

A short review of dietary assessment methods used in National and Scottish Research Studies

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Introduction

The appropriate tool for dietary assessment will depend on the purpose for which it is needed. The purpose may be to measure nutrients, foods or eating habits. To monitor the Scottish Dietary Targets it is necessary to measure both nutrient and food intake although exploration of eating habits may be helpful to understand the process of achieving dietary change. Many different methods have been developed for the purpose of assessing dietary intake. These range from detailed individual weighed records collected over a period of 7 days or more to food frequency questionnaires, household survey methods and simple food lists. Each has merits, associated errors and practical difficulties to be considered when choosing one method above another. Several of the dietary assessment tools described do not collect sufficient detail to assess nutrient intake (and thus progress towards nutrient based targets) but may be capable of assessing and estimating intake of specific foods (and thus some of the food-based targets). Criteria for choosing dietary methods for monitoring the Scottish Dietary Targets are shown in the introduction to the main report.

1. Methods designed to measure food and/or nutrient intakes

In general the procedure for measuring energy and nutrient intake involves:

- (i) A report of all food consumed by an individual
- (ii) Identification of the foods such that an appropriate item can be chosen from standard food tables. In detailed studies a duplicate portion of the food may be chemically analysed to find out the nutrient content
- (iii) Quantification of the portion size of each food item
- (iv) Determination of the frequency with which each food is eaten
- (v) Calculation of the nutrient intake (portion size (g) x frequency x the nutrient content per g).
(Rutishauser and Black, 2002)

To measure food intake alone it is possible to miss out steps (ii) and (v). Indeed if we are only interested in the intake of certain foods it may not be necessary to have a report of all food consumed. However quantification of the amounts eaten is necessary if comparison with a food based target or recommendation is required e.g. the 400g of fruit and vegetables in the Scottish Diet Action Plan Targets

1.1 Weighed Food Records

This involves an individual or an investigator weighing each and every item of food and drink prior to consumption. A detailed description of the food and its weight is recorded in a specially designed booklet. Usually a space is left to record any leftovers so that the precise weight of food eaten can be calculated. Weighed records can be kept for 3,4,5 or 7 days. The 7 day weighed record has often been taken as the 'gold standard' against which less detailed and demanding methods can be compared. It is now recognised that the method also has limitations and it is necessary to use physiological and biochemical methods (e.g. the use of doubly labelled water which measures energy expenditure- energy intakes less than the energy expenditure are likely to be invalid) to check that any method of measuring food intake is measuring what it is supposed to measure. Weighed food records of 7 days or 4 days were used in the National Diet and Nutrition Surveys (see Section 1 of main report).

Strengths

- Widely used method
- Precision of portion sizes

Weaknesses

- High respondent burden
- Mis-reporting
- Expensive
- Food composition data limited

1.2 Estimated Food Records

This is similar to the weighed food record method except that the quantification of the foods and drink is estimated rather than weighed. This estimation is carried out using

- household measures such as cups or spoons
- food photographs
- food models

The investigator converts these estimates into weights that can then be used to calculate food and nutrient intake. The EPIC study (see 3.9) used a 7 day estimated food diary with portion sizes being recorded using household measures and colour photographs

Strengths

- Widely used method
- Lower respondent burden than weighed food diaries

Weaknesses

- Estimation of portion sizes
- Mis-reporting
- Expensive
- Food composition data limited

1.3 24 Hour Recall

This method requires a trained interviewer to ask the respondent to remember in detail all the food and drink they consumed during a period of time in the recent past (often the previous 24 hours). As a retrospective method it relies on an accurate memory of intake, reliability of the respondent not to under / misreport, and an ability to estimate portion size. This may be helped by the interviewer prompting the respondent to remember eating and drinking episodes by time periods (e.g. starting on awakening), or linking to day time activities (e.g. arriving at work). In addition the interviewer may use prompts to assist the respondent to estimate portion sizes of the items consumed. The interviewer records the dietary information which at the end is checked for omission / errors and is then coded for analysis. The primary limitation of this method is that recording consumption for a single day is seldom representative of a person's usual intake due to day-to-day variation. An extended and more accurate version of this method is the Multiple Pass 24 hour recall.

Strengths

- Low respondent burden
- Suitable for large scale surveys
- Can be administered by telephone

Weaknesses

- Estimation of portion sizes
- Single observation provides poor measure of individual intake
- Bias in recording "good/bad" foods
- Memory dependent

1.4 Multiple Pass Recall

This method was developed in the USA to assess diet and nutrition in large population studies; 1999-2000 National Health and Nutrition Examination Study (NHANES) and the Continuing Survey of Food Intakes by Individuals (CSFII). In the USA it has been used to assess the diets of children and adults. The diet is assessed over a period of three to five days during which the respondent is asked to recall and describe all food and drinks consumed in the 24 hour prior to the interview. Interviews can be a combination of face to face and telephone. The *multiple pass* refers to the steps involved during interview to allow revisiting and checking of dietary information: in the *first pass*, a quick list of foods consumed is obtained; in the *second pass*, information about the

meal / snacks consumed (including time and place) are recorded. The *third pass* prompts for foods that may have been forgotten. Finally a review of the record and further details of foods consumed and portion sizes are completed. The method has been modified over the past five year with the specific aim to minimise under-reporting and the burden on respondents.

The method was adapted and validated for measuring energy intake in a Scottish sample of pre-school children. In the validation study (Reilly et al., 2001) of 41 pre-school children aged 3-4 years (23 boys, 18 girls) recall interviews with parents were used to assess diet over 3 consecutive days (two weekdays, one weekend) using both face to face and telephone interviews. For the first recall interview (face to face) the time averaged 15 - 20 minutes. For the second and third recall interview (telephone) it was < 10 minutes. Portion sizes were estimates from household measures and published food portions. The group estimate of energy intake was significantly ($p < 0.01$) greater than energy expenditure (measured using doubly-labelled water) by 11%. The method was found to be quick for investigators and respondents and well tolerated. The bias in estimating energy intake may be reduced by using children's portion sizes to estimate food weights. Data entry can be labour intensive.

The multiple pass methodology is currently being used in the UK wide Low Income Diet and Nutrition Survey (LIDNS) described in Section 1 of the main report.

Strengths

- Improved precision compared with 24 hour recall
- Low respondent burden
- Suitable for large scale surveys
- Can be administered by telephone

Weaknesses

- Estimation of portion sizes
- Bias in recording "good/bad" foods
- Memory dependent

Further details on NHANES can be found on the following website:

<http://www.cdc.gov/nchs/about/major/nhanes/datalink.htm>.

1.5 Food Frequency Questionnaires (FFQ) and semi-quantitative FFQs

At its simplest, the food frequency questionnaire consists of a list of foods and a selection of options relating to the frequency of consumption of each of the foods listed (e.g. times per day, daily, weekly, monthly). FFQs are designed to collect dietary information from large numbers of individuals (100 individuals or more) and are normally self-administered, though interviewer administered and telephone interview are possible modifications (Haraldsdottir et al., 2001). FFQs normally ask about intake within a given time frame (e.g. in the past 2-3 months, 1 year or longer) and therefore aim to capture habitual intake. The length of the food list can vary depending on the nutrients or foods of interest. If a range of different nutrients and energy values are required, the list of foods may be upwards of 150 foods whereas the Ca/VitDFFQ described below contains just 11 food items since the major sources of the nutrients of interest are found in relatively few food types. Many FFQs also attempt to collect information about portion size in addition to frequency of consumption. These may be referred to as semi-quantitative FFQs. Where portion size information is not obtained standard food portion sizes (MAFF 1993) are often used to calculate nutrient intakes as is done for many of the FFQs based on the Caerphilly questionnaire (Yarnell et al., 1983) Although there are difficulties implicit in calculating the absolute nutrient intake of individuals from food frequency questionnaires, they are useful for gathering information on groups of individuals as well as for looking at habitual intake of a range of foods.

Food lists are a type of FFQ used in the Scottish Health Survey and the various Health and Lifestyle Surveys carried out by individual health boards. These are brief questionnaires designed to measure specific dietary behaviours (Cade et al., 2001). It is not possible to measure nutrient intake from these questionnaires and depending on the foods and frequencies specified it may be difficult to look at adherence to specific dietary targets. However, Lean et al., (2003) described how the dietary questions from the Scottish Health Survey could be used for limited monitoring of the Dietary Targets. They measured relative validity using the MONICA FFQ (see 3.7 and Section 4 of the main report) and found that there was a bias to underreporting fruit and vegetables and starchy foods, but not fish using the Scottish Health Survey questionnaire.

Strengths

- Low respondent burden
- Suitable for large scale surveys
- Can be self completed
- Can be posted

Weaknesses

- Estimation of portion sizes (though use of food photographs may improve precision)
- Possible over-reporting of 'healthy' foods (e.g. fruit and vegetables)
- Requires to be validated in relation to reference method

1.6 Household Food Surveys

A number of surveys aim to collect information about dietary intake at the household level. The most notable of these, in terms of monitoring long term UK dietary intake, is the Expenditure and Food Survey (EFS) and its predecessor the National Food Survey (NFS), which together provide information on UK food expenditure and food and nutrient intake trends over a period of more than 40 years. The EFS and NFS are covered in detail in Section 1 of the main report.

Some market research surveys relating to food purchases trends are conducted at the household level (see Sections 1 and 5 of the main report).

Recently, a feasibility study has highlighted the potential of utilising large quantities of readily available data generated from supermarket checkouts in dietary surveys (Ransley et al., 2001). The association between fat and energy measured by supermarket till receipts and 4 day weighed records was found to be strong.

Till receipts are also collected as part of the new Expenditure and Food Survey (see Section 1 of the main report)

Strengths

- Suitable for large scale surveys
- Designed for monitoring diet trends at the population level (e.g. the NFS/EFS)

Weaknesses

- Data not collected at the individual level

1.7 Methods measuring nutritional status (non biological)

Nutritional assessment tools are frequently used in clinical practice but few have been developed scientifically for use in public health studies. The Nutrition Assessment questionnaire (described 3.10 and in the summary tables for Section 4 of the main report) was developed to identify individuals at risk of marginal and poor micronutrient **status** (as opposed to dietary intake) living within the community.

2. Issues Relating to Dietary Assessment.

2.1 Derivation of Portion Size

In all dietary assessment methods, where food is not weighed, portion sizes must be applied before nutrient output can be calculated. There are a number of methods by which portion sizes may be obtained. These may include field workers weighing certain food items on the individual's behalf, the use of photographic atlases (e.g. Nelson et al., 1997) showing portion sizes of commonly eaten foods, data from manufacturers, portion sizes collected from previous weighed food records, and household measures. The rigour required in applying portion size is well illustrated by the methods used in the North/South Ireland Food Composition Survey (Harrington et al., 2001). See Appendix 1.

2.2 Under reporting

A recently completed Food Standards Agency (FSA) funded study (Project NO8001: Detecting and Modelling Misreporting of Food Intake with Special Reference to Under-reporting in the Obese) has investigated the problems of "under reporting" commonly recognised in association with dietary assessment methodology. Recommendations compiled from the report are included in Appendix 2. A summary of the report can be found at:

<http://www.food.gov.uk/science/research/NutritionResearch/n08programme/n08projectlist/n08001project/>

Full copies of the report can be obtained from the FSA.

The key findings and conclusions from the report are summarised below:

- A change in eating behaviour occurs when individuals are asked to record their intake (**observation effect**) and
- Individuals may mis-report their changed eating behaviour (**reporting effect**)
- The observation effect appears to have certain macronutrient specificity in that women reduce their fat intake (-12%) and men their alcohol intake (-13%). Overall the observation effect, in the studies reported, led to a decrease of 5% of energy intake.
- The reporting effect is more variable (5-20%,) depending on intake measurement used. The reporting effect does not appear to be macronutrient specific.
- The mis-reporting effect was more marked in individuals when the measurements were carried out in their own homes as compared to a controlled laboratory setting.
- It is also difficult to predict mis-reporting based on subjects' sex, age, Body Mass Index (BMI), dietary restraint and other psychomotor parameters. This is because the observation and reporting effects are both normally distributed, and neither accounts for a large percentage of the variance in the discrepancy between "true" and reported intake. Although most people, when observed, will demonstrate both the observation and reporting effects these do not aggregate into discrete clusters making these effects difficult to predict.
- The sensitivity and specificity of the Goldberg (Goldberg et al., 1991) cut- offs (the "accepted" method for detecting under reporting) is poor at detecting a change in eating behaviour as subjects appear to demonstrate both the observation and reporting effects at all times.

Conclusions

It is important to recognise that the current state of many data sets in diet surveys are difficult to interpret. Furthermore, the removal of the lowest energy intake to basal metabolic rate values from a data set does not remove all, or even the majority of under-reporters, and thus distorts the data further.

- To improve the interpretation of future dietary survey data, the following is strongly recommended:

- Use of Weighed Diet Records, of at least 7 consecutive days, repeated if possible, as the method of choice. This measurement should be made in the context of energy balance. Ideally, volunteers should be weighed before, during and after the study and should also include an energy expenditure measurement.
- The structure of the sample should be balanced (e.g. with respect to BMI) rather than random.
- The duration, representativeness and the type of data collected should be reviewed.
- Every survey should feature intensive components in which the sub-sample mirrors the structure of the main sample.

The continued collection of data, which is difficult to interpret, is no substitute for greater effort and investment required to assess discrepancies between true and reported intake. A smaller amount of high quality data is infinitely more valuable than a large amount of data, which cannot be relied upon.

3. Details of dietary assessment methods used in Scottish Studies

Detailed descriptions of the dietary assessment tools used in the studies described in summary tables for Section 4 of the main report are given below.

Many epidemiological studies being carried out in Scotland are using Food Frequency Questionnaires. Other method in use in research studies include weighed food records, non-weighed records, multiple pass recall and food lists.

3.1 Scottish Collaborative Group-MRC Food Frequency Questionnaire (SCG-MRC/FFQ)

A number of epidemiological studies in Scotland and England are currently using or have recently used the SCG-MRC/FFQ. This questionnaire has been derived from the dietary questionnaires used in the Scottish Heart Health/ MONICA Study which is described in Section 3.7 (Bolton-Smith & Milne, 1991). Collaborators in the development of this questionnaire are scientists at the University of Aberdeen and the MRC Human Nutrition Research, Cambridge.

The SCG-MRC/FFQ is a research tool designed to estimate the daily intake of a wide range of nutrients, usually over a 2-3 month period, in epidemiological studies in the UK. It is semi quantitative and includes 166 commonly eaten foods or drinks organised into 19 food groups.

Nutrient Output from the SCG-MRC/FFQ

Questionnaire analysis is carried out at the University of Aberdeen after data has been entered, either into the SCG-MRC/FFQ Access data entry programme or by optical scanner at the University of Aberdeen.

The output provides the nutrient intake from food and drink for each subject as:

Nutrients per day

Nutrients per food group per day

Nutrients per food per day

Nutrients routinely analysed are those in the McCance and Widdowson's Composition of Foods (5th Edition plus related supplements).

Additional databases have been developed for specialist use. These include values for fatty acids, phytoestrogens, flavanoids and Vitamin K. Data about dietary supplement use is collected by the SCG-MRC/FFQ but nutrient intake from supplements is not calculated by the analysis package.

Validity of the SCG-MRC/FFQ

In a validation study in 41 men and 40 women aged 18-50years, Spearman correlation coefficients between intake by FFQ and 4-day weighed record were above 0.5, indicating good agreement in ranking, for saturated fat, NSP, alcohol, folate and iron in men and women and for total fat, MUFA, PUFA, sugar, starch, vit E, vit C and zinc in women (Masson et al., 2003)

3.2 Pre-School Food Frequency Questionnaire (PSFFQ)

Recently, a modified version of the SCG-MRC/FFQ designed to measure diet and nutrient intake in children aged 4-5 years has been developed. This questionnaire includes 120 foods and drinks in 16 groups and also collects information on the use of dietary supplements. Output is provided for nutrients in McCance and Widdowson's Composition of Foods (5th edition plus related supplements) as nutrients per day, per food group and per food per day. Validation of this questionnaire is planned for 2004.

3.3 Aberdeen Prospective Osteoporosis Screening Study (APOSS) Diet and Physical Activity Questionnaire. (APOSS/DPAQ)

The APOSS/DPAQ has been used in a number of studies of diet and bone health carried out under the umbrella of ASPOSS (New et al, 1997 & 2000, MacDonald et al., 2001a, 2001b & 2003). As many of the subjects recruited for the APOSS are being studied longitudinally, the APOSS/DPAQ has remained essentially unchanged since its development in 1993

The APOSS/DPAQ was designed specifically for the study of nutrients associated with bone health using, as its basis, the Scottish Health Heart/MONICA Questionnaire (Bolton-Smith & Milne, 1991). The APOSS/DPAQ contains 98 foods organised into 20 sections and contains sub-sections on both present and past food intake (up to 12 years and 30 years previously). Additional sections of the questionnaire are designed to collect data on dietary supplement use, dietary habits and physical activity. Data relating to sunlight exposure are not collected by this questionnaire but are collected by a separate short questionnaire.

Nutrient Output from the APOSS/DPAQ

Nutrients are calculated using McCance and Widdowson The Composition of Foods (5th Edition plus related supplements) and the output is presented as nutrients per person per day. A database of vitamin K values was added in 2001/2.

Validity of the APOSS/DPAQ

It has been validated against 7 day weighed records (New, 1995) by biochemical markers of antioxidant intake (Bodner et al., 1998) and its short-term reproducibility has been tested (New, 1995).

3.4 Ca and Vitamin D Food Frequency Questionnaire (Ca&VitDFFQ)

The Ca&VitDFFQ was devised in Aberdeen specifically for the MRC RECORD trial to estimate baseline calcium and vitamin D intake (including dietary supplements) and to score sunlight exposure in those aged 70 years and over. The Ca&VitDFFQ was based on an earlier questionnaire designed to estimate calcium intake (Nelson et al., 1988) and on dietary sources of calcium and vitamin D published by the National Diet and Nutrition Survey of people aged 65 years and over (Finch et al., 1998). In addition, data was collected on the calcium and vitamin D content of commonly used dietary supplements to enable these supplements to be grouped in the questionnaire.

Nutrient output from this questionnaire is based on McCance & Widdowson's Composition of Foods (5th edition plus related supplements).

This short questionnaire consists of 5 dietary questions about food types eaten in relation to calcium and 6 in relation to Vitamin D. There are 3 additional questions relating to dietary supplements containing Vitamin D and 2 relating to calcium.

3.5 EPIC FFQ

This is a 10-page A4 document with questions on 130 foods developed by Bingham et al., (2001) as part of the dietary assessment methodology for the UK arm of the European Prospective Investigation of Cancer (EPIC). It consists of food list with an accompanying multiple response grid in which respondents can estimate the frequency of foods eaten on average over the past year.

A variation of the EPIC FFQ is currently being used in Scotland (Sharp, study ongoing) and in addition the ability of the EPIC FFQ to estimate nutrient intakes in Scottish adolescents was tested by Lietz et al., 2002. They found it to be adequate for classifying high medium and low consumers but agreement with weighed records in this population was very poor, demonstrating that the EPIC FFQ is not an appropriate method estimating absolute intake in Scottish adolescents.

3.6 DALDI FFQ

The population-specific Food Frequency Questionnaires (FFQ's) called DALDI (diet/anthropometry/lifestyle data instrument), were developed to assess the concordance of dietary and lifestyle behaviours with the 1997 World Cancer Research Fund/ American Institute of Cancer Research (WCRF/AICR) recommendations for the prevention of cancer in 4 countries. The WCRF/AICR recommendations include dietary and lifestyle habits including food preparation (low temperature of cooking) and preservation, physical activity and body weight.

The questionnaire includes a 137-items dietary semi-structured questionnaire together with open ended questions on food preparation methods, food preparation methods and lifestyle (physical activity, use of supplements and smoking).

Participants were asked to report frequency of eating, for example, total cheese per week, bowls of breakfast cereal, and tablespoons of pasta.

The Scottish questionnaire was posted to be self-administered.

Portion sizes for the Scottish questionnaire were derived from a combination of sources including the adult food portions book (MAFF 1993) and data from the photographic atlas of food portions (Nelson et al., 1997)

Foods and nutrients are being calculated from the semi-quantitative data produced.

It is currently being validated against 7-day weighed food diaries and 24 hour urine collections.

3.7 MONICA study FFQ

This FFQ was the same as that used in the Scottish Heart Health Study of 1983 The food frequency questionnaire was developed from one already validated against weighed intake in both a Welsh (Yarnell et al., 1983) and a Scottish population (Bolton-Smith & Milne, 1991). The food frequency questionnaire asked subjects about frequency of consumption (number of days each week, once a month, rarely or never) of over 65 different foods and drinks. It is possible to measure nutrients from this semi-quantitative questionnaire. The FFQ was administered in all four of the Scottish MONICA (MONItoring trends and determinants in CARDiovascular disease) independent random population surveys in 1986, 1989, 1992 and 1995. It was updated as necessary for specific new items, which means that care has to be taken when comparing the different years. However a paper has been recently submitted taking this into account, and which specifically addresses the progress toward the food-based targets of the Scottish Diet Action Plan (Wrieden et al., 2003)

3.8 Caerphilly (and Tinuviel) FFQs

This questionnaire was developed by the Medical Research Council Cardiff Group in the early 1980s for use in epidemiological studies of coronary heart disease (Yarnell et al., 1983). The Tinuviel is a commercially available version of this FFQ. (Tinuviel Software, Warrington UK)

3.9 EPIC Food Diary

Recently, Welch et al., (2001) have reported improved validity of dietary data collected by the EPIC Food Diary (a non weighed record) as compared to the EPIC FFQ. The diary comprises an A5, 45-page booklet in which the description and the amount of foods eaten and meal times over a 7 day period can be recorded. There are detailed instructions about the type of information the subject is required to record and the diary contains 17 sets of colour photographs to help subjects describe their portion sizes.

A suite of in-house databases and programmes, Data into Nutrients for Nutritional Research (DINER) has been developed to convert the dietary information into nutrient data. Portion size estimates used in the diary are converted to weights and linked to codes for tables of food composition. The tables are updated and extended as new data becomes available. The DINER database contains data for approximately 7190 foods **in addition** to the Royal Society of Chemistry (RSC) published data on 2460 foods. For example, the DINER database has 50 different codes for muesli which are linked (either singly or proportionately depending on composition) to the three codes for muesli published by the RSC to match their individual compositions as best as possible. Portion weight data were obtained from direct weighing of foods and from published data. On average each diary takes approximately 2 hours to code (including checks).

One study, currently being carried out by MacDonald in Aberdeen, uses the EPIC food diary and EPIC portion weights but the analysis is being carried out using the 6th edition of McCance and Widdowsons and supplements. Although it is possible to carry out data analysis in this way it cannot be designated as an EPIC method in any publications.

Details of the EPIC study are given at the end of the summary tables for the main report.

3.10 Nutrition Assessment Questionnaire (NAQ)

In contrast to other studies included in the summary table for section 4 of the main report the study by McNeill et al., 2002 focussed on the development of a nutritional assessment tool. This tool is currently being used by Avenell to measure baseline nutritional status in a study of nutritional supplementation and infection in an elderly population. This 18- item, health and diet questionnaire was designed to identify people over 75 years living in the community who are at increased risk of deficiency of iron, folate, vitamin C and Vitamin D. The 18 items were selected from 114 questions and anthropometric measurements and their association with micronutrient status assessed from blood samples taken from 201 men and 197 women aged 75 years and over in Aberdeen. (McNeill et al., 2002).

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APPENDIX 1: Quantification of food diaries in the North/South Ireland Food Consumption Survey

A hierarchical approach was developed, with foods and drinks being quantified by eight specific methods according to a quantification protocol. If it was not possible to quantify a food or drink by one method a subsequent method was used.

The 8 methods of food quantification were:

1. Weighing. Weights of certain foods were obtained by the fieldworkers using portable scales. Foods in this section included weights of cereals, milk on cereals, milk in tea and spreading fats on bread.
2. Photographic atlas. The atlas, consisting of 61 colour prints, was specifically designed for the survey and included foods commonly eaten in Ireland. The majority of food weights shown in the photographs were derived from UK average portion weights.
3. Manufacturers Information. Weights printed on packaging were collected from foods including confectionary, franchised fast foods, canned or bottled goods and packaged bakery goods. Respondents were asked to collect all packaging in a storage box provided and this information was added to the computer analysis programme.
4. Irish Universities Nutrition Alliance (IUNA) information. In this, average portion sizes of certain foods, including fruits, vegetables, processed meats, meat products, cakes, breads, and takeaway foods were ascertained by the survey team.
5. Data collected as part of previous UK surveys, including weights on cereals, meat dishes, desserts/puddings, vegetables, sauces and others. Source unpublished data, BME Livingstone.
6. MAFF Food Portion sizes.
7. Household measures.
8. Estimated. Foods were defined as estimated if the field worker made an estimate based on their knowledge of the respondents eating habits.

APPENDIX 2: Recommendations from FSA Funded Project NO8001: Detecting and Modelling Misreporting of Food Intake with Special Reference to Under-reporting in the Obese.

1. The following references are made to enhance the ability to detect and account for behavioural and reporting discrepancies in dietary intakes.
2. Diet surveys should incorporate longer periods of assessment or multi-records of repeated days of the week-similar to the NHANES III.
3. Recruitment in large- scale studies should be based on structured samples with reference to subject age, sex, BMI, restraint and other individualistic traits.
4. All diet surveys need to incorporate estimates of change in energy balance, of physical activity and of Basic Metabolic Rate (BMR).
5. Further work is required to develop a mis-reporting questionnaire for post-hoc administration in diet surveys.
6. The EI:BMR cut-offs should be used not to detect mis-reporting per se but as apart of a more extensive analysis involving measures of the components of the energy balance equation.
7. The effect of mis-reporters is best appreciated by analysis with and without distorted dietary intakes using graded assessments of the degree of mis-reporting. This is a form of post-hoc modelling. The quality of these analyses will depend on the quality of data collected that relates to energy balance. We recommend that this approach is far more appropriate than exclusion of mis-reporters. This is because of the continuous nature of this trait.
8. Further scrutiny should be made of the current biomarkers. Limitations in cost or accuracy of energy expenditure measures need to be addressed. The principle and practises underlying the nitrogen balance method requires further assessment. This is also true for totality of urine collections. They are often so poor as to render the nitrogen balance method useless.
9. Since mis-reporting and the observation effect are difficult to predict every effort should be made to quantify them in each specific survey. This is especially so in view of the fact that at the individual level the Goldberg cut-offs are useless to detect mis-reporting. While they have utility in comparing one population to another they are more frequently misused to identify individuals who have not misreported. Thus the problems associated with mis-reporting in dietary surveys can be best addressed by improvement of measurement approaches at the individual level and analytical approaches at the population level.
10. Given the analysis of differences between actual and reported intakes we would recommend using weighed dietary records as a method of choice. This has the advantage of being to some extent a quantitative technique. Additional methods could be used for corroboration but not instead of energy balance methods, which are more important. There is considerable scope using modern technology to adapt weighed recording technique to improve assessments. For instance it should now be quite easy to generate a device that both weighs and photographs the food eaten.

11. We recommend that investigators do not confront subjects about the quality of the data produced, as this changes the experimental circumstances and alters the demand characteristics of the study. We predict this would increase errors due to observation effect. Post hoc questionnaires are more useful in this regard.
12. Considerable work needs to be done in assessing the efficiency of combining different means of EE. We can begin these analyses in the present datasets as EE has been measured in the context of total energy balance using 7 different techniques for assessing EE.

The main thrust of these recommendations is that more time, money and resources be spent improving the quality of dietary data collection, especially with reference to energy balance at the individual level.