnaire, the Health Habits and History Questionnaire, was tested with two sets of serving sizes: firstly, using a single median value for serving size and secondly, using small, medium and large serving size values. The results of the two questionnaires were compared with one-day diet records.

The use of a standard medium serving size produced accurate estimates of the mean intake only for females. Statistically significant underestimates of mean energy and nutrient intakes were produced for males. The three levels of serving size, small, medium and large, produced values not statistically different from the diet records for 90% of the age-sex specific mean nutrient estimates.

When correlated to the diet records, the questionnaire analysis using the single medium serving size produced correlation coefficients ranging from 0.54 for fat to 0.90 for vitamin A. The analysis using the three levels of serving size resulted in correlations ranging from 0.73 for fat to 0.94 for vitamin A.

The questionnaire's ability to classify into the same or within one quintile of the diet record differed between the two sets of serving sizes. The use of the medium serving size classified at least 80% of subjects into the same or adjacent quintile as the diet record whereas the use of small, medium and large serving sizes classified at least 90%.

These results were produced using a data-based approach whereby the two major sources of potential error in the food frequency questionnaire were separated. The adequacy of the food list and its associated quantitation was investigated in isolation from the accuracy with which an individual can report frequency of consumption.

Block et al (1992), using the Health Habits and History Questionnaire from 85 subjects, repeated the comparison between a single median serving size and the set of small, medium and large serving sizes The reference method used was sixteen days of diet record. The use of small, medium and large serving sizes accurately ranked the four age-sex groups whereas the use of the single medium serving size did not. The use of small, medium and large serving sizes accurately estimated energy intakes in all age-sex groups. The intake of elderly men was greater than that of younger men when the single medium serving size was used. There were also substantial underestimates for young and middle-aged men and overestimates for middle-aged women.

The Health Habits and History Questionnaire (HHHQ) was also tested by Cummings et al (1987) along with a food frequency questionnaire developed at the Oregon Health Sciences University. The HHHQ questionnaire required subjects to report their usual serving size compared with the medium serving size specified on the questionnaire. Their serving size was recorded as small, medium or large. The Oregon questionnaire required the subjects' usual serving size to be recorded in ounces (from measuring cups) or in terms of common units (e.g. slices of bread)

The HHHQ questionnaire was analysed using three different methods for handling the serving size information. Firstly, using a standard medium serving size (derived from NHANES II survey data). Secondly, adjusting the serving size according to the subjects' response using a factor of 0.5, 1 or 1.5 for small, medium or large, respectively. The third method used age-sex specific values derived from the NHANES II survey data for small, medium and large serving sizes. The second and third methods yielded virtually identical results and therefore results of the second simple, numerical method were presented.

The mean daily calcium intake calculated from seven day diet records for 37 elderly women was 612 mg (±212 mg standard deviation). The use of small medium and large serving sizes in the HHHQ questionnaire resulted in a mean daily calcium intake of 637 mg (±274 mg s.d.) whereas using medium serving sizes alone resulted in 792 mg (±333 mg s.d.). The Oregon questionnaire using the subjects' estimates of serving size resulted in a mean daily calcium intake of 688 mg (±404 mg s.d.).

The correlation coefficients, when correlated to the diet records, were 0.76, 0.64 and 0.49 respectively from the HHHQ with small, medium and large servings sizes, the HHHQ questionnaire using medium serving sizes only and the Oregon questionnaire using the subjects' estimates of serving sizes.

2.5.4 Correction for Total Frequency of Consumption of Food Types

Krebs-Smith et al (1992) investigated the relationship between the number of individual food items included in a food frequency questionnaire and the questionnaire's tendency to produce higher estimates of mean intakes. When summed together, the total frequency of fruits and vegetables was related to the number of individual fruit and vegetable items in the questionnaire. It is suggested that summary questions about overall daily consumption of fruits and vegetables could be used to make adjustments for the overestimate of the individual fruit and vegetable items.

Tjønneland et al (1992) used a questionnaire designed with a number of questions to check frequency of consumption of specific food groups. In the analysis, the frequency of consumption of foods within a food group was totalled and compared to the global frequency for that group. If the total of the individual food items exceeded the global frequency of consumption, an adjustment was made for the overestimation. Adjustments were found to be necessary for meat and poultry, vegetables, potatoes and bread. The global questions were used as a standard although the difference between the global and individual frequencies may not have been due solely to over-reporting of the individual items. The individual questions may have prompted the subjects' memory whereas the global questions may be prone to under-reporting due to a lack of memory cues.

2.6 Reference Methods

The validity of a food frequency questionnaire is the degree to which it actually measures the aspect of the diet that it was designed to measure. In order to establish the validity the individual estimates of nutrient intake based on the food frequency questionnaire must be compared with those measured by a more accurate method. There is, however, no perfect measure of dietary intake so a comparison is made against a method that is judged to be superior.

It is crucial that the errors of the reference method are as independent as possible of the errors present in the food frequency method. The major sources of error in the food frequency method are as follows:

1. Restrictions imposed by the fixed list of foods.
2. Reliance on the respondents memory.
3. Errors due to respondent's perception of serving size.
4. Respondent's interpretation of the questions.

Similar sources of error in the two methods being compared may result in spuriously high estimates of validity.

2.6.1 Diet Records

Diet records have the least correlated errors when compared to food frequency questionnaires. The restrictions of a fixed list of foods in the food frequency questionnaire is countered with the open-ended form of diet records. The diet record does not depend on memory as the subjects record their food intake at the time of eating. The foods are measured at the time of eating thus eliminating the problems of perception of serving size. Interpretation errors in the diet record method are most likely to occur when the foods are coded and analysed, not when the subjects are recording their intake.

The errors of the diet record method are largely independent of those of the food frequency method therefore providing an ideal reference method. The validity of a food frequency questionnaire when compared to diet record is, if anything, understated (Willett 1990).

The major issue when using diet records as the reference method for validity is the number of days required to give reliable results. Potosky et al (1990) tested the validity of a food frequency questionnaire against one, two and three 4-day diet records. For most nutrients, the single 4-day record was not suitable as a reliable estimator of an individuals usual intake compared to two or more sets of 4-day diet records. The use of an insufficient number of days as a reference when assessing another method may result in an underestimation of the true validity of the method.

Marr and Heady (1986) studied the within- and between-person variation in dietary surveys. They concluded that, in order to reliably classify individuals (80% reliability), the number of days required varied from 2-3 days for some nutrients up to 2-3 weeks for others. One week's survey classified most nutrients with 80% reliability or better.

2.6.2 Multiple 24-Hour Recalls

The twenty-four hour recall method has common features with the diet record method, however, it also shares some major errors with the food frequency method. The twenty-four hour recall is open-ended allowing the respondent free choice of foods. There is a requirement of the respondent to rely on memory to complete a recall of intake, both for the foods eaten and the estimate of serving sizes. This is in common with the food frequency method. The errors in interpretation will occur, as with the diet records, in the process of coding and analysing the data.

The twenty-four hour recall is a less desirable method for validation of a food frequency questionnaire than diet records although it does have some redeeming features. The level of literacy and motivation of the respondents need to be considered. Twenty-four hour recall interviews may be more successful than diet records in cases of low literacy and/or motivation. The twenty-four hour recall may provide a larger sample size if limited resources are available. The same number of days could be collected by the diet record method but from a considerably smaller sample size. The larger sample of twenty-four hour recalls would potentially provide a more heterogenous sample for validation of the food frequency questionnaire.

2.6.3 Diet Histories

The diet history method as a reference method provides a limited assessment of validity of a food frequency questionnaire. The major errors in the diet history method are common with those of the food frequency method. Diet histories rely on the respondent's ability to recall foods eaten and to estimate serving size. The diet history is also prone to errors in the interpretation of questions.

The use of the diet history method as a reference may result in spuriously high estimates of validity.

2.6.4 Direct Observation of Intake

"It is quite possible that the conscious observation of one's food intake reduces not only the perceived but also the actual intake for a short time" (Mertz 1992)

This quote applies to all methods of recording food intake but is most likely to occur when direct observation of food intake is practised. In principle the direct observation of food intake provides an excellent reference method. In practice, however, the artificial environment is the limiting factor.

Horwath and Worsley (1990) used direct observation of home food stores to test the validity of a food frequency questionnaire. Good agreement was reported between the food frequency questionnaire and presence and absence in the subjects' homes.

2.6.5 Proportion of total nutrient intake accounted for by foods on the Food Frequency Questionnaire

The development of the food list for a food frequency questionnaire often involves an 'open-ended' method such as diet records or diet recalls. This data set can also be used to determine the completeness of the questionnaire. The 'open-ended' method is analysed and the contribution to the total intake made by those foods listed in the questionnaire is calculated. If the contribution is 100% then all foods recorded in the 'open-ended' method must be present in the food frequency questionnaire.

This method has limited use as a measure of a questionnaire's performance. A low percentage of nutrient intake accounted for by the foods on the questionnaire would alert the investigator to the incompleteness of the food list. The questionnaire may, however, still be able to discriminate between individuals if the food list has been carefully compiled to include the major food sources of a nutrient and, more importantly, those foods whose intake would differ greatly between individuals.

A high percentage contribution is not necessarily indicative of the questionnaire's validity as this method does not allow for the random errors introduced by the respondents.

2.6.6 Comparison with a Biochemical Indicator of Dietary Intake

The measurement errors associated with biochemical indicators are uncorrelated with errors in the food frequency questionnaire method making their use for validation an attractive proposition. There are, however, so many major limitations to their use that they are rarely used.

Biochemical indicators of dietary intake are likely to be influenced by factors other than intake. The absorption and post-absorptive metabolism may affect levels of indicators. There may be physiologic variations such as levels of binding proteins, diurnal and menstrual cycle variations. The daily variation in dietary intake will cause fluctuation in the biochemical indicators although this will depend on the delay between intake and change in the biochemical indicator. In addition to these sources of error there is also the error of measurement involved in any biochemical assay. The sources of error in biochemical indicators will tend to weaken the validation of a food frequency questionnaire.

There are some biochemical markers available for a limited number of nutrients such as carotene and vitamin E. Some indicators are so strongly regulated by the body that they are of little use as measures of dietary intake, for example, plasma cholesterol. There are currently no indicators for major nutrients such as total fat, total carbohydrate, sucrose or fibre. This lack of indicators severely limits the method's usefulness in validation of a food frequency questionnaire.

An example of the use of biochemical indicators as a measure of dietary intake is the comparison of dietary carotene and plasma carotenoids, and intake of vitamin E with plasma alpha-tocopherol (Willett et al, 1983). The dietary intakes were adjusted for total energy intake and the plasma nutrients were adjusted for plasma lipid values. The resulting correlations were 0.35 for carotene and 0.34 for vitamin E.

2.6.7 Prediction of a Physiologic Response or Known Disease Relationship

The prediction of a physiologic response or known disease may be used as qualitative evidence that a questionnaire is valid (Willett 1990). There are, however, only a small number of responses and diseases that have well established relationships to diet. Willett cites the examples of calcium intake and lower blood pressure, milk consumption and bone density, saturated fat and coronary heart disease, and green and yellow vegetables and risk of squamous cell lung cancer. This approach is also hindered by the necessary time for a relationship of this nature to become apparent.

2.7 Comparison Techniques

2.7.1 Mean Nutrient Intakes

The comparison of the means from the food frequency questionnaire and the reference method is simple and inexpensive, however, this offers only limited information on validity. Similar means may lead to the assumption that the questionnaire is reasonably comprehensive. This assumption may be untrue if the serving sizes were erroneously high. The high serving sizes would compensate for the less than comprehensive food list. The comparison of means gives no indication of the questionnaire's ability to discriminate between individuals.

Crude nutrient intakes are of interest, but it is important to adjust the nutrient intakes for total energy as this variable is controlled for in epidemiologic analysis (Willett 1990).

2.7.2 Adjustment for Total Energy Intake

The intakes of most nutrients in free-living populations tend to be positively correlated with total energy intake. This correlation is, in part, from the contribution of the macronutrients to energy intake. In epidemiologic studies the total energy intake has implications for the interpretation of other nutrients as well as being of interest itself (Willett and Stampfer 1986).

There is uncertainty as to whether it is the absolute amount of a nutrient or the amount in relation to total energy intake that is most relevant in epidemiological studies. If a nutrient selectively affects an organ system, such as the central nervous system, that is unrelated to energy intake through being uncorrelated with body size, or the organ system's metabolism is unaffected by physical activity then the absolute intake may be most relevant. If, however, the nutrient is metabolised in approximate proportion to the total energy intake, such as the macronutrients and some vitamins, then the nutrients intake in relation to energy intake may be the most relevant measure.

There are two commonly used methods for correction for energy intake. The first is termed 'nutrient density', which is the nutrient intake divided by the energy intake. The second is termed 'adjusted for energy intake'. This method involves linear regression analysis with the nutrient as the dependent variable and energy as the independent variable. The residuals produced from this analysis are used to represent the variation in the nutrient independent of the variation due to the energy intake. The residuals are added to the expected nutrient value at the mean energy intake, as predicted by the regression equation. This results in a nutrient score adjusted to the energy intake and representative of the actual nutrient intake. (Willett and Stampfer 1986)

The regression approach adjusts for energy intake only to the extent that it is correlated with the nutrient intake whereas the nutrient density method results in a nutrient value that is partly a function of energy intake. For macronutrients that are strongly related to energy intake, both methods yield similar results. For micronutrients, which are usually more weakly associated with energy intake, the results for the two methods can be significantly different. (Willett et al 1985)

2.7.3 Classification of Individuals

The aim of many epidemiologic studies is to examine the relative risks in different levels of intake rather than determine the absolute levels of nutrient intake. This brings about the need to assess the ability of the food frequency questionnaire to classify individuals into broad categories of nutrient intake (Block 1982).

The classification of individuals into the same groups as the reference method is used as a measure of this ability. The groups are defined as percentiles (usually quintiles, sometimes tertiles) within each method. The assessment of the food frequency questionnaire's ability to appropriately classify individuals is usually based upon the percentage of subjects classified into the same or adjacent percentile. This measure is accompanied by the percentage of subjects grossly misclassified into extremely opposite percentiles (Pietinen et al 1988; Willett et al 1985).

2.7.4 Correlation Coefficients

The correlation coefficient indicates the degree of linear relationship between two variables.

The use of correlation coefficients in the comparison of measurement methods is claimed to be inappropriate by Bland and Altman (1986). The argument against correlation coefficients, however, is based upon their use in research on clinical measurements where the exact agreement between individual measurements is critical. An example of this situation is an investigation of the agreement between two Peak Flow Meters used with patients. It is noted that a 'perfect' correlation between methods requires that the variables plot along any straight line, whereas a 'perfect' agreement between methods requires, in addition, that the straight line is the line of equality.

In epidemiologic research the correlation coefficient is capable of demonstrating the relationship between the nutrient intakes calculated from the food frequency questionnaire method and another reference method. This indicator is sufficient to show that when one method yields a low or high intake, the other method yields a low or high intake, respectively. The exact agreement between the methods in not relevant to the ability to rank individuals by levels of intake.

Bland and Altman (1986) state that a test of significance may show that two methods are related but it is unlikely that two methods of measuring the same variable would not be related. Caution is also advised by Gibson (1987) when using correlation coefficients to compare two sets of data that are obviously related. The correlation coefficient should not be judged using the null hypothesis basis for no correlation. The size of the correlation coefficient that would be expected could be calculated and this used to assess the degree of correlation.

Correlation coefficients obtained in studies of reproducibility and validity of food frequency questionnaires typically range between 0.5 and 0.7. These may seem low when compared to correlations obtained in laboratory measurements, however, they are comparable to correlations between biological measurements. For example, serum cholesterol and blood pressure measurements made among free-living subjects over long periods of time are reliable predictors of disease in epidemiologic studies (Willett 1990).

2.7.5 Mean and Standard Deviation of the Difference

Bland and Altman (1986) advocate use of the mean and standard deviation of the difference as an alternative to the use of correlation coefficients to indicate agreement between methods of measuring the same variables. These indicators are not influenced by the between-person variation in the measurements.

Willett (1990) comments that the interpretation of the mean and standard deviation of the difference tends to be cumbersome when evaluating many nutrients as these parameters vary considerably from nutrient to nutrient.

2.7.6 Kappa Statistic

The Kappa statistic was originally devised by Cohen, 1960 (cited in (Maclure and Willett 1987)) as a measure of agreement between two observers classifying subjects into two nominal categories. The method has been extended to multicategory classifications and is used to assess reproducibility and validity.

To apply the Kappa statistic to continuous data requires that the data be grouped into categories of arbitrary number and size. The magnitude of the kappa statistic is more dependent upon how the categories were defined than upon the degree of reproducibility or validity of the observation methods. As more categories are used, the definition of exact agreement is narrowed as the proportion of observations which exactly agree is arbitrarily reduced.

MacLure and Willett (1987) suggest that use of the Kappa statistic with continuous data arbitrarily grouped into ordinal categories is virtually meaningless.

2.7.7 Actual Values for Surrogate Categories

Willett et al (1985) presented results of a semiquantitative food frequency questionnaire as actual values for surrogate categories. The subjects were grouped into categories, in this case – quintiles, on the basis of the food frequency questionnaire. Each category is represented by the mean of the 'true value' for each subject, i.e. the mean diet record value for the subjects in each category.

The advantage of this method is that it conveys information about the actual quantitative differences in the diet between groups ranked according to the food frequency questionnaire. These differences are a product of both the true variation in dietary intake and the measurement error of the food frequency questionnaire.

These 'true' values for the surrogate categories, as defined by the questionnaire, are useful in the presentation of epidemiologic studies relating a level of dietary intake with a disease risk (Willett 1990).

3 Methods

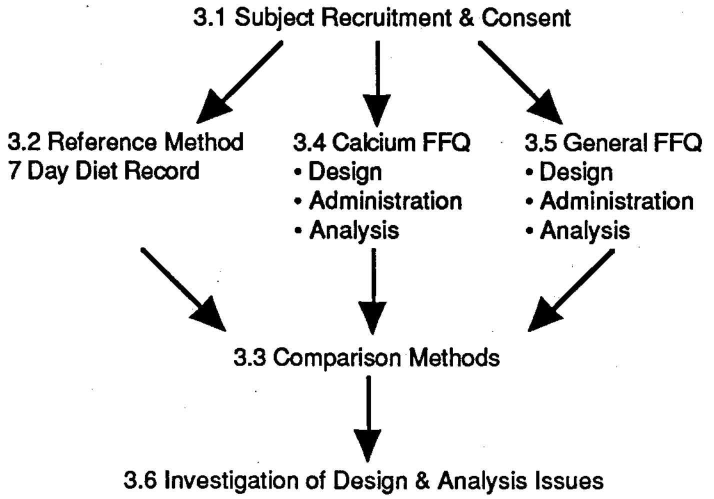
To address the question of which response scale format results in better performance of a food frequency questionnaire, a calcium specific food frequency questionnaire was administered in two forms. One form used an 'Open' response scale format requiring the subject to respond with the number of times the food is consumed per day, week or month. The other form used a 'Closed' response scale format consisting of a fixed number of broad frequency categories (e.g. daily, two to three times a week, monthly).

A general food frequency questionnaire was designed, administered and analysed to investigate the following issues:

- Effect of age and sex specific serving sizes compared to the use of common standard measures of the foods for serving sizes in the questionnaire analysis.
- Effect of analysing the questionnaire using small, medium or large serving sizes as specified by the subjects.
- Effect of using the total number of servings of a food type per day or week to adjust the frequency of the individual food items of that type.

Seven day diet records were the reference method against which the food frequency questionnaires were evaluated.

Figure 3.1 'Map' of Methods Chapter.



3.1 Subject Recruitment and Consent

A research project proposal (Appendix A) was written and submitted to the study supervisor. The project was approved under the blanket ethical approval the Department of Human Nutrition has been granted by the Ethics Committee, Dunedin Hospital.

The subjects were drawn from University students in their first year of studying Human Nutrition. The research was carried out in conjunction with the prescribed practical course in dietary assessment methodology. The practical course required each student to complete a seven-day diet record and two food frequency questionnaires, a general food frequency questionnaire and a calcium-specific food frequency questionnaire. The students were invited to contribute their diet record and food frequency questionnaire to this research. This study used this practical work and an additional calcium-specific food frequency questionnaire.

The purpose of the research project and the requirement of involvement was explained to the subjects and each signed and returned to the investigator a consent form (Appendix B).

3.2 The Reference Method - Seven Day Diet Records

The reference method, against which the food frequency questionnaire were compared, was chosen to be seven day diet records. The diet record is an ideal reference method as the errors in this method are independent of the errors in the food frequency method. (See Section 2.6.1)

Seven days of diet record was determined to be the optimal number of days when considering the following two factors. The greater the number of days, the higher the expected accuracy of the nutrient intake data. The longer the period of recording, however, increases the respondent burden and causes a corresponding decrease in accuracy of the nutrient intake data. A maximum of three consecutive days for recording periods was used to reduce boredom, fatigue and omissions and thus increase the accuracy of the diet records.

3.2.1 Instructions to Subjects

The subjects were instructed to record their diet for a total of seven days over a period of one month. The seven days of recording included one of each day of the week, with no more than three consecutive days of recording to reduce subject fatigue and possible omissions in the diet records, thus increasing their accuracy.

Instructions were given for recording amounts using common standard measures i.e. weights of portion sizes of foods, food models and photographs of small, medium and large portions of commonly eaten foods.

Additions to foods (such as spreads, dressings, sugar and sauces) and cooking methods were also recorded.

Emphasis was placed on the need to record foods at the time of eating and not to rely on memory at the end of the day to record foods eaten.

Subjects were provided with standard diet record sheets in booklet form with written instructions and portion size photographs (Appendix C).

The booklets were collected as part of the students practical assignment and were checked to ensure the quality of recording their diet.

3.2.2 Coding and Entering

The subjects entered their own seven day diet records into an Apple Macintosh™ computer. The diet records were entered into a diet analysis software package called 'Nutrition'. This software was written for use in undergraduate Nutrition laboratories by the Computing Services Centre, University of Otago. The subjects were instructed on the use of the computer and software by the author. The author and another postgraduate student experienced in entering diet records were present to assist the subjects. Written information on common serving sizes for a large number of foods was given to the subjects. Instructions and advice was given to aid in the assigning of portion sizes and the substitution of similar foods for food items that were not present in the database. At the conclusion of the practical course the diet record files were collected.

The same food composition database as used for the food frequency analysis, 'FOODfiles' the computer version of the New Zealand Food Composition Database (Milligan et al 1991), was used for analysing the diet records.

3.2.3 Analysis

The diet records were converted from the 'Nutrition' software file format to a format compatible with a batch processing diet analysis software package, 'Diet Cruncher' (Marshall 1991). This software was previously developed by the author for analyses of large numbers of diet records as in this study. This software produced a result file containing the average of each seven day diet record for energy and 47 nutrients.

3.3 Comparison Techniques

The individual nutrient results from the food frequency questionnaire analyses and the seven day diet records were imported into a program called 'Method Comparison' written by the author in HyperCard™ for the specific purpose of comparing two dietary assessment methods. The simple regression analysis and calculation of residuals was performed using StatView™ Version 4 (Abacus Concepts 1987b). The mean nutrient intakes, mean and standard deviation of the difference, classification into quintiles and actual values for surrogate categories were calculated with 'Method Comparison'.

3.3.1 Mean Nutrient Intakes

The mean, standard deviations, minimum and maximum of the nutrient intakes were calculated from the raw unadjusted results of the seven day diet records and each analysis of the food frequency questionnaire using 'Method Comparison'. The mean intake calculated from the food frequency questionnaire was divided by the mean intake calculated from the seven day diet record to give an indication of over– or under–estimation by the food frequency questionnaire.

3.3.2 Adjustment for Total Energy Intake

The seven day diet record and food frequency questionnaire nutrient results were adjusted for total energy intake using regression analyses. This was carried out using StatView™ Version 4. Residuals were calculated from the regression model with energy intake as the independent variable and the nutrient intake as the dependent variable. The mean energy intake at the mean nutrient intake is predicted by the regression equation. This constant was added to the residuals to provide a set of data representing, in magnitude, the actual nutrient intake. The addition of the constant eliminated the negative values, as residuals contain both positive and negative values to give a mean of zero.(Willett and Stampfer 1986)

3.3.3 Mean and Standard Deviation of the Difference

The energy–adjusted nutrient intakes were used in the calculation of the mean and standard deviation of the difference. The differences between each individuals' seven day diet record and each food frequency questionnaire analyses were calculated with 'Method Comparison'. The mean and standard deviation of the differences were then calculated.

3.3.4 Correlation of Nutrient Intakes

StatView™ Version 4 was used to calculate Pearson correlation coefficients between the seven day diet record nutrient intake and the nutrient intakes calculated from each of the food frequency questionnaire analyses. Since most nutrient intakes were skewed towards higher values, $\log_e$–transformed variables were used. An arbitrary constant was added to the alcohol intake figures as many subjects had a zero intake which cannot be logged. The correlation coefficients were calculated for both the raw intakes and the energy–adjusted intakes.

3.3.5 Classification into Quintiles

The nutrient intakes calculated from the seven day diet record and the food frequency questionnaire analyses were divided into quintiles using 'Method Comparison'. The percentage of subjects classified by the food frequency questionnaire in the same or within one quintile of their classification into quintiles according to the seven day diet records was calculated.

3.3.6 Actual Values for Surrogate Categories

The subjects were classified into quintiles according to their seven day diet record intake using 'Method Comparison'. The mean nutrient intake from the seven day diet record analyses were calculated for each food frequency questionnaire quintile group.

3.4 Calcium Food Frequency Questionnaire

3.4.1 Design of the Calcium Food Frequency Questionnaire

The foods included in the calcium food frequency questionnaire (Appendix D) were derived from a calcium food frequency questionnaire designed by Angus et al (1989) and from one designed by Nelson et al (1988).

Eight of the 29 food items were easily quantified into natural units, hence the question format used for these food items was the same in both questionnaires. For example, 'How many slices of wholemeal bread do you eat per day or per week?'.

One form of the calcium food frequency questionnaire was administered with an 'Open' response scale format. The 'Open' response scale allows the subject to specify the usual number of times a food is consumed per day, week or month.

The other form of the calcium food frequency questionnaire used a 'Closed' response scale format. The 'Closed' response scale consisted of five broad frequency categories. The categories were as follows:

- daily
- 5 or 6 times a week
- 3 or 4 times a week
- once or twice a week
- monthly (once or twice a month)
- rarely or never

No questions on calcium supplements were included in the questionnaire.

3.4.2 Administration of the Calcium Food Frequency Questionnaire

The two Calcium Food Frequency Questionnaires were computer-administered. The Food Frequency Questionnaire administration software was written by the author in HyperCard™ on an Apple Macintosh™ computer. Upon starting the Food Frequency Questionnaire software, the subjects were presented with a screen of instructions on how to answer the questionnaire. The subjects progress through the list of questions on the computer screen. As each question was answered the subjects response was recorded. The subject could review their answers by moving backwards and forwards through the screens of questions. The subject's responses and time taken to respond to the questions were stored on the computer for analysis.

Subjects were randomly assigned to complete either one of the two calcium questionnaires on the first occasion, and the second at least a week later.

The calcium food frequency questionnaires were administered during the same period that subjects were completing their seven day diet records.

3.4.3 Analysis of the Calcium Food Frequency Questionnaire

The calcium food frequency questionnaire was analysed with software written specifically for the questionnaire by the author in THINK Pascal™. The software produced a file of calcium intakes for each subject from both the 'Open' and 'Closed' questionnaires. The software also produced a second result file containing the frequency per day of each food item from both questionnaires. This result file allowed the responses from each questionnaire to be compared against each other.

The food composition data used in the analysis was a subset of the New Zealand food composition tables (Milligan et al 1991). The serving sizes were common standard measures of the food items (Gillanders and Milligan 1992).

3.5 General Food Frequency Questionnaire

See Appendix E

3.5.1 Design of the General Food Frequency Questionnaire

3.5.1.1 Criteria for Inclusion of Food Items

There were two criteria for the inclusion of a food item in the food frequency questionnaire.

Firstly, foods were selected if they were consumed frequently by the target population. There were two sources of this information, both from national diet surveys. The 1977 National Diet Survey (Birkbeck 1983) provided a sample of 1738 twenty-four hour recalls from 20 to 59 year olds. The national diet survey conducted by the School of Physical Education, University of Otago as part of the Hillary Commission's Life in New Zealand Survey (Horwath et al 1991) provided a sample of 1265 twenty-four hour recalls from 20 to 59 year olds. In addition, a sample of twenty-four hour recalls from 15 to 19 years olds (n=129) was included from the Life in New Zealand survey. This was to include any food items specific to the age group used in this research which were not included from the older age groups.

The food items from these samples were sorted according to the proportion of the population consuming them at least once per day. Foods that were consumed by at least two percent of the population were included in the questionnaire.

The second criteria for inclusion of a food item in the questionnaire was based on the contribution of the food item to the total nutrient intake of the population. This criteria took account the nutrient composition of the food item as well as the proportion of the population consuming it. This method allowed for inclusion of items such as liver, with a high nutrient contribution but a low frequency of consumption. Foods from the 1977 National Diet Survey (Birkbeck

1983) were ranked according to their contribution to the total intake of energy and specific nutrients (listed below). The food items included in the questionnaire were those present in a list that accounted for 75% of the total intake for each nutrient examined.

The food list was determined using as many nutrients as were available (listed below) in order to create a questionnaire applicable to as many nutrients as possible.

- Energy
- Protein
- Carbohydrate
- Starch
- Sucrose
- Alcohol
- Fibre
- Fat
- Saturated Fat
- Polyunsaturated Fat
- Cholesterol
- Sodium
- Magnesium
- Potassium
- Calcium
- Iron
- Copper
- Zinc
- Vitamin A
- Thiamin
- Riboflavin
- Niacin
- Vitamin B6
- Vitamin B12
- Folic Acid
- Vitamin C
- Vitamin D
- Energy from Protein
- Energy from Carbohydrate
- Energy from Fat

3.5.1.2 Frequency Responses Scales

The majority of food items in the questionnaire were not easily quantifiable and therefore required a standard question format inquiring about usual frequency of consumption. The category scale used in the 'closed' calcium food frequency questionnaire was used for these questions.

The question was worded 'How often do you usually eat these foods?'. Each food item was listed along with the following response choices:

- daily
- 5 or 6 times a week
- 3 or 4 times a week
- once or twice a week
- monthly (once or twice a week)
- rarely or never

Food items that were easily quantified such as slices of bread were formatted as follows:

'How many slices of these breads do you usually have each day or week?'

- White bread __ slices per day or __ slices per week
- Wholemeal __ slices per day or __ slices per week

This format was used for eggs, biscuits, cups of tea and coffee and for all other drinks.

Certain food items were inquired about in relation to foods already recorded. Examples of this are the addition of sugar to breakfast cereal and addition of milk or cream to tea and coffee.

Questions were included to illicit more information about food items. For example, preparation methods of eggs, type of fat used for cooking, type of milk and whether fat is trimmed from meat.

3.5.1.3 Reference Serving Sizes

For each food item in the questionnaire, which was not presented in terms of quantifiable amounts, a 'medium serve' was stated. Subjects were asked to respond whether they consumed a small, medium or large serve of each food item in relation to the medium serve.

The medium serving sizes were derived from common standard measures of foods (Gillanders and Milligan 1992). Considerable judgement was used to estimate the medium serves.

3.5.2 Administration of the General Food Frequency Questionnaire

The General Food Frequency Questionnaire was administered as a conventional 'pen and paper' questionnaire. Instructions on how to answer were given on the first page of the questionnaire.

3.5.3 Coding and Computer Entry of the Food Frequency Questionnaires

The General Food Frequency Questionnaire was entered into a software package called 'Q Entry'. This software was written by the author specifically for entering food frequency questionnaires. 'Q Entry' checked the entered data against the coding schedule and showed any discrepancies between the entered data and what was allowed according to the coding schedule.

The data was then printed out and checked against the original questionnaires, any corrections were made to the data in 'Q Entry'.

In cases where the subject had not given a response to a question, the question was coded as missing data. Methods for handling missing responses are detailed in section 3.3.4.5

3.5.4 Analysis of the General Food Frequency Questionnaires

The General Food Frequency Questionnaires was analysed for nutrients using software written specifically for each questionnaire by the author. The software was written in THINK Pascal™ on an Apple Macintosh™ computer.

The analysis software read in the food composition data and serving sizes for each food in the questionnaire, then read each subject's data in turn and wrote the nutrient results to a file.

There was no analysis of supplements that may have been consumed by the respondents.

3.5.4.1 Food Composition Data

The food composition database used in the food frequency questionnaire analysis was 'FOODfiles', the computer version of the New Zealand Food Composition Tables (Milligan et al 1991). The New Zealand food composition database consists of approximately 1200 food items, the data for which originates from McCance and Widdowson's The Composition of Foods (1978), Australian food composition tables and, where available, New Zealand analytical data. The data for each food item contains complete information for all nutrients.

Each food item in the food frequency questionnaire was assigned food codes from the food composition database. This was either a single food code for items which had one equivalent entry in the database, or multiple food codes for items represented by several entries in the database. The latter situation occurred when different food items were included in the same question, e.g. potato crisps and corn chips, or there was food composition data for several different preparation/cooking methods for the same food item, e.g. boiled celery and raw celery. In these situations the multiple food codes were assigned a proportion and this information was used by a computer program called 'Compile_FFQFoods' written by the author in THINK Pascal™. This program used the food codes and proportions and generated, from the main food composition database, a file of food composition for the analysis software.

Examples of this process were 'potato crisps/corn chips' comprised 50% from U6 (food code for potato crisps) and 50% from U17 (corn chips. Celery comprised 50% of X38 (food code for celery stem, boiled, drained) and 50% of X39 (food code for celery stem, raw).

3.5.4.2 Serving Size Data

Two sets of serving sizes were developed for the nutrient analysis (see Appendix F). The first set used the 'medium serves' that were derived from common standard measures of food items (Gillanders and Milligan 1992). The second set of serving sizes were age and sex specific. The data was derived from two sources. The Hillary Commission Life in New Zealand Survey (Horwath et al 1991) provided a sample of 199 twenty-four hour recalls from 15 to 29 year old females. The seven day diet records from 183 female undergraduate Nutrition students were also used. This sample included those students participating in this study.

Software, developed by the author, was used to derive, by the following process, an average serving size for each food item in the food frequency questionnaire.

For each food item, an average serving size was calculated for each subject. This data was then averaged to obtain a mean serving size for the entire sample. This process minimised the effect of those subjects who consumed a food item several times within the 24 hour recall or seven day diet record period.

The overall mean serving size for each food item was calculated using weighted averages from the Hillary Commission 24hr recall sample and the undergraduate student 7 day record sample. In the cases where several food items from the samples of diets represented the food in the questionnaire a further weighting was used to incorporate the multiple food items in the overall mean serving size.

3.5.4.3 Standard Frequency Question - Analysis Procedure

The subject's response to the 'closed' frequency question was translated to a frequency per day according to the following table.

Response	frequency per day
daily	1
5 or 6 times a week	$5.5/7$
3 or 4 times a week	$3.5/7$
once or twice a week	$1.5/7$
monthly (once or twice a month)	$1.5/30$
rarely or never	0
no response	0

Responses to the 'open' question format were divided by 1, 7 or 30 for per day, week or month respectively.

The nutrient intake per day from a food item was calculated as the product of the frequency of consumption per day, the serving size for the food item and the food item's composition per 100 grams.

The nutrient intake from each food was added to produce the total nutrient intake per day.

3.5.4.4 Other Question Types - Analysis Procedure

Nine questions concerned food items consumed in association with foods for which the frequency was asked separately, e.g. type of spread on bread, sugar in tea or coffee. The nutrient intake from these food items was calculated as the product of the food item's serving size, the food item's composition per 100 grams and the frequency of consumption per day of the associated food item.

Six questions were used to illicit more specific information about the consumption of a food item such as the cooking method, e.g. whether eggs were boiled, fried or scrambled, or the actual type of a generic food item, e.g. type of breakfast cereal.

The frequency of consumption of the food item was multiplied by the serving size and composition data specific to the cooking method or type of food item.

3.5.4.5 Methods for Handling Inconsistent and Missing Responses

The subjects were available only for completion of the food frequency questionnaire. It was not possible to return to the subjects for completion of missing responses and clarification of inconsistent responses. The occurrence of missing and inconsistent responses was investigated by generating crosstab tables with StatView™ SE+Graphics statistical software (Abacus Concepts 1987a).

The missing and inconsistent responses were handled by the following methods:

1. If a frequency was reported for a food but no serving size was reported, the serving size was assumed to be 'medium'.
2. If no frequency was reported, the frequency was assumed to be 'rarely or never'.
3. If a food item is reported as being consumed but an additional question relating to that food item is not responded to, the response is assumed to be an equal mixture of the options that were available. For example, the subject reports that milk is added to tea but does not report what type of milk is used. The type of milk is assumed to be an equal proportion of all the types that were available. A subject who consumes eggs but does not report how the eggs are cooked is assumed to have eggs cooked in equal proportions by all the different methods available.
4. An addition to a food item is reported but the food item itself is not reported as being consumed. The addition is ignored as the food item is assumed to be consumed 'rarely or never'. For example, a subject may report having a teaspoon of sugar in coffee but not report any consumption of coffee.

3.6 Investigation of Design and Analysis Issues

The objective of determining the optimal design and analysis of the general food frequency questionnaire was carried out by conducting a series of analyses of the food frequency questionnaire. Each analysis 'run' involved changing one or more aspects of the analysis (Table 3.1).

Table 3.1 Analyses conducted

Run	*Serve Size*	*Small*	*Medium*	*Large*	*Adjustment Factor*
A	Common Standard Measures	1	1	1	None
B	Age-Sex Specific	1	1	1	None
C	Common Standard Measures	1/2	1	2	None
D	Common Standard Measures	2/3	1	4/3	None
E	Common Standard Measures	1	1	1	Fruit
F	Common Standard Measures	1	1	1	Vegetable
G	Common Standard Measures	1	1	1	Meat
H	Common Standard Measures	1	1	1	Fruit, Vegetable, & Meat
I	Age-Sex Specific	1	1	1	Fruit, Vegetable, & Meat
J	Age-Sex Specific	2/3	1	4/3	Fruit, Vegetable, & Meat
K	Age-Sex Specific	1	1	1	'Soft' Fruit, Vegetable & Meat

3.6.1 Serving Sizes – Common Standard Measures or Age-Sex Specific

Two sets of serving sizes were available for analysis of the questionnaires. One set of serving sizes were based on common standard measures of the food items in the questionnaire, the second set were age and sex specific serving sizes derived from 24 hour recall and 7 day diet record data. These serving size sources are described in detail in section 3.3.4.2.

The baseline analysis (Run A) used the common standard measure based serving sizes. Run B provides a direct comparison through the use of the age and sex specific serving sizes. Run C through to Run H used the common standard measures while other factors were altered in these analyses. The analysis runs from I through to K used the age and sex specific serving sizes.

3.6.2 Small, Medium & Large Serving Size Information

The serving size responses of small, medium and large were used to adjust the serving sizes used in the analysis. Analyses were run to investigate the effect of changing the relationship between a small, medium and large serving size. Comparisons were made between no adjustment, i.e. disregarding small, medium and large responses (Run A), adjusting with factors of small=$^1/_2$, medium=1, and large=2 (Run C), and adjusting with factors of small=$^2/_3$, medium=1, and large=$^4/_3$ (Run D).

3.6.3 Adjustments for Total Number of Servings

The food frequency questionnaire included three questions asking the respondent to estimate the total number of servings of fruit, vegetables and meat they consume per day or per week. These questions were used to compensate for the amount of under- or over-estimation of foods within the questionnaire.

The number of servings of each fruit, vegetable, and meat item included in the questionnaire were added to give the sum of individual servings per day of fruit, vegetables, and meat. The food items included in these calculations are listed in Appendix G.

Adjustment factors were calculated by dividing the reported total servings per day by the sum of the individual reported servings per day. For example:

$$\text{'fruit factor'} = \frac{\text{reported total servings of fruit per day}}{\Sigma\ \text{individual fruit servings per day}}$$

The adjustment factors were used to proportionally adjust the frequency of the each fruit, vegetable and meat item in the questionnaire up or down accordingly.

This technique was tested with each of fruit, vegetables, and meat items separately (Run E, F and G, respectively). The three factors were combined in Run H, I and J.

The use of this technique places importance on the three questions on total servings per day or week of the food types. The individual food item responses are assumed to be less accurate than these estimates. To attempt to redress the balance between the summary questions and the individual questions an second method of calculating the adjustment factors was used. This factor was termed the 'soft' adjustment factor as it 'softened' the adjustment to an average between the two estimates of frequency.

For example: 'soft fruit factor' =

$$\frac{(\text{reported total servings of fruit} + \Sigma\ \text{individual fruit servings})/2}{\Sigma\ \text{individual fruit servings per day}}$$

This 'soft' factor technique was used to adjust the reported consumption of fruit, vegetables and meat in Run K.

3.6.4 Combinations of Analysis Variations

The first analysis with common standard measure serving sizes (Run A) is used as a baseline against which the effect of single variations in the analysis can be compared (Run B to Run G).

To demonstrate the effect of combining these variations the following analyses were carried out:

- Run H combined all three total serving adjustment factors.
- Run I used the age and sex specific serving sizes in conjunction with the three total servings adjustment factors.
- Run K was the same as Run I but used the 'softened' total servings adjustment factors.
- Run J combined the use of age and sex specific serving sizes with the adjustment of small=$^2/_3$, medium=1, and large=$^4/_3$ and the use of all three total servings adjustment factors.

4 Results

4.1 Response Scale Format

4.1.1 Calcium Food Frequency Questionnaire Sample

Forty seven females completed the calcium food frequency questionnaire and seven day diet record. The mean age of this group was 20.3 years, with a standard deviation of 1.5 years. The subjects ranged from 18 to 25 years.

4.1.2 Ranking of Individuals

The ability of the calcium food frequency questionnaires to rank individuals according to calcium intake is presented in tables 4.1 and 4.2.

The 'Open' format questionnaire correctly classified 64% of the subjects into the same or adjacent quintiles as the seven day diet record (indicated by the shaded region on Table 4.1). The percentage of subjects classified correctly into the same or adjacent quintile due to chance alone is 52%. The 'Open' format questionnaire did not grossly misclassify any subjects into extreme opposite quintiles, e.g the lowest quintile from the food frequency questionnaire and the highest quintile on the seven day diet record. The gross misclassification into extreme quintiles by chance alone is 8%.

The 'Closed' format questionnaire correctly classified 57% of the subjects (shaded region on Table 4.2) compared to 52% by chance. Two of the forty seven subjects (4%) were grossly misclassified into extreme opposite quintiles compared to 8% by chance.

Table 4.1 Quintile classification of 'Open' Calcium Food Frequency Questionnaire and Seven Day Diet Record

Female n = 47		7 Day Diet Record Q1	Q2	Q3	Q4	Q5
'Open' CaFFQ	Q1	3	3	1	2	0
	Q2	3	1	1	2	3
	Q3	0	3	3	1	2
	Q4	3	1	3	2	1
	Q5	0	2	1	3	3
						64 %

Table 4.2 Quintile classification of 'Closed' Calcium Food Frequency Questionnaire and Seven Day Diet Record

Female n = 47		7 Day Diet Record Q1	Q2	Q3	Q4	Q5
'Closed' CaFFQ	Q1	2	2	2	2	1
	Q2	3	3	0	3	1
	Q3	2	1	3	1	2
	Q4	1	3	3	2	1
	Q5	1	1	1	2	4
						57 %

Correlation coefficients were calculated. To improve normality the natural logarithm of the data was calculated. The correlation coefficient between the seven day diet record results and the 'Open' format questionnaire results was 0.38, whereas with the 'Closed' format questionnaire results it was 0.45.

The mean seven day diet record calcium intake in each of the surrogate categories defined by the food frequency questionnaire quintiles are presented in Table 4.3. The first line in the table indicates the 'true' values for each quintile according to the seven day diet record. The 'Open' and 'Closed' format questionnaires both distinguished well between the lowest and highest groups. The mean seven day diet record calcium intake for the fourth quintile group was less than that for the third quintiles group for both questionnaire formats.

Table 4.3 Actual Values for Surrogate Categories: 'Closed' and 'Open' Calcium Food Frequency Questionnaires

	Mean 7DDR Value in each FFQ Quintile				
	Q1	Q2	Q3	Q4	Q5
7DDR	*522*	*664*	*781*	*941*	*1360*
'Open' FFQ	680	858	902	779	1044
'Closed' FFQ	754	766	871	802	1078

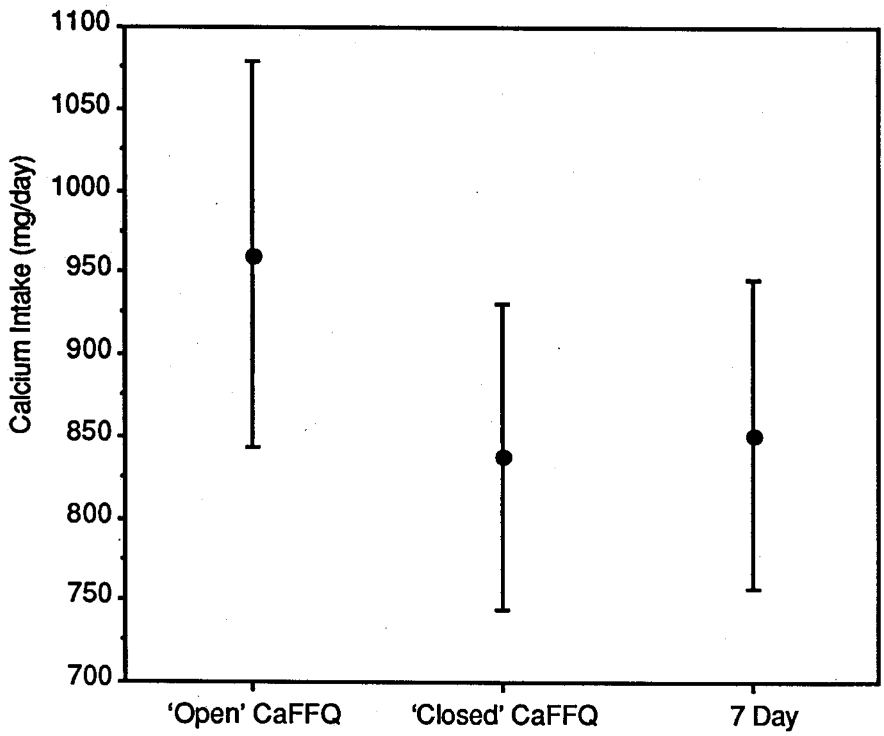
4.1.3 Estimate of Group Mean Intake

The group mean calcium intake calculated from the seven day diet records was 851 mg/day (±323 mg/day S.D.). The 'Open' format questionnaire resulted in a group mean of 960 mg/day (±401 mg/day S.D.). The 'Closed' format question resulted in a group mean intake of 838 mg/day (±317 mg/day S.D.).

The mean difference between the calcium intake as calculated from the 'Open' format questionnaire and the seven day diet record was 109 mg/day, an overestimate, whereas the 'Closed' format underestimates slightly with a mean difference of -13 mg/day. The standard deviation of the difference was greater for the 'Open' format than the 'Closed' format questionnaire.

Figure 4.1 illustrates the difference between the estimates of group mean intake with 95% confidence intervals.

Figure 4.1 Mean Calcium Intake (±95% Confidence Intervals)



4.1.4 Comparison of Responses

The subjects' responses to the 'Open' format questions were converted into the same categorical responses as the 'Closed' format questions (Table 4.4). Two categories were added for '2 or more times a day' and '3 times a month' which were not accounted for directly by the 'Closed' response scale.

Table 4.4 Response Scale Equivalents

'Open' Response			Frequency per day	'Closed' Response
9/D			9	
8/D			8	
7/D			7	
6/D			6	2 or more times a day*
5/D			5	
4/D			4	
3/D			3	
2/D			2	
	9/W		1.29	
	8/W		1.14	daily
1/D	7/W		1	
	6/W		0.86	5 or 6 times a week
	5/W		0.71	
	4/W		0.57	3 or 4 times a week
	3/W		0.43	
		9/M	0.3	
	2/W		0.29	
		8/M	0.27	
		7/M	0.23	once or twice a week
		6/M	0.20	
		5/M	0.17	
	1/W		0.14	
		4/M	0.13	
		3/M	0.10	3 times a month*
		2/M	0.07	monthly (once or twice a month)
		1/M	0.03	

* responses not included in the 'closed' response scale

The percent of responses (not including 'Rarely or Never') are presented in Table 4.5. Sixty five percent of the responses were identical between the two formats as indicated by the shaded region.

Responses below and to the left of the shaded region indicate a greater frequency of consumption reported on the 'Open' format questionnaire compared to the 'Closed' format questionnaire. This occurred for 24% of the questions. The opposite situation occurred for 11% of the questions, i.e. the reported frequency of consumption was greater for the 'Closed' format questionnaire than the 'Open' format questionnaire (the region above and to the right of the shaded region).

Table 4.5 Comparison of Responses from 'Open' and 'Closed' Calcium Food Frequency Questionnaires. (Excluding 'Rarely or Never' responses)

%	(n=680)	Recoded Responses from 'Open' Calcium FFQ						
		≥2/day	daily	5-6/week	3-4/week	1-2/week	3/month	1-2/month
Responses from 'Closed' Calcium FFQ	≥2/day							
	daily	0.9	4.6	1.2	0.4	0.1	0	0
	5-6/week	0	2.4	1.9	1.3	0.1	0	0
	3-4/week	0.1	2.0	1.6	9.0	3.1	0.1	0.1
	1-2/week	0	0.3	0.3	3.1	21.2	3.1	1.9
	3/month							
	1-2/month	0.1	0.4	0	0.7	8.2	3.5	27.9

4.1.5 Comparison of Response Times

The mean time to complete the 'Open' format questionnaire was 8.6 minutes (±1.8 minutes S.D.). The 'Closed' format questionnaire took a mean time of 7.5 minutes (±2.2 minutes S.D.) to complete. A Mann-Whitney U test showed the time to complete to be significantly different ($p<0.001$).

4.2 General Food Frequency Questionnaire Sample

One hundred and one females completed the general food frequency questionnaire and the seven day diet record. The mean age was 20.6 years, with a standard deviation of 2.9 years. The ages ranged from 18 to 42 years.

4.3 Occurrence of Inconsistent Responses

Inconsistent responses arose when a subject answered a question with a response that contradicted another questions response. There were two situations where these contradictions occurred. The first situation involved a subject reporting that a food item was consumed but not responding to a question asking further information about the food item. There were 13 occurrences of this type of inconsistency. The second type of contradiction, which occurred 23 times, involved subjects responding to questions asking additional information on a food item they reported as not consuming.

4.4 General Food Frequency Questionnaire Nutrient Results

Table 4.6 Results presented in the following tables

Mean	Mean (unadjusted for energy)
S.D.	Standard deviation (unadjusted for energy)
Min.	Minimum (unadjusted for energy)
Max.	Maximum (unadjusted for energy)
$\frac{\text{FFQ}}{\text{7DDR}}$	Ratio of food frequency questionnaire to 7-day diet record (adjusted for energy)
Mean Diff.	Mean of the difference between 7-day diet record and food frequency questionnaire (adjusted for energy)
S.D. Diff.	Standard deviation of the difference between 7-day diet record and food frequency questionnaire (adjusted for energy)
Corr. Coeff.	Pearson correlation coefficients (adjusted for energy, natural logarithm)
Within 1 Quin.	Percentage of subjects classified by the food frequency questionnaire into the same or within one quintile of the 7-day diet record classification into quintiles (adjusted for energy). By chance alone, 52% of subjects will be classified into the same or within one quintile.
Gross Miscl.	Gross Misclassification: Percentage of subjects classified by the food frequency questionnaire into extremely opposite quintiles as the classification by the 7-day diet record (adjusted for energy). By chance alone, 8% of subjects will classified into extremely opposite quintiles.

The mean difference column also contains an indication of whether the value is significantly different from zero (t-test). The symbol † is used to indicate a positive result, i.e. those analyses labelled with a † produced an estimate of group mean statistically similar to the group mean of the 7-day diet record.

Table 4.7 Energy (MJ)

	Mean	S.D.	Min.	Max.	FFQ/7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*7.53*	*1.89*	*3.35*	*12.72*						
A	9.47	2.36	5.08	15.35	1.26	1.94	2.37	0.43	68	2
B	8.99	2.34	4.67	14.83	1.19	1.46	2.38	0.38	69	2
C	9.56	2.69	3.32	17.25	1.27	2.03	2.56	0.46	67	3
D	9.29	2.44	4.06	15.29	1.23	1.76	2.40	0.45	69	3
E	9.26	2.31	4.79	15.23	1.23	1.72	2.30	0.46	68	2
F	8.65	2.17	4.48	14.42	1.15	1.12	2.20	0.46	70	2
G	8.95	2.18	4.62	14.95	1.19	1.42	2.22	0.44	67	3
H	7.92	1.96	3.98	13.84	1.05	0.38 †	2.00	0.51	67	1
I	7.52	1.90	3.81	12.84	1.00	-0.03 †	1.98	0.49	67	2
J	7.43	1.94	2.88	12.71	0.98	-0.12 †	1.97	0.50	71	3
K	8.26	2.09	4.39	13.64	1.10	0.72	2.15	0.45	71	2

Table 4.8 Carbohydrate (g)

	Mean	S.D.	Min.	Max.	FFQ/7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*236*	*65*	*120*	*433*						
A	293	72	155	498	1.24	59	29	0.52	77	2
B	273	67	144	457	1.16	39	28	0.54	78	3
C	303	86	95	583	1.29	66	31	0.53	78	4
D	290	76	115	495	1.23	54	29	0.53	79	4
E	282	69	142	478	1.19	45	29	0.53	82	3
F	260	64	141	440	1.11	31	28	0.55	79	2
G	290	72	150	494	1.23	62	30	0.43	78	4
H	246	62	123	416	1.04	9	29	0.47	81	2
I	231	57	119	384	0.98	-5 †	28	0.48	76	3
J	230	59	91	382	0.98	0 †	28	0.50	77	1
K	253	61	133	420	1.07	22	27	0.54	78	3

Key	*Serve Size*	*Small*	*Medium*	*Large*	*Adjustment Factor*
A	Common Standard Measures	1	1	1	None
B	Age-Sex Specific	1	1	1	None
C	Common Standard Measures	1/2	1	2	None
D	Common Standard Measures	2/3	1	4/3	None
E	Common Standard Measures	1	1	1	Fruit
F	Common Standard Measures	1	1	1	Vegetable
G	Common Standard Measures	1	1	1	Meat
H	Common Standard Measures	1	1	1	Fruit, Vegetable, & Meat
I	Age-Sex Specific	1	1	1	Fruit, Vegetable, & Meat
J	Age-Sex Specific	2/3	1	4/3	Fruit, Vegetable, & Meat
K	Age-Sex Specific	1	1	1	'Soft' Fruit, Vegetable & Meat

Table 4.9 Starch (g)

	Mean	S.D.	Min.	Max.	FFQ 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*139*	*38*	*56*	*241*						
A	160	39	69	284	1.16	20	22	0.43	80	2
B	152	38	65	269	1.10	14	21	0.46	79	1
C	168	48	37	286	1.21	34	23	0.50	79	4
D	160	41	47	283	1.15	24	21	0.49	84	2
E	160	39	68	283	1.15	18	22	0.45	81	2
F	136	34	60	236	0.98	-7	22	0.44	81	1
G	158	38	66	281	1.14	18	22	0.40	77	1
H	133	33	56	232	0.96	-4 †	22	0.45	80	1
I	128	32	55	225	0.92	-10	21	0.47	77	1
J	128	33	38	224	0.92	-13	20	0.52	79	1
K	140	34	60	247	1.01	2 †	21	0.48	76	1

Table 4.10 Total Sugars (g)

	Mean	S.D.	Min.	Max.	FFQ 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*97*	*41*	*36*	*318*						
A	132	42	54	249	1.37	39	31	0.46	75	3
B	121	38	53	219	1.25	26	30	0.49	79	3
C	135	49	53	336	1.40	42	34	0.45	77	3
D	130	43	53	260	1.35	40	32	0.46	77	3
E	122	40	46	229	1.26	28	31	0.49	75	3
F	124	41	50	235	1.29	29	32	0.44	75	4
G	132	42	54	249	1.37	36	32	0.43	79	5
H	113	39	40	209	1.17	22	31	0.46	79	5
I	103	36	37	182	1.06	6	29	0.52	82	5
J	102	36	35	188	1.05	7	29	0.52	78	4
K	112	36	49	201	1.16	21	29	0.52	80	3

Key	*Serve Size*	*Small*	*Medium*	*Large*	*Adjustment Factor*
A	Common Standard Measures	1	1	1	None
B	Age-Sex Specific	1	1	1	None
C	Common Standard Measures	1/2	1	2	None
D	Common Standard Measures	2/3	1	4/3	None
E	Common Standard Measures	1	1	1	Fruit
F	Common Standard Measures	1	1	1	Vegetable
G	Common Standard Measures	1	1	1	Meat
H	Common Standard Measures	1	1	1	Fruit, Vegetable, & Meat
I	Age-Sex Specific	1	1	1	Fruit, Vegetable, & Meat
J	Age-Sex Specific	2/3	1	4/3	Fruit, Vegetable, & Meat
K	Age-Sex Specific	1	1	1	'Soft' Fruit, Vegetable & Meat

Table 4.11 Total Fat (g)

	Mean	S.D.	Min.	Max.	FFQ 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*67*	*23*	*17*	*124*						
A	86	29	27	166	1.27	12	13	0.34	73	1
B	83	30	25	162	1.23	14	12	0.34	69	1
C	84	32	25	174	1.25	17	13	0.45	73	3
D	83	30	25	166	1.23	11	13	0.40	73	3
E	85	29	26	166	1.27	18	12	0.36	70	2
F	81	28	24	161	1.20	11	12	0.36	72	1
G	78	26	26	161	1.16	8	13	0.33	74	2
H	73	26	23	155	1.08	4	12	0.37	74	2
I	70	25	21	141	1.04	-1 †	12	0.36	68	2
J	69	26	19	142	1.02	-2 †	11	0.42	69	2
K	77	27	23	147	1.14	6	12	0.35	71	1

Table 4.12 Saturated Fat (g)

	Mean	S.D.	Min.	Max.	FFQ 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*28*	*11*	*6*	*59*						
A	34	12	11	70	1.21	1.3	5.8	0.44	70	0
B	32	12	10	71	1.14	-1.8	5.5	0.45	68	1
C	33	13	9	71	1.17	2.5	5.9	0.52	67	0
D	33	12	10	69	1.16	0.5 †	5.7	0.47	71	0
E	34	12	11	70	1.21	0.3 †	5.7	0.45	69	0
F	33	11	9	69	1.15	-1.9	5.7	0.45	73	0
G	31	11	11	68	1.10	0.0 †	5.8	0.43	71	0
H	30	10	9	66	1.04	-3.7	5.6	0.46	72	0
I	27	10	9	59	0.96	-5.6	5.4	0.47	69	1
J	27	10	8	58	0.94	-5.8	5.2	0.51	70	1
K	30	11	10	61	1.05	-4.0	5.0	0.47	68	1

Key	*Serve Size*	*Small*	*Medium*	*Large*	*Adjustment Factor*
A	Common Standard Measures	1	1	1	None
B	Age-Sex Specific	1	1	1	None
C	Common Standard Measures	1/2	1	2	None
D	Common Standard Measures	2/3	1	4/3	None
E	Common Standard Measures	1	1	1	Fruit
F	Common Standard Measures	1	1	1	Vegetable
G	Common Standard Measures	1	1	1	Meat
H	Common Standard Measures	1	1	1	Fruit, Vegetable, & Meat
I	Age-Sex Specific	1	1	1	Fruit, Vegetable, & Meat
J	Age-Sex Specific	2/3	1	4/3	Fruit, Vegetable, & Meat
K	Age-Sex Specific	1	1	1	'Soft' Fruit, Vegetable & Meat

Table 4.13 Polyunsaturated Fat (g)

	Mean	S.D.	Min.	Max.	FFQ 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*9.7*	*3.9*	*1.6*	*19.8*						
A	14.2	6.7	3.5	33.0	1.46	5.6	4.4	0.33	66	1
B	13.9	6.7	3.4	33.0	1.44	5.5	4.4	0.35	68	1
C	13.9	6.7	3.4	33.0	1.47	7.5	4.5	0.37	69	2
D	14.3	7.0	2.6	34.2	1.44	5.8	4.4	0.35	68	1
E	14.0	6.7	3.3	32.9	1.45	5.0	4.4	0.33	67	1
F	13.1	6.6	2.9	31.4	1.35	3.4	4.4	0.32	66	1
G	13.3	6.5	3.4	32.0	1.37	4.0	4.4	0.32	68	0
H	12.1	6.4	2.7	30.2	1.25	1.3	4.4	0.29	66	1
I	12.1	6.4	2.7	30.4	1.25	8.2	4.4	0.31	67	1
J	12.0	6.4	1.8	30.6	1.24	8.4	4.3	0.33	68	1
K	13.0	6.5	3.0	31.7	1.34	3.0	4.0	0.34	66	1

Table 4.14 Protein (g)

	Mean	S.D.	Min.	Max.	FFQ 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*66*	*17*	*20*	*128*						
A	89	22	39	151	1.36	24	13	0.46	72	4
B	85	24	41	172	1.29	22	13	0.45	69	2
C	89	25	39	151	1.35	23	12	0.52	71	3
D	87	22	39	149	1.32	22	12	0.50	71	3
E	88	22	37	150	1.34	23	13	0.46	71	4
F	82	21	35	142	1.25	16	12	0.47	72	4
G	78	17	36	121	1.19	8	13	0.37	68	2
H	70	16	30	108	1.06	1†	13	0.40	70	2
I	66	16	31	103	1.00	2†	12	0.40	69	2
J	65	16	31	104	0.98	1†	12	0.43	66	2
K	75	19	36	123	1.14	13	12	0.47	69	4

Key	*Serve Size*	*Small*	*Medium*	*Large*	*Adjustment Factor*
A	Common Standard Measures	1	1	1	None
B	Age-Sex Specific	1	1	1	None
C	Common Standard Measures	1/2	1	2	None
D	Common Standard Measures	2/3	1	4/3	None
E	Common Standard Measures	1	1	1	Fruit
F	Common Standard Measures	1	1	1	Vegetable
G	Common Standard Measures	1	1	1	Meat
H	Common Standard Measures	1	1	1	Fruit, Vegetable, & Meat
I	Age-Sex Specific	1	1	1	Fruit, Vegetable, & Meat
J	Age-Sex Specific	2/3	1	4/3	Fruit, Vegetable, & Meat
K	Age-Sex Specific	1	1	1	'Soft' Fruit, Vegetable & Meat

Table 4.15 Dietary Fibre (g)

	Mean	S.D.	Min.	Max.	FFQ / 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*23*	*7*	*9*	*49*						
A	38	9	19	67	1.61	17	7	0.47	72	3
B	33	8	17	56	1.39	7	6	0.50	74	3
C	39	12	12	71	1.68	14	8	0.47	75	6
D	38	10	16	66	1.60	16	7	0.49	75	3
E	35	9	16	61	1.49	8	7	0.44	69	3
F	28	8	10	50	1.18	4	6	0.48	71	2
G	38	9	19	66	1.60	15	7	0.45	72	3
H	24	8	8	53	1.04	1 †	7	0.40	74	4
I	22	7	9	47	0.93	0 †	6	0.42	69	4
J	22	7	8	48	0.94	-1 †	6	0.44	71	7
K	27	7	14	47	1.16	5	6	0.50	72	3

Table 4.16 Calcium (mg)

	Mean	S.D.	Min.	Max.	FFQ / 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*755*	*253*	*285*	*1761*						
A	1175	346	482	2081	1.56	425	276	0.46	75	4
B	1055	327	366	1892	1.40	306	268	0.43	73	4
C	1146	353	412	2087	1.52	396	248	0.56	81	3
D	1133	337	445	2075	1.50	379	255	0.51	78	3
E	1156	342	482	2081	1.53	398	276	0.47	75	4
F	1080	337	436	2007	1.43	327	270	0.47	76	4
G	1151	339	486	1995	1.53	396	269	0.48	76	3
H	1038	326	429	1965	1.37	280	263	0.49	75	3
I	935	307	342	1767	1.23	180	255	0.47	77	4
J	914	303	331	1809	1.21	157	242	0.50	78	4
K	994	316	354	1790	1.31	241	260	0.45	75	4

Key	*Serve Size*	*Small*	*Medium*	*Large*	*Adjustment Factor*
A	Common Standard Measures	1	1	1	None
B	Age-Sex Specific	1	1	1	None
C	Common Standard Measures	1/2	1	2	None
D	Common Standard Measures	2/3	1	4/3	None
E	Common Standard Measures	1	1	1	Fruit
F	Common Standard Measures	1	1	1	Vegetable
G	Common Standard Measures	1	1	1	Meat
H	Common Standard Measures	1	1	1	Fruit, Vegetable, & Meat
I	Age-Sex Specific	1	1	1	Fruit, Vegetable, & Meat
J	Age-Sex Specific	2/3	1	4/3	Fruit, Vegetable, & Meat
K	Age-Sex Specific	1	1	1	'Soft' Fruit, Vegetable & Meat

Table 4.17 Iron (mg)

	Mean	S.D.	Min.	Max.	FFQ/7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*11.0*	*2.9*	*4.0*	*20.8*						
A	14.1	3.6	7.6	24.8	1.28	1.1	2.1	0.39	71	1
B	13.2	3.5	7.1	23.0	1.20	0.6	2.0	0.39	72	2
C	14.5	4.3	4.8	25.9	1.31	0.8	2.2	0.42	71	0
D	13.9	3.8	6.1	24.5	1.26	0.8	2.1	0.41	72	1
E	13.8	3.6	6.9	24.8	1.25	0.8	2.2	0.38	69	1
F	11.9	3.2	6.3	22.5	1.08	-0.2 †	2.0	0.42	74	3
G	13.0	3.2	6.7	22.7	1.18	1.1	2.1	0.38	70	1
H	10.4	2.8	4.9	19.2	0.94	-0.7	2.0	0.40	69	2
I	9.9	2.5	4.9	18.1	0.89	-0.7	1.9	0.40	66	2
J	9.8	2.6	3.4	18.1	0.89	-1.0	1.9	0.42	71	3
K	11.5	2.9	6.2	20.5	1.04	0.2 †	1.9	0.41	67	2

Table 4.18 Zinc (mg)

	Mean	S.D.	Min.	Max.	FFQ/7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*9.1*	*2.6*	*3.0*	*19.2*						
A	12.2	3.0	5.2	20.4	1.34	1.8	1.9	0.42	69	1
B	11.5	3.2	5.3	23.0	1.26	0.4	1.9	0.41	70	3
C	12.3	3.5	5.1	20.9	1.35	1.4	2.0	0.42	65	0
D	12.0	3.1	5.1	20.1	1.31	1.4	1.9	0.42	67	0
E	12.1	3.0	4.9	20.4	1.33	1.6	1.9	0.42	67	2
F	11.1	2.8	4.5	19.4	1.21	0.7	1.9	0.43	68	1
G	10.9	2.3	5.0	16.7	1.19	2.1	1.9	0.35	67	1
H	9.6	2.2	4.0	15.3	1.05	0.8	1.9	0.38	66	1
I	9.0	2.1	4.2	14.2	0.99	0.1 †	1.8	0.39	66	1
J	8.9	2.2	4.2	14.4	0.97	-0.3 †	1.8	0.40	63	0
K	10.3	2.6	4.8	17.2	1.12	0.4	1.8	0.42	68	1

Key	*Serve Size*	*Small*	*Medium*	*Large*	*Adjustment Factor*
A	Common Standard Measures	1	1	1	None
B	Age-Sex Specific	1	1	1	None
C	Common Standard Measures	1/2	1	2	None
D	Common Standard Measures	2/3	1	4/3	None
E	Common Standard Measures	1	1	1	Fruit
F	Common Standard Measures	1	1	1	Vegetable
G	Common Standard Measures	1	1	1	Meat
H	Common Standard Measures	1	1	1	Fruit, Vegetable, & Meat
I	Age-Sex Specific	1	1	1	Fruit, Vegetable, & Meat
J	Age-Sex Specific	2/3	1	4/3	Fruit, Vegetable, & Meat
K	Age-Sex Specific	1	1	1	'Soft' Fruit, Vegetable & Meat

Table 4.19 Thiamin (mg)

	Mean	S.D.	Min.	Max.	FFQ 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*1.18*	*0.45*	*0.51*	*3.41*						
A	1.51	0.37	0.75	2.50	1.28	0.33	0.36	0.40	70	2
B	1.39	0.34	0.66	2.53	1.18	0.22	0.37	0.34	66	4
C	1.55	0.45	0.61	2.60	1.31	0.37	0.38	0.37	68	3
D	1.49	0.39	0.66	2.47	1.26	0.31	0.36	0.39	68	3
E	1.46	0.36	0.70	2.39	1.24	0.28	0.36	0.41	71	2
F	1.25	0.33	0.58	2.31	1.06	0.07 †	0.36	0.42	70	2
G	1.45	0.35	0.74	2.42	1.23	0.27	0.36	0.39	66	2
H	1.15	0.32	0.52	2.14	0.97	-0.03 †	0.36	0.42	66	2
I	1.10	0.29	0.49	2.24	0.93	-0.08	0.37	0.35	68	3
J	1.09	0.30	0.45	2.22	0.92	-0.09	0.37	0.36	67	2
K	1.25	0.31	0.57	2.38	1.05	0.07 †	0.37	0.35	68	3

Table 4.20 Ascorbic Acid (mg)

	Mean	S.D.	Min.	Max.	FFQ 7DDR	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.
7DDR	*95*	*53*	*24*	*257*						
A	182	75	65	416	1.92	81	71	0.34	75	5
B	164	69	60	392	1.73	68	68	0.28	72	5
C	202	93	56	481	2.13	108	83	0.30	73	5
D	186	80	68	426	1.96	90	74	0.33	75	6
E	153	70	60	408	1.61	54	70	0.32	63	3
F	134	64	45	367	1.41	40	65	0.35	74	4
G	182	75	65	415	1.92	84	72	0.34	70	5
H	105	63	31	368	1.10	9 †	67	0.30	63	5
I	98	61	30	356	1.03	-1 †	66	0.29	63	4
J	101	65	31	357	1.06	1 †	69	0.28	63	5
K	131	62	53	367	1.38	30	64	0.35	72	4

Key	*Serve Size*	*Small*	*Medium*	*Large*	*Adjustment Factor*
A	Common Standard Measures	1	1	1	None
B	Age-Sex Specific	1	1	1	None
C	Common Standard Measures	1/2	1	2	None
D	Common Standard Measures	2/3	1	4/3	None
E	Common Standard Measures	1	1	1	Fruit
F	Common Standard Measures	1	1	1	Vegetable
G	Common Standard Measures	1	1	1	Meat
H	Common Standard Measures	1	1	1	Fruit, Vegetable, & Meat
I	Age-Sex Specific	1	1	1	Fruit, Vegetable, & Meat
J	Age-Sex Specific	2/3	1	4/3	Fruit, Vegetable, & Meat
K	Age-Sex Specific	1	1	1	'Soft' Fruit, Vegetable & Meat

4.5 Actual Values for Surrogate Categories

Figures 4.2 to 4.15 illustrate the actual values for surrogate categories. The categories are determined by the division of subjects into quintiles according to the food frequency questionnaire. The columns represent the actual values, i.e. the mean of the seven-day diet records for each quintile group.

The first set of columns represents the ideal situation, i.e. the mean of the seven-day diet records for each quintile as determined by the seven-day diet record. The subsequent columns represent each analysis of the food frequency questionnaire from A through to K.

Figure 4.2 Energy: Actual Values for Surrogate Categories

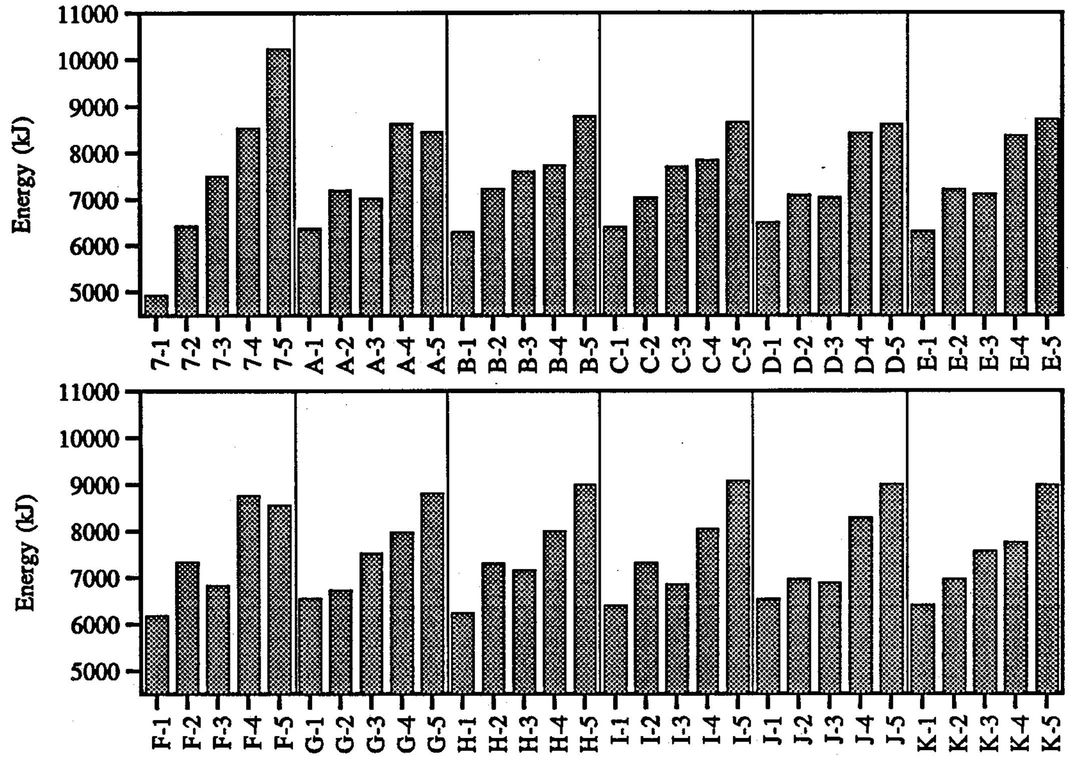


Figure 4.3 Carbohydrate: Actual Values for Surrogate Categories

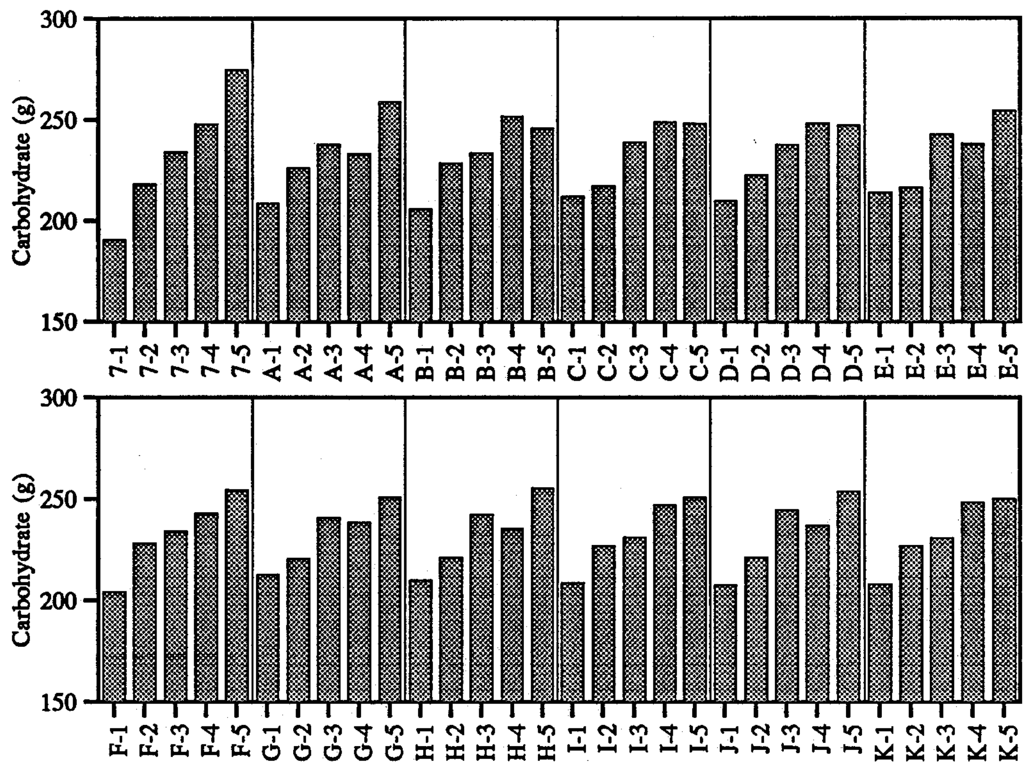


Figure 4.4 Starch: Actual Values for Surrogate Categories

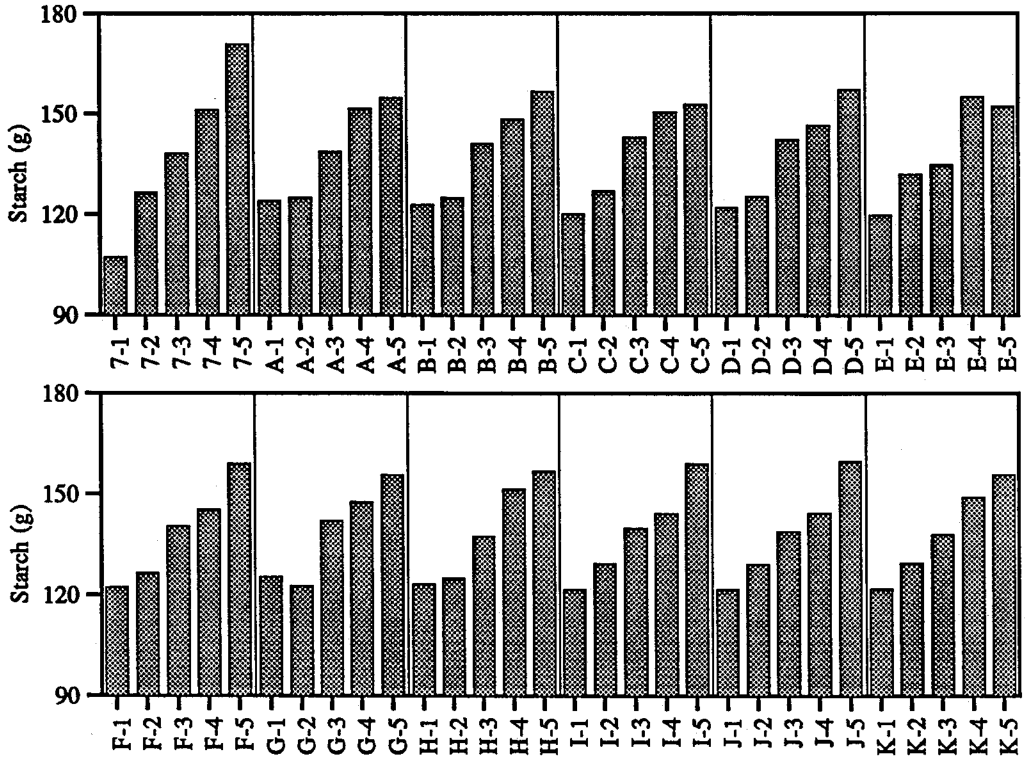


Figure 4.5 Total Sugars: Actual Values for Surrogate Categories

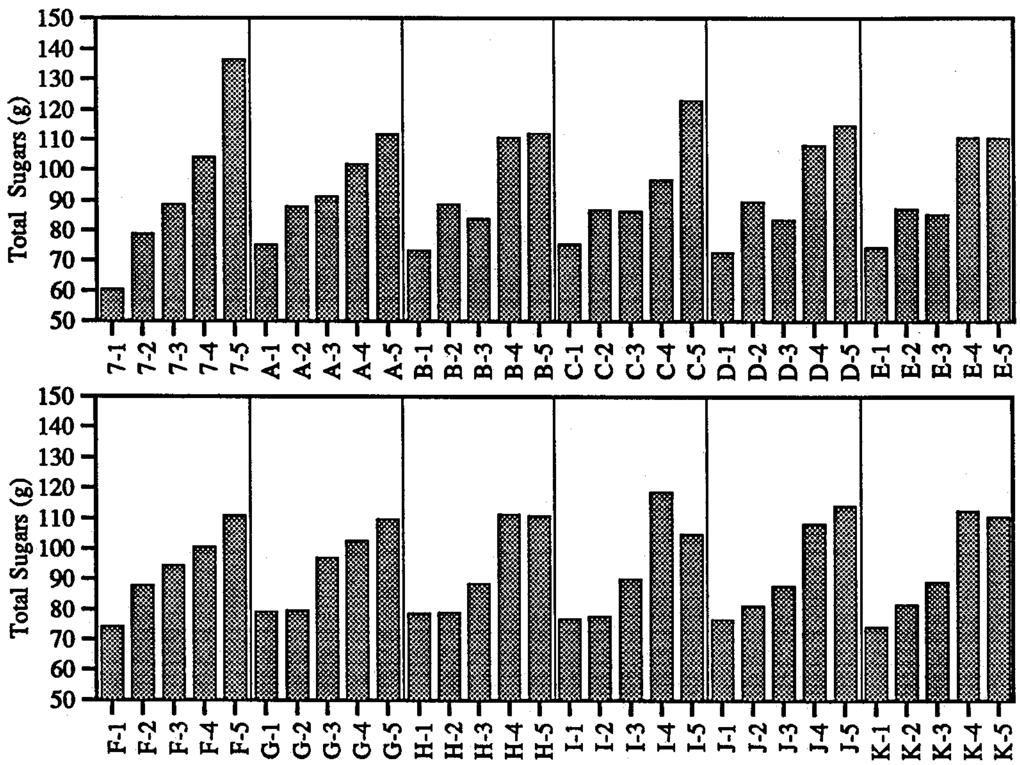


Figure 4.6 Total Fat: Actual Values for Surrogate Categories

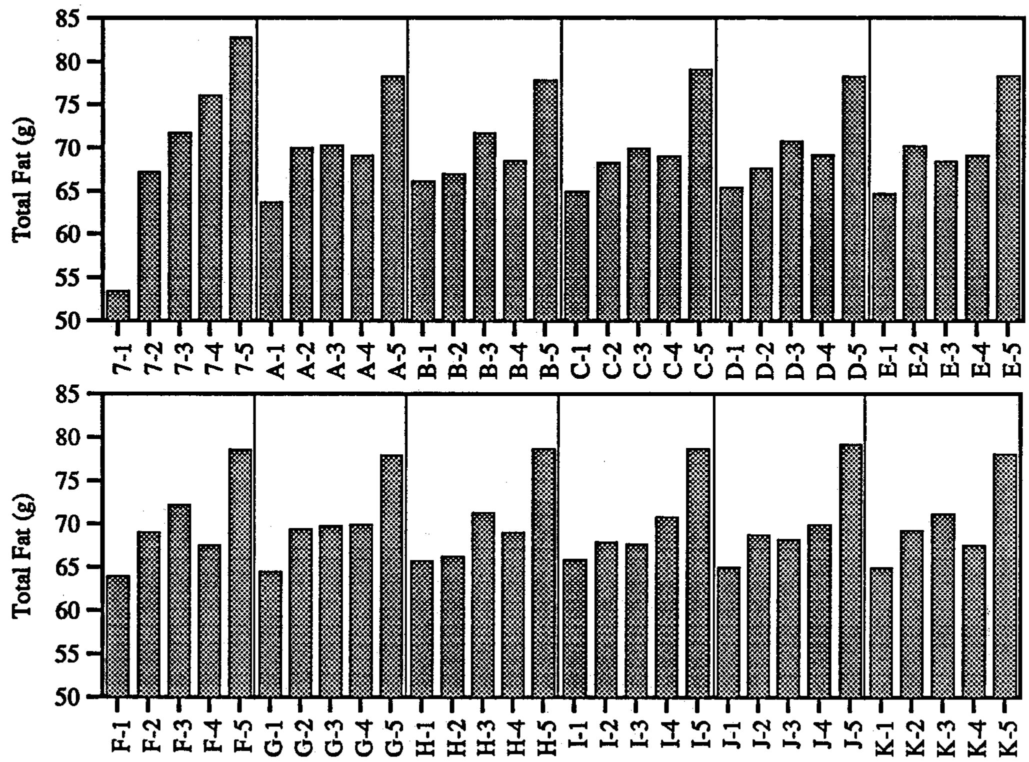


Figure 4.7 Saturated Fat: Actual Values for Surrogate Categories

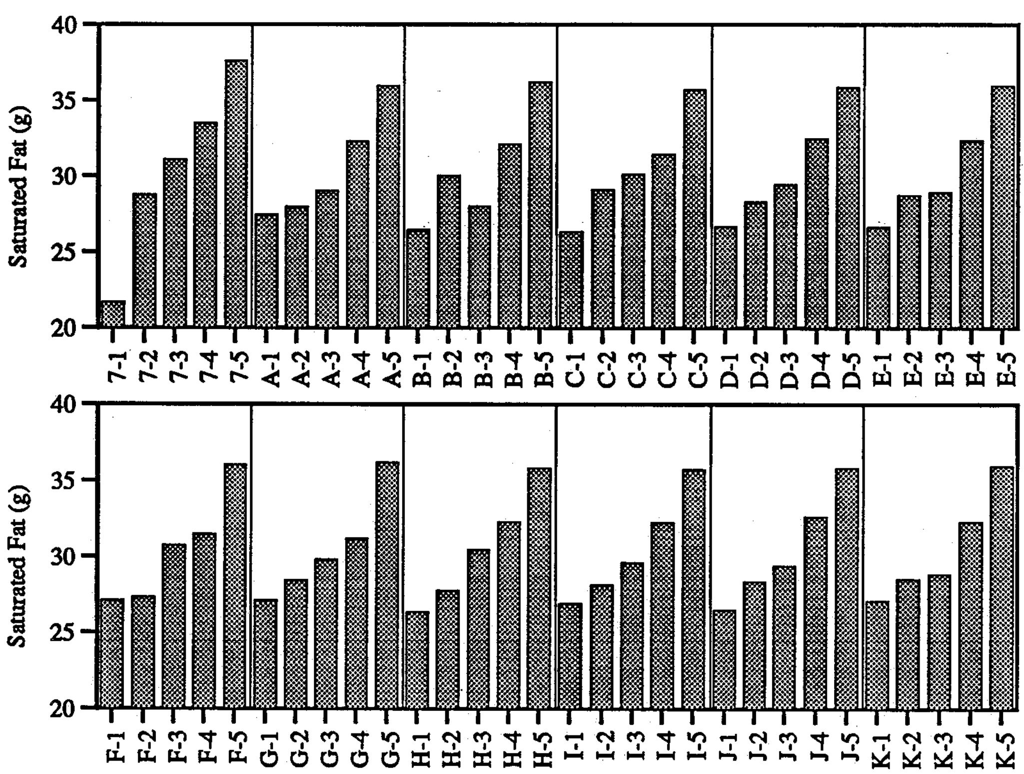


Figure 4.8 Polyunsaturated Fat: Actual Values for Surrogate Categories

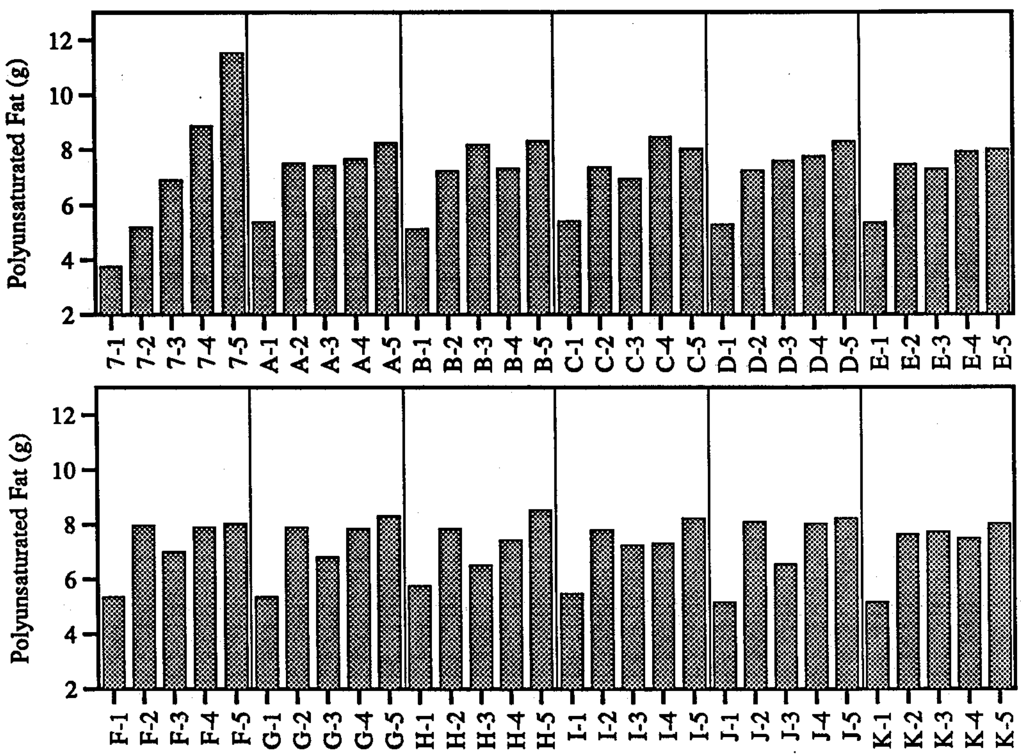


Figure 4.9 Protein: Actual Values for Surrogate Categories

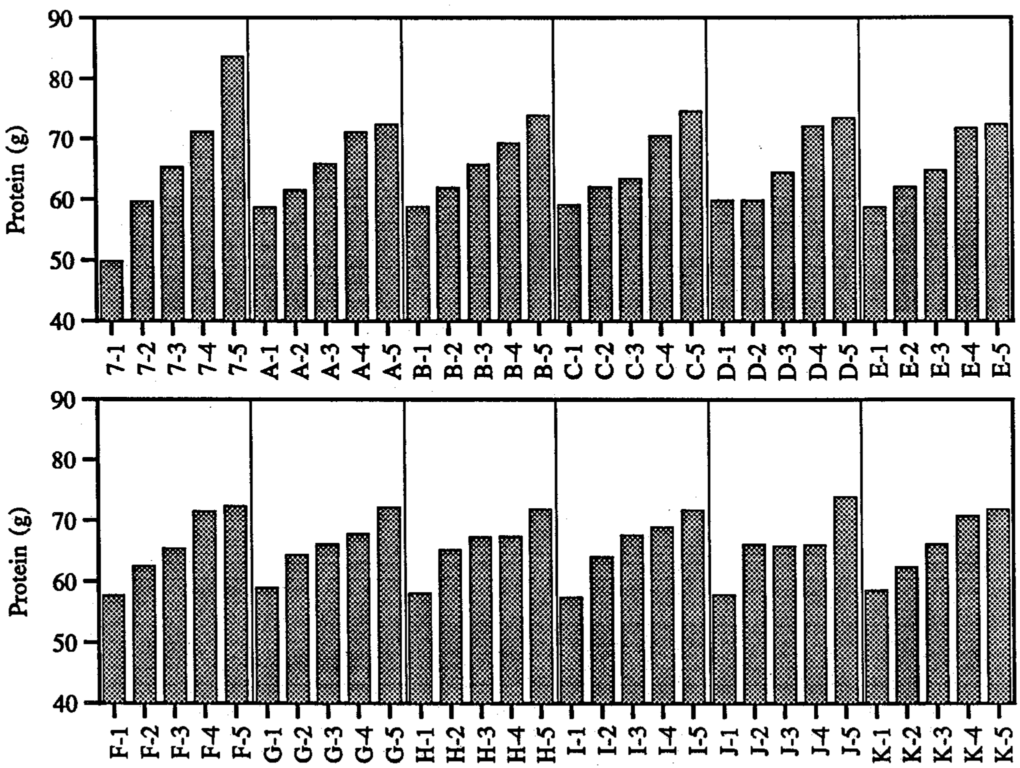


Figure 4.10 Dietary Fibre: Actual Values for Surrogate Categories

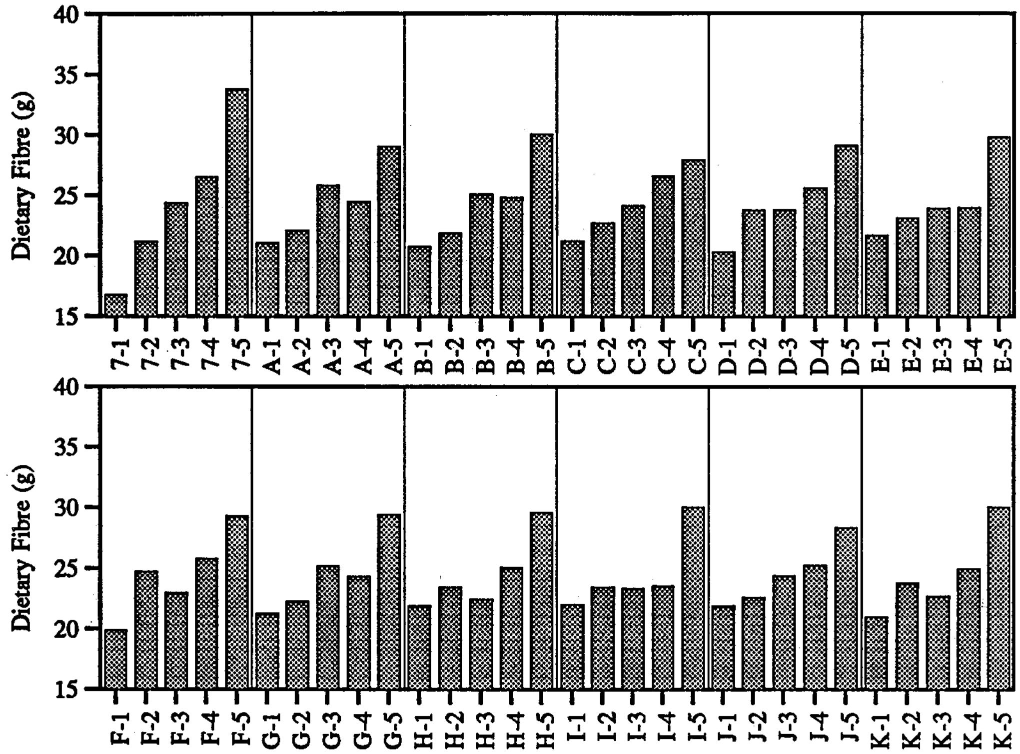


Figure 4.11 Calcium: Actual Values for Surrogate Categories

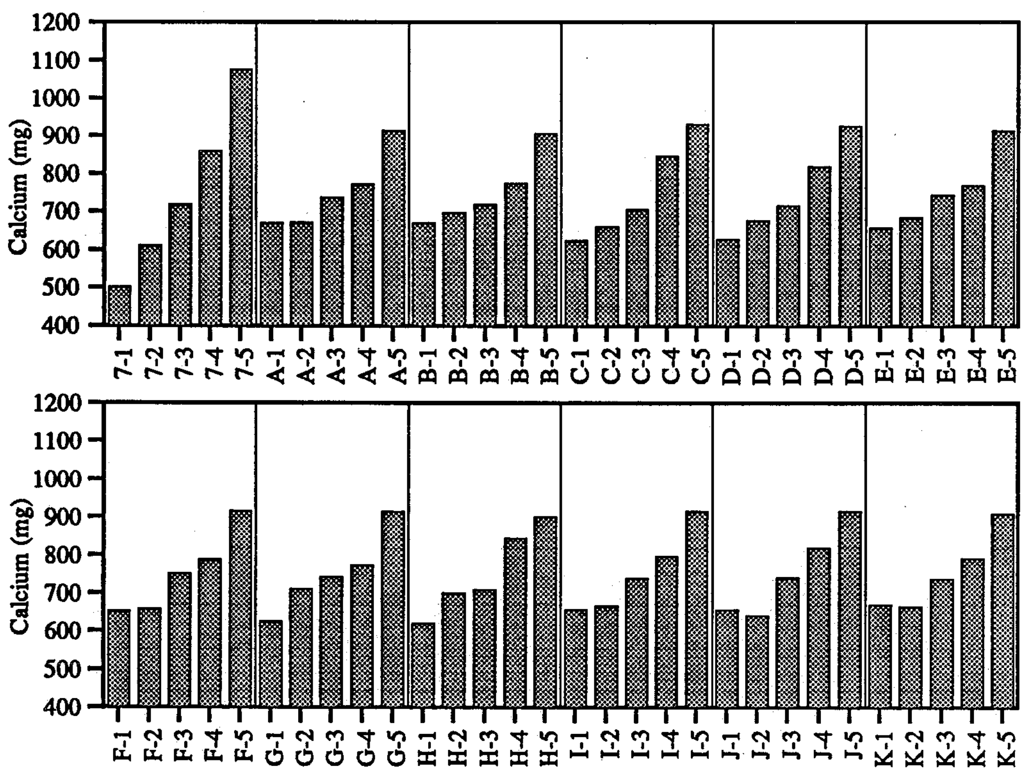


Figure 4.12 Iron: Actual Values for Surrogate Categories

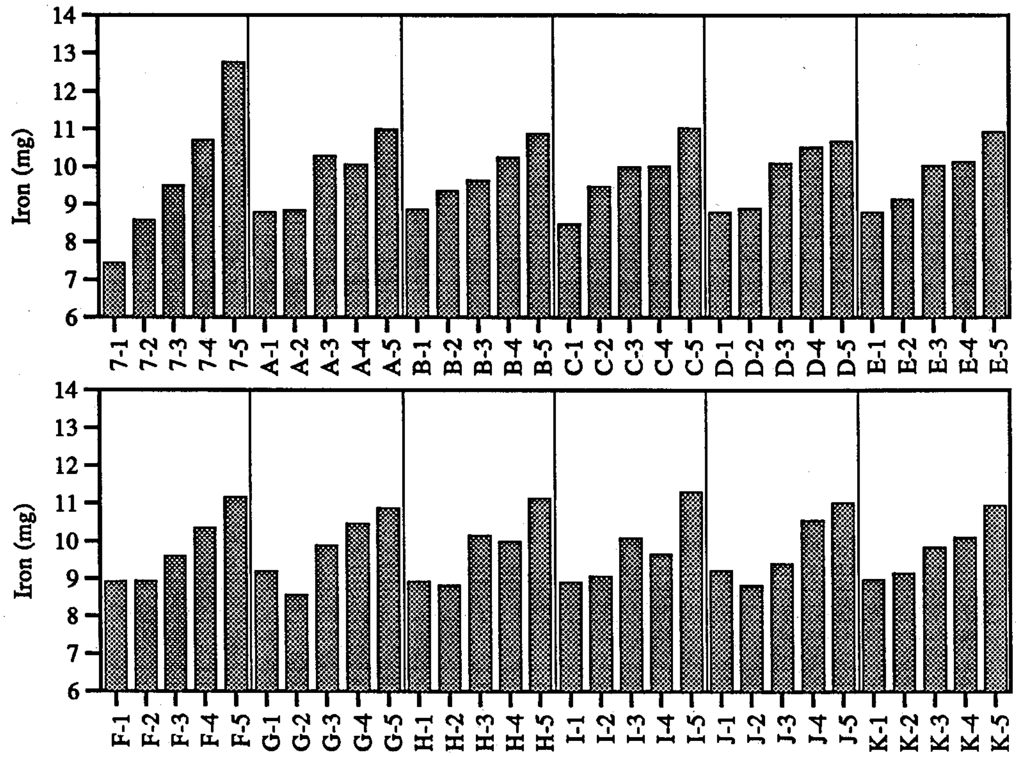


Figure 4.13 Zinc: Actual Values for Surrogate Categories

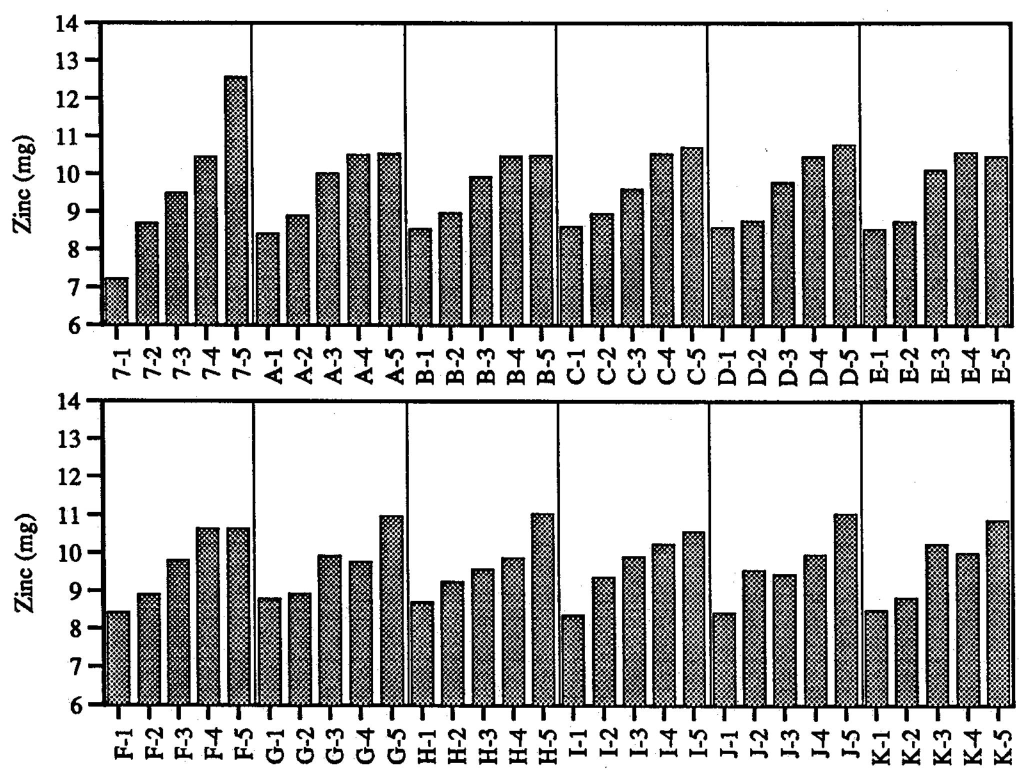


Figure 4.14 Thiamin: Actual Values for Surrogate Categories

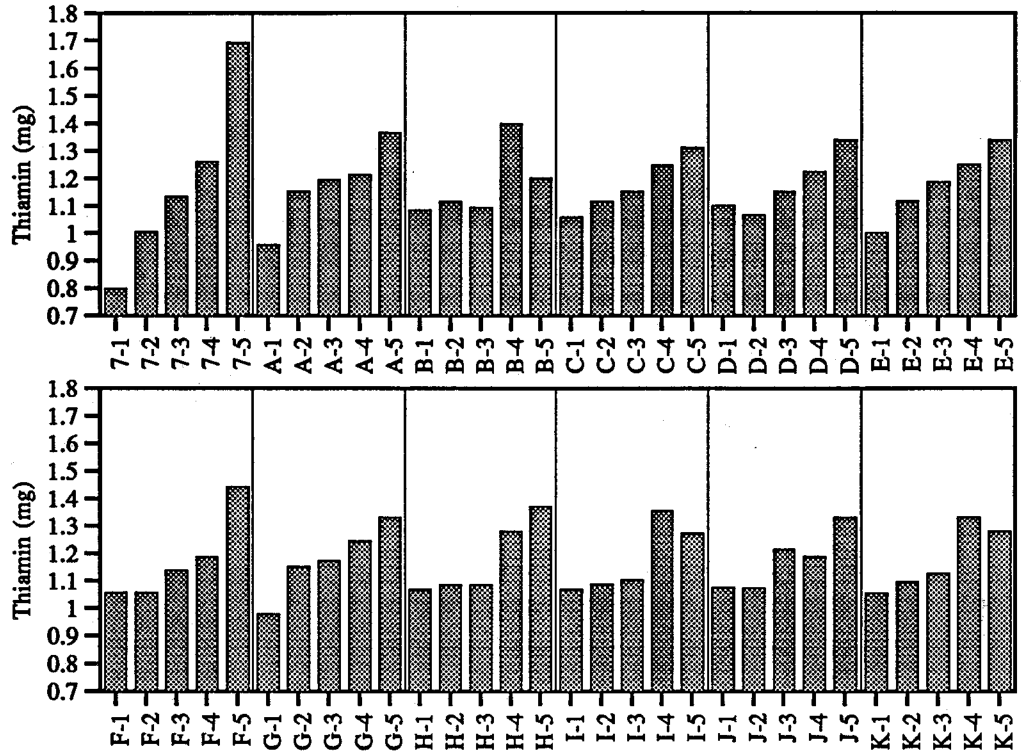
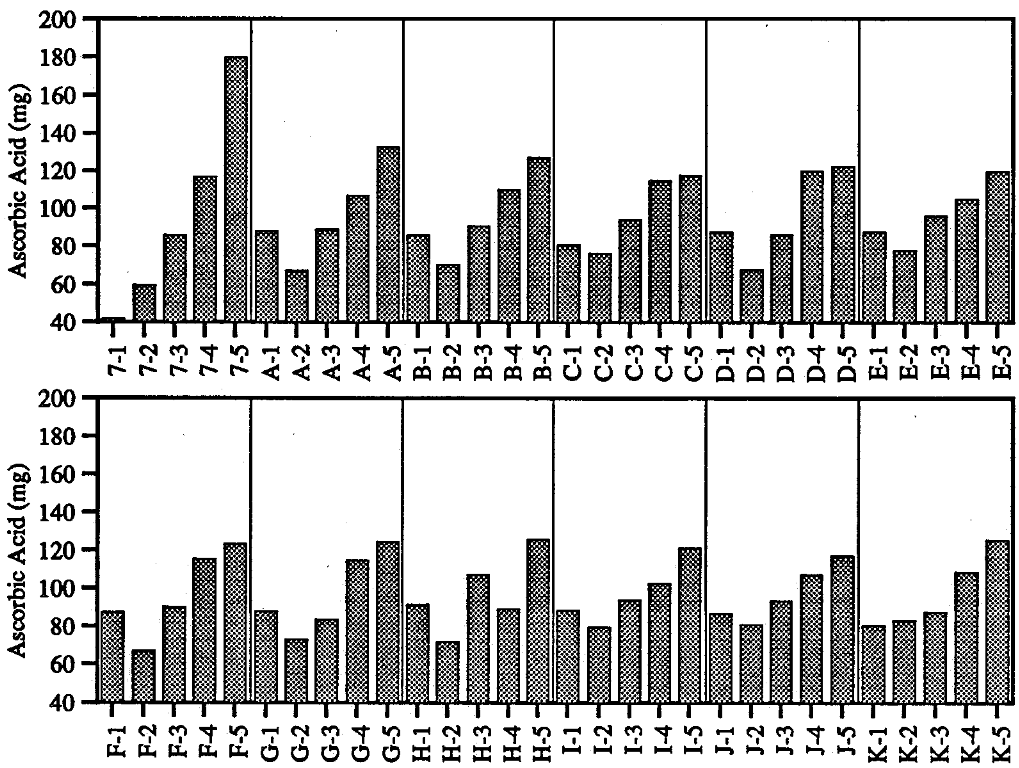


Figure 4.15 Ascorbic Acid: Actual Values for Surrogate Categories



Presentation of Result Summaries

The following tables summarise the effect of changing one aspect of the design or analysis of the food frequency questionnaire. A positive effect is recorded as a '+', a negative effect as a '-' and no effect is indicated with a 'o'. It should be noted that a *decrease* in the mean difference, standard deviation of the difference and gross misclassification are recorded as positive effects. An *increase* in the correlation coefficient and within 1 quintile classification are recorded as positive effects. A positive effect on the actual values for surrogate categories was based on the change in the graphs. This was judged according to the slope of the graph, the separation of adjacent columns and comparison with the desired graph (that of the seven day record categories).

4.6 Serving Sizes: Common Standard Measures or Age-Sex Specific

Table 4.21 Effect on Performance Indicators: Use of Age-Sex Specific Serving Sizes (Run B) compared to use of Common Standard Measure Serving Sizes (Run A)

Run A -> Run B	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	+	–	–	+	o	+
Carbohydrate	+	+	+	+	–	–
Starch	+	+	+	–	+	o
Total Sugars	+	+	+	+	o	–
Total Fat	–	+	o	–	o	o
Saturated Fat	–	+	+	–	–	–
Polyunsaturated Fat	+	o	+	+	o	–
Protein	+	o	–	–	+	+
Dietary Fibre	+	+	+	+	o	+
Calcium	+	+	–	–	o	+
Iron	+	+	o	+	–	+
Zinc	+	o	–	+	–	o
Thiamin	+	–	–	–	–	–
Ascorbic Acid	+	+	–	–	o	o
Summary	+10	+7	0	0	–3	0

4.7 Small, Medium & Large Serving Size Information

Table 4.22 Use of Small, Medium and Large Serving Size Information

n=9595	Daily	5-6/Week	3-4/Week	1-2/Week	Monthly	Rarely or Never
Small	15%	12%	17%	22%	24%	0%
Medium	56%	72%	69%	68%	66%	0%
Large	29%	16%	15%	10%	10%	0%

The responses at the more frequent end of the response scale were accompanied by a higher percentage of 'Large' serving size responses. The responses at the less frequent end of the response scale were accompanied by a higher percentage of 'Small' serving size responses. For example, 29% of the 'Daily' responses were reported with 'Large' serving sizes and 15% with 'Small', whereas, only 10% of the 'Monthly' responses were reported with 'Large' and 24% reported with 'Small' serving sizes.

Table 4.23 Effect on Performance Indicators: Adjusting Serving Size with Small = $^1/_2$, Medium = 1, Large = 2 (Run C) compared with No Serving Size Adjustment (Run A)

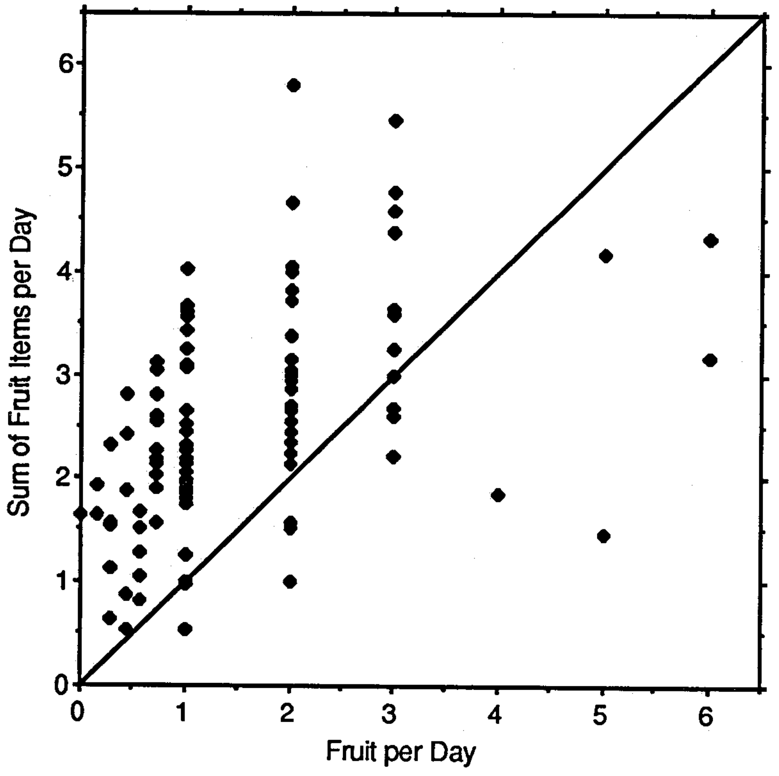
Run A -> Run C	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	–	–	+	–	–	+
Carbohydrate	–	–	+	+	–	–
Starch	–	–	+	–	–	+
Total Sugars	–	–	–	+	o	o
Total Fat	–	o	+	o	–	o
Saturated Fat	–	–	+	–	o	+
Polyunsaturated Fat	–	–	+	+	–	–
Protein	+	+	+	–	+	+
Dietary Fibre	+	–	o	+	–	+
Calcium	+	+	+	+	+	+
Iron	+	–	+	o	+	+
Zinc	+	–	o	–	+	o
Thiamin	–	–	–	–	–	–
Ascorbic Acid	–	–	–	–	o	+
Summary	–4	–9	+6	–2	–3	+5

Table 4.24 Effect on Performance Indicators: Adjusting Serving Size with Small = $^{2}/_{3}$, Medium = 1, Large = $^{4}/_{3}$ (Run D) compared with No Serving Size Adjustment (Run A)

Run A -> Run D	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	+	–	+	+	–	o
Carbohydrate	+	o	+	+	–	–
Starch	–	+	+	+	o	o
Total Sugars	–	–	o	+	o	–
Total Fat	+	o	+	o	–	o
Saturated Fat	+	+	+	+	o	o
Polyunsaturated Fat	–	o	+	+	o	o
Protein	+	+	+	–	+	–
Dietary Fibre	+	o	+	+	o	+
Calcium	+	+	+	+	+	+
Iron	+	o	+	+	o	+
Zinc	+	o	o	–	+	o
Thiamin	+	o	–	–	–	–
Ascorbic Acid	–	–	–	o	–	–
Summary	+6	+1	+8	+6	–2	–2

4.8 Fruit, Vegetable and Meat Adjustment Factors

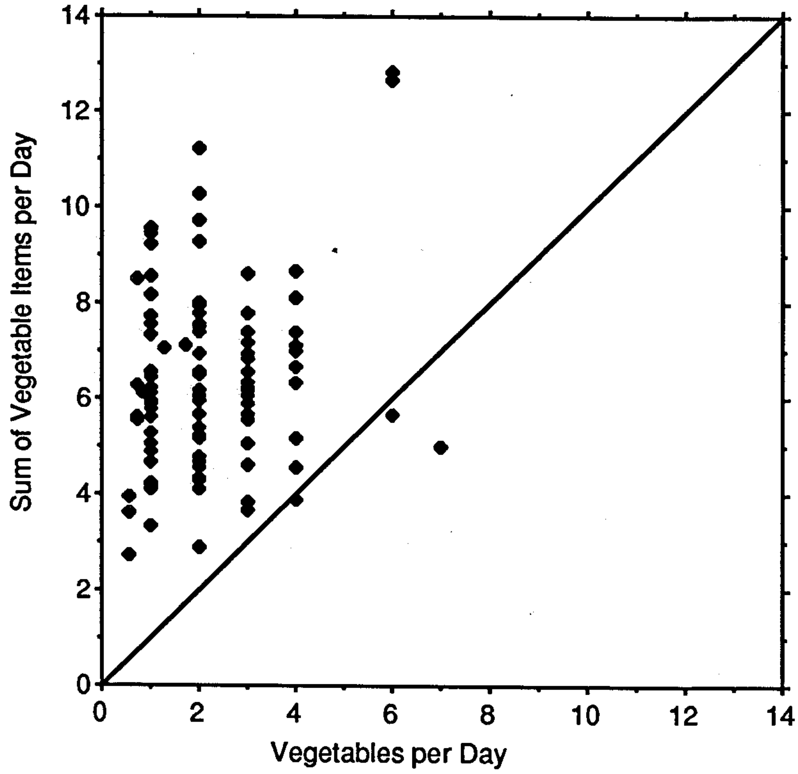
Figure 4.16 Servings of Fruit: Total Number of Servings versus Sum of Individual Servings



The sum of the consumption of individual fruit items per day for the majority of subjects were greater than the reported number of servings of fruit per day. In some cases, the sum of the individual items were 6-8 times the number of servings of fruit per day.

The fruit factor was calculated to adjust the individual items so that the sum of these items was along the line of equality shown on the graph.

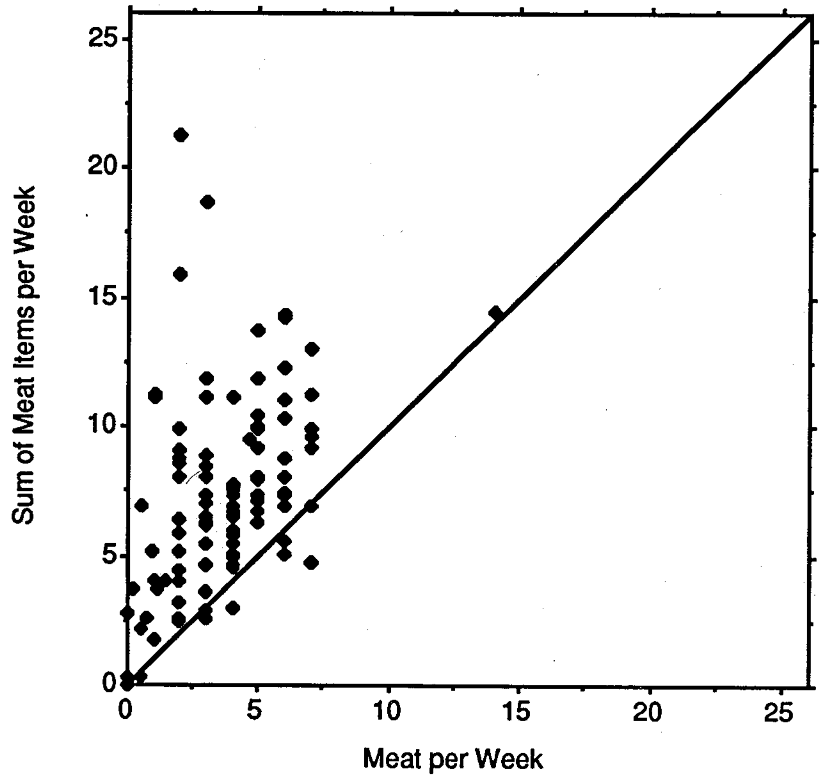
Figure 4.17 Servings of Vegetables: Total Number of Servings versus Sum of Individual Servings



The sum of the individual consumption of vegetable items per day is, in 97% of subjects, higher than the reported number of servings of vegetables per day. In some cases the sum of individual items is almost ten times the reported number of servings per day.

There are considerably less subjects near the line of equality compared to the distribution of subjects on the fruit or meat servings graphs (figures 4.16 & 4.18)

Figure 4.18 Servings of Meat: Total Number of Servings versus Sum of Individual Servings



The sum of the individual consumption of meat items per week is, in most of the subjects, higher than the reported number of servings of meat per week.

Table 4.25 Effect on Performance Indicators: Use of an Adjustment for Total Servings of Fruit (Run E) compared with no Fruit Adjustment (Run A)

Run A -> Run E	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	+	+	+	o	o	o
Carbohydrate	+	o	+	+	–	–
Starch	+	o	+	+	o	o
Total Sugars	+	o	+	o	o	–
Total Fat	–	+	+	–	–	o
Saturated Fat	+	+	+	–	o	o
Polyunsaturated Fat	+	o	o	+	o	–
Protein	+	o	o	–	o	o
Dietary Fibre	+	o	–	–	o	+
Calcium	+	o	+	o	o	+
Iron	+	–	–	–	o	+
Zinc	+	o	o	–	–	o
Thiamin	+	o	+	+	o	o
Ascorbic Acid	+	+	–	–	+	+
Summary	+12	+3	+5	–3	–2	+1

Table 4.26 Effect on Performance Indicators: Use of an Adjustment for Total Servings of Vegetables (Run F) compared with no Vegetable Adjustment (Run A)

Run A -> Run F	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	+	+	+	+	o	o
Carbohydrate	+	+	+	+	o	+
Starch	+	o	+	+	+	+
Total Sugars	+	–	–	o	–	o
Total Fat	+	+	+	–	o	–
Saturated Fat	–	+	+	+	o	o
Polyunsaturated Fat	+	o	–	o	o	–
Protein	+	+	+	o	o	o
Dietary Fibre	+	+	+	–	+	o
Calcium	+	+	+	+	o	o
Iron	+	+	+	+	–	+
Zinc	+	o	+	–	o	o
Thiamin	+	o	+	o	o	–
Ascorbic Acid	+	+	+	–	+	o
Summary	+12	+8	+10	+2	+1	0

Table 4.27 Effect on Performance Indicators: Use of an Adjustment for Total Servings of Meat (Run G) compared with no Meat Adjustment (Run A)

Run A -> Run G	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	+	+	+	–	–	+
Carbohydrate	+	–	–	+	–	–
Starch	+	o	–	–	+	o
Total Sugars	+	–	–	+	–	–
Total Fat	+	o	–	+	–	o
Saturated Fat	+	o	–	+	o	o
Polyunsaturated Fat	+	o	–	+	+	–
Protein	+	o	–	–	+	+
Dietary Fibre	+	o	–	o	o	o
Calcium	+	+	+	+	+	+
Iron	o	o	–	–	o	o
Zinc	–	o	–	–	o	–
Thiamin	+	o	–	–	o	o
Ascorbic Acid	–	–	o	–	o	o
Summary	+9	–1	–9	–1	0	–1

Table 4.28 Effect on Performance Indicators: Use of Adjustment for Total Servings of Fruit, Vegetables & Meat (Run H) compared with no Fruit, Vegetable & Meat Adjustments (Run A)

Run A -> Run H	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	+	+	+	–	+	+
Carbohydrate	+	o	–	+	o	o
Starch	+	o	+	o	+	o
Total Sugars	+	o	o	+	–	–
Total Fat	+	+	+	+	–	–
Saturated Fat	–	+	+	+	o	+
Polyunsaturated Fat	+	o	–	o	o	–
Protein	+	o	–	–	+	+
Dietary Fibre	+	o	–	+	–	o
Calcium	+	+	+	o	+	+
Iron	+	+	+	–	–	o
Zinc	+	o	–	–	o	+
Thiamin	+	o	+	–	o	–
Ascorbic Acid	+	+	–	–	o	–
Summary	+12	+6	+1	–1	0	0

Table 4.29 Effect on Performance Indicators: Use of Adjustment for Total Servings of Fruit, Vegetables and Meat (Run I) compared with no Fruit, Vegetable and Meat Adjustments (Run B)

Run B -> Run I	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	+	+	+	–	o	–
Carbohydrate	+	o	–	–	o	+
Starch	+	o	+	–	o	+
Total Sugars	+	+	+	+	–	–
Total Fat	+	o	+	–	–	+
Saturated Fat	–	+	+	+	o	+
Polyunsaturated Fat	–	o	–	–	o	o
Protein	+	+	–	o	o	o
Dietary Fibre	+	o	–	–	–	–
Calcium	+	+	+	+	o	–
Iron	–	+	+	–	o	–
Zinc	+	+	–	–	+	+
Thiamin	+	o	+	+	+	o
Ascorbic Acid	+	+	+	–	+	+
Summary	+8	+8	+4	–5	0	+1

Table 4.30 Effect on Performance Indicators: Use of 'Soft' Adjustment for Total Servings of Fruit, Vegetables and Meat (Run K) compared with no Fruit, Vegetable and Meat Adjustments (Run B)

Run B -> Run K	Mean Diff.	S.D. Diff.	Corr. Coeff.	Within 1 Quin	Gross Miscl.	Surr. Cat.
Energy	+	+	+	+	o	o
Carbohydrate	+	+	o	o	o	o
Starch	+	o	+	–	o	+
Total Sugars	+	+	+	+	o	o
Total Fat	+	o	+	+	o	+
Saturated Fat	–	+	+	o	o	+
Polyunsaturated Fat	+	+	–	–	o	+
Protein	+	+	+	o	–	–
Dietary Fibre	+	o	o	–	o	–
Calcium	+	+	+	+	o	–
Iron	+	+	+	–	o	o
Zinc	o	+	+	–	+	–
Thiamin	+	o	+	+	+	+
Ascorbic Acid	+	+	+	o	+	+
Summary	+11	+10	+10	0	+2	+2

5 Discussion

The discussion includes two major sections, firstly a discussion of the evaluation of the food frequency questionnaire. Following this will be a discussion of the design and analysis issues investigated and their effect on the performance of the food frequency questionnaire.

5.1 Evaluation of the Food Frequency Questionnaire

This section discusses the two factors involved in evaluating the performance of the food frequency questionnaire. Firstly, the reference method against which the performance of the food frequent questionnaire is assessed. The second factor is the technique used to compare the performance of the food frequency questionnaire with that of the reference method.

5.1.1 The Reference Method

The food frequency questionnaire was being evaluated in comparison with seven day diet records. The use of a 'golden standard' means that the instrument being investigated can only be stated as being 'as good as' the standard. If the standard has weaknesses then the method being investigated may actually produce more accurate results but there is no means of showing this. Every effort has to be made to obtain the best quality 'golden standard' possible.

The quality of the seven day diet records is related to many factors. Firstly, the subjects taking part in this study were undergraduate Nutrition students. They were recording their diet as part of the practical component of the Nutrition course. It is expected that their motivation would be higher than the average study participant (if there is such a thing) as they were actively involved in completing their diet record for their own interest, learning and assignment grades.

One possible source of error, or variation in quality, in the seven day diet records is that each subject entered their own diet record into the computer for analysis. The subjects were instructed and provided with assistance in deciding upon substitute food items and estimating amounts of foods that were not weighed or easily measured in some way. Despite the support given there will be variation between each subjects ability to estimate amounts and find suitable substitutions in the food composition database. The diet record method is considered to be an open-ended method of assessing dietary intake, it is however limited in this respect by the number and diversity of the food items in the food composition database used. In this study a database of approximately 1200 foods was used, it is likely that a large number of substitutions of similar foods was made by the subjects.

5.1.2 The Comparison Techniques

The comparison techniques will be discussed with emphasis on which element of the food frequency questionnaire's performance is being assessed and the suitability of the technique for evaluating the performance.

5.1.2.1 Mean Nutrient Intakes

The comparison of mean nutrient intake provides only basic information on the ability of the food frequency questionnaire to provide an accurate estimate of the group mean intake. An example of this is the agreement between the mean seven day diet record energy intake of 7.53 MJ (s.d. = 1.89 MJ) and the food frequency questionnaire analysis 'Run I' with a mean energy intake of 7.52 MJ (s.d. = 1.90 MJ).

This comparison technique does not, however, give any information about the ability of the questionnaire to accurately estimate the intake of a subset of subjects - as would be necessary to classify subjects into low or high intake groups. The standard deviations of each of the methods may be similar but this is no indication that the actual distribution of subjects is similar, only that the distribution of the nutrient intakes is similar.

There is the possibility of compensating errors in the food frequency questionnaire method producing similar estimates of the mean and standard deviation to the seven day diet record.

In isolation, the comparison of the mean nutrient intake is of little value in assessing the performance of the food frequency questionnaire.

5.1.2.2 Adjustment for Total Energy Intake

The nutrient intakes calculated from both the food frequency questionnaire and the reference method were adjusted for total energy intake to provide data in a form similar to that used in epidemiological studies, the most common use of food frequency questionnaires.

Two methods of adjusting for energy intake were possible. The method used in this study for adjusting for energy intake involved regression analyses and further calculation to determine the energy-adjusted nutrient intakes. Considerably less computing work is necessary to use the alternative method of dividing the nutrient intake by energy intake (nutrient density method).

The adjustment using regression analyses alters the nutrient intake only to the extent to which it is correlated to the energy intake whereas the nutrient density method results in intake values that are partly a function of energy intake. There would be value in investigating further the effect of adjusting for energy intake in food frequency questionnaire validation studies and which adjustment method to use.

The adjustment for energy intake may, in some cases, confuse the effect of altering a design or analysis parameter. For example, the adjustment for total servings of fruit decreased the mean difference for iron and calcium. These nutrients would not be expected to change as a direct consequence of the alteration in the consumption of fruit. This effect is likely to be caused by the change (decrease) in total energy intake, in turn affecting the energy-adjusted values for these nutrients.

5.1.2.3 Mean and Standard Deviation of the Difference

Willett (1990) comments that the interpretation of the mean and standard deviation of the difference is cumbersome when evaluating many nutrients, because of the required knowledge of the usual intake and variation of the nutrients being assessed. In this study, the mean and standard deviation of the difference were interpreted by looking at their change across many analysis runs for the same nutrient.

The mean and standard deviation of the difference gives not only an indication of the food frequency questionnaire's ability to estimate group mean intake but also an indication of the accuracy of the questionnaire on an individual level.

The ultimate agreement between the two methods would be indicated by a mean difference of zero and a standard deviation of the difference of zero.

A low mean difference with a large standard deviation of the difference would suggest that, although, there is good agreement in the estimate of the group mean, there was a distribution of differences in intake that cancelled each other out.

A high mean difference with a low standard deviation of the difference would imply that the distribution of the intakes from the two methods is similar, however one method is providing results higher, across the board, than the other method.

The mean differences for each nutrient varied quite dramatically between different analyses of the food frequency questionnaire. For example, the mean difference for energy was 1.94 MJ for analysis A and -0.03 MJ for analysis I. The standard deviation of the difference did not vary greatly; 2.37 MJ in analysis A and 1.98 MJ in analysis I. Another example is the change in carbohydrate values from analysis A (mean difference = 59 g, standard deviation of the difference = 29 g) to analysis J (mean difference = 0 g, standard deviation of the difference = 28 g). This pattern is present across most of the nutrients. The improvement (decrease) in mean difference indicates the food frequency questionnaire's ability to estimate the group mean is improving.

The lack of change in the standard deviation of the difference indicates that the improvement in estimate of group mean was not accompanied by an improvement in the individual estimates.

5.1.2.4 Correlation of Nutrient Intakes

A correlation coefficient shows how closely two variables are linearly related. A good linear relationship between the food frequency questionnaire and diet record intakes would indicate an accurate ranking of subjects by the food frequency questionnaire.

Two points of discussion arise from this method of comparing the food frequency questionnaire with the diet record. Firstly, the level of correlation coefficient considered to be indicative of a good linear relationship and, secondly, the nature of the linear relationship.

The level of acceptable correlation coefficients in the literature for food frequency questionnaire validation studies has been in the range of 0.5 to 0.7. There has been little or no attempt in the literature to calculate the correlation coefficients that would be expected. It is unlikely that two methods for measuring the same variable would not be related and therefore the calculation of an expected value would allow a test of significance to be applied to the comparison. This approach was suggested by Gibson (1987) and Bland & Altman (1986).

The range of correlation coefficients obtained in this study range from 0.28 to 0.56. This is quite low compared to the accepted values. The possible reason for the low correlation coefficients is that the subjects participating were a relatively homogenous group. They were all females of similar age, and being university students, of similar lifestyle. A homogenous group of subjects are more likely to have a distribution of nutrient intakes in a cluster. A heterogeneous group would have a greater range of nutrient intakes, and thus tend to produce higher correlation coefficients.

There was no attempt in this study to test the significance of the correlation coefficients. The absolute correlation coefficients were of lesser importance than the change in correlation coefficient with each analysis. The change in correlation coefficient was used as a measure of the effect of design and analysis issues on the performance of the food frequency questionnaire.

The second issue relating to correlation coefficients is the nature of the linear relationship. A correlation coefficient of 1.0 would indicate a perfect linear relationship between the two methods. It does not, however, imply that a measurement from one method is equal to the corresponding measurement from the other method. One method could produce results that are a ratio of the other method whilst retaining the linear relationship.

Therefore, the correlation coefficient should only be taken as an indicator of the food frequency questionnaire's ability to rank individuals, not as an indicator of the accuracy of the absolute nutrient intakes estimated from the food frequency questionnaire.

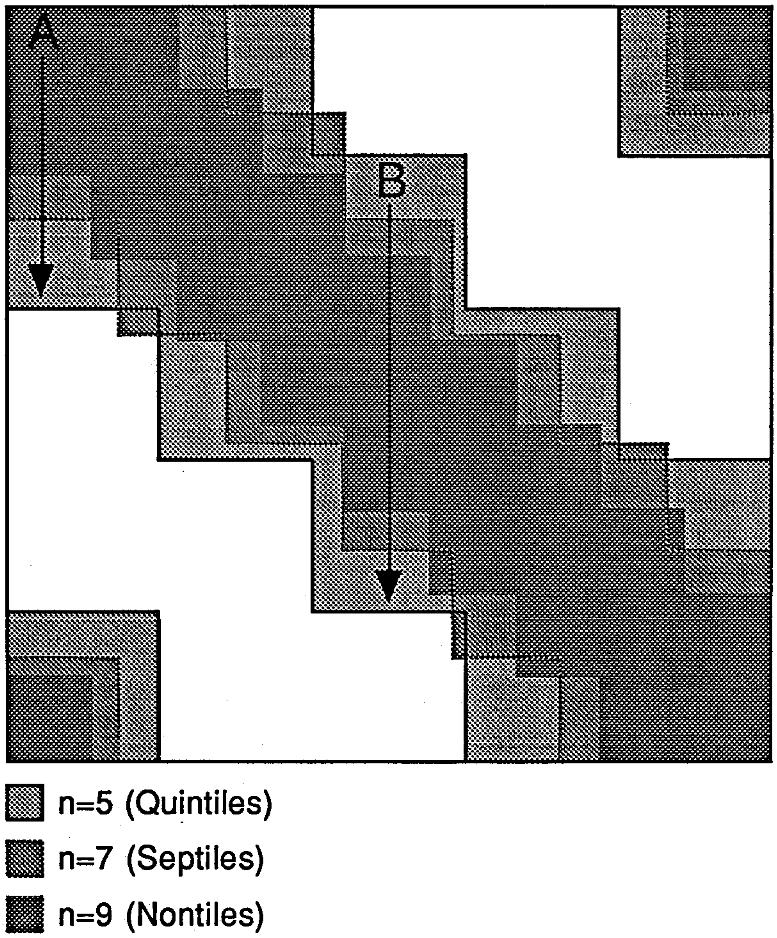
5.1.2.5 Classification into Quintiles

The element of the food frequency questionnaire's performance being assessed by 'quintile classification' is the ability to rank subjects by their nutrient intake. There is no indication that the absolute values for the food frequency questionnaire resemble the intake levels obtained from the reference method.

If the nutrient intakes were to be graphed, the requirement of being in the same or adjacent quintiles essentially draws a broad band through the graph (see figure 5.1). If the distributions were purely random, 52% of the subjects would fall within the limits of this band. There is no use, in the literature, of a statistical test to ascertain whether the percentage classifications obtained are significantly different from this random distribution. The levels in the literature for classification in to the same or adjacent quintiles range from 60% to 80% (Willett et al 1985; Pietinen et al 1988).

The range of percentages classified into the same or adjacent quintiles by this study varied from 63% to 84%. It was evident, however, that within a single nutrient the values obtained from this comparison technique did not vary greatly with each analysis run. For example, the energy figures ranged from 67% to 71%. There are two possibilities for the minimal change in this measure. The first possibility is that the food frequency questionnaire's ability to classify subjects is very stable regardless of the changes made to the analysis. The second possibility is that the use of classification into the same or adjacent quintile is not a very sensitive technique for assessing the performance of the food frequency questionnaire. The former possibility is the least likely of the two. The latter possibility will be discussed in further detail.

Figure 5.1 Classification into the Same or Within One n-tile, Gross Misclassification into Extreme n-tiles.



The broad band, mentioned above, that is drawn across the distribution of nutrient intakes sets the boundaries within which intakes can vary between analyses without affecting the overall classification. A subject that is within an extreme quintile for the reference method (first or fifth quintile) can vary in food frequency questionnaire intake up to the equivalent of two quintiles. This is indicated with 'Subject A' on figure 5.1. A subject in either the second, third or fourth quintile can vary as much as the equivalent of three quintiles without affecting the overall classification. This is illustrated with 'Subject B' on figure 5.1. The large degree of subject movement allowed by this comparison technique would account for the minimal change in the measure in relation to the changes in the analysis of the food frequency questionnaire.

The sensitivity of this measure could be improved by narrowing the band through the distribution. This could be accomplished by using seven (septiles) or nine (nontiles) divisions. The narrowing of the band is illustrated in figure 5.1. The percentage of subjects classified by chance into the same or adjacent septiles is 39%, for nontiles it is 31%. Table 5.1 lists the energy results reanalysed for classification into the same or adjacent n-tiles, for n = 5, 7 and 9.

Table 5.1 Percentage of subjects classified into the same or adjacent n-tiles for Energy (sample size = 101)

FFQ Analysis	n=5 Quintiles	n=7 Septiles	n=9 Nontiles
A	68	52	42
B	69	58	46
C	67	57	48
D	69	55	46
E	68	52	44
F	70	54	40
G	67	53	45
H	67	49	44
I	67	51	45
J	71	53	49
K	71	54	47
By Chance	52	39	31

There is considerably more variation in the percentage figures when using septiles (49% to 58%) and nontiles (40% to 49%) compared to using quintiles (67% to 71%). The lack of variation between analysis runs in the 'quintile classification' limits it's use as a measure of food frequency questionnaire performance.

There is some disagreement between the different measures. Analysis C (Common Standard Measures with small serving = 1/2, medium = 1, large = 2) is assessed as being able to appropriately classify the low figure of 67% of subjects according to the quintile method. The septile figure for analysis C is 57% and the nontile figure is 48%, both of which are the second highest in their categories. This situation would arise if most of the similarly classified subjects are within the septile/nontile bands with very few subjects outside of this region but still within the quintile band.

The contrary situation occurs with analysis F (Common Standard Measures, adjusted for servings of vegetables) where the quintile method produces the high figure of 70% compared to the lowest of 40% gained from the nontile method. The explanation for this is that most of the similarly classified subjects, although within the quintile band were outside the bounds of the narrower nontile band.

The classification into the same or adjacent quintiles has an accompanying measure - 'gross misclassification'. This is the percentage of subjects classified into extremely opposite quintiles by the two methods. The number of subjects expected in this situation, by chance, would be 8%. The actual values obtained in this study ranged from 0% to 7%, and as with the 'quintile classification' the 'gross misclassification' did not vary considerably between different analyses of the food frequency questionnaire. The use of septiles or nontiles would reduce the percentage of subjects misclassified by chance to 4% or 2.5% respectively. The lack of variation between analysis runs in the 'gross misclassification' limits it's use as a measure of food frequency questionnaire performance.

It can be seen from these issues that the 'quintile classification' method can give misleading results. In this study, the 'quintile classification' method has not been sensitive to changes in the analysis of the food frequency questionnaire. In some cases the values obtained from this method have been contradicted by results obtained through the same general method but with the subjects classified into a different number of categories.

This 'quintile classification' method is, however, commonly accepted in the literature. The continued use of this method requires further investigation. Firstly, there is a need for statistical tests to establish the significance of the values obtained from the classification method. This would allow investigators to determine whether the values obtained differ from those expected by chance. Secondly, investigation into the optimal number of categories is necessary to determine a more sensitive test of the food frequency questionnaire's ability to classify individuals.

The problems associated with this method of evaluating the food frequency questionnaire's ability to rank individuals limits the interpretation of results in this study.

5.1.2.6 Actual Values for Surrogate Categories

The actual values for surrogate categories are calculated by assigning subjects to quintiles according to the food frequency questionnaire, and averaging each of the quintile group's diet record results. This conveys information about the 'true' quantitative differences in intake between the groups ranked according to the food frequency questionnaire. The other methods for assessing the ability of the food frequency questionnaire to rank individuals do not give such a clear picture of exactly how much of a difference there is between the high and low intake groups.

The element of performance being assessed by this technique is the ability of the questionnaire to rank subjects accurately. Any subject who is ranked into an inappropriate quintile will affect that quintile's mean actual value, either increasing or decreasing it. The magnitude of this effect will depend on how many quintiles distant this subject is from their appropriate quintile.

The interpretation of this measure of food frequency questionnaire performance proved to be difficult as there are several aspects to the results which indicate good performance. The difference between the actual values for the quintiles was important in showing that subjects were classified into the appropriate categories. The results should show a relatively constant increase from the lowest quintile to the highest quintile. The proximity of each of the food frequency questionnaire results to those of the reference method was also taken into account. Graphs were drawn to enable relatively simple visual comparisons between the different analyses of the food frequency questionnaire and the reference method.

5.2 Design and Analysis of the Food Frequency Questionnaire

5.2.1 Criteria for Inclusion of Food Items

Willett (1990) noted three characteristics of a food for it to be of value in a food frequency questionnaire.

1. the food must be consumed reasonably often by a significant number of individuals.
2. the food must have a substantial nutrient content especially of the nutrient or nutrients of interest.
3. the consumption of the food must vary from person to person in order to discriminate between individuals.

The first criteria was met by deriving lists of frequently consumed foods from two national surveys of New Zealanders' diets. There is some possibility of bias in the food lists compiled from these sources. The time of year or season in which the surveys were conducted will affect the completeness of the food list. The food list needs to include commonly consumed food items from all seasons if it is to assess the usual nutrient intake. The 1977 National Diet Survey (Birkbeck 1983) was conducted over a six week period in September to November 1977. The Hillary Commission's Life in New Zealand Survey (Horwath et al 1991) was conducted in June, July and August 1989. Both of these surveys consisted of twenty four hour recalls and thus only recorded foods that were consumed by the sample over the relatively limited time period.

If the cut-off point for inclusion of food items was low enough on the list of frequently consumed food items, one can speculate that foods consumed frequently outside of the time period of these surveys will be included as they may still feature in the list but at a lower frequency of consumption. There may however be foods that are consumed heavily outside of the time period of these surveys that do not feature in the list.

The second criteria for inclusion of a food item is the food's contribution to the total nutrient intake of the population. The food list for this study was compiled based upon the nutrient contributions of foods in the 1977 National Diet Survey. The nutrient data from the Hillary Commission's Life in New Zealand Survey was unavailable at the time of designing the questionnaire. This situation means that any changes in the major nutrient contributing foods between 1977 and 1989 would not be included in the design of this questionnaire. The nutrient data from the Hillary Commission's Life in New Zealand Survey that has been published since this food frequency questionnaire was designed is not in a form suitable for designing the food list. The contribution of general food groups to nutrient intake is listed in the published results. A ranking of individual foods rather than groups is required to compile the food list for a food frequency questionnaire. This situation illustrates that specific analyses of survey data may be necessary to derive suitable data for food frequency questionnaire design.

The third criteria was not considered in the design of this food frequency questionnaire. More extensive analysis of diet survey data would produce information on the inter-individual variation in the consumption of food items.

These shortcomings of the design process could be overcome if more extensive diet survey data was available to an investigator. It would be preferable to compile the food list from surveys conducted throughout the year to account for seasonal variation in the foods consumed by the target population. The surveys should also be as recent as possible to compile the most appropriate list of frequently consumed foods.

5.2.2 Food Composition Data

The food composition data used in the analysis of the food frequency questionnaire was derived using several assumptions. As described in section 3.5.4.1 a composite of food composition data was used for the analysis of certain food items in the questionnaire. This technique was used for questions about the consumption of a group of foods, for example, potato crisps and corn chips. It was also used where the food could have been eaten in different ways, such as raw or cooked. To derive the food composition used for analysis from the database, arbitrary proportions of the food items were combined. These proportions may not necessarily be related to the proportions in which the subjects actually ate these food items.

This effect should be minimal as only those food items that are similar in composition were grouped into the same question. The differences in preparation and cooking methods may have had more of an effect on the analysis results.

5.2.3 Serving Size Data

Two sets of serving size data were compiled for use in the analyses of the food frequency questionnaire. The 'Common Standard Measure' serving sizes were derived from a published source (Gillanders and Milligan 1992). Considerable time and effort was necessary to derive suitable 'Age and Sex Specific' serving sizes. This study only used one sex and age group, the process of deriving serving sizes would have to be repeated for different age and sex groups for this food frequency questionnaire to be used for other samples.

There are several factors which could affect the accuracy of the serving sizes generated from the dietary intake data.

The food list was generated from the full samples of both national diet surveys whereas the serving sizes were derived from the age and sex subset used in this study. This meant that some food items were eaten by a small number of individuals in this subset, and some foods were not consumed at all. In certain cases foods that were frequently consumed in the 1977 National Diet Survey may not have featured so highly in the Hillary Commission's Life in New Zealand Survey and the 7 day diet records from Undergraduate Nutrition Students. In the instance where there was very little or no information to base a serving size on, the serving size was estimated using common standard measures.

The limited time period covered by the diet survey data may also have contributed to a low number of subjects from whom a serving size could be derived.

The manner in which the diet survey data was entered could have an effect on the estimation of serving sizes. The limited number of food items in the food composition database requires that substitution foods need to be used when entering diets. These substitutions may not be consistent across many people entering the diets, the consequence of which is that a single food item may be represented in the dietary data by several separate food items.

The second diet entry issue is the situation where time and effort is conserved by adding several servings of a food item together and entering them as one occurrence. This creates a single larger serving size rather than the actual smaller individual serves.

Gladys Block (1986) describes the process of deriving serving sizes as follows...

> *"It should be noted that this is not simply a mechanical process; a considerable element of judgement remains important in the determination of portion sizes."*

The investigator agrees with this viewpoint, the process used in this study involved a great deal of judgement in deriving the serving sizes from the survey data.

5.2.4 Methods for Handling Inconsistent and Missing Responses

In any usage of a food frequency questionnaire there has to be a contingency plan for dealing with missing or inconsistent responses. If the subjects are readily available to clarify their responses or respond to omitted questions, this is the best option. Failing having access to the subjects after completing their questionnaire, as is the case with mail surveys, the missing responses could either be ignored or dealt with by one of the methods described in section 3.5.4.5. Using the methods described involved making assumptions about the subject's responses which could result in erroneous intake data. This situation needs to be weighed against the errors involved in accepting a large number of missing or inappropriate responses.

Although not used in this case, there could be a threshold set to disqualify any questionnaire with too many missing responses. Allowing such questionnaires to be analysed could result in a biased sample, particularly affecting the low intake groups as determined by the questionnaire.

5.3 Response Scale Format

The following question was addressed: Which of the two predominant response scale formats result in enhanced performance of the food frequency questionnaire?

- An 'Open' format requiring the subject to respond with the number of times the food is consumed within a time period (day, week or month).
- A 'Closed' format consisting of a fixed number of broad frequency categories (e.g. daily, two to three times per week).

A calcium-specific food frequency questionnaire was tested with each of these possible response scale formats.

Firstly, these two response scales will be compared to establish to what extent they actually differ.

The scales essentially cover the same possible frequency options (see table 4.4) The 'Open' scale, however, has some overlap within itself. It is possible to respond with either one per day or seven per week to indicate a daily consumption of a food item. This situation also applies to weekly and four times a month, as well as to twice a week and eight times a month. The 'Open' scale includes some options that are unlikely to be used such as nine times per day, eight times per week and seven times per month. There is considerable redundant information being presented to the respondent by the 'Open' response scale.

The 'Closed' response scale represents a range of frequencies with one response choice. This could be seen either as a limitation, the respondent may be able to give a more accurate frequency than is possible with the response scale, or an advantage, the respondent can choose the response closest to their approximation of the frequency of consumption.

There is not a complete coverage of all possible frequencies by the 'Closed' scale. Although the response scale options are worded to cover a broad frequency range, there is no option for three times per month or two or more times per day.

The time taken to complete the calcium food frequency questionnaires gives some insight into the effect of the different frequency response scales.

The 'Closed' category response scale allowed the respondent to complete the questionnaire in a shorter time than the 'Open' response scale. This time difference could be attributed to two possibilities. The frequency response scales required the subjects to, firstly, decide what their response was going to be and, secondly, physically respond with that choice. The Calcium food frequency questionnaire were computer-administered and, as such, responding to the choice required either one positioning and 'clicking' of the computer's pointing device (a 'mouse') for the 'Closed' response scale, or two positioning and clicks of the 'mouse' for the 'Open' scale.

The shorter time required to complete the 'Closed' response scale could be attributed partially to the simplicity of responding with only one physical movement and partially to the simpler range of choices faced by the respondent.

The Calcium food frequency questionnaire consisted of 38 questions, 29 of which were suitable for either response scales. This number of questions, relatively small for a food frequency questionnaire, produced a significant difference in the time taken to complete the questionnaire using the two different response scales. A longer food frequency questionnaire can be expected to produce an even greater time difference between the 'Open' and 'Closed' response scale formats. The time involved in responding to a food frequency questionnaire is central to the potential threat of respondent fatigue which would result in lower quality data.

The responses from the different response scales were directly compared by recording the 'Open' responses to the appropriate categories on the 'Closed' response scale (Table 4.5). Sixty six percent of the responses (excluding 'Rarely or Never') correspond between the two response scale formats. The subjects responded with a lower frequency choice on the 'Closed' scale compared to their choice on the 'Open' scale in 24% of the responses. The opposite situation occurred in only 11% of the responses, i.e. a lower response was selected from the 'Open' scale compared to the 'Closed' scale.

The higher frequency responses from the 'Open' response scale format would account for the overestimation of the group mean calcium intake, whereas the 'Closed' response scale format accurately estimated the group mean calcium intake.

The 'Closed' response scale resulted in a higher correlation coefficient than the 'Open' response scale format. The 'Closed' and 'Open' formats did not differ considerably when assessed by the 'actual values for surrogate categories' technique.

The overall assessment of these two response scale formats put forward the 'Closed' format as the most favourable due to its more accurate estimate of the group mean, higher correlation coefficient and significantly shorter time for subjects to respond to the questions.

5.4 Serving Sizes: Common Standard Measures or Age-Sex Specific

The following question was addressed: Does the use of age and sex specific serving sizes derived from 24-Hour Recalls and Seven Day Diet Records enhance the performance compared to the use of common standard measures of the foods?

This issue was investigated using the subjects frequency responses and two different sets of serving sizes. The first set (used in analysis A) was derived from a published source (Gillanders and Milligan 1992) of Common Standard Measures. The second set of serving sizes (used in analysis B) was derived from open-ended methods of dietary assessment.

The effect of using age and sex specific serving sizes instead of common standard measures is clearly evident in the indicators of performance (Table 4.21). There was a reasonably consistent improvement in the mean difference accompanied by an improvement in the standard deviation of the difference.

The indicators of the food frequency questionnaire's ability to rank individuals (correlation coefficients and 'surrogate categories') did not change overall.

These results would indicate that using age-sex specific serving sizes improves the food frequency questionnaire's ability to estimate the group mean without affecting the ability to rank individuals. This finding is in agreement with the general principle described by Flegal & Larkin (1988). They found that alterations to the serving size had effect on the ability of the food frequency questionnaire to estimate group mean whereas changes in the frequency of consumption alters the ranking of individuals.

This finding can be interpreted from another angle. If the principle objective of using the food frequency questionnaire is to rank individuals, the considerable effort involved in deriving age and sex specific serving sizes is not justified. Using common standard measures would be sufficient if the absolute intakes are not to be considered.

5.5 Small, Medium & Large Serving Size Information

The following question was addressed: Do questions asking the subject to specify serving size as small, medium or large, given a description of a medium serving, enhance the performance of the food frequency questionnaire?

Two comparisons were made to investigate this issue. The first used a small serving as an equivalent to half a medium serving, with a large serving equal to twice a medium serving. The second comparison used a small serving equal to two-thirds a medium serving, and a large equivalent to one and one-third a medium serving.

The questions regarding the usual serving size, in relation to a stated medium serving size, add considerably to the length of the food frequency questionnaire. This will increase the respondent burden and fatigue the subjects with possible detrimental effects on the quality of the data collected. This effect has to weighed against the benefits, if any, of gathering this additional data.

Table 4.22 showed a higher prevalence of 'Large' serving size responses associated with food items reported as consumed more frequently, and 'Small' serving sizes for those consumed less frequently. This situation may arise from one or more of the following possible reasons.

The food items reported as more frequently consumed are also those consumed in larger amounts. If the reference serving sizes were reasonable descriptions of a medium serving size this reason would be unlikely.

The reference medium serving sizes that were associated with the more frequently consumed food items could have been too small.

The reverse situation may have been so for the less frequently consumed food items. The food items were consumed in smaller amounts than the stated medium serving size or the medium serving size was too large.

There is the possibility of bias in the responses to these questions. The subjects may have been able to better compare their usual servings size against the stated medium serving size for those foods that they consumed more often. The respondents may not be able to estimate/compare accurately their usual serving size of foods not eaten very often.

The selection of a small or large serving size at the more frequent end of the response scale will have quite a pronounced effect on the calculated nutrient intake. The use of a small serving size being equivalent to half of a medium serving, and a large serving being twice a medium one results in a large difference between respondents choosing different serving sizes. A large serving of a food item is, in this case, four times the amount of a small serving. The use of small = 2/3 of a medium and large = 4/3 of a medium reduces this difference to a large servings being twice the amount of a small one.

The use of small = 1/2, medium = 1, and large = 2 had an overall negative effect on the mean difference and standard deviation of the difference (Table 4.23) while improving the overall correlation coefficients and 'surrogate category' measure of performance.

A possible explanation for these effects would be that the use of the serving size information is essentially spreading out the distribution of the food frequency questionnaire results. The increased spread of intakes would strengthen the linear relationship between the food frequency questionnaire results and those of the reference method, hence the overall improvement in the correlation coefficients. This same spreading of results would also be responsible for the negative effect on mean difference and standard deviation of the difference, the individual intakes would effectively move away from their corresponding intakes from the reference method. The 'surrogate categories' measure of performance improved with the use of the serving size information. This effect may also be due to a spreading out of intakes and the separation of those subjects with high intakes into the higher quintiles and vice versa.

The use of small = 2/3, medium = 1, and large = 4/3, although still maintaining the effect on correlation coefficients, reversed the effect on the mean difference and had minimal effect on the 'surrogate categories'. The reason for this may be that the linear relationship was strengthened but the individual results did not deviate as far from the reference method results as they did in the previous analysis.

These findings correspond, in principle, with those of Block et al (1986) and Cummings et al (1987), in which the correlation coefficients improved with the use of small, medium and large serving size information.

In summary, the use of small, medium and large serving sizes has a positive effect on the ability of the food frequency questionnaire to rank individuals. The effect on the estimate of the group mean is not clear.

5.6 Adjustments for Total Number of Servings

The following question was addressed: Do questions asking for total number of servings of a food type per day or per week to adjust the frequency of consumption of the individual food items of that type enhance the performance of the food frequency questionnaire? For example, using the total number of servings of fruit per day or per week to proportionally increase or decrease the individual frequency of consumption of the individual fruit items.

Three questions at the conclusion of the food frequency questionnaire prompted the subjects to estimate the number of servings of fruit, vegetables and meat they consumed per day (or week in the case of meat). The sum of the individual fruit, vegetable and meat items were compared with the respective 'global' estimates of consumption (Figures 4.16, 4.17 & 4.18).

The trend observed from the graphs of these comparisons is that the sum of the individual food items, in the majority of cases, illustrates an overestimation of consumption. This overestimation is possibly related to the number of individual food items in the questionnaire (Krebs-Smith et al 1992).

Use of the adjustment for the total servings of fruit improved dramatically the food frequency questionnaire's ability to estimate the group mean, as indicated by the mean difference summary (Table 4.25).

The correlation coefficient summary improved although there was little improvement in the 'surrogate categories' measure.

The adjustment for vegetable servings similarly improved the mean difference and correlation coefficient summaries (Table 4.26).

The adjustment for meat servings had a similar effect on the mean difference, however, the situation with the correlation coefficient summary was completely reversed (Table 4.27).

The interpretation of the direct effect of these adjustments is difficult because of the changes in energy intake between the analyses. The general decrease in energy intake caused by using the adjustment factors will affect the energy-adjusted nutrient intakes even though these nutrients may not be directly related to the foods being adjusted. For example, the adjustment for total servings of fruit decreased the mean difference for iron and calcium.

When the adjustments for fruit, vegetables and meat were combined the mean difference summary, as expected, reflected the definite trend to improve the food frequency questionnaire's ability to estimate group mean (Table 4.28)

The indicators of the food frequency questionnaire's ability to rank individuals (correlation coefficient and 'surrogate categories') do not show any overall change.

5.7 Application of Findings

The subjects used in this study were a very specific sample, one age and sex group of Nutrition undergraduate students, therefore the results are not specifically applicable to other samples or other food frequency questionnaires. However, the general principles demonstrated in this study provide a basis for optimising the performance of a food frequency questionnaire through alterations in it's design and analysis.

These potential gains should be assessed in the validation process of the food frequency questionnaire. The comparison techniques should be chosen on their merits and suitability for assessing the aspect of the food frequency questionnaire's performance which is important to the researcher.

The effects on food frequency questionnaire performance in this study were summarised for a specific group of nutrients, i.e. those nutrients of special consideration for New Zealanders according to the Nutrition Taskforce (1991). The general results would be expected to differ if a different set of nutrients were chosen as indicators of the food frequency questionnaire's performance. Investigating the effect of the different analyses at the level of individual nutrients would give yet another set of results. Researchers interested in specific nutrients would need to inspect the effect of the different analyses on the nutrients of interest rather than relying on the general principles described.

6 Conclusion

The objective of this study was to determine the optimal design and analysis of a food frequency questionnaire to assess the usual nutrient intake of New Zealand adults.

To achieve this objective five aspects of design and analysis were investigated to study their effect on the performance of a 132 item food frequency questionnaire administered to 101 female undergraduate Nutrition students. The performance was gauged by the ability to estimate group mean intake and the ability to rank individuals in comparison to seven-day diet records. The findings were based upon energy and a set of nutrients of special consideration for New Zealanders according to the Nutrition taskforce. The nutrients were carbohydrate, starch, sugars, fat, saturated fat, polyunsaturated fat, protein, dietary fibre, calcium, iron, zinc, thiamin and ascorbic acid. The effect on the food frequency questionnaire's performance was summarised across this group of nutrients to provide a general view of each aspect of design and analysis investigated.

The five aspects of design and analysis addressed and the general findings are as follows:

Which of the two predominant response scale formats result in enhanced performance of the food frequency questionnaire?

- *An 'Open' format requiring the subject to respond with the number of times the food is consumed within a time period (day, week or month).*
- *A 'Closed' format consisting of a fixed number of broad frequency categories (e.g. daily, two to three times per week, monthly).*

The use of a 'Closed' frequency response scale had a positive effect on the food frequency questionnaire's ability to estimate group mean intake and the ability to rank individuals. The 'Closed' format also required less time for subjects to respond.

Does the use of age and sex specific serving sizes derived from 24-Hour Recalls and Seven Day Diet Records enhance the performance compared to the use of common standard measures of the foods?

The use of age and sex specific serving sizes had a positive effect on the food frequency questionnaires ability to estimate group mean intake. The food frequency questionnaire's ability to rank individuals was not affected.

Do questions asking the subject to specify serving size as small, medium or large, given a description of a medium serving, enhance the performance of the food frequency questionnaire?

The use of the subjects' specified serving size had a positive effect on the ranking of individuals although the magnitude of this effect may not be great enough to justify the longer time taken to complete the questionnaire. A statistical test would assist in deciding the worth of the additional serving size questions. The effect on the food frequency questionnaire's ability to estimate group mean intake is unclear.

Do questions asking for total number of servings of a food type per day or per week to adjust the frequency of consumption of the individual food items of that type enhance the performance of the food frequency questionnaire? For example, using the total number of servings of fruit per day or per week to proportionally increase or decrease the individual frequency of consumption of the individual fruit items.

The use of adjustments for the total number of servings of fruit, vegetables and meat had a positive effect on the food frequency questionnaire's ability to estimate group mean intake. The food frequency questionnaire's ability to rank individuals did not show an overall change.

To gauge the effect of these issues on the performance of the food frequency questionnaire, several techniques for comparison against the reference method were utilised. The main issues raised from the use of the different comparison techniques were the need for further investigation into the sensitivity of the 'quintile classification' method. The use of a statistical test to assess the significance in changes in classification is necessary. The use of more than five categories, e.g. 7 or 9, requires consideration for a more sensitive measure of the food frequency questionnaire's ability to classify individuals.

Was the objective of the optimal design and analysis of a food frequency questionnaire for the assessment of nutrient intake of New Zealand adults reached?

Using the general principles found in this study, the optimal design and analysis for a food frequency questionnaire for estimating group mean intake would involve a 'Closed' categorical response scale format (rather than an open-ended scale), age and sex specific serving sizes (rather than common standard measures) and adjustments for the total servings of fruit, vegetables and meat.

The optimal design and analysis of a food frequency questionnaire for classifying individuals would involve a 'Closed' categorical response scale format (rather than an open-ended scale), use of common standard measures as serving sizes, and asking the respondent to specify small, medium or large serving sizes.

The situation is quite common where research requires both a ranking of individuals and an estimate of group mean is required. There are several possible courses of action available. The first possibility is to choose which of the results is more important to the research and accept the error involved in the least important of the two required results. The second course of action is to conduct separate analyses, one which is fine-tuned for gaining an estimate of the group mean, and the other for obtaining a ranking of subjects. The third course of action is to look in more detail at the nutrients being investigated. The behaviour of individual nutrients may not be reflected in the general effects described in this study.

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Appendices

A Research Proposal

The Design, Analysis and Evaluation of Food Frequency Questionnaires

Food frequency questionnaires were first developed during the 1960s in response to a need for new methods for determining dietary intake in large population studies. The diet history and diet record methods which are so useful with individuals or in small group studies, were too time-consuming and demanding of interviewer skills and subject cooperation to be suitable for large scale dietary and epidemiological studies.

Food frequency questionnaires elicit information concerning the frequency of consumption of each of a specified list of foods and drinks. Their advantages over other methods include: comparatively low burden to respondents, high response rates in random population studies, the ability to be administered by non-professionals or to be self-administered, low cost, the production of standardised results and a direct assessment of usual intake.

The food frequency method has been hotly debated over the past decade. Questions concerning the most appropriate design (e.g. whether to include estimations of portion size; the optimal response scales for specifying frequency of use; the best methods of grouping foods together - by meals or food groups; the effect of the ordering of the food items), validity and reproducibility issues have been of major concern. The development of reliable, valid food frequency questionnaires for assessment of usual dietary intake is central to many areas of nutrition and epidemiological research, so there is a strong need for more methodology research and the refinement of methods.

This project aims to:

1. Determine the optimal design for a food frequency questionnaire to assess the usual dietary intake of New Zealand adults. Food frequency questionnaires must be customised for specific countries, with foods selected for inclusion in the questionnaire on the basis of open-ended methods of dietary assessment (e.g. diet records or recalls) which identify the foods making important contributions to the diet of the population of interest. Up-to-date National Diet Survey 24 hour recall data will be used as the basis for selection of foods. Design issues which will be examined include: the question of whether serving size information significantly enhances the validity of nutrient intake results and the effects of changing the response scales used to measure frequency of consumption.

2. Develop methods for analysing nutrient intake from food frequency questionnaires.

3. Evaluate the validity of nutrient intakes estimated from a computer self-administered food frequency questionnaire. This is to be by comparison with the optimal method for accurately assessing nutrient intake, namely, multiple diet records.

B Consent Form

Food Frequency Questionnaire Design and Analysis

An M.Sc. Study by Ross Marshall

The purpose of this study is to determine the optimal design for a food frequency questionnaire to assess the usual dietary intake of New Zealand adults, and to evaluate the use of 'computer administered' food frequency questionnaires.

You will be required to answer two computer administered food frequency questionnaires and fill out a conventional food frequency questionnaire. There will be a time period of a week between each questionnaire. The questionnaires will take between 20 and 40 minutes to complete.

Your seven-day diet records will be used as the method against which these food frequency questionnaires will be compared.

Consent Form

I give my consent for inclusion in this study of food frequency questionnaire design, administration, and analysis.

I realise the study involves completing two computer administered food frequency questionnaires and one conventional food frequency questionnaire.

I give consent for the use of my seven-day diet record to be used in this study.

I realise that I may choose to withdraw from this study at any time and I will let those involved know of my decision.

Signed ______________________ Date ___________

Thank you for your cooperation in this study.

C Sample of Diet Record Booklet

NAME: I.D.

RECORD SHEET

PLEASE READ THESE IMPORTANT INSTRUCTIONS CAREFULLY

* Please record ALL food and drinks consumed

* Please record the food at the time of eating and NOT from memory at the end of the day

* You should include all meals & snacks, plus sweets, drinks (including water) etc.

*Remember to include any additions to foods already recorded such as: sauces, dressings or extras e.g. gravy, salad dressings, stuffings sugar, honey, syrups etc., butter or margarine (e.g. added to bread, crackers, vegetables).

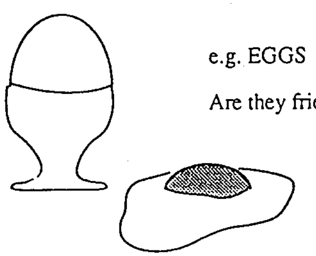
*If you do not eat a particular meal or snack, simply draw a line across the page at this point. This will show that you definitely have not eaten anything.

DESCRIBING FOOD AND DRINK – GUIDELINES

1. Please give details of the method of cooking all foods (e.g. fried, grilled, boiled, roasted, steamed, poached, stewed.

2. Give as many details as possible about the **type** of food that you eat e.g. brand name of food where applicable (e.g. Miracle margarine);
type of: Breakfast cereal (e.g. Weetbix)
milk (e.g. whole milk or 'trim milk')
cake or biscuit (e.g. fruit cake, wheatmeal biscuit)
fruit (e.g. fresh, canned, dried, stewed)
soft drink (e.g. regular or low calorie)

3. Name the type of cheese, fish or meat (e.g. cheddar, cod fillet, loin of pork)



e.g. EGGS

Are they fried, boiled, poached or scrambled?

RECORDING THE AMOUNTS OF FOODS YOU EAT

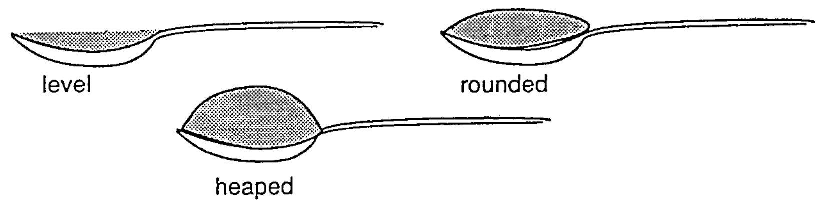
It is also very important to record the quantity of each food and drink you consume.

Here are some suggestions on how to record amounts:

- IN HOUSEHOLD MEASUREMENTS

  For many foods such as vegetables, cereals and canned or stewed fruit, a household measurement is adequate.

  e.g. STATE THE NUMBER OF TEASPOONS (t), TABLESPOONS (T), CUPS etc. State whether spoons are level, rounded or heaped.



  Butter and margarine can be measured in teaspoons or tablespoons if you find this an easy method.

- WEIGHTS MARKED ON PACKAGES

  All convenience foods have their weight marked on the packaging and this can be quoted e.g. half a 425g can of baked beans.

- BREAD - indicate the size of the slices (e.g. sandwich, medium, toaster).

- CHEESE, MEAT & FISH

  If at all possible, it would be very helpful to weigh your portions of these foods.

  If this is not possible, please use **the pictures on the attached sheets** to indicate what sort of portion sizes you eat e.g. you might have 1 portion of spaghetti size A, 1 portion of meat size B or 2 slices of cheese size C.

- USE COMPARISONS for describing portion sizes where this is easier e.g. potato - size of a hen's egg, cheese - size of a matchbox.

IT IS VERY IMPORTANT THAT YOU DO NOT ADJUST WHAT YOU EAT AND DRINK BECAUSE YOU ARE KEEPING A RECORD. THIS IS VERY EASY TO DO, BUT REMEMBER, WE ARE INTERESTED IN YOUR EATING HABITS, NOT THE PERFECT DIET!!!

DAY 1 - Date ....

- Record ALL food and drink consumed during the day including sweets, snacks, 'nibbles', sauces and dressings.
- Please record: METHOD OF COOKING (e.g. *boiled* pasta)
  TYPE OF FOOD (e.g. boiled *wholegrain* pasta)
  QUANTITY OF FOOD (e.g. *6 heaped T* boiled wholegrain pasta)

LEAVE BLANK

MEAL/ SNACK	QUANTITY EATEN	DETAILS OF FOOD AND DRINK	
EARLY MORNING			
BREAKFAST			
DURING MORNING			
MIDDAY			

DAY 1 - continued

LEAVE BLANK

MEAL/ SNACK	QUANTITY EATEN	DETAILS OF FOOD AND DRINK	
DURING AFTER-NOON			
EVENING MEAL			
DURING EVENING/ BEDTIME SNACK			

DAY 1 - Date ....

- Record ALL food and drink consumed during the day including sweets, snacks, 'nibbles', sauces and dressings.
- Please record: METHOD OF COOKING (e.g. *boiled* pasta)
  TYPE OF FOOD (e.g. boiled *wholegrain* pasta)
  QUANTITY OF FOOD (e.g. *6 heaped T* boiled wholegrain pasta)

LEAVE BLANK

MEAL/ SNACK	QUANTITY EATEN	DETAILS OF FOOD AND DRINK	
EARLY MORNING			
BREAKFAST			
DURING MORNING			
MIDDAY			

DAY 1 - continued

LEAVE BLANK

MEAL/ SNACK	QUANTITY EATEN	DETAILS OF FOOD AND DRINK	
DURING AFTER-NOON			
EVENING MEAL			
DURING EVENING/ BEDTIME SNACK			

D Calcium Food Frequency Questionnaire

What type of milk do you usually drink ?
How many cups of tea or coffee with milk do you usually drink ?
How many glasses of milk do you usually drink ?
How many other drinks with milk do you usually drink ?
How often do you usually eat breakfast cereal with milk on it ?
How many slices of white or brown bread do you usually eat ?
How many slices of wholemeal bread do you usually eat ?
How often do you usually eat natural yoghurt ?
How often do you usually eat fruit yoghurt ?
How often do you usually eat hard cheeses (eg cheddar cheese) ?
How often do you usually eat cream cheese ?
How often do you usually eat cottage cheese ?
How often do you usually eat soft cheeses (eg Camembert) ?
How often do you usually eat white meat ?
How often do you usually eat red meat ?
How often do you usually eat soybeans or tofu ?
How many eggs do you usually eat ?
How often do you usually eat tinned salmon ?
How often do you usually eat tinned sardines ?
How often do you usually eat prawns or shrimps ?
How often do you usually eat fresh fish ?
How often do you usually eat battered fish ?
How often do you usually eat fish cakes ?
How often do you usually eat shellfish ?
How many plain biscuits or crackers do you usually eat ?
How many chocolate biscuits do you usually eat ?
How often do you usually eat cake ?
How often do you usually eat green leafy vegetables ?
How often do you usually eat dried fruit (eg. figs, raisins) ?
How often do you usually eat nuts ?
How often do you usually eat porridge made with milk ?
How often do you usually eat muesli ?
How often do you usually eat allbran cereal ?
How often do you usually eat ice-cream ?
How often do you usually eat desserts made with milk ?
How often do you usually eat milk-based sauces ?
How often do you usually eat soups made with milk ?
How often do you usually drink milkshakes ?

E General Food Frequency Questionnaire

Food Frequency Questionnaire

Department of Human Nutrition
University of Otago

Name:____________________ Date:__________

How to answer: You will be asked a series of questions about how often you usually eat certain food items. For each food, tick the answer which **best** describes how often you **usually** eat it. You will also be asked to indicate how much of this food you usually eat at any one time, by ticking the small, medium or large serve size. A medium serve size is given for each food. If you tick 'rarely or never', you do not need to tick a serve size.

Please answer **all** questions.

How often do you usually eat these foods ?

(Tick **one** frequency, and **one** serve size for each food)

regular cheese, eg. cheddar

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = 2 slices or 60 gm

- ☐ small
- ☐ medium
- ☐ large

low fat cheese, eg. cottage or ricotta

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = $^1/_2$ cup

- ☐ small
- ☐ medium
- ☐ large

icecream

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = $^1/_2$ cup

- ☐ small
- ☐ medium
- ☐ large

yoghurt, plain or flavoured

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = 1 pottle

- ☐ small
- ☐ medium
- ☐ large

cream

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 2 tablespoons

- [ ] small
- [ ] medium
- [ ] large

custard

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup

- [ ] small
- [ ] medium
- [ ] large

cakes, buns or scones

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 piece

- [ ] small
- [ ] medium
- [ ] large

vegemite or marmite

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve per slice of bread = 1 teaspoon

- [ ] small
- [ ] medium
- [ ] large

peanut butter

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve per slice of bread = 1 tablespoon

- [ ] small
- [ ] medium
- [ ] large

puddings, eg. trifle or fruit crumble

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup

- [ ] small
- [ ] medium
- [ ] large

rice

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 cup

- [ ] small
- [ ] medium
- [ ] large

crackers, salada or crispbread

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 2 crackers

- [ ] small
- [ ] medium
- [ ] large

tinned spaghetti in tomato sauce

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 cup

- [ ] small
- [ ] medium
- [ ] large

other pasta, eg. macaroni or noodles

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 cup

- [ ] small
- [ ] medium
- [ ] large

breakfast cereal, muesli or porridge — **medium serve = 1 cup**

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

If you eat breakfast cereal, muesli or porridge, which do you usually eat most ?

- [ ] I don't eat breakfast cereal, muesli or porridge
- [ ] Porridge
- [ ] Muesli – toasted
- [ ] Muesli – non-toasted
- [ ] Weetbix, Weetaflakes, Puffed Wheat etc.
- [ ] Cornflakes, Kornies etc.
- [ ] Puffed Rice, Ricies, Rice Bubbles etc.
- [ ] Bran cereal, San Bran, Sultana Bran etc.
- [ ] Other

If you eat breakfast cereal, muesli or porridge, what do you usually add to it ?

- [ ] I don't eat breakfast cereal, muesli or porridge
- [ ] Whole milk
- [ ] 'Trim' milk
- [ ] Non-fat skim milk
- [ ] Fruit juice
- [ ] Soy milk
- [ ] Nothing
- [ ] Other, eg. yoghurt, cream, water etc.

If you eat breakfast cereal, muesli or porridge, how many teaspoons of sugar do you usually add to it ?

_______ teaspoons of sugar

How many slices of these breads do you usually have each day or week ? Remember toast, bread rolls and sandwiches.

White bread	_____ slices per day	or	_____ slices per week
Wholemeal or wholegrain bread	_____ slices per day	or	_____ slices per week
Brown bread	_____ slices per day	or	_____ slices per week
Other bread, eg. fruit or rye	_____ slices per day	or	_____ slices per week

What do you usually spread on your bread ?

- [ ] I don't eat bread
- [ ] Butter
- [ ] Margarine
- [ ] Low-salt or Salt-free butter
- [ ] Low-salt or Salt-free margarine
- [ ] Nothing
- [ ] Other

How often do you usually eat these foods ?

(Tick one frequency, and one serve size for each food)

ham — **medium serve = 2 slices**

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

corned beef — **medium serve = 2 thin slices**

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

luncheon meat or salami — **medium serve = 2 slices**

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

tinned or packet soup (in winter) — **medium serve = 1 cup**

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

homemade soup (in winter)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 cup
- [ ] small
- [ ] medium
- [ ] large

honey, jam or marmalade
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve per slice of bread = 1 tablespoon
- [ ] small
- [ ] medium
- [ ] large

chocolates or lollies
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 Moro sized bar
- [ ] small
- [ ] medium
- [ ] large

nuts
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 2 tablespoons
- [ ] small
- [ ] medium
- [ ] large

mayonnaise or salad dressing (in summer)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 tablespoon
- [ ] small
- [ ] medium
- [ ] large

How many eggs do you eat in an average week (or in a month), not counting eggs used in baking cakes etc ?

_____ per week or _____ per month

How are your eggs usually cooked ?
- [ ] I don't eat eggs
- [ ] Boiled or poached
- [ ] Fried
- [ ] Scrambled or as an omelette
- [ ] Other

How many of these biscuits do you eat in an average day or week ?

Plain biscuits eg. digestive, arrowroot _____ per day or _____ per week

Sweet biscuits eg. cream-filled, chocolate _____ per day or _____ per week

How often do you usually eat these foods ?
(Tick one frequency, and one serve size for each food)

turnip or swede
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup
- [ ] small
- [ ] medium
- [ ] large

parsnip
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup
- [ ] small
- [ ] medium
- [ ] large

green peas
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup
- [ ] small
- [ ] medium
- [ ] large

pumpkin — medium serve = 1/2 cup

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

corn (whole kernel, creamed or on the cob) — medium serve = 1/2 cup or 1 cob

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

carrots — medium serve = 1/2 cup

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

cabbage or coleslaw — medium serve = 1/2 cup

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

mushrooms — medium serve = 1/2 cup

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

silverbeet or spinach — medium serve = 1/2 cup

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

baked beans — medium serve = 1 cup

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

lentils or other beans, eg. kidney, haricot — medium serve = 1/2 cup

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

potatoes: boiled, steamed, mashed, baked — medium serve = 1 potato

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

roast potatoes — medium serve = 1 potato

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

fried potatoes, ie. hot chips or french fries
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 cup
- [ ] small
- [ ] medium
- [ ] large

potato crisps or corn chips
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = medium bag (50 g)
- [ ] small
- [ ] medium
- [ ] large

onions
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_4$ onion
- [ ] small
- [ ] medium
- [ ] large

mixed vegetables, eg. peas and carrots
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup
- [ ] small
- [ ] medium
- [ ] large

When they are in season, how often do you usually eat these foods ?
(Tick one frequency, and one serve size for each food)

brussels sprouts (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 3 large sprouts
- [ ] small
- [ ] medium
- [ ] large

broccoli (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup
- [ ] small
- [ ] medium
- [ ] large

green beans (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup
- [ ] small
- [ ] medium
- [ ] large

cauliflower (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ cup
- [ ] small
- [ ] medium
- [ ] large

celery (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 10 cm stick
- [ ] small
- [ ] medium
- [ ] large

capsicum, ie. green/red pepper (in season) — **medium serve = 1/4 cup**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

tomato (in season) — **medium serve = 1 medium tomato**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

courgettes or zucchini (in season) — **medium serve = 1/2 cup**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

kumara (in season) — **medium serve = 1/2 cup**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

leeks (in season) — **medium serve = 1/2 cup**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

lettuce (in season) — **medium serve = 2 medium leaves**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

asparagus (in season) — **medium serve = 1/2 cup**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

yams (in season) — **medium serve = 1/2 cup**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

When they are in season, how often do you usually eat these foods ?

(Tick one frequency, and one serve size for each food)

fresh apple (in season) — **medium serve = 1 medium apple**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

fresh pears (in season) — **medium serve = 1 medium pear**

- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

- ☐ small
- ☐ medium
- ☐ large

fresh banana (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 medium banana
- [ ] small
- [ ] medium
- [ ] large

fresh orange or mandarin (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 medium orange
- [ ] small
- [ ] medium
- [ ] large

fresh grapefruit (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = $^1/_2$ med. grapefruit
- [ ] small
- [ ] medium
- [ ] large

fresh peach (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 medium peach
- [ ] small
- [ ] medium
- [ ] large

fresh plums (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 2 medium plums
- [ ] small
- [ ] medium
- [ ] large

fresh nectarines (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 med. nectarine
- [ ] small
- [ ] medium
- [ ] large

fresh apricots (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 2 small apricots
- [ ] small
- [ ] medium
- [ ] large

melon, eg. water or rockmelon (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 10 cm slice
- [ ] small
- [ ] medium
- [ ] large

other tropical fruits, eg. feijoas, mangoes (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 piece of fruit
- [ ] small
- [ ] medium
- [ ] large

kiwifruit (in season)
- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 medium kiwifruit
- [ ] small
- [ ] medium
- [ ] large

fresh grapes (in season)
- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = $1/2$ cup
- ☐ small
- ☐ medium
- ☐ large

strawberries (in season)
- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = $1/2$ cup
- ☐ small
- ☐ medium
- ☐ large

How often do you usually eat these foods ?
(Tick one frequency, and one serve size for each food)

stewed fruit
- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = $1/2$ cup
- ☐ small
- ☐ medium
- ☐ large

tinned pineapple
- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = $1/2$ cup
- ☐ small
- ☐ medium
- ☐ large

other tinned fruit
- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = $1/2$ cup
- ☐ small
- ☐ medium
- ☐ large

sultana, raisins, or currants
- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = 2 tablespoons
- ☐ small
- ☐ medium
- ☐ large

dried apricots
- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = 6 halves
- ☐ small
- ☐ medium
- ☐ large

other dried fruit, eg. prunes or dates
- ☐ daily
- ☐ 5 or 6 times a week
- ☐ 3 or 4 times a week
- ☐ once or twice a week
- ☐ monthly (once or twice a month)
- ☐ rarely or never

medium serve = 4 – 5 prunes/dates
- ☐ small
- ☐ medium
- ☐ large

How many cups of tea (including herbal teas) do you usually drink each day ?
_______ cups of tea per day

How many cups of coffee (including decaffeinated) do you usually drink each day ?
_______ cups of coffee per day

How many teaspoons of sugar do you usually add to a cup of tea ? (Do not include artificial sweeteners)
_______ teaspoons of sugar per cup of tea

How many teaspoons of sugar do you usually add to a cup of coffee ? (Do not include artificial sweeteners)
_______ teaspoons of sugar per cup of coffee

How many teaspoons of sugar do you usually add to a cup of milk drink, eg. milo, cocoa ? (Do not include artificial sweeteners)
_______ teaspoons of sugar per cup of milk drink

What do you usually have in tea ?

- [ ] I don't drink tea
- [ ] Milk
- [ ] Cream
- [ ] Nothing
- [ ] Other

What do you usually have in coffee ?

- [ ] I don't drink coffee
- [ ] Milk
- [ ] Cream
- [ ] Nothing
- [ ] Other

What type of milk do you usually have ?

- [ ] I never have milk
- [ ] Whole milk
- [ ] 'Trim' milk
- [ ] Non-fat skim milk
- [ ] Soy milk
- [ ] Other

How many glasses or cups of the following do you usually drink in an average day, week or month ?

Plain milk (as a drink by itself)	____	per day	or	____	per week	or	____	per month
Flavoured milk or milkshake	____	per day	or	____	per week	or	____	per month
Tomato juice	____	per day	or	____	per week	or	____	per month
Fruit juice	____	per day	or	____	per week	or	____	per month
Fruit drink or cordial	____	per day	or	____	per week	or	____	per month
Softdrink, eg. cola or lemonade	____	per day	or	____	per week	or	____	per month
Wine	____	per day	or	____	per week	or	____	per month
Beer	____	per day	or	____	per week	or	____	per month
Spirits	____	per day	or	____	per week	or	____	per month
Water (as a drink by itself)	____	per day	or	____	per week	or	____	per month
Milo, Chocolate, Bournvita or Cocoa	____	per day	or	____	per week	or	____	per month

What type of softdrink or cordial do you drink most often ?

- [ ] Low-calorie
- [ ] Ordinary

Do you usually eat the fat on meat ?

- [ ] I don't eat meat
- [ ] Yes
- [ ] No

Do you usually eat the skin on chicken ?

- [ ] I don't eat chicken
- [ ] Yes
- [ ] No

What type of fat is usually used to fry or roast your meat ?

- [ ] I don't eat fried or roasted meat
- [ ] Butter
- [ ] Dripping or lard
- [ ] Margarine
- [ ] Vegetable oils, eg. sunflower oil, olive oil etc.
- [ ] Other
- [ ] None
- [ ] I don't know

How often do you usually eat these foods ?

(Tick one frequency, and one serve size for each food)

stew, casserole or curry (made with meat)

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 cup

- [ ] small
- [ ] medium
- [ ] large

fried steak

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 10 × 7 cm

- [ ] small
- [ ] medium
- [ ] large

grilled steak

medium serve = 10 × 7 cm

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

fried chops (lamb, mutton or pork)

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

grilled chops (lamb, mutton or pork)

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

How many chops do you usually eat at a time ?

_______ chops

mince meat, eg. savoury mince, rissoles

medium serve = 1/2 cup

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

chicken - fried or roasted

medium serve = 2 legs/wings or 1 breast

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

chicken - boiled, steamed or microwaved

medium serve =2 legs/wings or 1 breast

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

roast meat (lamb, mutton, pork or beef)

medium serve = 2 or 3 slices

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

- [ ] small
- [ ] medium
- [ ] large

fried sausages

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

grilled sausages

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

How many sausages do you usually eat at a time ?

_______ sausages

fried bacon

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

grilled bacon

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

How many rashers of bacon do you usually eat at a time ?

_______ rashers of bacon

liver

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1/2 cup

- [ ] small
- [ ] medium
- [ ] large

fried fish

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 fillet

- [ ] small
- [ ] medium
- [ ] large

fish: baked, grilled, steamed, microwaved

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 fillet

- [ ] small
- [ ] medium
- [ ] large

tinned fish, eg. tuna, sardines or salmon

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1/2 cup

- [ ] small
- [ ] medium
- [ ] large

shellfish, eg. mussels or scallops, or seafood, eg. prawns or crabs

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1/2 cup

- [ ] small
- [ ] medium
- [ ] large

meat pies, pasties or sausage rolls

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 pie/pastie/roll

- [ ] small
- [ ] medium
- [ ] large

gravy

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 2 tablespoons

- [ ] small
- [ ] medium
- [ ] large

tomato sauce

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 tablespoon

- [ ] small
- [ ] medium
- [ ] large

pizza

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 2 wedges

- [ ] small
- [ ] medium
- [ ] large

hot dogs

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 hotdog

- [ ] small
- [ ] medium
- [ ] large

quiche

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 slice

- [ ] small
- [ ] medium
- [ ] large

cheeseburger

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 medium burger

- [ ] small
- [ ] medium
- [ ] large

hamburger

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 medium burger

- [ ] small
- [ ] medium
- [ ] large

muesli or health bars

- [ ] daily
- [ ] 5 or 6 times a week
- [ ] 3 or 4 times a week
- [ ] once or twice a week
- [ ] monthly (once or twice a month)
- [ ] rarely or never

medium serve = 1 bar

- [ ] small
- [ ] medium
- [ ] large

How many servings of fruit do you usually have per day or per week ?

_____ per day or _____ per week

How many servings of vegetables do you usually have per day or per week ?

_____ per day or _____ per week

How many servings of meat (red meat or chicken) do you usually have per week or per month ?

_____ per week or _____ per month

What is your age in years ?

_____ years

What sex are you ?

- [ ] Female
- [ ] Male

Please check that you have answered **all** questions.

Thank you for your cooperation in this study.

F Serving Sizes

Table F1 Serving Sizes

Food No.	Age-Sex Specific	Common Standard	Common Description	Food Item
1	40	60	2 slices or 60 gm	regular cheese, eg. cheddar
2	36	120	1/2 cup	low fat cheese, eg. cottage or ricotta
3	98	70	1/2 cup	icecream
4	123	160	1 pottle	yoghurt, plain or flavoured
5	30	28	2 tablespoons	cream
6	120	120	1/2 cup	custard
7	70	50	1 piece	cakes, buns or scones
8	5	4	1 teaspoon per slice	vegemite or marmite
9	11	16	1 tablespoon per slice	peanut butter
10	137	125	1/2 cup	puddings, eg trifle or fruit crumble
11	148	190	1 cup	rice
12	33	10	2 crackers	crackers, salada or crispbread
13	173	265	1 cup	tinned spaghetti in tomato sauce
14	105	160	1 cup	other pasta, eg. macaroni or noodles
15	197	260	1 cup	porridge
16	65	120	1 cup	muesli--toasted
17	64	120	1 cup	muesli--non-toasted
18	45	40	1 cup	weetbix, weetaflakes, puffed wheat etc.
19	57	40	1 cup	cornflakes, kornies etc.
20	22	40	1 cup	puffed rice, ricies, rice bubbles etc.
21	33	40	1 cup	bran cereal, san bran, sultana bran etc.
22	180	180		whole milk (on cereal)
23	180	180		trim milk (on cereal)
24	180	180		non-fat skim milk (on cereal)
25	180	180		fruit juice (on cereal)
26	180	180		soy milk (on cereal)
27	4	4	1 teaspoon	sugar (on cereal)
28	35	35	1 slice	white bread
29	35	35	1 slice	wholemeal/wholegrain bread
30	35	35	1 slice	brown bread
31	35	35	1 slice	other bread, eg. fruit or rye
32	6	6		butter (on bread)
33	7	7		margarine (on bread)
34	6	6		low-salt or salt-free butter (on bread)
35	7	7		low-salt or salt-free margarine (on bread)
36	42	50	2 slices	ham
37	91	50	2 thin slices	corned beef
38	34	50	2 slices	luncheon meat or salami
39	225	260	1 cup	tinned or packet soup (in winter)
40	220	255	1 cup	homemade soup (in winter)
41	15	20	1 tablespoon per slice	honey, jam or marmalade
42	45	80	1 Moro sized bar	chocolates or lollies
43	35	20	2 tablespoons	nuts
44	18	15	1 tablespoon	mayonnaise or salad dressing (in summer)
45	53	53	1 egg	egg—boiled or poached
46	53	53	1 egg	egg—fried
47	53	53	1 egg	egg—scrambled or omelette
48	12	12	1 biscuit	plain biscuit
49	17	17	1 biscuit	sweet biscuit
50	56	75	1/2 cup	turnip or swede
51	58	80	1/2 cup	parsnip
52	58	80	1/2 cup	green peas
53	105	95	1/2 cup	pumpkin
54	70	130	1/2 cup or 1 cob	corn (whole kernel, creamed or on the cob)
55	55	115	1/2 cup	carrots
56	70	70	1/2 cup	cabbage or coleslaw

Food No.	Age-Sex Specific	Common Standard	Common Description	Food Item
57	40	75	1/2 cup	mushrooms
58	75	55	1/2 cup	silverbeet or spinach
59	163	270	1 cup	baked beans
60	61	110	1/2 cup	lentils or other beans, eg. kidney, haricot
61	150	150	1 potato	potatoes: boiled, steamed, mashed, baked
62	163	150	1 potato	roast potatoes
63	170	225	1 cup	fried potatoes, ie. hot chips or french fries
64	55	50	medium bag (50 g)	potato crisps or corn chips
65	25	20	1/4 onion	onions
66	68	120	3 large sprouts	brussels sprouts
67	60	80	1/2 cup	broccoli
68	38	65	1/2 cup	green beans
69	59	70	1/2 cup	cauliflower
70	24	15	10 cm stick	celery
71	21	65	1/4 cup	capsicum, ie. green/red pepper
72	38	60	1 medium tomato	tomato
73	71	110	1/2 cup	courgettes or zucchini
74	95	140	1/2 cup	kumara
75	44	70	1/2 cup	leeks
76	23	30	2 medium leaves	lettuce
77	50	100	1/2 cup	asparagus
78	76	70	1/2 cup	yams
79	152	130	1 medium apple	fresh apple
80	135	120	1 medium pear	fresh pears
81	108	100	1 medium banana	fresh banana
82	120	165	1 medium orange	fresh orange or mandarin
83	175	100	1/2 med. grapefruit	fresh grapefruit
84	114	90	1 medium peach	fresh peach
85	36	55	2 medium plums	fresh plums
86	123	70	1 med. nectarine	fresh nectarines
87	100	50	2 small apricots	fresh apricots
88	60	100	10 cm slice	melon, eg. water or rockmelon
89	83	100	1 piece of fruit	other tropical fruits, eg. feijoas, mangoes
90	108	100	1 medium kiwifruit	kiwifruit
91	115	100	1/2 cup	fresh grapes
92	57	120	1/2 cup	strawberries
93	81	140	1/2 cup	stewed fruit
94	45	135	1/2 cup	tinned pineapple
95	97	130	1/2 cup	other tinned fruit
96	33	20	2 tablespoons	sultana, raisins, or currants
97	20	30	6 halves	dried apricots
98	29	30	4-5 prunes/dates	other dried fruit, eg. prunes or dates
99	150	150	1 cup	tea
100	200	200	1 cup	coffee
101	4	4	1 teaspoon	sugar (in tea)
102	4	4	1 teaspoon	sugar (in coffee)
103	4	4	1 teaspoon	sugar (in milk drinks)
104	30	30		whole milk (in tea)
105	30	30		trim milk (in tea)
106	30	30		non-fat skim milk (in tea)
107	30	30		soy milk (in tea)
108	20	20		cream (in tea)
109	50	50		whole milk (in coffee)
110	50	50		trim milk (in coffee)
111	50	50		non-fat skim milk (in coffee)
112	50	50		soy milk (in coffee)
113	20	20		cream (in coffee)
114	220	220	1 glass	whole milk (as a drink)
115	220	220	1 glass	trim milk (as a drink)

Food No.	Age-Sex Specific	Common Standard	Common Description	Food Item
116	220	220	1 glass	non-fat skim milk (as a drink)
117	220	220	1 glass	soy milk (as a drink)
118	220	220	1 glass	flavoured milk or milkshake
119	220	220	1 glass	tomato juice
120	220	220	1 glass	fruit juice
121	220	220	1 glass	fruit drink or cordial (low-calorie)
122	220	220	1 glass	fruit drink or cordial (ordinary)
123	220	220	1 glass	softdrink (low-calorie)
124	220	220	1 glass	softdrink (ordinary)
125	100	100	1 glass	wine
126	200	200	1 glass	beer
127	40	40	1 glass	spirits
128	220	220	1 glass	water
129	200	200	1 cup	milo, chocolate, bournvita or cocoa
130	144	230	1 cup	stew, casserole or curry (made with meat)
131	152	85	10 x 7 cm	fried steak (lean)
132	147	90	10 x 7 cm	fried steak (lean & fat)
133	152	85	10 x 7 cm	grilled steak (lean)
134	147	90	10 x 7 cm	grilled steak (lean & fat)
135	111	85	1 chop	fried chops (lean)
136	123	90	1 chop	fried chops (lean & fat)
137	111	85	1 chop	grilled chops (lamb, mutton or pork) (lean)
138	123	90	1 chop	grilled chops (lamb, mutton or pork) (lean & fat)
139	96	110	1/2 cup	mince meat, eg. savoury mince, rissoles
140	66	70	2 legs/wings or 1 breast	chicken - fried or roasted (no skin)
141	78	70	2 legs/wings or 1 breast	chicken - fried or roasted (+ skin)
142	80	70	2 legs/wings or 1 breast	chicken - boiled, steamed, microwaved (no skin)
143	80	70	2 legs/wings or 1 breast	chicken - boiled, steamed or microwaved (+ skin)
144	101	100	2 or 3 slices	roast meat (lamb, mutton, pork or beef) (lean)
145	93	100	2 or 3 slices	roast meat (lamb, mutton, pork, beef) (lean & fat)
146	108	80	1 sausage	fried sausages
147	145	80	1 sausage	grilled sausages
148	26	20	1 rasher	fried bacon (lean)
149	22	20	1 rasher	fried bacon (lean & fat)
150	26	20	1 rasher	grilled bacon (lean)
151	22	20	1 rasher	grilled bacon (lean & fat)
152	104	80	1/2 cup	liver
153	120	65	1 fillet	fried fish
154	108	65	1 fillet	fish: baked, grilled, steamed, microwaved
155	78	125	1/2 cup	tinned fish, eg. tuna, sardines or salmon
156	68	125	1/2 cup	shellfish, eg. mussels or scallops, or seafood, eg. prawns or crabs
157	145	125	1 pie/pastie/roll	meat pies, pasties or sausage rolls
158	58	30	2 tablespoons	gravy
159	43	15	1 tablespoon	tomato sauce
160	205	120	2 wedges	pizza
161	144	80	1 hotdog	hot dogs
162	200	100	1 slice	quiche
163	201	100	1 medium burger	cheeseburger
164	163	100	1 medium burger	hamburger
165	65	80	1 bar	muesli or health bars

G Fruits, Vegetables and Meats included in Adjustment Factors

Table G1 Fruits included in Fruit Adjustment Factor with Seasonality

Fruit	Seasonal Availability (Months)
Apple	9
Pears	9
Banana	10
Orange	10
Grapefruit	6
Peach	4
Plum	4
Nectarines	4
Apricots	2
Melon	2
Other Tropical Fruits	3
Kiwifruit	6
Grapes	3
Strawberries	3

Table G2 Vegetables included in Vegetable Adjustment Factor with Seasonality

Vegetable	Seasonal Availability (Months)
Turnip	10
Parsnip	11
Green Peas	12
Pumpkin	12
Corn	12
Carrots	12
Cabbage or Coleslaw	12
Mushrooms	12
Silverbeet or Spinach	12
Baked Beans	12
Lentils or Other Beans	12
Potatoes: boiled, steamed, mashed, baked	12
Roast Potatoes	12
Fried Potatoes	12
Onions	12
Brussels Sprouts	5
Broccoli	10
Green Beans	12
Cauliflower	12
Celery	12
Capsicum	3
Tomato	9
Courgettes or Zucchini	7
Kumara	9
Leeks	8
Lettuce	12
Asparagus	3
Yams	6

Table G3 Meats included in Meat Adjustment Factor

Stew, Casserole, Curry
Fried Steak
Grilled Steak
Fried Chops
Grilled Chops
Mince Meat
Chicken: Fried or Roasted
Chicken: Boiled,
 Steamed, Microwaved
Roast Meat
Fried Sausages
Grilled Sausages
Fried Bacon
Grilled Bacon
Liver
Fried Fish
Fish: Baked, Grilled,
 Steamed, Microwaved
Tinned Fish
Shellfish
Meat Pies, Pasties,
 Sausage Rolls