National Diet and Nutrition Survey Rolling Programme

Comparison Study

A comparison of results by dietary assessment method: repeat 24-hour recall and four-day estimated diet diary

April 2008 (updated September 2020*)

Alison Stephen, Birgit Teucher, Les Bluck, Darren Cole, Emily Fitt, Adrian Mander, Rachel Woodward, Anthony Wright (MRC Human Nutrition Research)

Beverley Bates, Claire Deverill, Helen Mackenzie, Caireen Roberts, (National Centre for Social Research)

Jenny Mindell (Joint Surveys Team at University College London)

*Edited for publication

CONTENTS

1 Executive Summary

In 2004, The Food Standards Agency ("the Agency") made the decision to initiate a rolling programme for the National Diet and Nutrition Survey (NDNS), covering all age groups from 18 months to the elderly surveyed on a continuous basis, and in 2006, contracted a consortium of the National Centre for Social Research (*NatCen*), MRC Human Nutrition Research (HNR) and the Joint Surveys team at University College London (UCL) to conduct the programme. Following considerable discussion of the dietary assessment method to use for the programme, it was decided to conduct a study to compare the two possible methods that might be adopted, a repeat 24-hour recall method as used in the Low Income Diet and Nutrition Survey (LIDNS) and a commonly used method in the United States, and an estimated or unweighed diary, which is more commonly used in the UK. The repeat 24-hour recall is a retrospective method with four days of dietary information collected; the estimated diary is a prospective method, for which four days of collection was chosen as the appropriate duration to optimise compliance, yet obtain sufficient days of dietary data to reflect intake over the survey period.

The comparisons of particular interest in relation to these two methods were:

a. response rate, since these had been decreasing over time in past NDNS surveys, presenting challenges for the representativeness of the resulting dietary intake data;
b. experience in the field, in terms of ease of operation for interviewers and comprehension by respondents; and
c. completeness of the dietary data and degree of under, adequate and over-reporting.

The opportunity to conduct a significantly sized study prior to the main rolling programme also enabled a number of other new aspects of the programme to be explored. Most particularly, there is a growing need for reliable data on physical activity in the population, obtained using methods that do not incur significant respondent burden, but which can provide detailed and complete information about all types of physical activity undertaken during the period surveyed. Moreover, given that the rolling programme involves all age groups of the population, there is a need to have methods for physical activity that are suitable for the varying age groups, including young and school aged children, where assessment of physical activity is particularly challenging. The comparison study therefore enabled investigation of both newly designed detailed physical activity questionnaires, and the objective measurement of physical activity, ActiGraph™ device, proposed to be used in children. See Comparison Study for the NDNS RP: measuring physical activity and energy expenditure.

Inclusion of a substudy assessing energy expenditure using doubly labelled water (DLW) on a sample of the comparison study respondents provided an opportunity both for assessing completeness of the two dietary assessment methods being compared, and validation of the physical activity questionnaires and the ActiGraph™.

The comparison study was set up to cover a nationally representative sample of Great Britain, broadly reflecting the anticipated design of the NDNS RP and surveying both adults and children over the age of four years. Interviewers administered both types of dietary assessment within their survey locations to ensure no interviewer bias. DLW subjects were obtained as a quota sample of eight individuals in each of 20 age and sex cells. Physical activity questionnaires were administered to all respondents over the age of 11 years; ActiGraphs™ were provided and instruction for use given to all those participating in the DLW substudy and to all 11-15 year olds in the study.

Fieldwork was carried out from February to July 2007, following which response rates and acceptability of both the 24-hour recall and the diet diary, for both interviewers and respondents, were analysed and compiled. This, plus the evaluation of the acceptability of the two methods were discussed with the Agency to assist determination of the method to be used in the NDNS rolling programme. In the months following the end of fieldwork, the dietary records and diaries were coded using the DINO (Diet In Nutrients Out) dietary assessment system, and converted into nutrients. The physical activity questionnaires and ActiGraph™ data were converted into energy expenditures and the DLW urine samples were analysed by mass spectrometry and Total Energy Expenditure (TEE) calculated. A comparison of the energy intakes by the two different dietary assessment methods and the extent of misreporting by each method were presented in a preliminary report, submitted to the Agency in February 2008.

This report provides the compilation of the response rate report, the preliminary report on energy intakes and misreporting and the analysis of the dietary data for nutrients.

Dietary results are presented here for 1067 individuals, 504 completing the repeat 24-hour recall and 563 completing the four-day diary. Results of the substudy for the misreporting as assessed using DLW, are for 157 individuals. Results for nutrients intakes were weighted so that they reflect the British population of persons aged over four years, in terms of age, sex and region, and also take account of any selection bias in the sampling procedure.

The results of the comparison study indicate that there are few substantial differences between the two dietary assessment methods, in terms of response rate, acceptability in the field, energy intake, or extent of misreporting. The main outcomes of the comparison study were:

a. the response rate for the 24-hour recall was 49% of respondents in productive Catering Units completing three or four dietary days, while the response rate of the estimated diet diary was 52%, with no difference between methods;

b. both dietary assessment methods presented some challenges in the field for interviewers and respondents; one of the main determinants of the chosen method was the need to include two weekend days in the dietary assessment period, which was more difficult to achieve for the recall method for both interviewers and respondents;
c. there were few differences in energy intake for the two dietary assessment methods. Only in one group was there a difference between the methods, in men aged 35-49 years, where the energy intakes using the diary were lower than those for this age group using the 24-hour recall
d. there were few differences in misreporting between the two assessment methods. Both methods had substantial under-reporting, particularly in certain age and sex groups, but these did not present in any consistent direction; there appeared to be slightly more over-reporting with 24-hour recall in young children than with the diary; and
e. there were no substantial differences in intakes of macronutrients (carbohydrate, fat, protein, total sugars, non-milk extrinsic sugars (NMES), protein), non-starch polysaccharide (NSP) or selected micronutrients (calcium, iron, folate, and vitamin C) by dietary assessment method. Results were also similar to past NDNS surveys of older people (1994-95), young people (1997) and adults (2000-01).

The comparison study therefore demonstrated that both repeat 24-hour recall and estimated diet diary provide similar information on dietary intake. Given that the decision to adopt the diary was made in August 2007 based on the response rate and acceptability in the field, the dietary results and those from the DLW substudy provide helpful information going forward into the main rolling programme:

a. the response rate in the comparison study was lower than the target of 55% as outlined by the Agency for the rolling programme. However, the comparison study was conducted over a very short window of time and there will be longer period for interviewers to pursue addresses during the main study;
b. there is a need for extra attention in instructing and checking the diaries of men, particularly those aged 35-49 years, to ensure that there is an understanding about detail required and the extent of completeness necessary for a reliable dietary record. Where there may be lack of understanding of food detail in this group, there is a need to encourage liaison with the food provider for more detail of the food items consumed;
c. with a high degree of underreporting, women over the age of 65 years also need extra attention to ensure completeness with encouragement to note foods down as they eat them, and not trust to memory, which may be less than optimal at this age; and
d. there appeared to be a tendency for over-reporting with children. The fact that some over-reporting occurred with the diary as well as with recall indicates reasons beyond the invention of foods by the confusing of days where foods were eaten. It may be that some of the over-reporting is due to larger than consumed portion sizes for this age group, suggesting a need for further investigation of the portion sizes consumed by young children, since both methods

incurred over-reporting in this age group. While this could be attributed to ”phantom foods” in the recall, this is not possible with the diary and hence higher than expenditure energy intakes may be a result of portions that are too large.

In conclusion, the comparison study has shown equivalent response rates, comparable experiences in the field, similar energy and nutrient intakes, and similar extent of misreporting by the two dietary assessment methods compared. Increasing the response rate to the goal of 55% and addressing the challenges of specific age-sex groups point to methodological considerations that need to be taken into account during training and implementation of the main stage of the survey.

2 Introduction

The Food Standards Agency ("the Agency") commissioned a collaboration comprising the National Centre for Social Research (*NatCen*), the MRC Human Nutrition Research (HNR) based in Cambridge and the Department of Epidemiology and Public Health at the Royal Free and University College London Medical School (UCL) to carry out a comparison study to determine the most appropriate method for collecting information on diet for the main National Diet and Nutrition Survey (NDNS).

2.1 The NDNS rolling programme

The Agency's information needs are obtained through its dietary survey programme, of which the NDNS is the major component. In the past, the NDNS involved a series of cross-section surveys, each covering a different age group: pre-school children (1½-4½ years); school-aged children and young people (4-18 years); adults aged 19-64 years; and older adults aged 65 and over. Although there was an adult survey conducted in a similar way in 1986/87 (Dietary and Nutritional Survey of British Adults), this was not part of the NDNS programme. The first survey of the NDNS programme proper was carried out in 1992-93. Since then there has been a survey about every three years, with the most recent carried out in 2000-01.

A key feature of the NDNS programme is that it combines a number of different types of information, including data on food intake, biochemical measures of nutritional status, measures of body composition and physical activity for each individual in the survey.

The rolling programme will be continuous, covering all ages 1.5 years and above. The specific aims of the NDNS rolling programme are to:

- provide quantitative data on the food and nutrient intakes, sources of nutrients and nutritional status of the UK population;
- provide information on trends in food consumption, nutrient intake and nutritional status in different age groups;
- describe the characteristics of individuals with intakes of specific nutrients above or below the national average;
- produce a database of food consumption which will be used to calculate intakes of natural toxicants, contaminants, additives and other food chemicals;

- measure blood and urine indices that provide evidence of nutritional status or dietary biomarkers, and to relate these to dietary, physiological and social data;
- provide height, weight and other anthropometric measurements and examine their relationship to social, dietary, biochemical and health data;
- monitor the diet of the population to establish the extent to which it is adequately nutritious and varied;
- monitor the extent to which the diets of population sub-groups vary from expert recommendations;
- assess physical activity levels and patterns in the study population; and
- provide information on oral health status in relation to diet and nutritional status.

2.2 Purpose and design of the Comparison Study

2.2.1 Aims of the Comparison Study

The specific aims of the comparison study were to:
(a) compare the response rates achieved with two methods of dietary data collection – a four-day unweighed diary ('the diary') and four interviewer-administered recalls of food consumed in the past 24 hours (the '24-hour recall');
(b) compare the quality of data achieved with the two methods and the degree of under-reporting;
(c) test a new physical activity questionnaire;
(d) investigate the feasibility of using physical activity monitors with children in a household-based study;
(e) validate the new physical activity questionnaire against an objective measure of energy expenditure;
(f) test questions on food consumption and social and domestic circumstances affecting consumption; and
(g) investigate the feasibility of obtaining more detailed information on food packaging (add-on).

Aims (a), (b) and (g) are covered in this report. Aims (c)-(e) are reported separately. Aim (f) is not covered under the remit of the reports but the CAPI questions were checked before being included in the mainstage.

The key elements to the Comparison Study were as follows:

- face-to-face interview conducted using CAPI (computer assisted personal interviewing);
- dietary data collection (four-day diary or four 24-hour recalls);
- anthropometric measurements (height and weight); and
- a sub-study involving Doubly Labelled Water (DLW) and physical activity monitors (ActiGraphs™) for a sub-sample of respondents.

The comparison study covered England, Wales and Scotland[1] and sampled people living in private residential Catering Units (CUs)[2] only. The sample included adults and children (aged four and older)[3]. Pregnant and breastfeeding women were excluded.

Half of the sample were asked to provide dietary information through four 24-hour recalls while the other half were asked to complete a four-day estimated (unweighed) food diary. Methods were assigned randomly but the same method was used with both the adult and child respondent in any single CU. The method could not be changed – if the respondent was unwilling to take part using one method, the interviewer could not offer the alternative method.

Prior to starting fieldwork, interviewers attended a three-day training course, at which they were fully briefed on the administration of the survey. The briefing sessions covered background and content, doorstep approach, questionnaire administration (including practice sessions), administering of both dietary data collection methods and practical training in taking height and weight measurements. Interviewers were also briefed on the background and protocols for the DLW and ActiGraph™ sub-study.

2.2.2 The Interviewer Visits

Interviewers made up to four main visits to a participating CU, depending on the dietary method used. The interviewer visits covered:

- questionnaire administration (the interview was an interviewer-administered CAPI questionnaire carried out face-to-face);
- collection of dietary data for four days using either the 24-hour recall method or a diary; and
- the taking of physical measurements of standing height and weight, following detailed protocols.

The number of interviewer visits depended on the dietary method (24-hour recall or diary). The following table summarises the tasks at each visit.

	24-hour recall sample	**Diary sample**
1st visit	CAPI questionnaire Height and weight measurements 1st 24-hour recall	CAPI questionnaire Height & weight measurements Place diary
2nd visit	2nd 24-hour recall	Collect diary & complete checklist CAPI modules:physical activity, sun exposure Give token of appreciation Introduce DLW and ActiGraph™ if applicable
3rd visit	3rd 24-hour recall	N/A
4th visit	4th 24-hour recall CAPI modules:physical activity, sun exposure,eating habits in recall period Give token of appreciation Introduce DLW and ActiGraph™ if applicable	N/A

Additional interviewer visits were made to the sub-sample of respondents taking part in the DLW/Actigraph sub-study. These visits involved administering the DLW dose, instructing respondents how to wear the ActiGraph™ and showing them how to complete the paperwork associated with the follow-up study. Interviewers then returned to the household to collect urine samples, physical activity monitors and the accompanying paperwork.

2.2.3 Tokens of appreciation

In acknowledgement of the amount of time and effort respondents were asked to devote to this study, we offered a token of appreciation to those who completed three or four 24-hour recalls or a diary for three or four days (i.e. those defined as 'fully productive'). The tokens were £40 in high street gift vouchers for each respondent.

Those who took part in the DLW/ ActiGraph™ sub-study, and who provided at least one sample of urine post-dosing and who wore the ActiGraph™ for at least one day received £30 in high street gift vouchers. Any child aged 11-15 years who took part in the ActiGraph™ only sub-study, also received £30 in high street gift vouchers.

2.2.4 Ethical approval

Research ethics approval for the NDNS Comparison Study was obtained from the Cambridge 4 Multi-centre Research Ethics Committee (MREC), study reference no. 07/MRE05/11.

[1] The mainstage sample will include Northern Ireland
[2] The CU is the primary grouping for this study. It is a group of people "who eat food that is bought and prepared for them (largely) as a group". Occasionally a household will be found to

consist of more than one CU. Although people may share accommodation and even be related, they may not be in the same CU. For example, adult children sharing a house with their

parents may shop, cook and eat by themselves, in which case the parents would be in one CU and the children in another

[3] The main NDNS will include individuals aged age 1.5 years and older.

3 Methods

3.1 Sample design

3.1.1 The sample

The sample was drawn from the publicly available Postcode Address File (Small Users) (PAF). The sample consisted of 1,840 addresses in 80 postcode sectors (points) across England, Wales and Scotland. Each point (assignment) had 23 issued addresses. Roughly half an assignment was allocated at random to the 24-hour recall method and half to the diary method, to give interviewers experience of both dietary methods.

An advance letter was sent to each address, introducing the study and explaining that the interviewer would be calling. In Wales, a Welsh version of the letter was sent to all issued addresses, along with the English version.

At each address, the interviewer enumerated the number of households and in cases where there were two or more, selected one at random. Within each selected household the CUs were enumerated and one randomly selected.

3.1.2 Respondent selection

In CUs containing at least one child aged four or older, interviewers selected one adult (aged 19+ years) and one child (aged 4-18 years) at random. In CUs with no such children, just one adult was selected.

The selected respondents were asked to take part in the CAPI interview, the collection of dietary information (through recall of four 24-hour periods or via a four-day diary) and have their height and weight measured. If the adult selected was not the 'Main Food Provider (MFP)'[1], this person was also invited to take part in a short CAPI interview.

A sub-sample of 160 respondents were recruited to a sub-study, to assess total daily energy expenditure using the doubly labelled water method (DLW). This involved the respondent drinking a glass of water labelled with the stable isotopes of hydrogen and oxygen, ^{2}H and ^{18}O, (tracer water) and collecting spot urine samples, both before the dose of labelled water and on 10 consecutive days after the dose. The DLW sub-sample, plus all children aged 11-15 years, were also asked to wear an ActiGraph™ (physical activity monitor) for seven consecutive days.

3.2 CAPI data collection

The main interview for the Comparison Study was carried out using computer-assisted personal interviewing (CAPI). The CAPI questionnaire had three elements:

- 'Household Structure' interview
- Main Food Provider (MFP) interview
- Individual interviews

The questionnaire was organised into a number of modules that could be accessed at different times at the interviewer's discretion.

The 'Household Structure' interview allowed the structure of the catering unit to be established, with questions about:

- those living in the catering unit's accommodation;
- the relationship of each person in the catering unit to everyone else;
- the 'Household Reference Person' (HRP);
- the 'Main Food Provider' (MFP);
- the individual respondent(s);
- the nature of tenure of the accommodation.

The Household interview also established each person's sex, date of birth or age, relationship of members of the catering unit to each other, work status and ethnicity.

The MFP questionnaire was divided into the following sections:

- Cooking facilities
- Shopping for food
- Free foods
- Barbecue use
- Food preparation
- Cooking skills

The individual questionnaire had two parts:

- CAPI 1, which was asked before the dietary data collection period; and
- CAPI 2, which was asked after the dietary data collection period.

The individual questionnaire was divided into a number of sections. Each section of CAPI 1 and CAPI 2 is shown in order below, and the intended respondent(s) are indicated:

CAPI 1 Sections	Respondent
• Cooking Skills (Adult)	All respondents 19+ years (or 16+ years and in full time employment)
• Access to Food at School	All respondents 4-18 years (unless if 16+ years and in full time employment)
• Cooking Skills (Child)	All respondents 4-18 years (unless if 16+ years and in full time employment)
• Usual Eating Habits	All respondents
• Education	All respondents 19+ years (or 16+ years and no longer at school)
• Job/Income	All respondents 19+ years (or 16+ years and in employment)

CAPI 2 Sections	Respondent
• Eating Habits over the past 2 weeks	All respondents in 24-hour recall sample
• Physical activity (Adult)	All respondents 16+ years
• Physical activity (Child)	Respondents 11-15 years
• Exposure outdoors	All respondents

If a respondent was eligible for, and agreed to take part in, the DLW and/or ActiGraph™ part of the study, there was a third part to the questionnaire, CAPI 3. CAPI 3 included administrative questions about DLW and the ActiGraph™, as well as re-administering the physical activity questionnaire.

3.3 Anthropometry

All respondents aged four and over were eligible to have their height and weight measurements taken with the exception of pregnant or breastfeeding women. Heights and weights were measured during the interviewer visit following the introduction of the diary or after the first 24-hour recall had been completed.

3.3.1 Height

Height was measured using a portable stadiometer with a sliding head plate, a base plate and three connecting rods marked with a metric measuring scale. The respondents were asked to remove their shoes, stand facing forwards with their feet flat on the centre of the base plate, feet together and heels against the rod. Respondents were asked to stretch to their maximum height with their head positioned in the Frankfort plane. A maximum of three measurements were taken, the third required if the difference between the first two measurements was greater than 0.5cm. The readings were

recorded to the nearest millimetre. An average of the two closest measurements was used for analysis.

3.3.2 Weight

Weight was measured using Soehnle, Seca and Tanita electronic scales with a digital display. Respondents were asked to remove shoes and any bulky items of clothing. A single measurement was recorded to the nearest 100g. Respondents who weighed more than 130kg did not have a valid measurement recorded because the scales are inaccurate above this level.

In the analysis of height and weight, data from those that interviewer considered to have unreliable measurements were excluded from the analysis.

3.3.3 Body Mass Index

Body Mass Index (BMI) is a widely accepted measure of weight for height and is used to define overweight or obesity. BMI is defined as weight (kg)/height^2 (m). However BMI does not distinguish between mass due to body fat or muscular physique, and does not take into account the distribution of fat around the body.

BMI was calculated for all respondents for whom both a valid height and weight measurement was recorded. Respondents aged 19+ years were categorised using the WHO classification into the following groups:

BMI (kg/m^2)	**Description**
18.5 or less	Underweight
Over 18.5-25	Desirable
Over 25-30	Overweight
Over 30	Obese

Overweight and obesity prevalence for children aged 2-18 years was estimated using the age and sex-specific UK National BMI percentiles classification. Different growth patterns among boys and girls at each age mean that a universal categorisation cannot be used to define childhood overweight/obesity. The UK National BMI percentiles classification gives the BMI threshold for each age above which a child is considered overweight or obese. The classification estimates were produced by calculating the percentage of boys and girls who were over the 85th (overweight) or 95th (obese) BMI percentiles of the 1990 reference population.

3.4 Energy Expenditure

3.4.1 Doubly-labelled water (DLW)

Study design

Because of cost and logistical limitations it was not considered feasible to perform DLW measurements in every respondent in the comparison study. Accordingly measurements were made in a subset of respondents using the two dietary assessment methods, in five age ranges, and further subdivided by sex. Previous calculations had indicated that, with an assumed total coefficient of variation (CV) in the comparison study of 20%, a bias in reporting of 20% would be detected at 5% significance and 80% power with eight respondents. Therefore the target was to recruit eight respondents to each of the 20 age/sex groups, yielding 160 respondents in all (see Table 3A). This represents 16% of the intended total number of participants in the comparison study.

Table 3A DLW recruitment quota (number of respondents)

Age (years)	24-hour recall		Diary	
	Male	Female	Male	Female
4 – 10	8	8	8	8
11 – 15	8	8	8	8
16 – 49	8	8	8	8
50 – 64	8	8	8	8
65+	8	8	8	8

The control of recruiting into each of the sub groups for the comparison study was the responsibility of HNR and once a particular cell was filled no more DLW subjects were recruited for that age/sex group.

Interviewer training

On day three of the briefings, interviewers were introduced to the DLW method of energy expenditure measurement, and briefed on matters of eligibility, consent, dosing protocols, urine collection requirements and general field operations. The briefing session was split into two sections, the first giving a simplified account of the scientific rationale behind the DLW method, and the second describing the practicalities of the fieldwork required in measuring energy expenditure and in particular the requirements of the interviewers and consenting respondents in the study.

Recruitment

The DLW method was introduced at the end of the final main visit to the household, when respondents had finished their dietary data collection. To be eligible respondents had to have provided dietary data for at least three recall/diary days, and also to have provided accurate height (or

demi-span) and weight measurements. Respondents also had to agree to all of the requirements of te DLW substudy.

Summary of field procedures for DLW

Once basic eligibility criteria had been established for the respondent to take part in the DLW study and written consent had been obtained the following procedures were followed:

1. An instruction leaflet and pre-dose kit was given to the respondent
2. HNR was contacted with respondent details (serial number, age, sex, height and weight) and a dose and sampling kit requested
3. The respondent was checked against the quota. If the respondent was not required, HNR informed the interviewer, who relayed this to the respondent, and a £10 voucher was dispatched
4. If the respondent was required, details were logged and a custom-made dosing and sampling kit (comprising the dose, drinking straw, ten pre-labelled sample bottles, a pen, and a returns bag) was dispatched to the interviewer via a traceable delivery service.
5. The interviewer then revisited the respondent, and first ensured that the respondent was still willing to continue with the study. If so, and once it was certain that a pre-dose urine sample had been obtained, the respondent was asked to drink the dose using the straw provided. The bottle was then refilled with tap water and the washings drunk again to ensure complete consumption of the dose. The date and time of dosing was recorded.
6. The respondent was then instructed to supply daily urine samples (not the first void of the day) for a period of ten days. Plastic cups were provided by the interviewer to aid collection, one clean cup for each collection. When each urine sample was collected the respondent was required to note the date and time on both their logging form and on the sample bottles themselves.
7. The respondent was asked to store the samples in a cool and preferably refrigerated place using all the packing material provided until the end of the 10-day study period.
8. The interviewer was required to telephone each respondent half way through the collection period to ensure correct compliance and to make sure no problems were being encountered. The interviewer then returned after the end of the sampling period to collect the samples and dispatched the full sampling kits back to HNR using a traceable delivery service.
9. On receipt of the samples at HNR the samples were logged into the sample reception system, and frozen at –20^{o}C until analysis.

Dose Preparation

The DLW dose was tailored according to each respondent's body weight. An aliquot of water containing the equivalent of 80mg/kg body weight ^{2}H and 150mg/kg body weight ^{18}O was cold filtered into an autoclaved bottle with a tight fitting seal. The bottle was marked to indicate the level of filling, so that the interviewer could detect gross spillage on delivery and request a replacement if necessary. A sample of the dose was kept frozen at -20^{o}C for compositional analysis performed as part of the mass spectrometric determinations.

Result computation

(a) Raw mass spectrometric data: Isotope ratios ($^{2}H/^{1}H$ or $^{18}O/^{16}O$) are measured in the both the sample and also in a reference gas of arbitrary composition during each sample assay. Isotope ratios are reported as fractional increments ('delta values') of the reference gas composition.

$$\delta_{samp,ref} = \frac{\left(R_{samp} - R_{ref}\right)}{R_{ref}}$$

(b) Standardized mass spectrometric data: Included in every analysis batch are samples derived from two waters, which have an isotopic composition traceable back to international standards. These waters are selected to have isotopic compositions $\delta_{1,ref}$, and $\delta_{2,ref}$ at either end of expected range of enrichments. The international standard for this work is V-SMOW (Vienna Standard Mean Ocean Water), and the delta values of these waters with respect to V-SMOW, $\delta_{1,V-SMOW}$ and $\delta_{2,V-SMOW}$ are known. The raw data mass spectrometric data can then be standardized to the V-SMOW scale by using:

$$\delta_{samp,V-SMOW} = \frac{\left(\delta_{2,V-SMOW} - \delta_{1,V-SMOW}\right)}{\left(\delta_{2,ref} - \delta_{1,ref}\right)}\left(\delta_{samp,ref} - \delta_{1,V-SMOW}\right) + \delta_{1,V-SMOW}$$

This is an implementation of the SMOW/SLAP correction often referred to in the literature

(c) Normalization of mass spectrometric data: A sample of the dose given is also analysed for isotopic composition along with the urine samples. Since the enrichment of the dose exceeds the dynamic range of the mass spectrometer it is first diluted by weighing out a small aliquot (d) into a known volume (T) of local tap water. Normalisation of the mass spectrometric data by the dose is then achieved by:

$$\Delta_{samp} = \frac{18.02d}{DT}\frac{\left(\delta_{samp,V-SMOW} - \delta_{basal,V-SMOW}\right)}{\left(\delta_{d,ref} - \delta_{T,ref}\right)}$$

Where Δ_{samp} is the normalised enrichment, D the weight of the dose given, and the factor of 18.02 is the relative molar mass of (unlabelled) water.

(d) Derivation of kinetic parameters from standardized mass spec. data: From the assumption of a monocompartmental model of water distribution with elimination following first-order kinetics it follows that the normalised enrichments should decay exponentially with time

$$\Delta_H(t) = \frac{1}{N_H}\exp\{-k_H t\}$$
$$\Delta_O(t) = \frac{1}{N_O}\exp\{-k_O t\}$$

Where the subscripts H and O denote hydrogen and oxygen isotopes respectively. Following Cole and Coward.[1] These equations are transformed by taking the logarithm of quotient and product

$$Ln\{Q(t)\} = Ln\left\{\frac{N_H}{N_O}\right\} - (k_H - k_O)t = Ln\{I_Q\} - k_Q t$$
$$Ln\{P(t)\} = Ln\frac{1}{N_H N_O} - (k_H + k_O)t = Ln\{I_P\} - k_P t$$

Linear regression is then be used to find N_Q, k_Q, N_P, and k_P, which are then combined to transform back to the original variables

$$N_H = 1/\sqrt{I_Q I_P}$$
$$k_H = (k_P + k_Q)/2$$
$$N_O = I_Q/\sqrt{I_Q I_P}$$
$$k_O = (k_P - k_Q)/2$$

(e) Calculation of CO_2 Production: Carbon dioxide production is calculated from the kinetic parameters obtained via

$$F_{CO_2} = \frac{N_O k_O - N_H k_H - F_s(f_2 - f_1)}{2f_3 + q(f_2 - f_1)}$$

In this equation F_S represents the skin losses, which are fractionated, taken to be 27.3moles per day for adults in a temperate climate, and q the fractionated respiratory losses expressed as a fraction of CO_2 production taken to be 1.1 under similar conditions. $f_1 = 0.941$, $f_2 = 0.991$, and $f_3 = 1.037$ are fractionation factors for ^2H leaving the body as water vapour, ^{18}O leaving via the same route, and the exchange of ^{18}O between carbon dioxide and water respectively.

(f) Calculation of total energy expenditure :Total energy expenditure is calculated from CO_2 production rate assuming that 12% of total energy is derived from protein oxidation[2]

$$TEE = (15.480/RQ + 5.550)F_{CO_2}$$

with the respiratory quotient RQ taken as 0.85

Quality control and assurance

(a) Quality Control applied to the batch of samples being analysed: In addition to the samples of reference waters used in normalising the mass spectrometer results, other reference waters are included in the sample batch. The analytical performance of the equipment was monitored using these, and if an analysis was obtained which deviated by more than 2.5% of that expected then the results from that batch were discarded.

(b) Quality Control applied to individual samples: Each sample was analysed in duplicate. In the event of the duplicate analyses differing by more than 7‰ absolute or 1% relative (whichever is greater) then the analysis was repeated.
(c) Quality control during kinetic analysis - Outlier identification: Since the model requires a logarithmic relationship between normalised mass spectrometric data and time for both the ^{2}H and the ^{18}O analytes, visual inspection of the semi-logarithmic plots of the experimental and fitted data were routinely performed to identify outliers.
(d) Investigation of quotient and product plots: Short-term fluctuations in water turnover produce covariant deviations from the model for the ^{2}H and ^{18}O. One of the advantages of the transformations described is that this covariance can be observed visually. If severely non-covariant data were observed then the samples were re-analysed.

Precision of the estimates of TEE.

With the procedures described the precision (calculated as described by Cole and Coward[1] is expected to be of the order of 5% (coefficient of variation). The method allows an individual estimate of the precision of the DLW method to be obtained for each subject, for use in subsequent analysis.

Supplementary calculations

Total energy expenditure (TEE) is highly dependent on age and on the level of physical activity. It can be considered to have two contributing terms: the basal metabolic rate (BMR), which is the energy requirement to maintain life, and the energy, expended in activity (AEE). The BMR is calculated from predictive equations[3], according to the equations outlined in Table 3B.

Table 3B Equations used to calculate BMR

Age (years)	Sex	BMR MJ/d
3 – 10	Male	0.082W+0.545H+1.736
	Female	0.071W+0.677H+1.553
10 – 18	Male	0.068W+0.574H+2.157
	Female	0.035W+1.948H+0.837
18 – 30	Male	0.063W-0.042H+2.953
	Female	0.057W+1.184H+0.411
30 – 60	Male	0.063W-0.042H+2.953
	Female	0.034W+0.006H+3.530
60+	Male	0.038W+4.068H-3.491
	Female	0.033W+1.917H+0.074

W is the subject's weight (kg), and H height (m).

3.5 Dietary data collection

3.5.1 24-hour recall

Respondents in the 24-hour recall sample were asked by the interviewers to recall their food and drink consumption over four non-consecutive 24-hour periods. The day before the first individual CAPI interview was selected as the first 'recall day'. Following that, the laptop randomly selected one day in the week as the second, third and fourth 'recall day' ensuring that both weekend days had been selected. Each of the four days was at least two days apart.

Interviewers were permitted to substitute days if necessary. The preferred type of flexibility was to allocate as substitute the same day of the week as originally allocated, but one week later. At the very least, if a non-weekend day had to be missed, another non-weekend day was substituted, and if a weekend day was missed, another weekend day was substituted**.** If a CU contained two respondents, both were assigned the same four recall days.

The 24-hour recall method used was the 'triple pass' method. Initially, respondents were asked to provide a 'quick list' (first pass) of all the items that they ate or drank on the previous day (midnight to midnight). This was done without interruption from the interviewer. Next the interviewer went through the 'quick list' gathering details to identify fully each item of food and drink and to quantify the amount consumed (second pass). Respondents (adults and children) could describe portion sizes using a) the Photographic Atlas of Food Portion Sizes[4] ('the food atlas'), b) household measures when no reference photograph was available in the food atlas or c) weights taken directly from packets (e.g. yoghurts, confectionery, other convenience foods). The food atlas involved the respondent selecting one of, on average, eight different portion sizes of an identical or a similar food to the one consumed. Respondents were also asked separately about any leftovers. A 'third pass' consisted of the interviewer probing for additional foods consumed at each occasion mentioned, as well as between occasions. Each recall took approximately 35 minutes to complete.

For consistency, all interviewers followed a standard protocol telling them exactly what to say, the order in which the recall should be carried out and when to refer to other materials such as showcards.

Recalls for children aged 12 and under were conducted with the parent/carer responding as necessary on the child's behalf unless the child was able to provide the information for themselves.

Interviewers were permitted to conduct the third recall over the telephone if they felt it was appropriate to do so. Telephone recalls were conducted in 31% of cases. Respondents aged 65 and over were less likely to have a telephone recall.

Finally, interviewers completed a feedback questionnaire as soon as possible after each 24-hour recall interview. This provided an indication of how complete or accurate they considered the information given by the respondent to be.

3.5.2 Unweighed food intake diary

Respondents in the diary sample were asked to keep a record of all they ate or drank over a consecutive four-day period including both weekend days. The laptop selected the four consecutive days. If a CU contained two respondents, both respondents were assigned the same diary days. Interviewers placed the diary with the respondent and then collected it as soon as possible after the four-day dietary recording period had finished.

When placing the diary interviewers followed written instructions on how to explain it to the respondent. Interviewers went through the different sections of the diary including an instruction page, information on how respondents should describe their food and drink and how much they consumed, and a completed example day. The information provided for the respondent covered a range of different types of food and various descriptions of portion size. The diary provided photographs of 15 frequently consumed foods as small, medium and large portion sizes which respondents could use for identical or similar foods. Otherwise they were asked to record portion sizes in household measures. For packaged foods that were consumed as such, respondents were instructed to note the weight consumed in the diary (e.g. yoghurts, confectionery, ready meals). Respondents were also asked to collect the food label information/wrappers for any unusual foods and ready meals consumed to help coders identify or clarify food and drink consumed.

Two versions of the diary were provided: an A5 diary for adults and a larger A4 diary for children. The examples given for how to record food and drink were appropriate for age. For children aged 12 years and under, the parent/carer was asked to complete the four-day diary with help from the child as appropriate. If necessary, additional detail and information was obtained from the MFP (if they were not completing the diary on behalf of the child). Children over 12 years were asked to complete the diary themselves but interviewers were expected to confirm details, where necessary, with the MFP.

Respondents were asked to record food and drink consumed at home and away from home (e.g. restaurant, friend's house and school). Therefore, they were expected to take their diary with them when they are away from home. For young children this meant another adult such as a teacher or friend's parent completing the diary for the child. The diary was collected at the second visit no later than three days after the last diary day. Interviewers were instructed to review the diary with the respondent present to identify and edit (in green pen) possible omissions and missing detail. An interviewer checklist for guidance was provided.

As for the 24-hour recall, interviewers were asked to complete feedback on each diary, as soon as possible after collecting it, to record how complete or accurate they felt the information recorded by the respondent was.

3.6 Dietary data processing

3.6.1 DINO – Dietary assessment system for NDNS data processing

Data from the 24-hour recalls and diaries was entered into a modified version of HNR's dietary assessment system DINO (Diet In Nutrients Out).[2] DINO, written in Microsoft Access, is an all-in-one dietary recording and analysis system. Foods, food groups, and respective nutrient values were imported from the Agency's nutrient databank to ensure consistency (see section 3.6.3).

Within the DINO analysis program, total available carbohydrate has been calculated as starch plus free sugars (glucose, fructose, sucrose, maltose and lactose) all expressed as monosaccharides. Energy from carbohydrate was calculated as monosaccharide equivalents (grams) *3.75 kilocalories and monosaccharide equivalents (grams)*16 kilojoules. In the Agency's nutrient databank, total sugars includes other sugars that are not generally considered to be available; these were therefore subtracted from total sugars to arrive at a value for free sugars that was added to the value for the starch as described above.

DINO holds a table of respondents containing the respondent serial number, date of birth and sex, prided by NatCen. When coding a diet, the coder was required to enter these details, which were validated against these data. This requirement prevented accidental input of diet against a wrong respondent.

Where a respondent consumed a homemade recipe each individual food was flagged with the food group of the recipe. DINO has the capability to report on these foods both at the recipe level and food level, which will facilitate a clearer picture of consumption of components like meat, fish and vegetables. This approach means that it has been possible to reduce the number of foods in the nutrient databank by more than 4000, as it no longer needs to hold numerous variations of the same dish. Having fewer food codes has improved coding efficiency and consistency.

3.6.2 Coding and editing

Summary of coding

The 24-hour recall booklets and diaries were returned by the interviewers to NatCen's Operations Department. The data entry was carried out by NatCen and HNR coders who were all trained by the study nutritionists. Coders assigned a food code and a portion code from DINO to each item of food and drink recorded in the 24-hour recall or diary. For composite items, which could be split into their

component parts, for example sandwiches, each individual component was assigned a code. Coders could refer to questions in the diary and information collected from relevant sections of the face-to-face interview regarding eating habits and food preparation to assist in coding. For the diary only, wrappers and labels collected by respondents were useful when coding especially for weights of items. If an item had been recorded and there was no suitable code in DINO or there was insufficient detail to code the food, it was assigned an “unknown food” code. Coders did not code homemade recipes or dietary supplements: the nutritionists coded these during the editing stage.

Within DINO, each food code was linked to appropriate portion size descriptors for that food, which were then linked to the correct weight for that particular food. These descriptors were mainly household measures (e.g. small portion, large glass, tablespoon). The option of coding a food consumed as small, medium or large portion was based on the Agency’s reference book on Food Portion Sizes (3rd edition)[5]. In addition, where portion size was described as a weight, the weight could be entered directly in grams. However, for the 24-hour recall, there were no descriptors in DINO corresponding to the eight photographs in the food atlas. Therefore, for data entry and method comparison purposes (24-hour recall versus diary), these were either entered as weights or categorised into small (photos 1 and 2), medium (photos 3 to 5) or large (photos 6 to 8) and entered as such.
Additional information was entered for each food and drink item, such as food packaging, the place where the food was consumed and with whom the food was consumed. Coders could flag any entry so that it would be checked by the study nutritionists. After entering a diet record, coders could make a comment on the overall quality and completeness of the recall or diary.

Food queries: type and rate by method
For a proportion of 24-hour recalls (33%) and diaries (35%), all of the entries flagged by coders were categorised by the study nutritionists into eight query types and a record kept of the number of each type for each of the two methods. The eight categories were:

A Food code not available in DINO.

B portion code not available in DINO.

C Food is a recipe (all recipes were entered by the nutritionists).

D missing/insufficient detail to code food: included foods eaten away from home where the respondent wouldn't always be able to provide adequate detail.

E missing/insufficient detail to code portion.

F check requested by coder/nutritionist: included any food or portion that the coder was unsure about that did not fall into categories A-E and where the nutritionists wished to manually QC the entry (which was the case for a number of pictures in the Food Atlas).

G packaging.

H other: included queries related to non-nutrition fields such as place.

Overall, the average number of queries per respondent was very similar for both methods: 20.2 for the 24-hour recall and 19.6 for the diary. As shown in Table 3C, insufficient detail to code the food was the most common query raised by coders for both methods, accounting for 30% of all queries for the 24-hour recall and 39% for the diary. However, no distinction was made between those foods where details had not been recorded either by the interviewer or the respondent and where details may not have been known (often the case when foods were consumed outside of the home). For the 24-hour recall, the second highest proportion of queries was raised as a result of checks requested by the nutritionists or the coders: 23% compared with only 7% for the diary. This was mainly because of the checks needed when certain pictures in the Food Atlas were used. Insufficient detail to code the portion made up 16-23% of all queries for both methods. Initial concerns that interviewers and respondents would find describing packaging daunting and difficult meant that queries relating to packaging warranted their own group. In the end, packaging queries accounted for only 1-2% of the total. However, 16% of all food items coded were missing a packaging code because packaging type was not specified by the interviewer in the 24-hour recall or the respondent in the diary. This was particularly the case for the diary where 21% of all food items were missing a corresponding packaging code.

Table 3C Type of query raised by coders, by dietary method

Query type			24-hour recall	Diary
Food code not available	Average number per respondent		2.0	2.1
	% of all queries		10	11
Portion code not available	Average number per respondent		1.9	1.9
	% of all queries		10	10
Recipe	Average number per respondent		1.4	1.3
	% of all queries		7	6
Insufficient detail to code food	Average number per respondent		6.0	7.6
	% of all queries		30	39
Insufficient detail to code portion	Average number per respondent		3.3	4.4
	% of all queries		16	23
Check requested by coder/nutritionist	Average number per respondent		4.7	1.4
	% of all queries		23	7
Packaging	Average number per respondent		0.3	0.4
	% of all queries		1	2
Other	Average number per respondent		0.8	0.5
	% of all queries		4	3
Base			*352*	*377*

Editing and dealing with missing data

After data entry, the 24-hour recalls and diaries were passed onto the study nutritionists. The nutritionists assigned appropriate codes for all flagged food and portion codes and checked any other queries raised by the coders.

In general, where pertinent details for the coding of foods were missing, formally agreed default codes were used by the study nutritionists. For example, milk in tea or coffee in a café or lasagne eaten at a restaurant. Where portion sizes were missing, an estimate was made using (in order of preference) the same weight if the food was consumed on another dietary day, or a portion size consistent with

the respondent's usual consumption e.g. small, medium or large or an age-appropriate average portion.

For new products not in DINO, the nutritionists visited supermarkets or contacted the manufacturer to obtain information on nutrient content in order to decide whether a new food code was needed. This decision was based on nutritional composition compared to that of existing codes and the frequency of consumption and was made with advice from the Agency. If a new food code was required, the nutrient content was entered into the databank (see section 3.6.3). If a portion was used but there was no corresponding portion code on DINO, a new portion code was created using either a weight from an equivalent food, or the food item was weighed and the weight entered into DINO for future use.

For homemade dishes where a recipe had been recorded, the ingredients were entered individually using the appropriate cooked food code. Furthermore, each individual food code that made up a recipe was allocated a recipe food group. The weight of each cooked ingredient was calculated using the raw weights recorded by the respondent, a weight loss for the whole dish (from a comparable recipe in McCance and Widdowson's The Composition of Foods series[6-16] and the weight of the portion consumed. Where the food was stated as homemade but there was no recipe given, a standard homemade recipe food code was chosen.

In cases where the interviewer had recorded a missing meal or there was inadequate detail to code a large part of the day's intake, the whole day was deleted and analysis was carried out using the three remaining dietary days.

Coding error rate

At the start of coding process, the nutritionists checked two entire 24-hour recalls and two diaries for each coder and gave them individual feedback on the standard of their work. For a random 10% of all diet records (5% for each method) the nutritionists undertook a further 100% full check of all food and portion code entries. This ensured that error rates were contained for all the coders working on the project and helped identify any coding issues.

3.6.3 NDNS databank modifications and additions

Intakes of nutrients were calculated from the records of food consumption using a specially adapted nutrient databank. The nutrient databank was originally developed for the Ministry of Agriculture, Fisheries and Food (MAFF) for the Dietary and Nutritional Survey of British Adults[17]. It was updated for the National Diet and Nutrition Surveys of children aged 1½-4½ years[18], people aged 65 years and over[19], and young people aged 4-18 years[20]. Further revisions and updates were carried out by the Agency for the NDNS Survey of adults aged 19-64 years[21] and for LIDNS[22].

The nutrient databank was revised again by the Agency for the comparison study with many nutrient values updated and some new codes added to accommodate new products that had become available as well as additional standard homemade recipes. Specific food groups that were revised included; bread, breakfast cereals, sausages, bacon and ham, cheese, baked beans, savoury snacks, fast foods, ready meals, fish based products, potato products, sauces, canned pasta, flours and grains. The databank now contains over 4000 foods and drinks, including manufactured products, homemade recipe dishes and dietary supplements. Each food on the databank has values assigned for 54 nutrients and energy (see below). Some foods have additional values for niacin, tryptophan/60 and selenium. The nutrient values assigned to the foods in the databank are based on data from the Agency's rolling programme of nutrient analysis of foods, which are also incorporated into McCance and Widdowson's The Composition of Foods series. Data obtained from food manufacturers were also used in the databank, as was nutritional information given on labels. All data were carefully evaluated before being incorporated into the databank.

In order to calculate the nutrient intakes from consumption data it is important that there are no missing values on the databank. For some foods reliable information was not available for all nutrients. Therefore it was necessary to estimate nutrient values for such foods by referring to similar foods. For homemade dishes and manufactured products where no nutrient data were available, nutrients were calculated from their constituents using a computer recipe program that allows adjustments to be made for weight and vitamin losses on cooking.

The nutrients included in the analysis for this report and their units are given in table 3D.

Table 3D Nutrients used in report and their units

Nutrient	Units
Energy	kJ (17 x protein) + (37 x fat) + (16 x carbohydrate) + (29 x alcohol) [1]
Energy	kcal (4 x protein) + (9 x fat) + (3.75 x carbohydrate) + (7 x alcohol) [1]
Carbohydrate	g (sum of sugars plus starch, expressed as monosaccharide equivalents) [1] and as % energy
Total sugars	g (total sugars, expressed as monosaccharide equivalents) and as % energy
Non-milk extrinsic sugars	g (includes all sugars in fruit juices, table sugar, honey, sucrose, glucose and glucose syrups added to food + 50% of the sugars in canned, stewed, dried or preserved fruits) and as % energy
Fat	g and as % energy
Protein	g and as % energy
Non-starch polysaccharides (NSP)	g (expressed as Englyst method)[23,24]
Alcohol	g and as % energy

Calcium	mg
Iron	mg
Folate	μg
Vitamin C	mg

[1] In the databank, carbohydrate is calculated as the sum of free sugars (glucose, fructose, sucrose, maltose and lactose) and other sugars such as oligosaccharides plus starch. In this analysis, total available carbohydrate was calculated as starch plus glucose, fructose, sucrose, maltose and lactose only and did NOT include oligosaccharides. Energy from carbohydrate was calculated using the values for total available carbohydrate (see section 3.6.1)

3.7 Dietary feedback to respondents

Providing dietary feedback to respondents was considered a potential incentive for people to participate and would therefore improve survey response rate. The aim was to provide results for each respondent for selected nutrients and to compare these to the UK guidelines for nutrient intake. It was acknowledged that it was not appropriate for the feedback to provide individually tailored dietary advice, but directions to useful websites for healthy eating advice were provided.

3.7.1 Format of feedback

Feedback was provided within three to four months of participation in the study so that it was relevant and would retain credibility as an incentive to take part. The format and content of the feedback itself was therefore determined by the type of data that could practically be provided within three months. In terms of data processing this limited the data available for feedback to information on nutrient intake rather than types of foods consumed or their contribution to nutrient intake.

In deciding on the format and content of the feedback the following considerations were also taken into account:

- Selection of nutrients that were likely to be of interest to respondents
- Format of presentation that could be automated and produced within the three-month time frame
- Graphical presentation of results that could be understood by a layperson
- Provision of additional information about a healthy diet that would be of interest to respondents

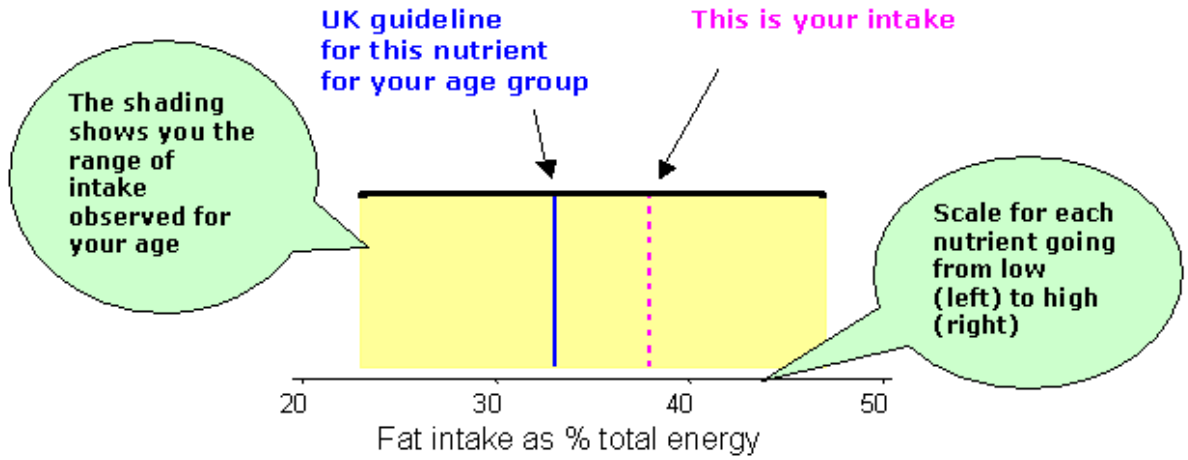
Every respondent was given the opportunity to request feedback on their reported diet. Three different mail merge feedback templates were used depending on the age of the respondent. Each template was tailored to the age ranges 4-10 years, 11-15 years and 16+ years. The feedback letter informed the respondent about the intake of selected nutrients for the dietary informant provided, the UK guideline and the range of intake for that nutrient, generally the Dietary Reference Value (DRV) derived from the Department of Health (COMA) report on Dietary Reference Values for food energy and nutrients for the United Kingdom[25], and the range of intake observed in previous NDNS, the particular survey use depending on the age of respondent. The following nutrients were selected for feedback:

- Fat intake as % total energy

- Saturated fat as % total energy
- NMES as % total energy
- Non Starch Polysaccharide (NSP) g
- Vitamin C mg
- Folate µg
- Calcium mg
- Iron mg
- Energy intake kcal

This information was presented in the form of a graph, which indicated the actual value for the intake of the respondent. Alongside each graph the recipient was informed briefly about the importance of the relevant measure. The feedback letter also gave some generic healthy eating advice and links to useful websites. A copy of the graph explanation, which appeared on the first page of the letter, and an example of a typical result for saturated fat intake are shown below in figures 3A and 3B.

Figure 3A Dietary feedback graph explanation



What it means: If your intake is to the right of the solid blue line you consume more than the guideline; if it is to the left, you consume less. Eating more than the guideline is good for some nutrients, for example, fibre and folate, but not for others, such as saturated fat, where intake should be limited.

3.7.2 Evaluation of dietary feedback

To evaluate the success and impact of the feedback, a questionnaire was sent out to adult respondents (19+ years) to ask for their opinion on the feedback received. The questionnaire consisted of 5 questions and comment boxes, and a section asking about preference to receive additional information over a longer time period, as outlined below:

1. Do you think that the graphs showing your results compared with UK guidelines for the population are easy to understand?
2. Do you think comparing your results with UK guidelines is useful?
3. Is there any other information about your diet you would like to receive?
4. Would you be interested in a web page for NDNS participants that lists more information about the survey (for example results as they emerge), updates on what the nation consumes and nutrition information and advice?
5. Some additional information we could provide would take longer to produce e.g. The number of portions of fruit and vegetable you consume
    a. I would like to receive more information about my diet even if I have to wait up to 12 months to receive it.
    b. I am happy with the information provided which I receive within three months after completion of the dietary assessment.

3.8 Statistical Analyses

Unless otherwise stated, all analyses were carried out by the following standard break variables:

- Dietary method (24-hour recall, diary)
- Sex (male, female)
- Age group (4-10 years, 11-15 years, 16-49 years, 50-64 years, 65+ years)

For the tables showing percentages all percentages are weighted even if the base number was small. In all the tables, cumulative percentages in the row labelled `All' are always shown as 100%. The proportion of cases falling above the upper limit of the previous band can be calculated by subtracting from 100 the proportion in the previous band. The base numbers are the number of people that contributed to the calculations and are the number of respondents. The total column may include cases from small subgroups not shown separately elsewhere on the tables, therefore the individual column bases may not add to the base in the total column.

The "-" symbol is used in the tables to signify no people and 0% is used to indicate percentages smaller than 0.5%.

3.8.1 Weighting

The data for the Comparison Survey required a set of weights to address bias caused by unequal selection probabilities and non-response; survey estimates from unweighted data are likely to be biased. The aim was to provide a set of weights that would allow researchers to compare the weighted survey estimates for each dietary collection method.

Two weights were produced, one for all analyses at household level and one for all analyses at individual level. The individual level weight was also be used for analyses of the DLW and actigraph data. Unless otherwise stated, all proportions and means presented in the tables in this report are taken from weighted data.

The standard deviations for estimates of mean values are shown in the tables and have been calculated using the weights and using the information about cluster (primary sampling units) and stratification. Calculation of the standard deviation was done using the svy command in Stata version 10 and the Taylor-linearized variance estimation option was used.

Further information about the weighting method is provided in Appendix A.

3.8.2 The Mean Energy and Confidence interval tables

84% confidence intervals are calculated for the mean energy in each subgroup. In the absence of multiplicity correction a pair of 84% confidence intervals that do not overlap is equivalent to a “significant” difference with the p-value smaller than 0.05. If the number of comparisons made is greater than 1 then a multiplicity correction is needed in any interpretation.

3.8.3 Bland-Altman Plots

Bland-Altman plots are used when comparing a test measurement against a gold standard measurement. The difference between measurements were plotted against the average of the pairs of measurements, 95% agreement limits were calculated using the variance of the paired differences. The plots contained the mean bias which was calculated as the average difference between the pairs of measurements.

[1] The person in the CU with the main responsibility for shopping and preparing food. If these tasks are equally shared between two people, for example if one person does all the shopping and another person does all the cooking then either resident can be classified as the MFP.

4 Response rates and profile of respondents

4.1 Response rates

4.1.1 Introduction

The issued sample for the comparison study consisted of 1,840 addresses. The target response rate for the study was for 55% of individuals in eligible CUs to complete three or four dietary days. This chapter describes the response rates achieved in the comparison survey, overall and by dietary method. It also describes response rates achieved for each dietary method by age group and sex.

Response rates are based on unweighted data.

An account of the response in the comparison study was provided in a response rate report submitted to the Agency in August 2007. This earlier report was based on preliminary data; the response rates in this report are based on edited data.

4.1.2 Summary response rates

Table 4A Summary of achieved response rates, by dietary method & overall

Outcome	24-hour recall		Diary		All	
	By stage %	Overall %	*By stage* %	Overall %	*By stage* %	Overall %
Catering Units (CUs)						
Eligible for CU selection (non-deadwood)	86		88		87	
CU selected	86	74	88	77	87	75
Productive CUs (fully and partially)	61	52	61	54	61	53
Individuals in productive CUs						
Productive (fully and partially)	96	50	94	50	95	50
Fully productive (3+ dietary days)	93	**48**	92	**50**	93	**49**

Response rates are based on addresses eligible for CU selection (i.e. non-deadwood addresses). From this base of eligible CUs, the percentage selected for interview was calculated, as well as the percentage that were productive (either fully or partially). A CU was defined as 'fully productive' if all selected individuals within it (i.e. one adult and/or one child) completed three or four dietary days. If any selected individual completed less than three dietary days, the CU was defined as 'partially

productive'. Response rates at the individual level use 'addresses eligible for CU selection' as the base.

Overall, there was very little difference between the two dietary methods in terms of response rates achieved. CU selection was carried out at 87% of eligible addresses (88% of addresses in the diary sample, 86% of those allocated to the recall method) and of these, 61% of CUs were productive (overall and for both dietary methods).

Within productive CUs, fully productive interviews were achieved with 50% of respondents (49% of 24-hour recall and 52% of diary respondents).

4.1.3 Catering Unit (CU) level response rates

Table 4B Breakdown of CU-level response rates, by dietary method & overall

Outcome	24-hour recall		Diary		All	
	N	%	N	%	N	%
ISSUED ADDRESSES	920		920		1840	
Ineligible	130	14	109	12	239	13
Eligible	790	86	811	88	1601	87
ELIGIBLE Cus						
Total unproductive:	379	48	375	46	754	47
Non-contact	*12*	*2*	*14*	*2*	*26*	*2*
Refused (all selected respondents)	*309*	*39*	*299*	*37*	*608*	*38*
Other reason for unproductive	*58*	*7*	*62*	*8*	*120*	*7*
Partially productive CUs(<3 dietary days for all respondents)	27	3	13	2	40	2
Fully productive CUs (3+ dietary days for at least one respondent)	384	49	423	52	807	50

Because of rounding, column percentages may not add exactly to 100%

Table 4B above shows there was no real difference in CU level response rates according to dietary method, nor reasons for being unproductive. The vast majority of unproductive CUs (82% of unproductive CUs in the recall sample and 80% of unproductive CUs in the diary sample) were refusals. Overall and for both methods, there were very few CUs where no contact was made (just 2% of eligible CUs), showing that interviewers put a great deal of effort into making contact with potential respondents.

4.1.4 Individual level response rates, overall and by dietary method

Table 4C Individual level response rates (selected individuals), by dietary method & overall

Outcome	24-hour recall		Diary		All	
	N	%	N	%	N	%
Unproductive	23	4	38	6	61	5
Non contact	0	0	0	0	0	0
Refused to start	13	2	9	1	22	2
Other unproductive	10	2	29	5	39	3
Partially productive	17	3	8	1	25	2
Fully productive	504	93	563	92	1067	93
TOTAL selected	544		609		1153	

Because of rounding, column percentages may not add exactly to 100%

In total, 1,153 individuals were selected to take part in the survey – 609 from the diary sample and 544 from the 24-hour recall sample. Overall, fully productive interviews were achieved with 93% of these individuals and partially productive interviews (less than three dietary days) were achieved with a further 2%.

At the individual level, response rates were very similar for each of the two dietary methods. In the 24-hour recall sample, 96% of those selected were productive, compared with 94% of those selected in the diary sample. There were no significant differences between the two methods in selected respondents going on to fully complete their dietary record: 93% (n=504) of 24-hour recall respondents were fully productive compared with 92% (n=563) of diary respondents.

4.1.5 Individual level response rates, by sex and adult/child status

Table 4D Individual level response rates (productive individuals), by sex & adult/child status, dietary method & overall

Outcome	24-hour recall		Diary		All	
	N	%	N	%	N	%
Selected MALE respondents						
Men (16+)						
Partially productive	10	5	3	2	13	3
Fully productive	185	95	196	98	381	97
Base	*195*		*199*		*394*	
Boys (4-15)						
Partially productive	0	0	0	0	0	0
Fully productive	47	100	58	100	105	100
Base	*47*		*58*		*105*	
Selected FEMALE respondents						
Women (16+)						
Partially productive	7	3	3	1	10	2
Fully productive	226	97	260	99	486	98
Base	*233*		*263*		*496*	
Girls (4-15)						
Partially productive	0	0	2	4	2	2
Fully productive	46	100	49	96	95	98
Base	*46*		*51*		*97*	

Because of rounding, column percentages may not add exactly to 100%

Table 4D above shows a breakdown of response rates amongst productive individuals, by sex, adult/child status and dietary method. Base numbers shown in the table are the total number of productive individuals (both fully and partially) for each separate cell. Information is not available on age and sex for unproductive individuals so these cases cannot be included in this table.

The table is useful for determining any differences in drop-out during the dietary recording process according to sex and adult/child status. There were no substantial differences between the two dietary methods in terms of the sex of respondents.

Fully productive interviews were achieved with a slightly higher percentage of men in the diary sample than in the recall sample (98% compared with 95%) but this difference was not significant. There was a similar trend amongst women (99% in the diary sample compared with 97% in the recall sample) but again, this was not significant.

All girls and boys (aged 4-15 years) in the recall sample who started the interview went on to complete at least three dietary days. This was also the case for boys in the diary sample, but not for girls: 4% of girls started but did not complete the diary.

4.1.6 Individual level response rates, by age group

Table 4E Individual level summary response rates (productive individuals), by age group, dietary method & overall

Outcome	24- hour recall		Diary		All	
	N	%	N	%	N	%
Age 4-10						
Partially productive	0	0	2	3	2	2
Fully productive	49	100	70	97	119	98
Base	*49*		*72*		*121*	
Age 11-15						
Partially productive	0	0	0	0	0	0
Fully productive	44	100	37	100	81	100
Base	*44*		*37*		*81*	
Age 16-34						
Partially productive	5	5	0	0	5	2
Fully productive	102	95	119	100	221	98
Base	*107*		*119*		*226*	
Age 35-64						
Partially productive	9	4	4	2	13	3
Fully productive	219	96	245	98	464	97
Base	*228*		*249*		*477*	
Age 65+						
Partially productive	3	3	2	5	5	3
Fully productive	90	97	92	98	182	97
Base	*93*		*94*		*187*	

Because of rounding, column percentages may not add exactly to 100%

Table 4E shows a breakdown of response rates amongst productive individuals, by age group and dietary method. As in table 4D, base numbers shown are the total number of productive individuals (both fully and partially) for each separate cell.

There were no significant response rate differences between the two methods in relation to respondents' age group. The proportions of fully and partially productive interviews were virtually the same for both dietary methods for all age groups.

4.2 Age and sex profile

There were few differences in the age and sex distribution of respondents between the two dietary assessment methods, as shown in Tables 4F and 4G. For boys, there were more of those aged 4-6 years and less of those aged 7-10 years for the recall compared to the diary, but the numbers were small for these age groups. No differences were seen for adults with dietary assessment methods

Table 4F Age and sex distribution (%) of child sample by dietary method

Age (years)	24-hour recall	Diary
Boys		
4-10	37	53
11-18	63	47
Total	54	55
Girls		
4-10	49	49
11-18	51	51
Total	46	45
Bases		
Boys	*62*	*75*
Girls	*53*	*61*

Table 4G Age and sex distribution (%) of adult sample by dietary method

Age (years)	24-hour recall	Diary
Men		
19-34	21	22
35-49	31	28
50-64	26	30
65+	22	21
Total	44	42
Women		
19-34	20	21
35-49	29	33
50-64	27	24
65+	24	22
Total	56	58
Bases		
Men	*170*	*179*
Women	*219*	*248*

4.3 Anthropometric measurements by age, sex and dietary method

4.3.1 Height and weight

As can be seen from table 4G, there was no significant difference in either mean height or weight measurements for both men and women when comparing dietary methods. For both men and women, mean height declined with age but no similar pattern was noted for weight.

Table 4G Mean height and weight for men and women aged 19+ years*, by dietary method

Mean height (cm) and weight (kg)	24-hour recall					Diary				
	19-34	**35-49**	**50-64**	**65+**	**Total**	**19-34**	**35-49**	**50-64**	**65+**	**Total**
Men										
Mean height	178.1	177.1	173.3	172.0	175.8	177.1	177.1	173.8	170.9	175.1
Standard error of the mean	0.71	1.01	0.92	1.48	0.51	0.94	0.83	1.07	1.21	0.53
Mean weight	81.4	88.8	86.0	79.8	84.5	79.5	84.6	84.0	83.9	82.9
Standard error of the mean	1.92	1.77	2.06	2.46	1.03	2.13	1.63	2.02	2.22	1.00
Women										
Mean height	163.2	162.3	160.9	158.0	161.3	164.4	162.7	161.6	158.9	162.1
Standard error of the mean	0.87	0.72	0.81	1.13	0.45	0.91	0.68	0.95	1.16	0.46
Mean weight	70.4	71.0	70.8	70.6	70.7	66.2	69.8	70.6	68.5	68.8
Standard error of the mean	2.31	2.04	1.93	2.41	1.08	1.58	1.45	2.05	1.93	0.87
Weighted Bases										
Men										
Mean height	*59*	*54*	*48*	*25*	*185*	*58*	*55*	*49*	*38*	*200*
Mean weight	*59*	*55*	*48*	*27*	*188*	*56*	*54*	*49*	*42*	*200*
Women										
Mean height	*53*	*52*	*48*	*38*	*191*	*56*	*67*	*51*	*42*	*216*
Mean weight	*53*	*52*	*49*	*40*	*194*	*56*	*66*	*52*	*49*	*223*

* Aged 19 and over with a valid height or weight measurement

4.3.2 Body Mass Index (BMI)

There was no significant differences in overweight and obesity prevalence for children. Around two-thirds were normal weight, and about one-third were considered overweight or obese (table 4H).

Table 4H BMI classification, for boys and girls (4-18 years)*, by dietary method

BMI classification	24-hour recall			Diary		
	4-10	**11-18**	**Total**	**4-10**	**11-18**	**Total**
	%	%	%	%	%	%
Boys						
Normal weight	66	57	61	64	68	66
Over weight	14	26	21	19	12	15
Obese	20	17	18	16	20	19
Girls						
Normal weight	86	57	70	70	68	69
Over weight	-	17	9	14	19	17
Obese	14	25	20	15	13	14
Weighted Bases						
Boys	*22*	*36*	*58*	*38*	*33*	*71*
Girls	*26*	*27*	*53*	*30*	*31*	*61*

* with both valid height and weight measurements

Similarly to the height measurements, no difference was seen between dietary methods when analysing mean BMI by sex, and mean BMI increased with age (table 4I) for men and women. However, a greater proportion of both men and women who completed the 24-hour recall method were classed as obese (BMI >30) compared to those using the diary method (26% and 22% respectively). Among women, the proportion who where obese was nearly double that in the recall sample (27% versus 14% in the diary sample). There was also a significant interaction between dietary method and sex.

Table 4I Body Mass Index (BMI), for men and women aged 19+ years*, by dietary method

BMI (kg/m^2)	24-hour recall					Diary				
	19-34	**35-49**	**50-64**	**65+**	**Total**	**19-34**	**35-49**	**50-64**	**65+**	**Total**
	%	%	%	%	%	%	%	%	%	%
Men										
Under 18.5	-	-	-	2.3	0.3	4.1	-	1.1	-	1.4
Over 18.5-25	43.4	24.1	15.4	18.9	27.3	49.8	31.6	17.2	9.3	28.8
Over 25-30	36.4	43.7	50.3	66.6	46.1	32.0	43.1	61.2	57.4	47.2
Over 30-40	20.1	28.2	32.4	9.6	24.2	10.9	25.2	20.6	33.3	21.6
Over 40	-	4.0	1.9	2.5	2.0	3.2	-	-	-	0.9
Mean BMI	25.6	28.3	28.6	27.2	27.4	25.5	27.1	27.8	29.0	27.2
Standard error of the mean	0.56	0.60	0.57	0.81	0.32	0.74	0.56	0.57	0.62	0.33
Women										
Under 18.5	2.6	4.5	-	7.1	3.3	-	1.2	-	-	0.4
Over 18.5-25	46.6	38.7	37.8	22.1	37.3	73.2	39.8	37.2	51.6	50.2
Over 25-30	31.2	25.2	33.9	40.3	32.1	18.7	47.1	43.6	30.3	35.6
Over 30-40	18.5	31.6	27.4	24.4	25.5	7.4	11.2	19.2	18.1	13.5
Over 40	1.1	-	0.9	6.2	1.8	0.7	0.7	-	-	0.4
Mean BMI	26.3	27.1	27.5	28.3	27.2	24.4	26.4	26.9	26.2	26.0
Standard error of the mean	0.74	0.78	0.77	1.08	0.41	0.49	0.53	0.66	0.67	0.30
Weighted Bases										
Men	*59*	*54*	*48*	*25*	*185*	*56*	*54*	*49*	*38*	*196*
Women	*53*	*52*	*48*	*38*	*191*	*56*	*66*	*51*	*42*	*215*

* Aged 19 and over with both valid height and weight measurements

5 Results

5.1 Summary of interviewer and coder feedback

5.1.1 Summary of feedback

All interviewers and NatCen's data coders were asked for their feedback on the two methods tested in the comparison study.

All interviewers were asked to complete a questionnaire asking specifically about their experience of each method and their perception of the respondents' experience of the method allocated to them. In addition, eight interviewers attended a full-day personal debrief. The debrief interviewers were selected on the basis that they had gained good experience in both dietary methods. Further, these interviewers had also worked in different types of area across England and Scotland including market towns, urban areas, affluent and poorer areas.

All seven NatCen coders working on the comparison study attended a personal debrief lasting half a day. Three of the coders had previously worked on LIDNS and so were very experienced in food coding from 24-hour recalls although none of them had used the DINO program before.

Feedback on the 24-hour recall

The restrictive work pattern and burden was a key concern for the majority of interviewers. A particular complaint concerned the need to make Sunday visits to recall consumption for the previous day (Saturday). Interviewers commented that four visits could be daunting even for the most committed respondent and that both respondents and interviewers found the visits incredibly time-consuming and difficult to organise due to work and other commitments. Some interviewers felt this reflected on the accuracy of the information, as respondents were eager for the recall to end. Some drop-outs, particularly among those with busy or chaotic lifestyles, were attributed to the time-commitment needed for the recalls.

Feedback on the diary

The main area of concern for the interviewers was respondents not fully grasping what was required of them. It was also difficult to tell when placing the diary which respondents were likely to have problems, and at the collection stage, it was too late. The format of the diaries was also problematic: the adult diary had too small print and the child diary couldn't easily be folded to put in a school bag etc. Food labels and wrappers could be very useful when it came to coding. However, whilst some

respondents collected all their labels, even for the most basic foods, most did not collect any labels, or, more frustratingly, cut off and discarded relevant details such as the nutritional information.

General comments

Some interviewers commented that respondents often found it hard to judge portion sizes regardless of the dietary assessment method being used. This was particularly the case at parties, barbecues and buffets. Other issues common to both methods were large gaps in information when foods were consumed outside the home (especially school meals), children seeming to think they had eaten one thing and their parents indicating something different and filling in the packaging information (interviewers said they were often unsure about which packaging choice to record and therefore had to guess).

Coders felt it was rare that there was enough information to sufficiently code the foods consumed and this was the case with both methods. This is reflected in the query rate (see section 5.6.1). All coders agreed that as long as the quality of recording was good, the method was almost irrelevant.

5.1.2 Modifications for the mainstage

As a result of the feedback received, several improvements have been made to the diaries themselves, along with the introduction of supporting documents. There have also been changes to the way the diaries are placed and checked and how the interviewers are trained.

At diary placement, respondents will be asked to fill in one recent eating occasion, ideally a main meal, as a practice so that the level of detail required becomes clear and difficulties the respondent might have can be identified. The A5 adult diary has been redesigned, increasing the size of the text, and a larger A4 version made available for those adults who may experience difficulties with the smaller diary. A separate instruction booklet allows easier reference to the instructions, description prompts and examples whilst recording intake in the diary. For the A4 child version, the cardboard cover has been removed so that it can fold in half. As the mainstage now includes the toddler age group (1½ – 3 years old), a new version of the diary has been developed so that appropriate examples and more guidance on portion sizes can be included. There is also more reliance on out-of-home carers for this age group, so there is a “Carer pack” which includes a letter informing the teacher/child-minder/friend’s parent about the child’s participation in the study and a form with space for them to record any food or drink consumed whilst the child is in their care. All respondents are to be given a card which shows what is useful in terms of information on wrappers and labels.

More emphasis will be placed at briefings on interviewers understanding the different concepts of describing portion size (including the appropriate use of pictures of foods from the Food Atlas) and that they instruct respondents to take into account leftovers especially children and when food is eaten outside the home. Interviewers will try and obtain school menus so that they can probe for

missing detail. Where necessary, the nutritionists will follow up by contacting school caterers for details on how food is prepared.

The collection of packaging details was considered too burdensome (21% of all food items entered for the diary were missing a packaging code) and there was concern that detail about foods and portion sizes would be sacrificed. In addition, packaging type required a separate column which it was felt would be better used for collecting brand names. Therefore, this element of the data collection has been dropped for the mainstage.

5.2 Energy expenditure

5.2.1 Total Energy Expenditure (TEE_{DLW})

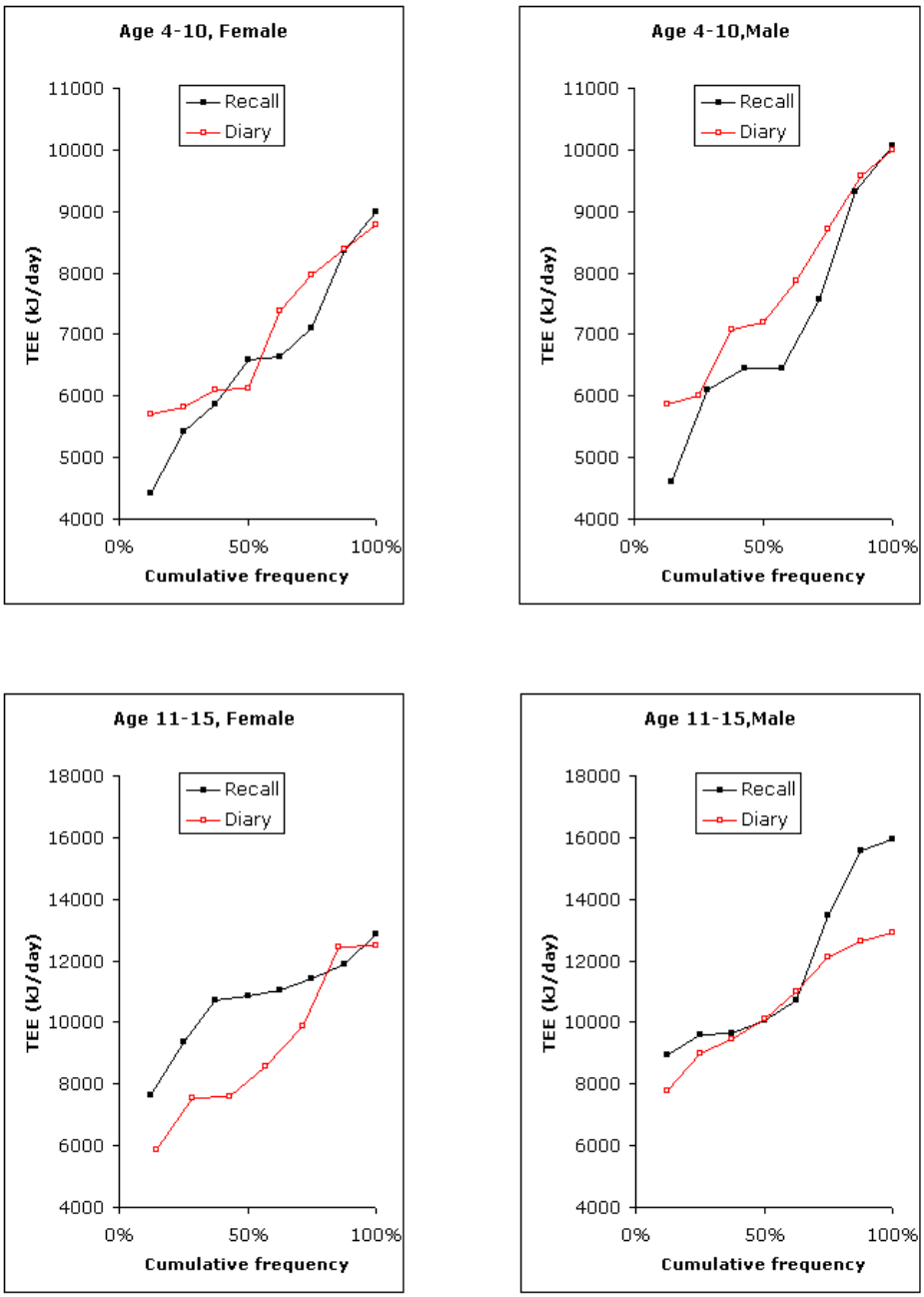
The mean values of TEE_{DLW} (MJ/day) and the ranges obtained for each of the five age groups subdivided by sex is shown in Table 5A.

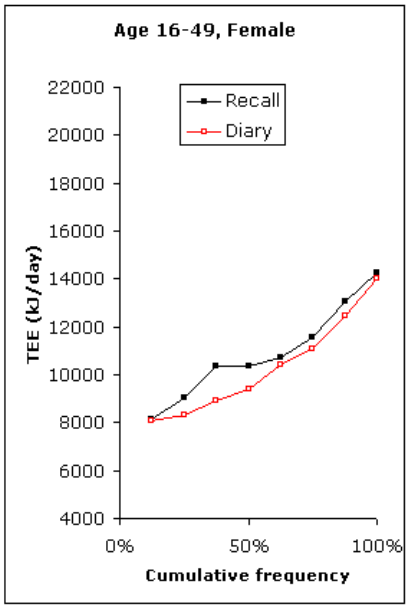
Table 5A Mean values of TEE_{DLW} (MJ/day) and the ranges obtained by dietary method, age and sex

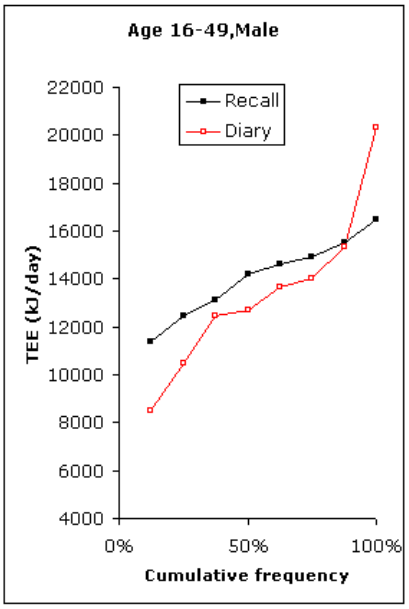
Age (years) & sex		24-hour recall			Diary		
		Min	Mean	Max	Min	Mean	Max
4-10	Male	4.61	7.22	10.07	5.87	7.79	9.99
	Female	4.41	6.67	8.98	5.71	7.03	8.78
11-15	Male	8.96	11.75	15.94	7.76	10.62	12.91
	Female	7.64	10.73	12.85	5.89	9.20	12.48
16-49	Male	11.40	14.08	16.46	8.48	13.44	20.34
	Female	8.12	10.94	14.26	8.07	10.34	13.99
50-64	Male	9.59	14.06	12.06	10.97	13.71	18.65
	Female	5.87	10.14	12.40	8.26	9.98	13.55
65+	Male	10.44	11.17	11.86	8.68	10.93	17.18
	Female	8.11	10.16	12.70	8.38	9.40	10.55

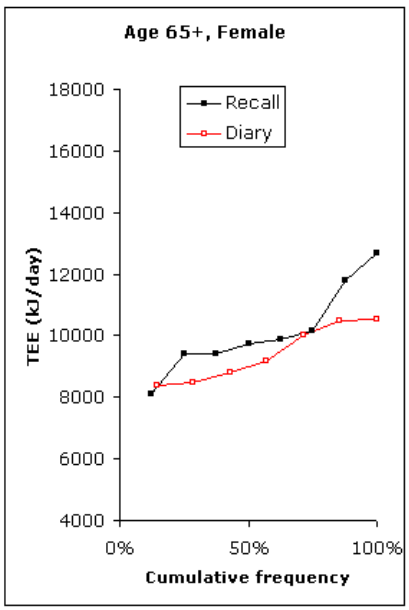
The cumulative frequency of energy expenditure for each of the five age groups is shown in Figure 5.1. Also shown by the solid line in these figures is the estimated population distribution from which the respondents were drawn.

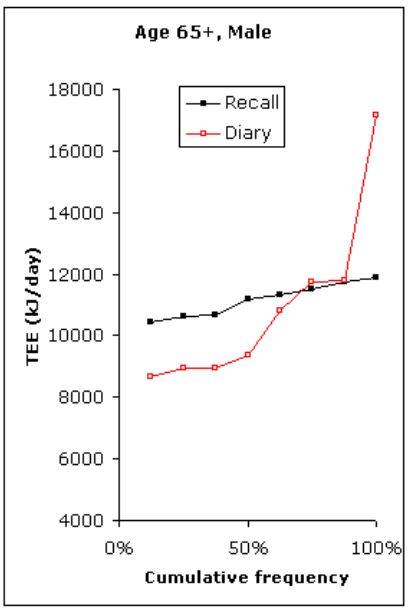
Figure 5.1 Cumulative frequency of TEE by dietary method, age and sex











5.3 Dietary feedback to respondents

Overall, 923 of the 1067 fully productive respondents (86%) requested dietary feedback. The high uptake of the option to receive feedback is very encouraging and supports the introduction of the feedback as a permanent feature of the NDNS rolling programme. The questionnaire was sent to adults only and was returned by 20% of the 706 adults requesting feedback.

The completed questionnaires received are summarized in table 5B below. Based on the replies received we can conclude that:

- the format of the feedback was well understood by respondents,
- approximately two thirds of respondents were satisfied with the information that is provided within three months of taking part, and
- about half of all respondents were interested in a webpage for participants.

Table 5B Responses to questions in feedback questionnaire

Feedback question	Responses		
Question	Yes %	No %	Not answered %
1. Do you think that the graphs showing your results compared with UK guidelines for the population are easy to understand?	97	3	0
2. Do you think comparing your results with UK guidelines is useful?	98	2	0
3. Is there any other information about your diet you would like to receive?	26	68	6
5. Would you be interested in a web page for NDNS participants that lists more information about the survey (for example results as they emerge), updates on what the nation consumes and nutrition information and advice?	42	56	2
	A %	B %	Not answered %
4. Some additional information we could provide would take longer to produce e.g. The number of portions of fruit and vegetable you consume. A) I would like to receive more information about my diet even if I have to wait up to 12 months to receive it. B) I am happy with the information provided which I receive within 3 months after completion of the dietary assessment.	32	64	4

Some respondents filled in comments in the space provided and a selection of these is presented below:

<u>Selected comments to question 3</u>

- "I would like to know how my diet reflects my overall health"
- "Alcohol intake should be included. Indications of 'too much' or 'too little' warnings"

- “The effect of the vitamin tablets I take”
- “Information of calories, fat, sugar, protein etc which is contained in each food”
- “Percentage calories from major food groups – fat, carbohydrate, protein as a pie chart. Number of portions of fruit and veg, protein foods, carbohydrate foods and dairy foods as in food pyramid. Information on salt intake, fluid and omega 3”

Selected comments to questions 4 or 5

- “I enjoyed taking part and it has changed my views about food portion sizes. I take more notice about what I consume and try to take more exercise and drink more water”
- “I have enjoyed taking part in this survey and these results have made me think about my diet and where I need to make adjustments. It’s been a big help. Thank you!”
- “The survey was a useful examination of diet and helped me realise how poor my diet was. I’ve since started to exercise twice weekly and tried to improve my diet”
    - “The survey was very interesting to do and the results well presented easy for anyone to understand”
    - “I was very impressed with the info returned and am very appreciative of the extra time put on to produce this feedback”
    - “I found this info very informative and useful for adjusting my sons diet. He is taking this info into school to discuss with his classmates”

6 Nutrient intake from foods

6.1 Introduction

In this section, data are presented for the intakes of energy, macronutrients and selected micronutrients for respondents in the comparison study who reported at least three days of 24-hour recall or prospective record by estimated diary. Tables can be found here. As indicated in earlier sections, all dietary data from the entire sample were weighted to compensate for the differential probabilities of selection and non-response. Since the main purpose of the comparison study was to determine the intake of energy by each method and the degree of underreporting, statistical analysis has only been carried out for the results on energy intake. For other nutrients, comments have been made about the mean intakes for all respondents and for age and sex differences, but these have not undergone statistical comparisons. It should also been borne in mind that for some age groups, the small number of individuals surveyed was small. Results have been presented and described in usual units for each nutrient as outlined in the introduction to each nutrient. They have also been compared to the Dietary Reference Values (DRVs) and recommended intakes of each nutrient, expressed in relation to the usual measure used for that nutrient as outlined in the Report of the Committee on Medical Aspects of Food Policy (COMA) on Dietary Reference Values for Food Energy and Nutrients for the United Kingdom, published by the Department of Health in 1991[25]. In some cases, where the COMA report did not outline a recommendation for a nutrient, or for a particular age group, another guide has been used for comparison and this is described for those nutrients. Comparison has also been made to previous NDNS reports, to enable the results of the comparison study to be put into context. Results for all nutrients are presented as the daily intake resulting from the average of the days recorded.

Results for nutrients have been described for the age and sex groups used in previous NDNS surveys, to provide continuity and to enable comparisons to be made with past surveys. For example, there is no grouping of 16-34 years from any previous survey and hence 19-34 years was used.

6.2 Energy

6.2.1 Introduction

This section outlines intakes of energy, expressed both in MJ and kcal for the two dietary methods compared. Previous NDNS reports have also provided data on intakes of food energy alone (without alcohol) but this has not been done for the comparison study. Results have also been compared to

the Estimated Average Requirements (EARs) for energy, as outlined in the 1991 COMA report[25]. A comparison between the intakes derived using the 24-hour recall and the diary is provided in Chapter 7. This component of the results was presented in a preliminary report to the Agency in February 2008.

6.2.2 Energy intake: 24-hour recall

Based on 24-hour recalls boys had higher mean intakes of energy (8.08MJ, 1918kcal) than girls (6.80MJ, 1614kcal). The medians were more similar, 7.26MJ for boys (1726kcal) versus 6.94MJ (1651kcal) for girls, reflecting a skewed distribution with more boys at the lower end of the energy spectrum. For boys, there was a gradient in mean energy intake with age from 6.87MJ (1630kcal) for the those 4-6 years to 9.48MJ (2255kcal) for 15-18 years. For girls there was increase from 4-6 years (5.63MJ, 1336kcal) to 7-10 years (7.00MJ, 1660kcal), but thereafter there was little further increase in energy intake with age.

The range of intakes was consistently narrower for girls compared to boys. Intakes at the lower 2.5 percentile were between 48% and 73% of the median for boys, and 62% to 85% for girls. Intakes at the upper 2.5 percentile were 32% to 133% higher than the median for boys and between 23% and 68% higher for girls.

Overall, the average intake of energy for boys and girls expressed as a % of the EAR, was 89% for both sexes. 72% of boys aged 4-6 years, 58% aged 7-10 years, 72% aged 11-14 years and 67% aged 15-18 years were below the EAR. For girls, the percentages below the EAR were 76% of those aged 4-6 years, 61% aged 7-10 years, 74% aged 11-14 years and 93% 15-18 years. Differences between the reported intakes and the EARs can arise for a number of reasons: inadequate energy intakes, incorrect estimates of intake resulting from misreporting of diet during the recall interview or overestimates of energy requirements. All of these issues were addressed in the comparison study, either in the entire sample or in a sub-study.

(Tables 6.1, 6.7, 6.14, and 6.18)

Men had higher mean energy intakes than women, 9.36MJ (2227kcal) compared to 6.96MJ (1655kcal). Mean intakes of energy were highest for men 35-49 years (10.11MJ (2406kcal), and lowest for men 65 years and over (8.72MJ, 2074kcal). In contrast, for women, mean intake was highest in the youngest group, those 19-34 years (7.33MJ, 1744kcal) and lowest for women 65 years and over (6.58MJ, 1566kcal).

Median intakes for both sexes showed the same patterns as for the mean values, although there was very little difference in median energy intakes for the two youngest groups of men. For men 35-49 years, the range was wide, with the higher 2.5 percentile at 16.93MJ (4028kcal), indicating a much more skewed distribution for this age group than for the younger men aged 19-34 years, where the

higher 2.5 percentile was 13.60MJ (3234kcal). This was the only group for which the median was higher than the mean, indicating the skewed distributions of energy intake in all but this group.

Overall, the average intake of energy for men and women expressed as a % EAR, was 90% and 86%, respectively. The lowest value was for women aged 65 years and over, where the mean intake was 84% EAR. 81% of men 19-34 years, 62% aged 35-49 years, 68% 50-64 years and 84% aged 65 years and over were below the EAR. For women, the percentages below the EAR were 73% of those 19-34 years, 69% aged 35-49 years, 78% 50-64 years and 94% 65 years and over.

(Tables 6.3, 6.9, 6.16, and 6.18)

6.2.3 Energy intake: diary

From the results of the assessment using the four-day diary, boys had higher mean intakes of energy (7.87MJ, 1870kcal) than girls (6.82MJ, 1621kcal). The median differences were similar, with a median intake of 7.86 MJ for boys (1869 kcal) versus 6.64 MJ (1580 kcal) for girls, which was rather different that the results for the 24-hour recall where the median intake for boys was considerably lower than the mean, reflecting a skewed distribution for that assessment. This could be due to the difference in the sample or a difference in ability of the method to capture intake appropriately. For boys, mean energy intake increased with age from 6.61 MJ (1570kcal) for 4-6 years to 9.15 MJ (2173kcal) for 15-18 years, although, unlike the 24-hour recall, there was no step-up increase between the two middle age groups. For girls there was an increase from 4-6 years (6.02MJ, 1431kcal) to 7-10 years (7.03MJ, 1670kcal), but thereafter there was little further increase in energy intake with age, a similar picture to the results from the 24-hour recall.

The range of intakes was consistently narrower in girls compared to boys, as was seen for the 24-hour recall. Intakes at the lower 2.5 percentile were between 24% and 71% of the median in boys, and 49% to 78% in girls. Intakes at the upper 2.5 percentile were 28% to 73% higher than the median in boys and between 11% and 55% higher in girls.

Overall, the average intake of energy for boys and girls expressed as a % of the EAR was 84% and 88%, respectively. For boys, all % EAR were lower than with 24-hour recall, with the age group 11-14 years showing the lowest values for all children using the diary, with a mean intake of 75% EAR. For girls, % EAR were similar to the 24-hour recall and higher in some cases. The oldest girls, aged 15-18 years, showed the lowest value for mean energy intake, representing 78% EAR for this group. 63% of boys aged 4-6 years, 64% aged 7-10 years, 92% 11-14 years and 94% aged 15-18 years were below the EAR. For girls, the percentages below the EAR were 62% of those aged 4-6 years, 48% aged 7-10 years, 70% 11-14 years and 84% 15-18 years. As with the 24-hour recall, differences between the reported intakes and the EARs can arise for various reasons: inadequate energy intakes, incorrect estimates of intake resulting from misreporting or modifying of diet during the recording period or overestimates of energy requirements.

(Tables 6.2, 6.8, 6.15, and 6.19)

As with the 24-hour recall, diary-keeping men had higher mean energy intakes than women, 8.90MJ (2117kcal) compared to 6.92MJ (1644kcal). Mean intakes of energy were highest for men 50-64 years (9.68MJ (2077kcal), and lowest for men aged 65 years and over (7.93MJ, 1885kcal). For women, there was little difference in mean energy intake across the age groups, even for the oldest women, whose mean energy intake was similar to those of younger women at 6.80MJ (1616kcal). This is in contrast to the 24-hour recall where there was a downward gradient in the mean intake from the youngest to the oldest women.

Median intakes for both sexes showed the same patterns as for the mean values, for both men and women, and the median values were very close to the mean values, indicating less skew in the distributions than shown for children and for the 24-hour recall.

Overall, the average intake of energy for men and women expressed as a % EAR, was 86% for both sexes for the diary. For men, the values for % EAR were generally a little lower than for the 24-hour recall, but they were very similar for women. The lowest value was for men aged 35-49 years, where the mean intake was 81% EAR. 81.5% of men aged 19-34 years, 79.4% 35-49 years, 64.7% 50-64 years and 92.8% 65 years and over were below the EAR. For women, the percentages below the EAR were 70% of those aged 19-34 years, 75.1% 35-49 years, 75.9% 50-64 years and 96.3% 65 years and over.

(Tables 6.4, 6.10, 6.17, and 6.19)

6.2.4 Comparison with previous surveys

Results from the comparison study for children can be compared with the NDNS survey of young people (aged 4-18 years) conducted in 1997[20]. This comparison indicates that the intakes of energy in the comparison study are generally similar to those obtained in 1997 for the same age groups. For the two younger ages of boys (4-6 years and 7-10 years) and for all the girls except the youngest age group, the previous NDNS results show slightly lower intakes than the comparison study, but for the two over ages of boys (11-14 years and 15-18 years), and for the youngest girls (4-6 years), the energy intakes are very similar, especially if recall and diary are considered together. The mean intakes are very similar between the two surveys: for boys: comparison study 8.08MJ by recall (1918kcal) and 7.87MJ by diary (1870kcal); NDNS YP[20] 8.01MJ (1905 kcal), and for girls: comparison study 6.80MJ by recall (1614kcal) and6.82MJ by diary (1621kcal); NDNS YP[20] 6.86 KJ (1582 kcal).

(Tables 6.1, 6.2)

For adults aged 19-64 years, results can be compared with the NDNS adult survey of 2000-01, published in 2004[21]. For men, the energy intakes were slightly lower in the comparison study, where results were 9.49MJ (2258kcal) by 24-hour recall and 9.13MJ 2173kcal by diary for men aged 19-64

years, compared to 9.72MJ (2313kcal) for NDNS adults. For women, the results were also very similar between the comparison study and NDNS adults[21]; intakes for all women were 7.06MJ (1677kcal) (24-hour recall) and 6.95MJ (1653kcal) (diary), for the comparison study and 6.87MJ (1633 kcal) for NDNS adults[21].

For the oldest age group of adults, those aged 65 years and over, the results can be compared with the free-living sample from the NDNS survey of people over 65 years conducted in 1994-95[19]. In this survey, men consumed 8.02 MJ (1909kcal) and women 5.98MJ (1422kcal). The values for the comparison study were similar for men, with mean energy intake of 8.72MJ (2074kcal) by recall and 7.93 MJ (1885kcal) by diary, but were slightly higher for women, 6.58MJ (1566kcal) by recall and 6.80MJ (1616kcal) by diary.

(Tables 6.3, 6.4)

6.2.5 Energy Intake: 24-hour recall compared to diary

Energy intake was compared and is reported for the 504 individuals who had productive recall data and the 563 with productive diaries, weighted as described earlier.

Table 6A shows the mean energy intake for children and Table 6B for adults by the two assessment methods. Note that these results have been updated since the report submitted in February as data have now been fully cleaned and edited. Results for which there is overlap between the confidence intervals between the two methods indicate there is not enough evidence to indicate a difference from one another. There is only one age-sex group for which no overlap occurred: men 35-49 years, where the mean energy intake by recall was 10.11MJ and by diary 8.73MJ. For all other age-sex groups, there was no evidence of a difference between the energy intake by recall and that by diary.

Table 6A Energy intake by dietary method in children aged 4-18 years*

	24-hour recall			Diary		
Age	**Base**	**Mean**	**84% CI**	**Base**	**Mean**	**84% CI**
			Boys			
4-6	14	6.87	(6.48, 7.25)	14	6.61	(5.97, 7.25)
7-10	9	7.83	(6.44, 9.23)	26	7.58	(7.01, 8.14)
11-14	16	8.14	(6.58,9.70)	13	7.00	(6.55, 7.45)
15-18	23	9.48	(8.45,10.56)	22	9.15	(8.23,10.06)
4-18	62	8.08	(7.48, 8.67)	75	7.87	(7.40, 8.35)
Girls						
4-6	12	5.63	(5.04,6.22)	16	6.02	(5.61, 6.44)
7-10	14	7.00	(6.25,7.75)	14	7.03	(6.29, 7.77)
11-14	14	7.38	(6.94,7.82)	11	7.13	(6.35, 7.90)
15-18	13	6.75	(6.06,7.45)	20	6.95	(6.47, 7.44)

4-18	53	6.80	(6.48, 7.12)	61	6.82	(6.54, 7.10)

Table 6B Energy intake by dietary method in adults aged 19+ years*

	24-hour recall			Diary		
Age	**Base**	**Mean**	**84% CI**	**Base**	**Mean**	**84% CI**
Men						
19-34	36	9.14	(8.51,9.76)	39	9.07	(8.61,9.54)
35-49	52	10.11	(9.41,10.81)	51	8.73	(8.34, 9.12)
50-64	44	9.23	(8.63,9.84)	53	9.68	(9.27,10.10)
65+	38	8.72	(8.12, 9.32)	37	7.93	(7.51, 8.35)
All men	170	9.36	(9.06, 9.66)	180	8.90	(8.70, 9.10)
Women						
19-34	44	7.33	(6.87, 7.80)	51	6.95	(6.40, 7.49)
35-49	63	6.93	(6.48, 7.38)	81	6.91	(6.57, 7.25)
50-64	60	6.89	(6.62, 7.17)	60	7.01	(6.75, 7.27)
65+	52	6.58	(6.20, 6.97)	55	6.80	(6.43, 7.17)
All women	219	6.96	(6.75, 7.17)	247	6.92	(6.70, 7.13)

* The values shown here are slightly different from those in the preliminary report submitted to the Agency in February 2008. This is due to differences in the factors used to convert macronutrients to energy and convert kcal to MJ in DINO.

6.3 Carbohydrate

6.3.1 Introduction

This section describes the results for total carbohydrate, in g and as % energy, using a factor of 3.75 kcal per g (16kJ per g) as the conversion factor for available carbohydrate to energy. There is no recommendation for the intake of carbohydrate in the UK and results have also been compared to the most recent international recommendation, that carbohydrate represent at least 50% of energy. This recommendation was suggested by the 2006 FAO/WHO Scientific Update on Carbohydrates in Human Nutrition[26], in preference to the value of 55% which had been suggested earlier by the 1997 Expert Panel on Carbohydrates in Human Nutrition[27].

6.3.2 Carbohydrate intake: 24-hour recall

Based on 24-hour recall boys (aged 4-18 years) had higher mean intakes of carbohydrate (253g) than girls (227g), with medians of 233g for boys and 215g for girls. For boys, mean carbohydrate intake increased with age from 223g for 4-6 years to 278g for 15-18 years. For girls, there was an increase from 4-6 years (189g) to 7-10 years (238g), but thereafter there was little variation in carbohydrate intake with age.

The range of intakes tended to be narrower for girls compared to boys. Intakes at the lower 2.5 percentile were between 38% and 82% of the median for boys, and 59% to 78% for girls. Intakes at the upper 2.5 percentile were 21% to 129% higher than the median for boys and from 42% and 63% higher for girls.

Carbohydrate provided on average, 50.1% of total energy for boys and 53.1% for girls. This percentage did not show a consistent trend with age for boys, ranging, on average, from the lowest value of 46.2% for boys aged 15-18 years to the highest of 52.5% for boys age 11-14 years; nor was there a consistent trend with age for girls, with girls aged 11-14 years having the lowest value of 49.8% energy from total carbohydrate and girls aged 15-18 years having the highest, 56.4%.

(Tables 6.20 and 6.24)

Men had higher mean carbohydrate intakes than women, 257g compared to 196g. Mean intakes of carbohydrate were substantially higher for the younger age groups of men than the older men, with the intake of those aged 19-34 years and 35-49 years at 268g and 278g respectively, while the intake of those aged 50-64 and 65 years and over were 233g and 238g respectively. For women, there was a steady downward gradient in intake from younger to older age groups, with the highest being for age 19-34 years (212g) and the lowest for women aged 65 years and over (183g).

Median intakes for both sexes showed the same patterns as for the mean values, although for women there was little difference in intake for all but the youngest age group where the median intake was roughly 20g higher at 204g. The range of intakes was similar for men and women; intakes at the lower 2.5 percentile were between 53% and 64% of the median in men, and 48% to 69% in women. Intakes at the upper 2.5 percentile were 47% to 84% higher than the median for men boys and from 45% and 71% higher in women.

Carbohydrate provided on average 43.4% of total energy for men and 45.1% for women. This percentage did not show a consistent trend for men, ranging, on average, from the lowest value of 40.8% for men aged 50-64 years to the highest of 45.6% for men aged 19-34 years; the mean contribution to energy from total carbohydrate was virtually identical for all ages of women, ranging only from 45.8% for those aged 65 years and over years to 45.6% for those aged 19-34 years. For both men and women, at the lower 2.5 percentile, 30-31% of energy was derived from carbohydrate and at the upper 2.5 percentile, the contribution of total carbohydrate to energy was 58%.

(Tables 6.22 and 6.26)

In relation to the recommendation that carbohydrate represent at least 50% energy, 49% of boys and 73% of girls had intakes below this intake by recall. For boys, the lowest percentage was for those 15-18 years, at 39% below 50% energy, with the highest at 65% not reaching 50%, while for girls, all age groups were over 80% not reaching 50% energy from carbohydrate, except those 11-14 years. For adults, 18% of men and 32% of women did not have carbohydrate intake greater than 50%

energy. This ranged from 7% for men aged 50-64 years to 31% of men aged 19-34 years, and for women from 20% of those aged 35-49 years, to 32% of those aged 50-64 years and 65 years and over.

6.3.3 Carbohydrate intake: diary

From the results of the assessment using the 4-day diary, boys had higher mean intakes of carbohydrate (249g) than girls (213g). The median intakes were similar, at 239g for boys versus 208g for girls. These values are similar to those derived using 24-hour recall. With the diary, in contrast to the 24-hour recall, there was no incremental gradient with age, although the lowest value was for the youngest age group (4-6 years), where intake was 205g, and the highest for the oldest children (15-18 years) at 287g. For girls there was an increase from 4-6 years (192g) to 7-10 years (224g), but thereafter there was little further variation in energy intake with age, a similar picture to the results from the 24-hour recall.

The range of intakes was consistently narrower in girls compared to boys, as with the 24-hour recall. Intakes at the lower 2.5 percentile were between 15% and 83% of the median in boys, and 53% to 76% in girls. Intakes at the upper 2.5 percentile were 37% to 62% higher than the median in boys and between 16% and 61% higher in girls.

Carbohydrate provided, on average, 49.7% of total energy for boys and 49.4% for girls. The value for boys was very similar to that using 24-hour recall, that for the girls being somewhat lower. For boys, all age groups showed very similar mean values for the % energy from carbohydrate, with the range from 49.0% for boys aged 4-6 years and 15-18 years, to that for boys aged 11-14 years at 51.0%. Similarly, the range for girls was also narrow, from the mean value for girls aged 11-14 years at 47.6% and that for girls aged 7-10 years at 50.7%. These are rather narrower ranges than seen for the 24-hour recall.

(Tables 6.21 and 6.25)

From the diary assessment, men had higher mean carbohydrate intakes than women, 241g compared to 193g, similar values to those seen using 24-hour recall. The mean intakes of carbohydrate were similar for all ages of men except the oldest, those aged 65 and over, where intakes were somewhat lower on average than the other three age groups. For women, there was also very little variation in the mean intakes with age, ranging from a mean of 187g for women aged 35-49 years to 199g for women aged 65 years and over. This is rather different than the 24-hour recall results, which showed a decreasing trend with age.

Median intakes for both sexes showed the same patterns as for the mean values, although the medians for all age groups of men were more similar to each other than the mean values. The range of intakes were similar for men and women; intakes at the lower 2.5 percentile were between 52%

and 63% of the median in men, and 51% to 62% in women. Intakes at the upper 2.5 percentile were 34% to 68% higher than the median for men and from 54% and 64% higher for women.

Carbohydrate provided on average 42.9% of total energy for men and 44.3% for women, values which are almost identical to those obtained using 24-hour recall. % energy from carbohydrate did not show a consistent trend with age for men, ranging, on average, from the lowest value of 41.6% for men aged 50-64 years to the highest of 44.0% for men aged 19-34 years and those aged 65 years and over; the mean contribution to energy from total carbohydrate was similar for the younger two age groups of women, and then showed a small increasing % with age, such that the highest % energy was for those aged 65 years and over at 46%. For both men and women, the range of intake appeared to be slightly less using the diary since at the lower 2.5 percentile, 30-33% of energy was derived from carbohydrate as with the recall, while at the upper 2.5 percentile, the contribution of total carbohydrate to energy was about 54-55% energy, rather than 58%, as in the recall.

(Tables 6.23 and 6.27)

In relation to the recommendation that carbohydrate represent at least 50% energy, 45% of boys and 49% of girls did not have carbohydrate intakes above this level. There was little variation in these proportions by age for the diary for boys. while for girls, the range was from 35% of girls 11-14 years to 72% of girls 7-10 years, not reaching this intake. These results show a similar pattern overall to those by recall although the percentage of girls not reaching 50% energy was rather higher by recall than by diary. For adults, the percentage not reaching 50% energy from carbohydrate was 19% for men and 16% for women. These percentages varied little by age, but were the lowest for those 35-49 years for both sexes, at 11% men and 8% women. The results of the men were similar to those obtained by recall but were lower than recall for the women

6.3.4 Comparison with previous surveys

The results for total carbohydrate intake in the comparison study can be compared with previous surveys. For young people, the comparison with the NDNS survey of young people[20] showed results that were similar to the results of the comparison study with mean carbohydrate intakes for boys being 260g or NDNS YP[20], compared to 253g by 24-hour recall and 249g by diary. For girls, the NDNS YP[20] showed a mean intake of 214g for girls, whereas the comparison study results are 227g by 24-hour recall and 213g by diary.

Results expressed as % total energy were also similar with the values for boys being 51.1% total energy in the NDNS survey of young people[20], compared to 50.1% by recall and 49.7% energy by diary in the comparison study. For girls, the NDNS YP[20] showed 50.7% total energy from carbohydrate, compared to 53.1% by recall and 49.4% by diary in the comparison study.

(Table 6.151)

6.4 Total sugars

6.4.1 Introduction

This section describes intakes for total sugars. There is currently no recommendation for total sugars in the diet in the UK, since the recommendation is for Non Milk Extrinsic Sugars (NMES) specifically, and this is described in the section following the results for total sugars.

6.4.2 Total sugars intake: 24-hour recall

Based on 24-hour recalls boys had slightly higher mean intakes of total sugars (116.5g) than girls (105.9g), with medians of 111.2g for boys and 104.2g for girls. For boys, mean sugars intake showed little change with age except for the oldest age group (15-18 years), which had a somewhat higher intake of 127.1g compared to 110-114g in the other three age groups. For girls, there was increase from 4-6 years (89.4g) to 7-10 years (113.8g), but thereafter there was little variation in sugars intake with age.

The range of intakes tended to be narrower in girls compared to boys. Intakes at the lower 2.5 percentile were between 12% and 66% of the median in boys, and 40% to 79% in girls. Intakes at the upper 2.5 percentile were 26% to 202% higher than the median in boys and from 37% to 79% higher in girls.

Total sugars provided on average, 22.3% of total energy for boys and 24.6% for girls. This percentage showed a downward trend with age in boys, from 26.3% for boys aged 4-6 years to 20.3% energy for boys aged 15-18 years. For girls there was no such trend, with all age groups having similar mean % energy values. The range in intake was quite wide, with the lower 2.5 percentile being 12.9% energy for boys and 11.5% for girls and the upper 2.5 percentile being 34.6% for boys and 38.4% for girls.

(Tables 6.28 and 6.32)

Results for the 24-hour recall indicated that men had higher mean sugars intakes than women, 114.7g compared to 88.8g. There was no difference in mean intake with age in either men or women, although there was some indication that the youngest women, those aged 19-34 years, had slightly higher intakes (97.9g) than the other age groups of women (84.1- 87.7g).

Median intakes for both sexes showed the same patterns as for the mean values. The ranges of intakes were wide for men and women; intakes at the lower 2.5 percentile were between 36 and 59% of the median in men, and 33% to 50% in women. Intakes at the upper 2.5 percentile were 60% to 150% higher than the median for men boys and from 55% to 147% higher in women. This indicates

some very high intakes in some individuals in the study. The maximum values were over 200g for all ages of men, with some ages of women showing equally high maximum intakes of total sugars as some of the groups of men.

Total sugars provided on average 19.3% of total energy for men and 20.0% for women. This percentage did not show any age trend for men or for women, and mean intake % energy values ranged from 18.5% to 20.5%, showing considerable consistency with age and sex. For both men and women, at the lower 2.5 percentile, 8.2-12.2% of energy was derived from total sugars and at the upper 2.5 percentile, the contribution of total sugars to energy was 28-33.8%. This range was even larger than that seen for the children.

(Tables 6.30 and 6.34)

6.4.3 Total sugars intake: diary

From the results of the assessment using the diary, boys had slightly higher mean intakes of sugars (113.3g) than girls (95.2g). The median intakes were more similar to each other, with a median intake of 105.4g for boys versus 99.2g for girls. Overall, these values were similar to those obtained using 24-hour recall. With the diary, there were no trends with age, with all age groups and sexes having similar mean values, ranging from 87.6g in the youngest age group of girls (4-6 years) to 105.1g for boys aged 7-10 years, except for the oldest boys (15-18 years), where the mean intake was 138.9g. This is a similar picture as the 24-hour recall results but slightly more marked.

The range of intakes was similar and wide for both boys and girls. Intakes at the lower 2.5 percentile were between 8% and 69% of the median for boys, and 35% to 74% for girls. Intakes at the upper 2.5 percentile were 58% to 96% higher than the median in boys and between 19% and 158% higher in girls.

Total sugars provided on average, 22.1% of total energy for boys and 21.9% for girls. The value for boys is very similar to that using 24-hour recall, that for the girls being somewhat lower. For boys, all age groups showed very similar mean values for the % energy from sugars, with the range from 21.4% for boys aged 4-6 years, to that for boys aged 15-18 years at 23.1%. The range for girls was similar, from the mean value for girls aged 11-14 years of 21.4% and that for girls aged 7-10 years of 23.5%. The values for total sugars intake as % total energy, are similar by recall and diary methods.

(Tables 6.29 and 6.33)

From the diary assessment, men had somewhat higher mean sugars intakes than women, 102.0g compared to 85.3g. There was no difference in mean intake with age in men, with intakes ranging from 94.3 to 107.0g. For women, the two younger age groups had slightly lower intakes, 79.5g and

79.3g for those aged 19-34 years and 35-49 years respectively, than the two older age groups, 90.4g for those aged 50-64 years, and 94.2g for those aged 65 years and over.

Median intakes for both sexes showed the same patterns as for the mean values. The range of intakes was similar for men and women, but for both the range of intake was wide: intakes at the lower 2.5 percentile were between 31% and 37% of the median in men, and 30% to 42% in women, while at the upper 2.5 percentile intakes were 67% to 167% higher than the median for men and from 86% to 125% higher in women. This indicates some very high intakes in some individuals with the diary, just as was found for the recall, with maximum values over 200g for all ages of men, with some ages of women showing equally high maximum intakes of total sugars as some of the groups of men.

Total sugars provided on average 17.8% of total energy for men and 19.2% for women. This percentage did not show any age trend for men, but for women, there was a graded increasing trend with age from 17.6% for the youngest age group, those aged 19-34 years, to 21.1% energy for those aged 65 years and over. For both men and women, at the lower 2.5 percentile, 8-9% of energy was derived from total sugars and at the upper 2.5 percentile, the contribution of total sugars to energy was 29-30%. This range was similar to the recall values.

(Tables 6.31 and 6.35)

6.4.4 Comparison with previous surveys

The results for total sugars in the comparison study can be compared to previous surveys. For young people, the comparison with the NDNS survey of young people[20], shows similar results to the comparison study with mean intakes for boys being 117.0g, compared to 116.5g by 24-hour recall and 113.3g by diary. For girls, the NDNS survey of young people[20] showed a mean intake of 97g for girls, whereas the comparison study results are 105.9g by 24-hour recall and 95.2g by diary.

Results expressed as % total energy were also similar with the values for both boys and girls being 23.0% total energy in the NDNS survey of young people[20], compared to 22.3% for boys and 24.6% for girls by recall and 22.1% for boys and 21.9% for girls by diary in the comparison study.

For adults, results can be compared with NDNS adults from 2000-01[21]. Results for total sugars intake were similar at 115g for men and 86g for women from the previous survey, compared to 114.8g by recall and 102.5g for diary for men and 89.9g by recall and 82.7g by diary for women in the comparison study. As a % total energy, total sugars provided 17.6% energy for men and 19.2% energy for women in NDNS adults[21], compared to 19.3% by recall and 17.8% by diary for men and 20.0% by recall and 19.2% by diary for women in the comparison study.

For those 65 years and over, the results for the NDNS of 1994-95[19] show intakes of 103g for men and 79g for women, compared to114.2g by recall and 100.2g by diary for men, and 84.6g by recall and

94.2g by diary for women in the comparison study, somewhat of an increase. As % energy, the values from the previous survey[19] were 20.2% energy for men and 20.8% energy for women, compared to 20.8% by recall and 19.7% by diary for men and 20.4% by recall and 21.3% energy by diary for women in the comparison study.

(Table 6.151)

6.5 Non-milk extrinsic sugars (NMES)

6.5.1 Introduction

This section describes the intake of Non Milk Extrinsic sugars (NMES). This includes all sugars in fruit juices, table sugar, honey, sucrose, glucose and glucose syrups added to food + 50% of the sugars in canned, stewed, dried or preserved fruits. Results have been compared to the COMA recommendation[25] that average NMES intake should not exceed 60g/d or 10% of total energy, and further to the intake level of 200g NMES per day, or 30% total energy, because above this level, adverse health consequences may occur.

6.5.2 NMES intake: 24-hour recall

Based on 24-hour recall, boys had slightly higher mean intakes of NMES (83.6g) than girls (77.5g), with closer median values of 76.7g for boys and 72.1g for girls. For boys, there was an incremental trend in mean NMES intake with age, from 77.2g for 4-6 years to 97.5g for 15-18 years. For girls, there was an increase from 4-6 years (61.8g) to 7-10 years (83.0g), but thereafter there was little variation in NMES intake with age.

The range of intakes tended to be narrower for girls compared to boys. Intakes at the lower 2.5 percentile were between 9% and 45% of the median for boys, and 30% to 62% for girls. Intakes at the upper 2.5 percentile were 42% to 287% higher than the median for boys and from 54% and 154% higher for girls.

NMES provided on average, 15.7% of total energy for boys and 17.8% for girls. This percentage showed little variation with age, from 14.0 for boys aged 11-14 years to 17.7% for boys aged 4-6 years, and for girls, from 17.0% for those aged 11-14 years to 18.8% for those aged 15-18 years. The range in intake was quite wide, with the lower 2.5 percentile being 5.6% energy for boys and 6.6% for girls and the upper 2.5 percentile being 28.1% for boys and 35.5% for girls.

In relation to the recommendation that average NMES intake should not exceed 60g/d or 10% of total energy, the proportion of children with average intake over 60g by dietary recall was 64% for the boys and 60% for the girls. There was very little difference with age in these proportions. When expressed

as % energy, the proportions who had intakes of NMES greater than 10% total energy was 83% for the boys and 87% for the girls. It appeared that these proportions were the highest for the youngest children, those aged 4-6 years, where 100% of boys and 94% of girls had NMES intakes above 10% total energy.

In relation to the intakes of 200g NMES per day, or 30% total energy, where adverse health consequences may occur, for the recall, 1% of boys and 6% of girls had NMES intakes were above 30% energy. This was exclusively in the oldest age group, 15-18 years, where the percentage of boys was 3% and of girls 13% with intakes above 30% energy. The small numbers in the cells for children in the comparison study should be borne in mind when considering these percentages.

(Tables 6.36 and 6.40)

Results for the 24-hour recall indicated that men had higher mean NMES intakes than women (79.0g compared to 52.8g). For men the two younger age groups appeared to have higher intakes (age 19-34 years 84.3g, age 35-49 years 82.6g), than the older age groups (50-64 years 71.1g, 65 years and over years 75.0g). For women, the youngest age group (19-34 years) had considerably higher intakes (68.5g) than the other age groups, which ranged from 46.0g to 49.6g.

Median intakes for both sexes showed the same patterns as for the mean values, except that for men, only the younger age group had higher values than the other age groups. The ranges of intakes were wide for both men and women; intakes at the lower 2.5 percentile were between 22% and 40% of the median for men, and 14% to 43% for women. Intakes at the upper 2.5 percentile were 99% to 236% higher than the median for men and from 95% to 247% higher in women. This indicates some very high intakes in some individuals in the study. The maximum values were over 160g for all age groups of men, with some ages of women, 35-49 years and 65 years and over, also showing maximum intakes of NMES this high.

NMES provided on average 13.1% of total energy for men and 11.7% for women. This percentage did not show any age trend for men or for women, although the youngest age group of women had a higher mean intake of 14.6% energy compared to 10.3% to 10.9% for the other age groups of women. For both men and women, at the lower 2.5 percentile, 2.2% to 7.6% of energy was derived from total NMES and at the upper 2.5 percentile, the contribution of total NMES to energy was 20.8% to 30.3%. The wider ranges, similar to those seen for children, were in the youngest age group of men and women, indicating a higher proportion of high consumers in this age group than in older adults.

(Tables 6.38 and 6.42)

According to the Department of Health recommendation, average NMES intake should not exceed 60g/d or 10% of total energy[25]. The percentage of adults with NMES intakes over 60g by the recall method was 65% for men and 33% for women. For men, there was very little difference with age in

these percentages, whereas for women, the youngest (aged 19-34 years) had a percentage similar to the men at 58%, while the other age groups has much small percentages (18-26%). When expressed as % energy, the proportions which had intakes of NMES greater than 10% total energy was 69% for the men and 58% for the women. These proportions were highest for the youngest age group, where 80% of men age 19-34 years and 79% of women of this age had NMES intakes above 10% total energy.

In relation to the Department of Health report[25] concerns about intakes of more than 200g NMES per day or 30% total energy, 1% of men and 1% of women completing the recalls had NMES intakes above 30% energy. This was exclusively in the youngest age group for men (19-34 years), where the percentage was 4%; for women, 1% of the mid-age groups (35-49 years and 50-64 years) had NMES intakes higher than 30% energy.

6.5.3 NMES intake: diary

From the results of the assessment using the diary, boys had higher mean intakes of NMES (86.5g) than girls (67.1g). The median intakes showed similar values, with a median intake of 82.4g for boys versus 67.3g for girls. Overall, these values were similar to those derived using 24-hour recall, although a little lower for girls. With the diary, there was some trend with age for boys, with the youngest age group, 4-6 years, having the lowest mean intake at 55.9g, and the oldest age group have the highest at 116.0g. For girls, there was an increase from the youngest age groups of girls, 4-6 years, (55.1g) to those aged 7-10 years (72.2g), but thereafter no change with age. This is a similar picture as for the 24-hour recall results.

The range of intakes was similar and wide for both boys and girls. Intakes at the lower 2.5 percentile were between 6% and 42% of the median for boys, and 25% to 47% for girls. Intakes at the upper 2.5 percentile were 43% to 143% higher than the median in boys and between 38% and 221% higher in girls.

NMES provided on average, 16.6% of total energy for boys and 15.3% for girls. These are similar to the values using 24-hour recall, although the value for girls was somewhat lower. For boys, there was an increasing trend in NMES intake as % energy with age, with the youngest age group (4-6 years) having the lowest mean value, at 12.6% and the oldest boys (aged 15-18 years) having the highest percentage at 19.1%. For girls, there was no trend with age, but as with the boys, the youngest age group had the lowest intake at 14.4%. The overall values for total NMES intake as % total energy are similar by recall and diary method, but the patterns by age are somewhat different, with increasing trends shown with the diary, but not with the recall.

(Tables 6.37 and 6.41)

The proportion of children with intakes exceeding 60g by the diary method was 77% for the boys and 59% for the girls. These are similar values as for recall, although the percentage of boys was

somewhat higher by diary. There was very little difference with age in these proportions. When expressed as % energy, the proportions who had intakes of NMES greater than 10% total energy was 83% for the boys and 81% for the girls. Unlike recall these proportions were not the highest for the youngest children, those aged 4-6 years; this age group, in fact, had the lowest proportions by diary at 57% and 62% compared to higher values for the older children, where 77-93% had NMES intakes over 10% energy.

In relation to the Department of Health report[25] that intakes of 200g NMES per day or 30% total energy may have adverse health consequences, for the diary, 7% of boys and 1% of girls had NMES intakes above 30% energy. This was exclusively in the oldest age group (15-18 years), for boys where 20% had intakes this high, whereas for girls it was the youngest age group alone where intakes over 30% energy were seen, at 4%. The small numbers in the cells for children in the comparison study should be borne in mind when considering these percentages.

From the diary assessment, men had somewhat higher mean NMES intakes than women (65.9g compared to 49.7g). There was generally a downward trend in mean intake with age for men, with the highest intake in the youngest age group (19-34 years) at 76.6g, and the lowest intake in the oldest age group (age 65 years and over) at 52.7g. For women there was no trend with age, with values having a narrow range for the different age groups from 47.0g to 51.1g. These intakes appeared somewhat lower by diary than by 24-hour recall on average, especially for the men, where the mean intake was 79.0g, compared to 65.9g.

Median intakes for both sexes showed the same patterns as for the mean values. The range of intakes was similar for men and women, but for both the range of intake was wide: intakes at the lower 2.5 percentile were between 15% and 34% of the median in men, and 14% to 26% in women, while at the upper 2.5 percentile intakes were 114% to 299% higher than the median for men and from 151% to 236% higher in women. This indicates some very high intakes in some individuals with the diary, just as was found for the recall, with maximum values over 160g for all age groups of men, except the oldest, those 65 years and over, and with older women also showing equally high maximum intake of total NMES as some of the groups of men.

NMES provided on average 11.3% of total energy for men and 11.0% for women. This percentage showed a downward trend with age for men, from 12.9% for the youngest age group, those 19-34 years, and 10.1% for those aged 65 years and over, while for women, there was no trend with age, mean intakes ranging from 10.7% to 11.2 % energy. For both men and women, at the lower 2.5 percentile, 2-5% of energy was derived from total NMES and at the upper 2.5 percentile, the contribution of total NMES to energy was 22-24%. This range was similar, though a little narrower than using recall.

(Tables 6.39 and 6.43)

Examining results in relation to the Department of Health recommendation[25] that average NMES intake should not exceed 60g/d or 10% of total energy, the proportion of diary-keeping adults over 10% was 51% for the men and 29% for the women. These are slightly lower values than seen by recall. For men, there was a decreasing percentage by age, with the highest value for the youngest age group (aged 19-34 years), where 67% were over 60g, versus the oldest age group (age 65 years and over), where 39% were over 60g. For women, there was no variation with age, with the percentage ranging from 26-31% having intakes over 60g. When expressed as % energy, the proportions who had intakes of NMES greater than 10% total energy by diary was 61% for the men and 53% for the women, again slightly lower than by recall. These proportions were highest for the youngest age group, where 77% of men aged 19-34 years and 62% of women of this age had NMES intakes above 10% total energy.

For the diary method, there were no men or women with NMES intakes above 30% energy.

6.5.4 Comparison with previous surveys

The results for NMES in the comparison study can be compared with previous surveys. For young people, the comparison with the NDNS survey of young people[20] shows very similar values to the comparison study with mean NMES intakes for boys being 85g, compared to 83.6g by 24-hour recall and 86.5g by diary. For girls, the NDNS survey of young people[20] showed a mean intake of 69g for girls, whereas the comparison study results are 77.5g by 24-hour recall and 67.1g by diary.

Results expressed as % total energy were also similar with the values for boys being 16.7% total energy in the NDNS survey of young people[20], compared to 15.7% by recall and 16.6% by diary, and 16.4 % for girls in the previous survey[20], compared to 17.8% by recall and 15.3% by diary for girls in the comparison study.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed similar results, with a mean intake for men aged 19-64 years of 79g, compared to 79g by recall and 65.9g by diary for men aged 19-64 years in the comparison study. Comparison of the oldest age group, those aged 65 years and over, can be made with the NDNS survey of this age group[19], conducted in 1994-95; this showed an intake of 64g NMES for free-living men, compared to 75g by recall and 52.8g by diary for this age group of men in the comparison study. For women, the NDNS adult survey of 2000-01[21] showed a mean intake of 51g for those aged 19-64 years, compared to 53g by recall and 49.7g by diary for women for this age range in the comparison study. Comparison of the oldest age group, those aged 65 years and over, from the NDNS survey of this age group[19], showed an intake of 52g NMES for free-living women, compared to 46g by recall and 50.6g by diary. The comparison study results are therefore very similar to the results from previous NDNS surveys[19-21].

(Table 151)

6.6 Fat

6.6.1 Introduction

This section reports the data on intakes of total fat, in g and as % energy. DRVs have been formulated for adults in the Department of Health report on dietary reference values for food energy and nutrients for the UK for adults[25]. Current recommendations for the UK are that fat should contribute a population average of no more than 33% of total energy (including alcohol). DRVs have not been formulated for children, because the scientific basis for the relationship between fat and health is less well established. Although the recommendation is for adults, this figure has also been used to compare intakes to recommendations in children as well, as was done, for example, for the NDNS survey of young people[20].

6.6.2 Total fat intake: 24-hour recall

Based on 24-hour recall boys had higher mean intakes of fat (74.6g) than girls (59.9g), with closer median values of 64.6g for boys and 59.6g for girls. For boys, there was some trend in mean fat intake with age, with the youngest group (4-6 years) having the lowest intake of 62.6g to 90.5g for 15-18 years. For girls, there was an increase from 4-6 years (50.9g) to 7-10 years (59.8g), but thereafter there was little variation in fat intake with age.

The range of intakes tended to be narrower for girls compared to boys. Intakes at the lower 2.5 percentile were between 46% and 59% of the median for boys, and 38% to 79% for girls. Intakes at the upper 2.5 percentile were 55% to 188% higher than the median for boys and from 26% to 82% higher for girls.

Total fat provided on average, 34.4% of total energy for boys and 33.1% for girls by recall. There was no consistent variation with age for boys, from 32.6% for boys aged 11-14 years to 36.1% for boys aged 7-10 years, or girls, from 30.2% for girls aged 15-18 years to 35.4% for girls aged 15-18 years. Compared to ranges for sugars and NMES, fat intakes showed narrower ranges, with the lower 2.5 percentile being 25.7% energy for boys and 19.9% for girls and the upper 2.5 percentile being 44.5% for boys and 42.7% for girls.

According to the COMA report[25], average fat intake should not exceed 33% of total energy. The proportion of children over 33% by the dietary recall method was 57% for the boys and 53% for the girls. There was some variation with group but this was not according to age. These values ranged from 73% over 33% energy for boys age 7-10 years and 68% for girls aged 11-14 years.

(Tables 6.44 and 6.48)

Results for the 24-hour recall indicated that men had higher mean fat intakes than women, 85.3g compared to 63.7g. For men the highest value for fat intake was seen for the age group 35-49 years (93.7g), the lowest men aged 65 years and over (80.5g); for women, there was little variation with age, ranging from 61.2g for those aged 35-49 years and the highest 66.7g for the youngest age group (19-34 years).

Median intakes for both sexes showed the same patterns as for the mean values. The ranges of intakes were similar for men and women; intakes at the lower 2.5 percentile were between 32% and 44% of the median for men, and 26% to 50% for women. Intakes at the upper 2.5 percentile were 73% to 115% higher than the median for men and from 64% to 115% higher in women.

Total fat provided on average 34.0% of total energy for men and 34.1% for women by recall. This percentage did not show any age trend for men or for women, with all group means in the range 33-35% energy. For both men and women, at the lower 2.5 percentile, 21% of energy was derived from total fat and at the upper 2.5 percentile, the contribution of total fat to energy was 45-47%.

The proportion of adults over 33% by the recall method was 56% for the men and the women. For both men and women, there was similar variation between groups, ranging from 48-62%, with no trends with age.

(Tables 6.46 and 6.50)

6.6.3 Total fat intake: diary

Using the four-day diary, boys and girls had similar mean values for fat intake: boys 71.4g; girls 65.7g. The median intakes showed similar values, with a value of 69.7g for boys versus 63.6g for girls. Overall, these values are very similar to those derived using 24-hour recall. There was little trend with age, although the highest mean intake for boys was in the oldest age group, 15-18 years, at 81.0g, with the lowest for the youngest group, 4-6 years, at 62.2g. For girls, there was an increase from the youngest age group of girls, 4-6 years, (56.1g) to those aged 7-10 years (68.8g), but thereafter no change with age.

The range of intakes was similar for boys and girls. Intakes at the lower 2.5 percentile were between 31% and 69% of the median for boys, and 35% to 65% for girls. Intakes at the upper 2.5 percentile were 27% to 90% higher than the median in boys and between 23% and 73% higher in girls.

Total fat provided on average, 34.6% of total energy for boys and 36.2% for girls. These are similar to the values using 24-hour recall for boys, but the value for girls is somewhat higher by diary. There were no trends with age for either boys or girls with all groups ranging from 33.5% to 37.4%.

The proportion of children over 33% energy by the diary method was 61% for the boys and 67% for the girls. These are rather higher values than obtained for the recall. There was some decreasing trend with age in the proportion of those over 33% energy with the two younger age groups having 79% and 80% over 33% energy for fat, while the older two age groups had 50% and 44% over 33% energy. For girls there was no trend with age in the proportion over 33% energy, with a range from 63% to 77%.

(Tables 6.45 and 6.49)

From the diary assessment, men had somewhat higher mean fat intakes than women, 80.8g compared to 63.3g. There were no trends with age for the men or women, although the oldest men, those aged 65 years and over had the lowest intakes for the men at 71.1g. For the women there was no trend with age, all mean intakes ranging from 61 to 65g. Results for the diary and the recall were similar.

Median intakes for both sexes showed the same patterns as for the mean values. The range of intakes was similar for men and women: intakes at the lower 2.5 percentile were between 48% and 54% of the median for men, and 37% to 48% for women, while at the upper 2.5 percentile intakes were 50% to 139% higher than the median for men and from 61% to 98% higher in women.

Total fat provided on average 34.2% of total energy for men and 34.3% for women. There were no trends with age for either men or women by diary, with mean intakes within the range of 33-35% energy for all age and sex groups. For both men and women, at the lower 2.5 percentile, 21% of energy on average was derived from total fat and at the upper 2.5 percentile, the contribution of total fat to energy was 45-47%. This range was the same as found for recall.

Examining results in relation to the COMA recommendation[25] that average fat intake should not exceed 33% of total energy, the proportion of adults over this intake by the diary method was 60% for the men and 59% for the women. These are slightly higher proportions than seen by recall. There were no trends with age in the proportion over 33% energy for either men or women.

(Tables 6.47 and 6.50)

6.6.4 Comparison with previous surveys

The results for fat in the comparison study can be compared with previous surveys. For young people, the comparison with the NDNS survey of young people[20], conducted in 1997 shows very similar values to the comparison study with mean fat intakes for boys being 75g, compared to 74.6g by 24-hour recall and 71.4g by diary. For girls, the NDNS survey of young people[20] showed a mean intake of 63g for girls, whereas the comparison study results are 59.9g by 24-hour recall and 65.7g by diary.

Results expressed as % total energy were also similar with the values for boys being 35.3% total energy in the NDNS survey of young people[20], compared to 34.4% by recall and 34.6% by diary, and 35.9% for girls in the previous survey[20], compared to 33.1% by recall and 36.2% by diary for girls in the comparison study.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed somewhat higher results in the comparison study, with a mean intake for men aged 19-64 years of 79g for NDNS adults, compared to 85.3g by recall and 80.8g by diary for men for the age range 19-64 years. Comparison of the oldest age group, those aged 65 years and over, with the NDNS survey of this age group[19], shows similar results, with an intake of 75g fat for free-living men, compared to 80.5g by recall and 71.1g by diary in the comparison study. For women, the NDNS adult survey of 2000-01[21] showed a mean intake of 61g for those aged 19-64 years, compared to 63.7g by recall and 63.3g by diary for 19-64 years in the comparison study. For the oldest age group, those aged 65 years and over, had an intake 58g fat for free-living women in the 1994-95 survey[19], compared to 62.5g by recall and 61.5g by diary for this age group of women in the comparison study.

Results expressed as % total energy were also similar with the values for men being 33.5% total energy in the NDNS survey of adults[21], compared to 34.0% by recall and 34.2% by diary, and 33.5% for women in the previous survey, compared to 34.1% by recall and 34.3% by diary for women in the comparison study. For the oldest age group, those aged 65 years and over, fat as % energy was 34.3% for men in the previous survey[19] and 35.6% for women, compared to 34.9% by recall and 34.2% by diary for women in the comparison study. The comparison study results are therefore very similar to the results from previous NDNS surveys for intakes of total fat.

(Table 6.151)

6.7 Protein

6.7.1 Introduction

This section reports the data on intakes of protein, in g and as % energy, and as % of the RNI.

6.7.2 Protein intake: 24-hour recall

Based on 24-hour recall boys had higher mean intakes of protein (71.3g) than girls (55.6g), with median values of 67.3g for boys and 54.2g for girls. For boys, there was a stepwise increasing trend with age, with the youngest group (4-6 years) having the lowest intake of 57.8g and the oldest group (15-18 years) the highest (87.6g). For girls, there was increase from 4-6 years (42.3g) to 7-10 years (57.0g), but thereafter no consistent trend in protein intake with age was seen.

The range of intakes tended to be narrower for girls compared to boys. Intakes at the lower 2.5 percentile were between 44% and 70% of the median for boys, and 58% to 78% for girls. Intakes at the upper 2.5 percentile were 27% to 148% higher than the median in boys and from 34% and 68% higher in girls.

Total protein provided on average, 15.0% of total energy for boys and 13.8% for girls by recall. There was a stepwise increasing trend with age for boys, ranging from 14.3% for boys aged 4-6 to 16.3% for boys aged 15-18. For girls, there was increase from 4-6 years (12.8%) to 7-10 years (14.1%), but thereafter no consistent trend in protein intake with age was seen. Protein intake ranges were narrow compared to other nutrients, with the lower 2.5 percentile being 10.3% energy for boys and 9.1% for girls and the upper 2.5 percentile being 20.2% for boys and 17.9% for girls.

On average, the intakes of protein from the recall represented from 159% of the RNI for boys aged 15-18 years to 294% RNI for boys aged 4-6 years, with an overall average of 213 % of the RNI. For boys, all boys in age groups 4-6 years, 7-10 years and 11-14 years exceeded the RNI for protein; for boys age 15-18 years 3% did not meet the RNI of 55.2g for that age group. For girls, all girls aged 4-6 years and 7-10 years exceeded the RNIs for their age groups. For age 11-14 years, 3% of girls did not meet the RNI of 41.2g and for 15-18 years, 26 % of girls did not meet the RNI of 45.4g.

(Tables 6.52, 6.53 and 6.60)

Results for the 24-hour recall indicated that men had higher mean protein intakes than women, 84.5g compared to 67.3g. For men the highest value for protein intake was seen for the age group 35-49 years (91.3g), the lowest for men aged 65 years and over (75.9g); for women, there was little variation with age, ranging from 66.6g for those aged 35-49 years to the highest, 68.7g, for those aged 50-64 years.

Median intakes for both sexes showed the same patterns as for the mean values. The ranges of intakes were similar for men and women; intakes at the lower 2.5 percentile were between 38% and 55% of the median for men, and 51% to 59% for women. Intakes at the upper 2.5 percentile were 47% to 106% higher than the median for men and from 47% and 65% higher for women.

Total protein provided on average 15.5% of total energy for men and 16.7% for women by recall. This percentage did not show any age trend for men, but for women, there was an increasing stepwise trend from 15.8% for those aged 19-34 years to 17.4% for those 65 years and over. For both men and women, at the lower 2.5 percentile, 10-11% of energy was derived from total protein and at the upper 2.5 percentile, the contribution of total protein to energy was 22-25%.

In relation to the RNI, the proportion of men not meeting the RNI for protein by recall ranged from 8% of those 50-64 years (RNI 53.3g) to 15% of those 19-34 years (RNI 55.5g). For women, the proportions were somewhat lower, ranging from 4% of those aged 19-34years (RNI 45.0g) to 8% of

those aged 65 years and over (RNI 46.5g). On average, men had protein intakes of 155% of the RNI and women 147%.

(Tables 6.56, 6.57 and 6.62)

6.7.3 Protein intake: diary

Using the diary, boys had higher mean values than girls for protein intake (boys 69.8g; girls 57.4g). The median intakes showed similar values as the means, with intakes of 68.7g for boys versus 58.2g for girls. Overall, these values are very like those derived using 24-hour recall. There was very little trend with age for boys, although the highest intake for boys was in the oldest age group, 15-18 years (82.0g), with the lowest for the youngest group, 4-6 years (60.5g). For girls, the two youngest age groups, 4-6 years (51.8g) and 7-10 years (53.1g) were lower than the two older groups, 11-14 years (61.9g) and 15-18 years (61.0g).

The range of intakes was similar for boys and girls. Intakes at the lower 2.5 percentile were between 37% and 71% of the median for boys, and 51% to 71% for girls. Intakes at the upper 2.5 percentile were 44% to 66% higher than the median in boys and between 28% and 69% higher in girls.

Total protein provided, on average, 15.1% of total energy for boys and 14.3% for girls. These are similar to the values using 24-hour recall for boys and for girls. There were no trends with age for either boys or girls with all groups ranging from 13% to 16%.

On average, the intakes of protein from the recall represented from 149% of the RNI for boys aged 15-18 years to 307% RNI for boys aged 4-6 years, with an overall average of 195 % of the RNI, very similar values to those obtained for recall. For boys, all boys in age groups 4-6 years and 7-10 years exceeded the RNI for protein; for boys age 11-14 years 18% did not meet the RNI of 42.1g and 3% of those aged 15-18 years did not meet the RNI of 55.2g for that age group. For girls, all girls aged 4-6 years, 7-10 years, and 11-14 years exceeded the RNIs for their age groups. For age 15-18 years, 13% % of girls did not meet the RNI of 45.4g. these results are similar to recall except of the boys aged 11-14 years, where all boys met the RNI for recall, compared to 18% not meeting by diary.

(Tables 6.53, 6.54 and 6.61)

From the diary assessment, men had somewhat higher mean protein intakes than women, 86.0g compared to 67.1g. There were no trends with age for the men or women, although the oldest men, those aged 65 years and over had the lowest intakes at 76.1g. For the women there was no trend with age, all mean intakes ranging from 66.1-69.1g. Results for the diary and the recall were similar.

Median intakes for both sexes showed the same patterns as for the mean values. The range of intakes was similar for men and women: intakes at the lower 2.5 percentile were between 58% and

78% of the median for men, and 48% to 73% for women, while at the upper 2.5 percentile intakes were 35% to 76% higher than the median for men and from 44% to 91% higher for women.

Total protein provided on average 16.6% of total energy for both men and women. This percentage did not show any age trend for men, but for women, there was an increasing stepwise trend, from 16.1% for those aged 19-34 years to 17.2% for those 65 years and over. For both men and women, at the lower 2.5 percentile, 11-12% of energy was derived from protein and at the upper 2.5 percentile, the contribution of total protein to energy was 24-25%. These values, ranges and trends were very similar to those found for recall.

In relation to the RNI, the proportion of men not meeting the RNI for protein by recall ranged from 1% of those 50-64 years and 65 years and over (RNI 53.3g) to 10% of those 35-49 years (RNI 55.5g). For women, the proportions were somewhat higher, ranging from 2% of those aged 50-64 years (RNI 46.5g) to 17% of those aged 35-49 years (RNI 45.0g). On average, men had protein intakes of 158% of the RNI and women 147%, similar values to those obtained with recall.

(Tables 6.56, 6.57 and 6.63)

6.7.4 Comparison with previous surveys

Compared to the NDNS survey of young people[20], the results from the comparison study were slightly higher than the previous survey where mean protein intake for boys were 62g, compared to 71g by 24-hour recall and 69.8g by diary. For girls, the NDNS survey of young people[20] showed a mean intake of 51g for girls, whereas the comparison study results are 56g by 24-hour recall and 57.4g by diary.

Results expressed as % total energy were also somewhat lower for the previous survey[20] with the value for boys being 12.9% total energy, compared to 15.0% by recall and 15.1% by diary, and 12.9% for girls in the previous survey, compared to 13.8% by recall and 14.3% by diary for girls in the comparison study.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed similar results, with a mean intake for men aged 19-64 years of 85g, compared to 84.5 by recall and 86.0g by diary for men for this age range in the comparison study. For the oldest age group, those aged 65 years and over, the NDNS survey of older people[19] also shows similar results, with an intake of 71g protein for free-living men, compared to 75.9g by recall and 76.1g by diary in the comparison study. For women, the NDNS adult survey of 2000-01[21] showed a mean intake of 64g for those aged 19-64 years, compared to 67.3g by recall and 67.1g by diary for this age range in the comparison study. For those aged 65 years and over, an intake of 56g protein was seen in the earlier survey[19], compared to a larger intake of 66.6g by recall and 67.8g by diary for this age group of women in the comparison study.

Results expressed as % total energy were also similar with the values for men being 15.4% total energy in the NDNS survey of adults[21], compared to 15.5% by recall and 16.6% by diary, and 15.9% energy for women in the previous survey, compared to 16.7% by recall and 16.6% by diary for women in the comparison study. For the oldest age group, those aged 65 years and over, protein as % energy was 15.4% for men in the previous survey[19] and 16.3% for women, compared to 17.4% for women by recall and 17.2% by diary in the comparison study. The comparison study results are therefore similar to the results from previous NDNS surveys for intakes of total protein and for those 65 years and over, somewhat higher.

(Tables 6.151)

6.8 Non-starch polysaccharides (NSP)

6.8.1 Introduction

The Department of Health report[25] on dietary reference values for food energy and nutrients for the UK made a recommendation that adults should have an average intake of 18g NSP per day, based on effects on colonic function. The COMA committee did not make a recommendation for dietary fibre or NSP intake for children, stating only that children should have proportionally lower intakes than adults. In generating a Guideline Daily Amount (GDA) for fibre for children, the IGD examined all recommendations for fibre from various bodies and arrived at a figure of age + 7.5g, being between the recommendation of minimum of age +5g and a maximum of age +10g, suggested by the American Health Foundation[28], as a suitable figure for guidance for fibre consumption for children in the UK[29]. In the absence of any other recommendation, these are the figures to which the results of the comparison study have been compared to assess adequacy of intakes. They are: 9g for 4-6 years, 12g for 7-10 years, 15g for 11-14 years and 18g for 15-18 years, the same value as for adults, with no differences by sex.

6.8.2 NSP intake: 24-hour recall

Based on 24-hour recalls boys had slightly higher mean intakes of NSP (12.2g) than girls (10.7g), with closer median values of 12.1g for boys and 11.4g for girls. For boys or girls, there was little variation with age, although for both sexes, the youngest age group (4-6 years) had slightly lower intakes (boys 10.8g, girls 9.8g) than older children.

The ranges of intakes were similar for boys and girls. Intakes at the lower 2.5 percentile were between 42% and 79% of the median for boys, and 54% to 73% for girls. Intakes at the upper 2.5 percentile were 24% to 76% higher than the median for boys and from 37% and 70% higher for girls.

In relation to the GDA guidance intakes outlined in the introduction, the proportion of boys not reaching the guidance levels ranged from 29% of those 4-6 years not reaching 9g, to 94% of 15-18

year olds not reaching 18g; for girls the picture was similar but rather worse with 52% of those 4-6 years not reaching 9g and 100% of those 15-18 years not reaching 18g.

(Table 6.64)

Results for the 24-hour recall indicated that men had slightly higher mean NSP intakes than women, 14.5g compared to 13.1g. For both men and women there were no trends with age in NSP intake, with mean intakes ranging from 11 to 16g, and overlap in mean values between men and women. Median intakes for both sexes showed the same patterns as for the mean values.

The ranges of intakes were similar for men and women and were wide in some cases; intakes at the lower 2.5 percentile were between 38% and 54% of the median for men, and 32% to 59% for women. Intakes at the upper 2.5 percentile were 44% to 201% higher than the median for men and from 63% to 127% higher in women. This indicates some very high intakes in some individuals in the study.

In relation to the recommendation of 18g, the proportion of adults not reaching this intake by the recall method was 81% for the men and 86% for the women. For men, there was very little difference with age in these proportions, although the age group 35-49 years was rather lower than the other ages at 69% not reaching 18g. For the women, the younger women, 19-34 years and 35-49 years, each had over 90% not reaching 18g, while the age group 50-64 years was lower at 75%.

(Table 6.66)

6.8.3 NSP intake: diary

The results of the assessment using the four-day diary showed very similar intakes for both boys and girls as found for the 24-hour recall, with boys having a mean intake of NSP of 11.7g and girls 10.6g. The median intakes showed almost identical values as the means. There was no trend with age for NSP intake for children with the diary, with mean intakes ranging from 10-12g for all age sex groups.

The range of intakes was similar for boys and girls. Intakes at the lower 2.5 percentile were between 22% and 61% of the median for boys, and 48% to 72% for girls. Intakes at the upper 2.5 percentile were 44% to 70% higher than the median in boys and between 38% and 66% higher for girls.

In relation to the GDA guidance intakes outlined in the introduction, the proportion of boys not reaching the guidance levels ranged from 17% of 4-6 year olds not reaching 9g to 95% of those 15-18 years not reaching 18g; for girls, 25% of 4-6 year olds did not reach 9g and 100% of those aged 15-18 years did not reach 18g. These proportions were similar to those for the 24-hour recall.

(Table 6.65)

Results for the diary indicated that men had slightly higher mean NSP intakes than women, 14.5g compared to 13.0g, very similar results to those from the recall. For both men and women there were some trends with age in NSP intake, with the youngest age groups, 19-34 years and 35-49 years

having lower intakes (13.3g and 14.0g for the men and 12.2g and 12.0g for the women), compared to the values for the older two age groups, 50-64 years and 65 years and over (15.8g and 15.6g for the men; 13.8g and 14.3g for the women). Median intakes for both sexes showed the same patterns as for the mean values.

The ranges of intakes were similar for men and women and were wide in some cases; intakes at the lower 2.5 percentile were between 38% and 70% of the median for men, and 39% to 56% for women. Intakes at the upper 2.5 percentile were 53% to 187% higher than the median for men and from 74% to 133% higher in women. This indicates some very high intakes in some individuals in the study.

In relation to the recommendation of 18g, the proportion of adults not reaching this intake by the recall method was 75% for the men and 85% for the women. For men, there was very little difference with age in these proportions, although the age group 35-49 years was rather higher than the other ages at 84% not reaching 18g. There was very little variation in proportions for the women, although the oldest age group, those 65 years and over, had the lowest percentage at 79%. These patterns are rather different than with the recall, but the small numbers in the study may well be the reason for this.

(Table 6.66)

6.8.4 Comparison with previous surveys

The results for total NSP in the comparison study can be compared to previous surveys. For young people, the comparison with the NDNS survey of young people[20], conducted in 1997, shows very similar, though somewhat lower values than the comparison study with mean NSP intakes for boys being 11.2g, compared to 12.2g by 24-hour recall and 11.7g by diary. For girls, the NDNS survey of young people[20] showed a mean intake of 9.7g for girls, whereas the comparison study results were 10.7g by 24-hour recall and 10.6g by diary. These may suggest small increases in NSP since the 1997 survey which may be confirmed in the main NDNS survey in the future.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed similar results, with a mean intake for men aged 19-64 years of 15.2g, compared to 14.5g by recall and diary for men for the age range 19-64 years in the comparison study. Comparison of the oldest age group, those aged 65 years and over with the NDNS survey of this age group[19], showed an intake of 13.5g NSP for free-living men, compared to 14.1g by recall and 15.6g by diary for this age group of men in the comparison study. For women, the NDNS adult survey of 2000-01[21] showed a mean intake of 12.6g for those aged 19-64 years, compared to 13.1g by recall and 14.3g by diary for women for this age range 19-64 years in the comparison study. Comparison of the oldest age group, those aged 65 years and over, from the NDNS survey of this age group[19], showed an intake of 12.1g NSP for free-living women, compared to 12.8g by recall and 14.3g by diary for this age group of women in the comparison study. The comparison study results are therefore similar to the results from previous NDNS surveys.

(Table 6.151)

6.9 Alcohol

6.9.1 Introduction

This section presents the results for alcohol intake. In previous NDNS surveys, data from the dietary interview have been presented, as well as results from the dietary assessment for both consumers only as well as for all respondents. In past surveys, results have also been converted to units of alcohol and compared to recommended maximum intakes. For the comparison study, the examination of alcohol intake has been limited to average consumption for all participants and variations by age and method of assessment. Comparison has been made to past surveys for these specific analyses. As in other surveys, substantial proportions of individuals did not consume alcohol during the period of dietary assessment.

6.9.2 Alcohol intake: 24-hour recall

Based on 24-hour recalls boys had higher mean intakes of alcohol (1.8g) than girls (0.2g). All intakes at lower 2.5 percentile and all median values for children were zero for alcohol consumption. Intakes at the upper 2.5 percentile were zero by recall for all age groups except for boys aged 7-10 years (0.9g), boys aged 15-18 years (69.3g), and for girls aged 15-18 years (7.7g).

Alcohol provided, on average, 0.5% of total energy intake for boys and 0.1% for girls. Virtually all intake was in the age group 15-18 years, where the mean % contribution to energy was 1.8% for boys and 0.4% for girls. The top 2.5 percentile values for boys aged 15-18 years was 17.3% energy, and 3.6% for girls of this age group.

(Tables 6.68 and 6.72)

Results for the 24-hour recall indicated that men had higher mean alcohol intakes than women, 22.2g compared to 11.5g. There was no trend with age for either sex. The highest mean intake for men was for those aged 50-64 years at 32.5g, whereas the highest intake for women was seen for those 35-49 years, at 16.4g. Median intakes for both sexes were considerably lower than the mean values, reflecting the high numbers of non-consumers of alcohol. The range in intake was high, with an average top 2.5 percentile of 92.4g for men and 53.6g for women. For women the top 2.5 percentile was higher for the two younger age groups (53.6g for 19-34 years, 60.1g for 35-49 years) than the two older groups (34.9g for 50-64 years and 30.9 g for those 65 years and over), indicating a greater consumption at the top of the distribution curve in the younger women compared to the older.

Alcohol provided on average 6.7% of total energy for men and 4.7% for women. There was no trend with age in the % energy from alcohol for either sex. The lower 2.5 percentile for both men and women was zero for alcohol, reflecting the high proportion of non-consumers during the survey

period. At the upper 2.5 percentile, the contribution of total alcohol to energy was 28.2% for men and 19.6% for women. There were no trends with age for these percentiles.

(Tables 6.70 and 6.74)

6.9.3 Alcohol intake: diary

From the results of the assessment using the diary, boys had higher mean intakes of alcohol (2.2g) than girls (0.4g). All intakes at the lower 2.5 percentile and all median values for children were zero for alcohol consumption. Intakes at the upper 2.5 percentile were zero for all age groups except for boys aged 11-14 years (2.8g), boys aged 15-18 36.3g), and for girls aged 15-18 years (11.1g). This is a similar picture as the 24-hour recall results.

Alcohol provided on average, 0.7% of total energy intake for boys and 0.1% for girls. Virtually all intake was in the age group 15-18 years, where the mean % contribution to energy was 1.8% for boys and 0.4% for girls. The top 2.5 percentile values for boys 15-18 years was 12.0% energy, and 4.7% for girls of this age group.

(Tables 6.69 and 6.73)

Results for the diary indicated that men had higher mean alcohol intakes than women, 20.3g compared to 11.7g, similar values to those found with the 24-hour recall. There was no trend with age for either sex. The highest mean intake for both men and women was for those aged 50-64 (26.4g and 14.6g respectively). Median intakes for both sexes were considerably lower than the mean values, reflecting the high numbers of non-consumers of alcohol. The range in intake was high, with an average top 2.5 percentile of 74.8g for men and 49.7g for women. For women, the top 2.5 percentile was lower for the oldest age groups, those aged 65 years and over, where the value was 33.0g compared to the other age groups, where the top 2.5 percentile ranged from 44g to 56g.

Alcohol provided on average 6.3% of total energy for men and 4.8% for women. There was no trend with age in the % energy from alcohol for either sex. The lower 2.5 percentile for both men and women was zero for alcohol, reflecting the high proportion of non-consumers during the survey period. At the upper 2.5 percentile, the contribution of total alcohol to energy was 23.5% for men and 19.3% for women. There were no trends with age for these percentiles, although the lowest value was for women 65 years and over at 14.4%.

(Tables 6.71 and 6.75)

6.9.4 Comparison with previous surveys

The results for alcohol intake in the comparison study can be compared to previous surveys. For young people, the comparison with the NDNS survey of 1997[20] shows very similar values to the comparison study with mean alcohol intakes for boys being 1.8g, compared to 1.8g by 24-hour recall

and 2.2g by diary. For girls, the NDNS survey of young people[20] showed a mean intake of 0.9g for girls, whereas the comparison study results are 0.2g by 24-hour recall and 0.4g by diary.

Results expressed as % total energy were also similar with the values for boys being 0.5% total energy in the NDNS survey of young people[20], compared to 0.5% by recall and 0.7% by diary, and 0.4% for girls in the previous survey, compared to 0.1% by recall and 0.1% by diary for girls in the comparison study.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed that the mean intake for men aged 19-64 years was 22g, compared to 23g by recall and 21g by diary for men for the age range 19-64 years in the comparison study. Comparison of the oldest age group, those aged 65 years and over, from the NDNS survey of this age group[19], showed an intake of 12g alcohol for free-living men, compared to 19g by recall and 17g by diary for this age group of men in the comparison study. For women, the NDNS adult survey of 2000-01[21] showed a mean intake of 9g for those aged 19-64 years, compared to 13g by recall and 13g by diary for women for the age range 19-64 years in the comparison study. Comparison of the oldest age group, those aged 65 years and over, from the NDNS survey of this age group[19], showed an intake of 3g alcohol for free-living women, compared to 7g by recall and 6g by diary for this age group of women in the comparison study.

Results expressed as % total energy were also similar with the values for men aged 19-64 years being 6.5% total energy in the NDNS survey of young people[20], compared to 6.7% by recall and 6.3% by diary, and 3.9% for women in the previous survey, compared to 4.7% by recall and 4.8% by diary in the comparison study. For the oldest age group, those 65 years and over, the values were 4.0% energy for men and 1.3% for women in the previous NDNS survey[19], compared to 6.0% by recall and 5.9% by diary, and for women, 3.3% by recall and 2.5% by diary in the comparison study.

The comparison study results are therefore similar for men aged 19-64 years as in previous surveys somewhat higher for women of this age range and for both older men and women than the previous surveys. Any differences seen with these small numbers will need confirmation by the main NDNS survey in the future.

(Tables 6.151)

6.10 Calcium

6.10.1 Introduction

This section describes the results for calcium from food sources only. The intake of supplements in the comparison study will be reported at a later date. Results are expressed as mg of calcium and results are compared to the RNI for calcium as outlined in the COMA report from 1991[25].

6.10.2 Calcium intake: 24-hour recall

Based on 24-hour recalls boys had higher mean intakes of calcium from food sources (935mg) than girls (714mg). The medians were lower, 829mg for boys versus 697mg for girls, reflecting a skewed distribution. For boys mean calcium intake increased with age from 857mg for those aged 4-6 years to 1048mg for those aged 15-18 years. Trends with age for girls were not continuous and less marked, ranging from 640mg for the youngest girls to 694mg for the oldest. The difference between lowest and highest mean intake between age groups was 192mg and 132mg for boys and girls, respectively.

The range of intakes was wide in both sexes, though consistently narrower in girls compared to boys. Intakes at the lower 2.5 percentile were between 26% and 75% of the median in boys, and 42% to 71% in girls. Intakes at the upper 2.5 percentile were 40% to 117% higher than the median in boys and between 42% and 75% higher in girls. Standards deviations were higher in boys than girls for each age group.

Overall, the average intake of calcium for boys and girls expressed as a percentage of RNI was 134% and 113%, respectively. However, the average intake expressed as percentage RNI was below 100% for both sexes aged 11-14 years as well as girls aged 15-18 years. In total, 6.9% of boys 7-10 years and 5.7% of boys 15-18 years failed to achieve the LRNI for their age group. Intakes were above the LRNI in all other groups.

Intakes less than 300mg were seen in 23% (2 out of 9) of boys aged 7-10years. All other boys in this age group had intakes above 700mg.

(Tables 6.77 and 6.78)

Men had higher mean intakes of calcium from food sources than women, 919mg versus 780mg, respectively. Mean intakes of calcium were highest for men aged 35-49 years (986mg), and below 900mg in men aged 19-34 years (875mg) as well as those aged 65 years and over (874mg). For women, the mean intake was highest for those aged 50-64 years (824mg), while all other age groups had very similar mean calcium intakes, ranging from 755mg to 773mg.

Median intakes for both sexes increased with age for all but those aged 65 years and over. However, the median intake of those aged 65 years and over (men: 840mg; women: 765mg) was still higher than that observed for those aged 19-34 years (men: 770mg; women: 694mg). Median intakes were lower than the means for men at all age groups, reflecting a slightly skewed distribution.

There was a wide range of calcium intake for men and women and the standard deviations were higher for men than women for all age groups. For men, intakes at the lower 2.5 percentile were between 36% and 63% and in women between 46% and 70% of the median. Intakes at the upper 2.5 percentile were 63% to 128% and 68% to 98% higher than the median for men and women, respectively.

Mean intakes were above the RNI for both sexes and all age groups and expressed as %RNI were 131% and 111% for men and women, respectively. For men, intakes below the LRNI were observed for those 19-34 years and those aged 65 years and over. for women, a small percentage of intakes below the LRNI was observed for all but those aged 50-64 years. In total, 0.8% of men and 1.1% of women had intakes below the LRNI.

(Tables 6.81 and 6.82)

6.10.3 Calcium intake: diary

When reporting by diary boys had higher mean intakes of calcium from food sources (798mg) than girls (719mg). For both sexes the youngest age groups had higher intakes than the oldest. Boys aged 4-6 years had intakes of 851mg compared to 810mg in boys aged 15-18 years and girls aged 4-6 years had intakes of 738mg compared to 664mg in those aged 15-18 years.

Median intakes for all boys and girls were 777mg and 712mg, respectively. The differences between means and medians were smaller for boys compared to girls suggesting a more skewed distribution for girls. For girls, there was a consistent downward trend in median intake with age.

There was a wide range of calcium intakes for boys and girls and the standard deviations were higher for boys than girls for most age groups. For boys, intakes at the lower 2.5 percentile were between 45% and 69% and for girls between 52% and 96% of the median. Intakes at the upper 2.5 percentile were 52% to 96% and 41% to 97% higher than the median for boys and girls, respectively.

When expressed as a percentage of RNI mean intakes were over 100% for boys and girls aged 4-6 years and 7-10 years. Boys aged 11-14 years and 15-18 years had mean intakes of 70% and 81% of the RNI, respectively, and girls of the same age groups had intakes of 89% and 83% of the RNI. In total, 3% of boys and 2.8% of girls aged 15-18 years had intakes below the LRNI. The average daily intakes in all other age groups were above the LRNI.

(Tables 6.79 and 6.80)

When reporting by diary the mean intakes of calcium from food sources were higher in men (893mg) than women (786mg). There was no consistent trend in intake with age. For men, the highest intake,1028mg, was seen for those aged 50-64 years. The lowest intake, 759mg, was seen for women aged 19-34 years. The difference between lowest and highest intake between age groups was 204mg and 81mg for men and women, respectively. Nearly all median values were slightly lower than the means, suggesting a skewed distribution.

There was a wide range of intake for men and women and the standard deviations were of a similar magnitude for most age groups and both sexes. At the lower 2.5 percentile intakes were between 33% and 58% and between 32% and 64% of the median for men and women, respectively. Intakes at

the upper 2.5 percentile were 83% to 133% for men and 45% to 131% higher than the median for women.

Average calcium intake expressed as a percentage of the RNI was over 100% for all age and sex groups. For men, intakes below the LRNI were only observed for those aged 19-34 years (2%). For women, age groups except for those aged 50-64 included individuals with intakes below the LRNI. The percentage of women with a calcium intake below the LRNI was 3.1% for those 19-34 years, 0.5% for 35-49 years, and 3.3% for those 65 years and over.

(Tables 6.83 and 6.84)

6.10.4 Comparison with previous surveys

The results for total calcium in the comparison study can be compared to previous surveys. For young people, the comparison with the NDNS survey of young people[20], conducted in 1997 shows very similar values to the comparison study diary method with mean intakes of calcium for boys being 784mg, compared to 798mg in the comparison study. Calcium intakes in boys as reported by 24-hour recall in the comparison study were higher at 935mg. For girls, the NDNS survey of young people[20] showed a mean intake of 652mg, whereas the comparison study results were slightly higher at 719mg by 24-hour recall and 714mg by diary.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed similar results, with a mean intake for women aged 19-64 years of 777mg, compared to 783mg by recall and 770mg by diary in the comparison study. For men, the NDNS adult survey of 2000-01[21] showed a mean intake of 1007mg for those aged 19-64 years, compared to 928mg by recall and 892mg by diary for women aged 19-64 years in the comparison study.

Similar results were also seen in men aged 65 years and over in the comparison study when compared to the NDNS people of this age group[19], conducted in 1994-95. Men in the comparison study had mean intakes of 874mg by recall and 898mg by diary, compared to 836mg calcium in free-living men in the 1994-95 NDNS[19]. For women mean intakes were slightly lower in the 1994-95 NDNS[19] of 690mg, compared to 768mg by recall and 840mg by diary in the comparison study. In most cases the comparison study results are therefore similar to the results from previous NDNS surveys.

(Table 6.152)

6.11 Iron

6.11.1 Introduction

This section describes the intakes for total iron from food sources only and the relationship to the RNIs for iron as indicated in the COMA report on DRVs from 1991[25].

6.11.2 Iron intake: 24-hour recall

Based on 24-hour recalls mean intakes of iron from food sources were higher in boys (10.2mg) than girls (9.2mg). Intakes increased with age in boys from 8.2mg in those aged 4-6 years, to 11.9mg in those aged 15-18 years. For girls, the lowest mean intake was 7mg in 4-6 year olds, all other age groups had intakes that ranged from 9-10mg. Median intakes were slightly lower than the means for both sexes (boys: 10.0mg, girls: 8.7mg). Median intakes increased with age from 8.3mg to 11.3mg for boys, and from 6.7mg to 10.3mg for girls.

Intakes at the lower 2.5 percentile were between 42% and 76% of median intake in boys and between 46% and 67% in girls. Intakes at the upper 2.5 percentile were 31% to 77% and 35% to 80% higher than the median in boys and girls, respectively. The standard deviations were smaller for boys than girls in all age groups, except those aged 7-10 years.

Mean intakes, when expressed as a percentage of RNI were 111% and 87% for boys and girls, respectively. Girls aged 11-14 years and 15-18 years had intakes of 69% and 66% RNI, respectively. Boys aged 11-14 had intakes of 99% RNI. All other groups had intakes over 100% RNI. Intakes below the LRNI were observed in 23% of boys aged 7-10 years, 12.3% of girls aged 11-14 years and 24.4% of girls 15-18 years.

(Tables 6.85 and 6.86)

Based on 24-hour recalls men had higher mean intakes of iron from food sources (12.5mg) than women (10.3mg). The medians were slightly lower at 12.4mg for men and 9.8mg for women. There was no consistent trend in intake with age. For men, the highest intake of 13.3mg was seen in those aged 35-49 years. The lowest intake of 9.2mg was seen for women aged 19-34 years. The difference between lowest and highest intake was 1.7mg and 2.1mg for men and women, respectively.

The standard deviations were higher for men than women for each age group. Intakes at the lower 2.5 percentile were between 41% and 47% of the median in men, and 50% and 61% in women. Intakes at the upper 2.5 percentile were 59% to 96% higher than the median in men and 48% to 86% higher in women.

When expressed as a percentage of RNI, mean intakes were over 100% of the RNI for all groups of men, and women aged 50-64 years and 65 years and over. Women aged 19-34 and 35-49 years had mean intakes of 62% and 71% of the RNI respectively. For men, intakes below the LRNI were observed only for those aged 35-49 (5.8%) and 65 years and over (2%). For women, 5.5% of all women failed to achieve the LRNI and all age groups included individuals with intakes below the LRNI.

(Tables 6.89 and 6.90)

6.11.3 Iron intake: diary

When reporting by diary mean intakes of iron from food sources were higher in boys (9.8mg) than girls (8.8mg). Intakes increased with age in boys from 7.9 mg to 11.2mg. For girls the highest and lowest intakes were observed in those aged 15-18 years (9.3mg) and 7-10 years (8.3mg). Median intakes were lower than the mean for boys (9.8mg) and slightly higher than the mean for girls (8.9mg). For boys, median intakes increased non-continuously with age from 7.2mg to 10.8mg. For girls, the lowest median intake was observed in 11-14 year olds (8.2mg) and the highest in 15-18 year olds (9.4mg).

The standard deviations were higher for boys than girls in all age groups. For boys, intakes at the lower 2.5 percentile were between 21% and 86% of the median and between 41% and 71% for girls. Intakes at the upper 2.5 percentile were 43% to 94% and 23% to 62% higher than the median for boys and girls, respectively.

Mean intakes, when expressed as a percentage of RNI were 103% and 86% for boys and girls, respectively. Boys aged 11-14 years and 15-18 years had intakes of 84% and 99% RNI, respectively. For girls, intakes decreased markedly with increasing age of 138% at 4-6 years to 63% in girls 15-18 years. Intakes below the LRNI were observed in 15.9% of boys aged 11-14 years and 14.9% 15-18 years. 20.9% of girls aged 11-14 years and 26.7% of girls aged 15-18 years also had mean intakes below the LRNI.

(Tables 6.87 and 6.88)

When reporting by diary the mean intakes of iron from food sources were higher for men (12.3mg) than women (10.6mg). There was no consistent trend in intake with age. For women, the highest intake of 11.2mg, observed in the top two age groups was 1.4mg higher than the lowest intake of 9.8mg in those aged 35-49 years. In men, this difference was 2.6mg from those aged 50-64 (14.0mg) to 19-34 (11.4mg). Median values were 11.9mg for men and 10.1mg for women, slightly lower than the means.

There was a wide range of intakes for men and women and the standard deviations were of a similar magnitude for most age groups and both sexes. At the lower 2.5 percentile intakes were between 49% and 60% and between 36% and 55% of the median for men and women, respectively. Intakes at

the upper 2.5 percentile were 61% to 116% higher than the median for men and between 69% and 149% higher than the median for women.

When expressed as a percentage of RNI mean intakes were over 100% for all groups of men, and women aged 50-64 years and 65 years and over. Women aged 19-34 years and 35-49 years had mean intakes of 71% and 67% of the RNI respectively. For men, 5.2% of men failed to achieve the LRNI and intakes below the LRNI were observed in all groups except those aged 65 years and over. 3.8% of women had intakes below the LRNI including women from all age groups.

(Tables 6.91 and 6.92)

6.11.4 Comparison with previous surveys

The results for total iron in the comparison study can be compared with previous surveys. Similar mean iron intakes were seen for boys in the 1997 NDNS survey of young people[20], where mean intake was 10.4mg, when compared to boys intakes in the comparison study of 10.2mg by recall and 9.8mg by diary. For girls, the 1997 NDNS survey of young people[20] showed a mean intake of 8.3mg, whereas the comparison study results are only slightly higher at 9.2mg by 24-hour recall and 8.8mg by diary.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed similar results, with a mean intake for men aged 19-64 years of 13.2mg, compared to 12.7mg by recall and 12.5mg by diary for men aged 19-64 years in the comparison study. For women, the NDNS adult survey of 2000-01[21] showed a mean intake of 10.0mg for those aged 19-64 years, compared to 10.3mg by recall and 10.4mg by diary for women aged 19-64 years in the comparison study.

Comparison of the oldest age group, those aged 65 years and over, can be made with the NDNS survey of this age group[19], conducted in 1994-95; this showed an intake of 11.0mg iron for free-living men, compared to 11.6mg by recall and 12.3mg by diary for this age group of men in the comparison study. The oldest age group of women in the comparison survey had mean iron intakes of 10.0mg and 11.2mg by recall and diary respectively, compared to 8.6mg in the NDNS survey of this age group. The comparison study results are therefore very similar to the results from previous NDNS surveys.

(Table 6.152)

6.12 Folate

6.12.1 Introduction

This section describes the intakes of folate in μg from food sources by both methods in the comparison study and the relationship of the intakes to the RNIs as outlined in the COMA report of 1991[25].

6.12.2 Folate intake: 24-hour recall

Based on 24-hour recalls boys had higher mean intakes of folate from food sources (229mg) than girls (201µg). The medians were lower, 215µg for boys and 178µg for girls. Mean intakes increased with age for girls from 154µg in those aged 4-6 years, to 225µg in those 15-18 years. For boys the highest intakes were observed for those 11-14 years (273µg), and the lowest in those 7-10 years (185mg). Median intakes increased with age from 187µg to 254µg for boys and from 148µg to 234µg for girls.

The range of intakes was wide for both sexes, though narrower in girls than boys at most age groups. Intakes at the lower 2.5 percentile were between 33% and 69% of the median for boys, and between 55% and 72% of the median for girls. Intakes at the upper 2.5 percentile were 38% to 261% and 30% to 106% higher than the median for boys and girls, respectively.

Overall, the average intake of folate expressed as % RNI was 146% and 124% for boys and girls, respectively. For girls, intakes below the LRNI were observed in those aged 4-6 (6.9%), 11-14 (29.4%) and 15-18 years (27.8%). In total 5.7% of boys failed to achieve the LRNI including 29.9% of 7-10 year olds and 3.2% of 15-18 year olds.

(Tables 6.93 and 6.94)

Based on 24-hour recalls men had higher mean intakes of folate from food sources (297µg) than women (244µg). The highest mean intakes for men were observed in those 35-49 years (335µg) and the highest for women in those 50-64 years (271µg). The lowest intakes for men were observed for those 19-34 years at 266µg and for women, at 212µg for this age group.

Median intakes were 284µg for men and 226µg for women, slightly lower than the means. The median intakes for women increased with age for all but those aged 65 years and over. However, the median intake of women aged 65 years and over (240µg) was still higher than for those 35-49 years (228µg). There was no consistent trend with age for men.

There was a wide range of folate intake for men and women and the standard deviations were higher for men than women in all age groups except those aged 65 years and over. Intakes at the lower 2.5 percentile were between 41% and 55% for men and between 51% and 74% of the median for women. Intakes at the upper 2.5 percentile were 54% to 125% and 69% to 115% higher than the median for men and women, respectively.

Mean intakes were above the RNI for both sexes and all age groups and expressed as %RNI were 148% for men and 122% for women. For men, a small percentage of intakes below the LRNI were observed for those aged 50-64 years (1.5%) and 65 years and over years (1.%). For women 15.9%

had intakes below the LRNI including those aged 19-34 years (34.3%), 35-49 years (22.5%) and 50-64 years (1.4%).

(Tables 6.97 and 6.98)

6.12.3 Folate intake: diary

When reporting by diary boys had higher mean intakes of folate from food sources (219µg) than girls (188µg). Mean intakes for boys ranged from 183µg for 4-6 years, to 254µg for 15-18 years. Mean intakes between age groups of girls were similar, ranging from 185µg to 192µg. All girls had intakes of less than 350µg per day. Nearly all median values were slightly lower than the means suggesting a skewed distribution in data. There was no consistent trend with age for median values.

There was a wide range of folate intake for boys and girls. The standard deviations increased with age for both sexes and were lower for girls than boys for each age group. Intakes at the lower 2.5 percentile were between 23% and 77% of the median for boys, and 36% to 79% of the median for girls. Intakes at the upper 2.5 percentile were 57% to 156% higher than the median for boys and between 41% and 83% higher for girls.

Overall, the average intake of folate for boys and girls expressed as a % of RNI was 133% and 120%, respectively. Mean intakes were above the RNI for all age and sex groups with the exception of women aged 11-14 years (95%) and 15-18 years (96%). In boys, intakes below the LRNI were observed in those 11-14 years (15.9%) and those 15-18 years (3%). For girls, 39.5% of those aged 11-14 years and 27.2% of those aged 15-18 years failed to achieve the LRNI.

(Tables 6.95 and 6.96)

When reporting by diary mean intakes of folate from food sources were higher for men (281µg) than women (245µg), and in all age groups. The highest mean intake for men was observed in those aged 50-64 years (316µg), the highest intake in women was in those aged 65 years and over (272µg). The lowest intakes were observed for men (265µg) and women (225µg) aged 19-34 years.

Median intakes were slightly lower than the means at 261µg for men and 231µg for women, reflecting a skewed distribution. The median intakes increased with age for men from 240µg for those aged 19-34 years to 304µg for those 50-64 years but were lower (245 µg) in those aged 65 years and over. For women, there was no consistent pattern of median intake with age.

There was a wide range of folate intakes for men and women, with no consistent pattern between age groups. At the lower 2.5 percentile intakes were between 47% and 71% and between 40% and 57% of the median in men and women, respectively. Intakes at the upper 2.5 percentile were 61% to 180% and 70% to 149% higher than the median for men and women, respectively.

Mean intakes were above the RNI for both sexes and all age groups and expressed as a %RNI were 140% and 123% for men and women, respectively. In total 31.6% of women aged 19-34 years and 33.2% of women aged 35-49 years had intakes below the LRNI. All mean intakes for men were above the LRNI.

(Tables 6.99 and 6.100)

6.12.4 Comparison with previous surveys

The results for folate in the comparison study can be compared to previous surveys. For young people, the comparison with the NDNS survey of young people[20], conducted in 1997 shows very similar values to the comparison study with mean folate intakes for boys being 240μg, compared to 229μg by 24-hour recall and 219μg by diary. For girls, the NDNS survey of young people[20] showed a mean intake of 194μg, whereas the comparison study results are 201μg by 24-hour recall and 188μg by diary.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed similar results, with a mean intake for men 19-64 years of 344μg, compared to 300μg by recall and 281μg by diary for men of this age range in the comparison study. Comparison of the oldest age group, those aged 65 years and over, with the NDNS survey of this age group[19], conducted in 1994-95 showed an intake of 270μg folate for free-living men, compared to 278μg by recall and 280μg by diary in the comparison study. For women, the NDNS adult survey of 2000-01[21] showed a mean intake of 251μg for those aged 19-64 years, compared to 238μg by recall and 237μg by diary for women aged 19-64 in the comparison study. Comparison of the oldest age group, those aged 65 years and over, from the NDNS survey of this age group[19], showed an intake of 207μg folate for free-living women, slightly lower than 266μg by recall and 272μg by diary in the comparison study. The comparison study results are therefore very similar to the results from previous NDNS surveys.

(Table 6.152)

6.13 Vitamin C

6.13.1 Introduction

Vitamin C intakes (mg) from food sources are described in this section and compared to the RNIs as described in the COMA report of 1991[25].

6.13.2 Vitamin C intake: 24-hour recall

Based on 24-hour recalls boys had very similar mean intakes of vitamin C from food sources to girls, 97.5mg and 96.5mg, respectively. The highest intakes were observed in boys aged 7-10 years

(114.4mg) and girls aged 15-18 years (125.9mg). The difference between the highest and lowest intakes was 33.8mg and 41.0mg in boys and girls, respectively. There was no consistent trend in intake with age in either the means or the medians. Median intakes were slightly lower than the means at 75.0mg for boys and 81.2mg for girls.

There was a wide range of vitamin C intakes and the standard deviations were large for both sexes. The range was twice as wide for 11-14 year old boys than any other age or sex group due to an outlying value in the data. In boys intakes at the lower 2.5 percentile were between 22% and 80% of the median and in girls between 30% and 66%. Intakes at the upper 2.5 percentile were 78% to 1162% and 96% to 204% higher than the median for boys and girls, respectively.

Overall the average intakes of vitamin C expressed as a percentage of RNI for boys and girls were 293% and 285%, respectively. Intakes in all groups were above the LRNI.

(Tables 6.101 and 6.102)

Based on 24-hour recalls, women had higher mean intakes of vitamin C from food sources than men, 93.6mg versus 85.7mg. Mean intakes for men were similar for all age groups ranging from 82.2mg to 88.4mg. The mean intakes varied more widely for women from 87.9mg to 99.6mg. There was no consistent trend in mean intakes with age. The median intakes were 70.2mg for men and 84.0mg for women. There is a greater difference between means and medians for women than men, suggesting that the data is more skewed for women.

There was a wide range in vitamin C intakes for both sexes and the standard deviations were higher for women than men in all age groups. For men, intakes at the lower 2.5 percentile were between 17% and 40% of the median and between 11% and 26% of the median in women. Intakes at the upper 2.5 percentile were 16% to 268% and 123% to 350% higher than the median for men and women, respectively.

The average vitamin C intake expressed as a percentage of RNI was 214% for men and 234% for women. In total 1.5% of men and 1.5% of women aged 65 years and over years failed to achieve the LRNI for their age group. For women 3.2% of 19-34 year olds and 6.9% of 35-49 year olds had intakes below the LRNI. Intakes were above the LRNI in all other groups.

(Tables 6.105 and 6.106)

6.13.3 Vitamin C intake: diary

When reporting by diary boys had higher mean intakes of vitamin C from food sources (86.6mg) than girls (75.9mg). There was no consistent trend in intake with age. The medians were lower than the means for boys (74.0mg) and girls (68.9mg). Mean vitamin C intakes were highest for boys 15-18 years (97.5mg) and girls 11-14 years (80.3mg). The lowest intakes were 70.0mg for boys 11-14 years

and 72.0mg for girls 7-10 years. The difference between the highest and lowest mean intake between age group was 27.5mg for boys and 8.3mg for girls.

Median intakes decreased with age from 80.6mg in boys aged 4-6 years to 57.8mg in boys 15-18 years, and from 69.4mg in girls 4-6 years to 66.2mg in girls 15-18 years.

There was a wide range of intakes, though they were consistently narrower in girls compared to boys. Intakes at the lower 2.5 percentile were between 3% and 33% of the median in boys, and between 20% and 49% of the median in boys. Intakes at the upper 2.5 percentile were between 34% and 415% higher than median intakes in boys, and between 100% and 184% higher than the median intakes in girls.

Overall, the average intake of vitamin C for boys and girls expressed as a % of RNI was 253% for boys and 223% for girls. Average intakes expressed as a % of RNI were above 200% for all age and sex groups, with the exception of girls aged 15-18 years whose mean intake was 193% of RNI. 3% of boys aged 15-18 years had intakes below the LRNI; intakes were above the LRNI in all other groups.

(Tables 6.103 and 6.104)

When reporting by diary, mean intakes of vitamin C from food sources were similar for men (87.7mg) and women (87.5mg). The highest intakes were for men aged 65 years and over (99.5mg) and women aged 50-64 years (104.9mg). The lowest intakes were 77.8mg for men and 75.0mg for women 35-49 years.

Median intakes of 80.2mg in men and 80.5mg in women were slightly lower than the means for both sexes. This reflects a skewed distribution. Medians increased with age in women from 65.2mg for 19-34 years to 91.3mg for those 65 years and over. The highest median intakes for men were observed for those aged 65 years and over years (93mg) and the lowest for those 35-49 years (66.4mg).

The range of intakes was wide for both sexes though narrower for women than men in all groups except those aged 50-64 years. Intakes at the lower 2.5 percentile were between 18% and 36% of the median for men and between 19% and 31% of the median for women. Intakes at the upper 2.5 percentile were 144% to 265% higher than the median for men and between 134% and 164% higher than the median for women.

Mean intakes expressed as a percentage of RNI were 219% for both sexes. A small percentage of intakes below the LRNI were observed for men 50-64 years (1.1%) and women 65 years and over (2.5%). The average daily intakes in all other age and sex groups were above the LRNI.

(Tables 6.107 and 6.108)

6.13.4 Comparison with previous surveys

The results for vitamin C in the comparison study can be compared to previous surveys. For young people, the comparison with the NDNS survey of young people[20], conducted in 1997 shows lower values than the comparison study with mean vitamin C intakes for boys being 75.2mg, and girls being 71.2mg compared to 97.5mg by 24-hour recall and 86.6mg by diary for boys, and 96.5mg by recall and 75.9mg by diary for girls.

For adults, comparison with the NDNS adult survey in 2000-01[21] showed similar results, with a mean intake for men aged 19-64 years of 83.4mg, compared to 85.2mg by recall and 84.9mg by diary for men aged 19-64 years in the comparison study. Results were also similar between the two surveys in women, with mean vitamin C intakes of 81.0mg in the NDNS adult survey 2000-01[21], compared to 93.2mg by recall and 84.4mg by diary in the comparison study.

Comparison of the oldest age group, those aged 65 years and over, with the NDNS survey of this age group[19], conducted in 1994-95 shows lower mean intakes of vitamin C in men and women of this age group, 66.9mg and 60.7mg respectively, when compared with the comparison study by both diary and recall methods, 88.4mg by recall and 99.5mg by diary for men; 95.0mg by recall and 98.0mg by diary for women.

(Table 6.152)

7 Misreporting of energy intake by method

7.1 Introduction

For respondents in energy balance, energy intake will be equal to energy expended. Comparison of energy expenditure assessed using DLW and reported energy intake, assessed by dietary records, and in particular the degree to which this deviates from unity, can be used to test the validity and accuracy of the methodology used to assess the dietary intake.

7.2 Misreporting by method

Table 7A presents the results for the total energy expenditure (TEE) and the energy intake (EI) for the same individuals for all age-sex groups who reported dietary intake by recall and Table 5E the equivalent table for dietary intake by diary.

Table 7A Results for the total energy expenditure (TEE) and the energy intake (EI) for 24-hour recall respondents who reported dietary intake, by age group and sex

Age (years)	n	EI	TEE	EI as % TEE
Males				
4-10	7	7.53	7.22	104.2
11-15	8	11.06	11.75	94.1
16-49	8	9.02	14.08	64.0
50-64	8	8.68	12.06	71.9
65+	8	8.65	11.17	77.4
Females				
4-10	8	7.62	6.67	114.2
11-15	8	7.65	10.73	71.3
16-49	8	8.88	10.94	81.2
50-64	8	6.85	10.14	67.5
65+	8	7.21	10.15	71.0

Table 7B Results for the total energy expenditure (TEE) and the energy intake (EI) for diary respondents who reported dietary intake, by age group and sex

Age (years)	n	EI	TEE	EI as% TEE
Males				
4-10	8	7.81	7.79	100.3
11-15	8	8.53	10.62	80.3
16-49	8	9.20	13.43	68.5
50-64	8	9.70	13.71	70.7
65+	8	8.82	10.93	80.7
Females				
4-10	8	6.81	7.03	96.8
11-15	7	6.67	9.20	72.5
16-49	8	8.18	10.33	79.2
50-64	8	7.38	9.98	73.9
65+	7	6.95	9.40	73.9

The differences between energy intake and expenditure for the two methods and the 95% agreement limits for these differences are shown in Table 7C.

Table 7C. Absolute differences between Energy Intake (EI) and TEE, assessed by DLW by dietary method.

Dietary method	Sex	Age Group	Mean Difference (EI-TEE) MJ	95% Agreement Limits (MJ)	
24-hour recall					
	Male	4-10	0.304	(-1.925,	2.533)
		11-15	-1.998	(-9.605,	8.218)
		16-49	-5.064	(-10.047,	-0.081)
		50-64	-3.388	(-8.618,	1.842)
		65+	-2.523	(-6.712,	1.666)
	Female	4-10	0.945	(-1.757,	3.648)
		11-15	-3.084	(-7.538,	1.371)
		16-49	-2.052	(-6.953,	2.849)
		50-64	-3.290	(-6.519,	-0.062)
		65+	-2.942	(-6.645,	0.760)
Diary					
	Male	4-10	0.025	(-3.326,	3.376)
		11-15	-2.097	(-7.898,	3.705)

		16-49	-4.238	(-11.842,	3.365)
		50-64	-4.013	(-9.924,	1.898)
		65+	-2.108	(-6.982,	2.766)
	Female	4-10	-0.226	(-3.243,	2.792)
		11-15	-2.528	(-9.167,	4.112)
		16-49	-2.151	(-6.870,	2.568)
		50-64	-2.607	(-8.252,	3.038)
		65+	-2.457	(-4.049,	-0.866)

These results show no differences between methods in terms of the extent of misreporting.

These results are shown graphically in Figures 7A and 7B for children and adults respectively for recall, and Figures 7C and 7D for children and adults using the diary, using the method of Bland and Altman[30].

Figure 7A and 7B Bland Altman plots of the difference between energy intake and expenditure and the average of energy intake and expenditure (log transformed) for children (Figure 7A) and adults (Figure 7B) and for assessment by recall.

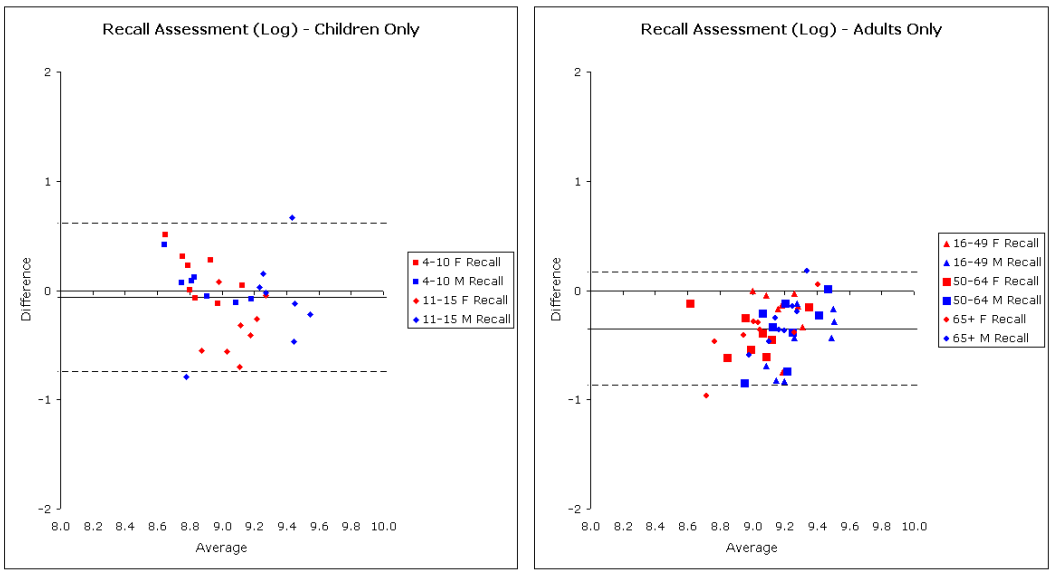
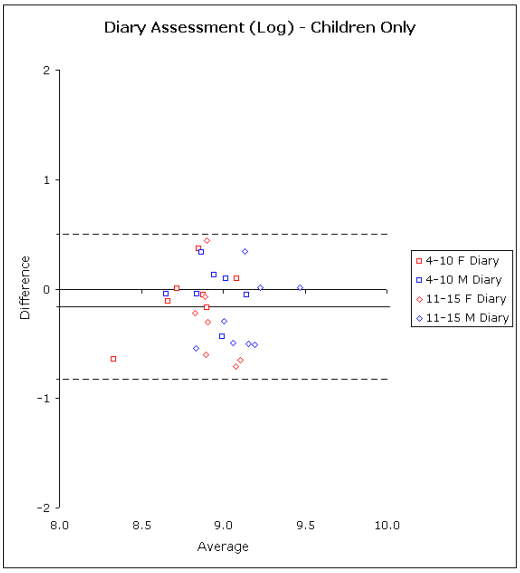
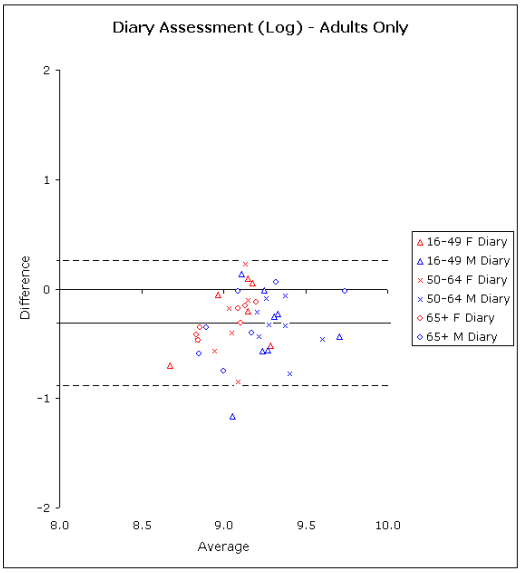


Figure 7C and 7D Bland Altman plots of the difference between energy intake and expenditure and the average of energy intake and expenditure (log transformed) for children (Figure 7C) and adults (Figure 7D) and for assessment by diary.





The results show that in all cases the limits of agreement are large, and that there is no evidence of any difference in the degree of underreporting by dietary assessment method. There are variations in the degree of underreporting by age and by sex, with some age groups having considerably more underreporting than others. The greatest underreporting was seen for men aged 16-49 for both methods, and children had apparently less underreporting, in general, than adults.

7.3 Identification of under, adequate and over reporters

Misreporting can exist either as under or over-reporting, and the overall percentages described in Tables 7A and 7B take into account misreporting in both directions. In order to distinguish between these two types of misreporting, a fractional reporting index (FRI) can be calculated for each respondent using:

$$FRI = \frac{EI_{diet}}{TEE_{DLW}}$$

where EI_{diet} = energy intake, and TEE_{DLW} = total energy expenditure, measured by the DLW method. The FRI was used to classify respondents into groups of under-, adequate-, and over-reporters by comparing the values obtained as FRI with the confidence limits of adequate reporting calculated as:

$$CI_{95} = 1 \pm 2\sqrt{CV_{diet}^2/d + CV_{DLW}^2}$$

where CV_{DLW} and CV_{diet} represent the coefficients of variation of the DLW measurement and the dietary instrument respectively, and d is the duration (days) over which dietary data was collected. The values of CV_{DLW} were calculated individually from the fits to a physiological model outlined by Cole and Coward.[1] In the absence of any information on the precision of the dietary instruments a value of 0.23 was used, as suggested by Black et al in 2000[31]. This approach is equivalent to that proposed by Black et al[31], except that here individual estimates of the DLW contribution to the imprecision were used, rather than a population value.

Worked example:

Respondent 12403 2.
DLW data: = 10699kJday-1, = 0.031
Dietary data: = 7752kJday-1 data collected over 4 days
DLW data: TEE_{DLW} = 10699kJday^{-1}, CV_{DLW} = 0.031
Dietary data: EI_{diet} = 7752kJday^{-1} data collected over 4 days

$$FRI = \frac{EI_{diet}}{TEE_{DLW}} = \frac{7752}{10699} = 0.724$$

$$CI_{95} = 1 \pm 2\sqrt{CV_{diet}^2/d + CV_{DLW}^2} = 1 \pm 2\sqrt{0.23^2/4 + 0.031^2} = \begin{cases} 1.24 \\ 0.76 \end{cases}$$

Since FRI is less than the lower confidence interval this respondent is classified as an under-reporter.

The results for reporting status, subdivided by age and sex for both the dietary assessment methods are given in Table 7D.

Table 7D. Prevalence of under and over-reporting according to TEE assessed using DLW for both repeat 24-hour recall and four-day diary, by age group and sex

Dietary Method	Age group (years)	Sex	Under Reporting	Adequate Reporting	Over Reporting
24-hour recall	4-10	Male	-	86%	14%
		Female	-	50%	50%
	11-15	Male	25%	62%	13%
		Female	63%	37%	-
	16-49	Male	63%	37%	-
		Female	25%	75%	-
	50-64	Male	50%	50%	-
		Female	63%	37%	-
	65+	Male	50%	50%	-
		Female	88%	12%	-
Diary	4-10	Male	14%	72%	14%
		Female	14%	72%	14%
	11-15	Male	62%	25%	13%
		Female	57%	29%	14%
	16-49	Male	50%	50%	-
		Female	38%	62%	-
	50-64	Male	63%	37%	-
		Female	57%	29%	14%
	65+	Male	50%	50%	-
		Female	71%	29%	-

Combining age-sex groups gives the following summary of these results (table 7E).

Table 7E Prevalence of under and over-reporting according to TEE assessed using DLW, by age group and sex

Dietary Method	Age group (years)	Sex	Under Reporting	Adequate Reporting	Over Reporting
24-hour recall	Child (4-15)	Male	13%	74%	13%
		Female	31%	44%	25%
	Adult (16+)	Male	54%	46%	-
		Female	58%	42%	-
Diary	Child (4-15)	Male	28%	50%	13%
		Female	31%	56%	13%
	Adult (16+	Male	54%	46%	
		Female	50%	45%	5%

These results on reporting status of individual respondents demonstrates again the variability in the degree of underreporting by age-sex group, and it also indicates that in some age groups, there is considerable over-reporting, most notably in the youngest children. While there is some over-reporting with both methods, there does appear to be more over-reporting with the recall method for girls aged 4 –10 years than for any other age group and for any diary group. These tables also point to a high proportion of under-reporters in women aged 65 years and over; this was seen for both methods but was an extremely high proportion for recall, where the proportion of adequate reporters was only 12%. When all adults were considered together, no differences were seen in the proportion of adequate reporters between the two dietary assessment methods

8 Discussion

The comparison study was designed to determine the preferred dietary assessment method to use in the NDNS rolling programme over the long term. The method had to be one that did not incur a respondent burden of a size that would deter participation in the survey, and yet had to produce reliable and complete dietary data. Two dietary assessment methods presented themselves as suitable for the rolling programme, the repeat 24-hour recall and the estimated or unweighed diary. Both these methods are used regularly in studies of various sizes throughout the world.

There were three main evaluation criteria for determining the preferred method in the comparison study:

a. response rate
b. feasibility and acceptability in the field
c. ability to obtain complete dietary data with minimal misreporting

Response rate

There was essentially no difference in the response rate by either method, although the diary appeared to have slightly higher rate at 52% of respondents in productive Catering Units, compared to 49% for the 24-hour recall. With virtually no difference between the two methods, it was not possible to make the decision about the method of choice on response rate alone.

Response rate by both methods was lower than the target of 55% of respondents. However, the comparison study was conducted in a very short period of time, much shorter than the timescale of the main rolling programme and the consortium is confident that they can attain the desired 55% response rate with a greater ability to pursue addresses that were unavailable at initial approach.

Experience in the field

As outlined in Chapter 4 of this report, there were positive and negative aspects of each of the two methods in the field, and there were issues that applied to both methods, such as difficulty in assessing portion sizes. Many interviewers preferred one or other method, but this was not consistent for the entire cohort of interviewers in the study. Many had had previous experience conducting 24-hour recalls in LIDNS and were therefore more comfortable with this method that they knew well, while others felt that the repeat recall was very time-consuming and they did not like to impose such time on respondents on a repeated basis. The well-accepted challenges of conducting dietary assessment in difficult groups, such as young children and the elderly, were apparent for both methods in the comparison study.

Prior to the beginning of the comparison study and in planning the entire NDNS rolling programme, analysis of day-to-day variation in dietary intake from previous NDNS was undertaken, in order to decide which days of the week needed to be included. These analyses indicated that for certain age groups in particular, there was considerable variation between nutrient intakes on weekdays from intakes at weekends, and moreover, that the two weekend days were different from one another and not always in the same direction. It was therefore considered essential to include both weekend days in the period over which the diet was assessed. While this is relatively straightforward for a diary, in that it can be given out and instructions provided to record on both weekend days, for 24-hour recall, this requirement is problematic, since it requires interviews to be conducted on Sundays, in order to get dietary information about Saturdays. In trying to comply with the requirement to include both weekend days, interviewers found it very difficult to interview at weekends and they also found that respondents often did not want to be interviewed at the weekend. The 24-hour recall therefore presented additional challenges for interviewers and respondents in the field compared to the diary in respect of obtaining dietary data for weekend days.

Completeness of dietary data obtained

Concurrently with the conducting of the comparison study described in this report, a review was undertaken of the existing literature where both 24-hour recall and unweighed diet diary had been compared in the same subjects or each compared against an objective measure. This analysis, presented to the Agency in August 2007, described the results from 17 studies located where such a comparison between methods had been conducted. Most of these comparisons were small in terms of the number of subjects studied, the 24-hour recall was usually conducted only once, rather than 4 times as in the comparison study, and the period of estimated diary being compared was variable from 1-16 days, not always four days or similar, as in the comparison study. The results of the analysis of the studies located indicated that for the literature to date, there was little difference found between the two methods, although overall there was a tendency for the diary to result in slightly higher energy intakes than the 24-hour recall.

Like the published literature, the results of the comparison study showed very little difference between energy intakes using the 24-hour recall and those obtained using the diary. However, the tendency was in the opposite direction, in that there was some evidence of a trend for recall to give slightly higher energy intakes than diary, at least for the men. The girls and women had very similar mean energy intakes by each method for all age groups. As indicated in Chapter 6, the group with the greatest difference in energy intake between the methods was men age 35-49 years, where the mean intake by 24-hour recall was 10.11MJ and by diary 8.73MJ.

The comparison study had rather a different design from the previously published papers comparing the two methods, since diet was not assessed in the same individuals by the two methods, but instead, in two parallel groups of individuals. It was remarked in several of the publications where the methods were compared that those doing the study would be paying closer attention to the food items

they were consuming because they had volunteered to carry out different types of assessment. This is a rather different scenario than the comparison study where respondents were asked to record what they ate with perhaps very limited knowledge of the detail of the foods they had eaten or less commitment to carrying out the task, and this may explain some of the difference in the direction of the results. However, apart from this group of men, variations were small and overall, there was very little difference in energy intake by the two methods, either in past studies or in the comparison study.

In terms of misreporting, this was assessed using Doubly Labelled Water in a sub-sample of eight respondents in 20 age and sex groups, given a total number of 160, from which results from157 could be used. These results, presented in Chapter 7, indicated that there was no evidence of any difference in the degree of under-reporting by dietary assessment method. On average, the dietary energy intake corresponded to 81% of Total Energy Expenditure (TEE) by the recall method (or 19% underreporting on average) and 80% by the diary (20% underreporting), with differences between adults and children. For children, by recall, energy intakes represented 96% of TEE on average, while for diary this was 88%. For adults, intake represented 72% of TEE on average for recall and 74% by diary. Further analysis of individuals to determine under, adequate and over-reporters was carried out by calculating the fractional reporting index (FRI) and comparing this to the confidence limits of adequate reporting, which takes into account the coefficients of variation of the DLW measurement and the dietary instrument used. Results showed that there was some over-reporting as well as under-reporting in the study. Over-reporting mainly occurred in children, particularly young children, and it appeared to be somewhat greater with recall than with diary. Over-reporting in children can therefore in part explain the closer values between energy intake and expenditure in children compared to adults, and the higher values for recall compared to diary.

Overall examination of these results highlighted some specific issues for certain age groups and these need to be taken into account as the programme moves forward into the main stage:

a. as with the comparison of energy intakes, the group of males aged 16-49 years presented challenges as they had the highest level of underreporting by both methods: 36% by recall and 32% by diary. Hence extra attention needs to be paid to this group during the main stage of the survey to ensure adequate reporting is achieved.

b. older women, those aged 65 years and over appeared to have considerable underreporting by both methods, 71% of this group by diary and 88% by recall.

c. There appeared to be a tendency for over-reporting with children. This could in part explain the closer mean values between energy intake and expenditure for children compared to adults. The fact that some over-reporting occurred with the diary as well as with recall indicates reasons beyond the inclusion of ”phantom foods”, those foods described through confusion of days where foods were eaten. It may be that some of the over-reporting was due to larger than consumed portion sizes for

this age group, suggesting further work on portion sizes may be required. Efforts will be made to investigate other available data on portion sizes consumed by children.

Intake of macronutrients and selected micronutrients

Although the main goal of the comparison study was to provide information on response rate, conduct in the field and completeness of dietary data obtained by the two dietary assessment methods being compared, the study also provided information on the dietary intake of macro and micronutrients. Thus, in addition to energy, intake of carbohydrate, fat, protein, total sugars, non-milk extrinsic sugars, non-starch polysaccharide, alcohol, calcium, iron, folate and vitamin C were examined for both methods, both in absolute terms as a percentage of total energy for those nutrients that provide energy. Intakes were also compared to Dietary Reference Values as outlined in the Department of Health report from COMA on the Dietary Reference Values for food energy and nutrients for the UK, published in 1991[25] or to other recommendations where there was no COMA value but another value form another authority exists. Intakes were also compared to those from past NDNS surveys, specifically the 1994-95 survey of those 65 years and over[19], the 1997 survey of young people[20], and the 2000-01 survey of adults[21].

The results of the comparison study indicated that overall there were few differences between the two methods for intake of any of the nutrients studied. There were slight variations between the methods in mean intakes in nutrients for some age groups and in trends with age, but these were numerically small and must be viewed taking in to consideration the sample sizes, particularly for children, where the bases were very small. The values obtained in the comparison study were also similar to those obtained in the previous NDNS surveys, which on the one hand, is encouraging that the two methods tested provide data that is comparable with past surveys conducted using another method (7-day weighed record), but on the other hand suggests very little change in intake over time for most nutrients. There were some changes in specific age groups that seemed to be greater than the past such as intake of alcohol and vitamin C for those over 65 years and older, but these would need confirmation in the main NDNS rolling programme.

In conclusion, the comparison study has shown no evidence of differences in response rate between dietary assessment methods and no differences in energy intake except in one age group of men, those age 35-49 years. This age group also appeared to have the greatest under-reporting overall. There was no evidence of differences between dietary assessment methods in the extent of misreporting, as determined using Doubly Labelled Water to assess energy expenditure in any group. Specific results in certain age-sex groups point to methodological challenges that need to be taken into account during training and implementation of the main stage of the survey. Experiences in the field also indicated improvements that could be made to the dietary assessment instruments to address these challenges with specific age and sex groups as the NDNS rolling programme embarks on the main stage.

9 Recommendations from Comparison Study

The results of the comparison study have indicated a number of recommendations related to dietary assessment in the main NDNS rolling programme.

Given the similarity in response rate by the two methods, in the resulting dietary data and in the degree of misreporting by the two methods, the decision about which method to use in the main rolling programme was difficult. Both methods would give similar results overall. However, there are a number of considerations that lean towards the dietary diary for the survey on an ongoing basis. The first is continuity with past NDNS surveys were the dietary assessment method was a prospective weighed record. While there is no suggestion of weighing food in the rolling programme, the prospective nature of the estimated diary means that it is similar in approach to the weighed assessments of the past. Secondly, the findings from past surveys that there is considerable day-to-day variation in intake, particularly between weekdays and weekend days and between the two weekend days themselves in certain age sex groups, indicated that both weekend days should be included in the four days assessed in the rolling programme. This was easier to achieve with the estimated diary than the recall, since it could be given out to respondents, who were then instructed to record over the weekend as well as for two weekdays. For recall, the need to conduct interviews at weekends was a problem and would have continued to be a problem if this method had been chosen. Lastly, the number of visits to the household was reduced with the diary, and so it was therefore less costly than the 24-hour recall method.

In choosing the estimated diary as the method for the NDNS rolling programme, there were a number of learnings from the comparison study. These can be addressed either through the protocol for the interviewers in the field, in the training of interviewers in their interactions with respondents, or in the development of the assessment instruments or the instruction documents for interviewers and respondents. It was clear that an intermediate visit would be of benefit with the diary, where the interviewer returned to the home after a day or two days to ensure that the diary was being completed correctly. This has now been instituted for all respondents in the main stage. The diaries themselves needed to be modified, with larger print for all, and special diaries for the elderly with very large print and A4 size for easier reading. There are now four different diaries:

a. A3 adult diary
b. A4 adult diary (for use with older people)
c. A4 child diary
d. A3 toddler diary

There were also a number of groups where groups where specific issues arose:

a. males aged 16-49 years are challenging. For the energy intake comparison, the age group 35-49 years showed a lower energy with the diary than with the recall and this group had the highest level of underreporting of any group by both methods. Hence extra attention needs to be paid during the main stage to ensure adequate reporting is achieved. At training, there is a need to anticipate the types of problems this group may have. For example, they may be less likely to cook for themselves or be more likely to eat out compared to other groups, and therefore be less able to describe the food they have consumed in sufficient detail. They may be less familiar with food in general and less interested in noting every detail. Therefore the importance of complete records needs to be stressed, and also when the diaries are collected, they need to checked with greater rigour than with other age groups and with women to ensure they are as complete and detailed as possible.
b. women 65 years and over showed considerable underreporting by both methods. While this age group tends to be compliant, they might benefit from special encouragement to make sure they record as they eat, as memory problems may interfere with a complete record being obtained if they leave it to fill in later. The larger diary will also benefit this group particularly.
c. there was a tendency for over-reporting with children. While this was greater with the recall, and may be explained by “phantom foods” with that method, there was some over-reporting with the diary also. This may be due to larger than consumed portion sizes for this age group. Interviewers can emphasise correct portion size estimates when they give parents the diary for young children, but this finding also suggests that further work is needed on portion size variation with age to help reduce over-reporting in young children.

Carrying out the comparison study has been very useful in making the decision on the method to use in the main NDNS rolling programme, and also in assessing how well the diary performed in the field. The experiences of the comparison study are leading to improved methods in terms of the protocol of the survey, the instruments themselves and the procedures during the visits with respondents. The modifications and changes being made should improve response rate and the completeness of the dietary information being collected in the main stage.

10 Acknowledgements

First of all, we wish to thank all of those who gave up their time to be interviewed and who welcomed interviewers into their home. We would also like to acknowledge the commitment and professionalism of the interviewers who worked on comparison study.

We would like to thank everyone who contributed to the comparison study and to the production of this report. In particular, the authors from each organisation would like to thank:

From HNR:
Marilena Leventi for technical assistance with the DLW sample preparation and analysis

Celia Greenberg for assistance with the dietary assessment, conversion of food intakes to nutrients, checking for accuracy of dietary data.

Christopher Thane for checking of tables and manuscript.

From NatCen:
Operations and Computing staff, especially members of the Blue team, Steve Kelly and Steve Edwards.

The other researchers who worked on the comparison study: Sarah Pigott and Lucy Natarajan.

From UCL:
Dr Emmanuel Stamatakis for his work in developing the physical activity questionnaires and Actigraph™ protocol and briefing interviewers.

11 References

1. Cole TJ & Coward WA (1992). Precision and accuracy of doubly labeled water energy-expenditure by multipoint and 2-point methods. Amer J Physiol 263: E965-73.
2. Elia M, Livesey G. (1988) Theory and validity of indirect calorimetry during net lipid synthesis. Amer J Clin Nutr. 1988 47:591-607.
3. Schofield WN. (1985) Predicting basal metabolic rate, new standards and review of previous work. Hum Nutr Clin Nutr. 1985;39 Suppl 1:5-41
4. Nelson M, Atkinson M, Meyer J. (2002) A photographic atlas of food portion sizes. London: Food Standards Agency.
5. Food Standards Agency (2008) Food portion sizes. Third edition. London: The Stationery Office.
6. Chan W, Brown J & Buss DH (1994) Miscellaneous foods. Fourth supplement to the fifth edition of McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
7. Chan W, Brown J, Church SM & Buss DH (1996) Meat products and dishes. .Sixth supplement to the fifth edition of McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
8. Chan W, Brown J, Lee SM & Buss DH (1995) Meat, poultry and game. Fifth supplement to the fifth edition of McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
9. Food Standards Agency (2002) McCance and Widdowson's The Composition of Foods, Sixth summary edition. Cambridge: Royal Society of Chemistry.
10. Holland B, Unwin ID & Buss DH (1988) Cereals and Cereal Products. Third supplement to McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
11. Holland B, Unwin ID, & Buss DH (1989) Milk products and eggs. Fourth supplement to McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
12. Holland B, Unwin ID & Buss DH (1991) Vegetables, Herbs and Spices. Fifth supplement to the fourth edition of McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.

13. Holland B, Unwin ID & Buss DH (1992) Fruit and Nuts. Fifth supplement to the fifth edition of McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
14. Holland B, Welch A & Buss DH (1992) Vegetable dishes. Second supplement to the fifth edition of McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
15. Holland B, Brown J, & Buss DH (1993) Fish and Fish products. Third supplement to the fifth edition of McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
16. Ministry of Agriculture, Fisheries and Food (1998) Fatty acids. Seventh supplement to the fifth edition of McCance and Widdowson's The Composition of Foods. London: Royal Society of Chemistry/Ministry of Agriculture, Fisheries and Food.
17. Gregory J, Foster K, Tyler H, Wiseman M. Dietary and Nutritional Survey of British Adults. London: HMSO, 1990.
18. Gregory JR, Collins DL, Davies PSW, Hughes JM, Clarke PC. National Diet and Nutrition Survey: children aged 1.5 to 4.5 years. Volume 1: Report of the diet and nutrition survey. London: HMSO, 1995
19. Finch S, Doyle W, Lowe C, et al. National Diet and Nutrition Survey: People Aged 65 Years and Over. Vol. 1: Report of the Diet and Nutrition Survey. London: The Stationery Office, 1998.
20. Gregory J, Lowe S, Bates CJ, et al. National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 1: Report of the diet and nutrition survey. London: The Stationery Office, 2000.
21. Henderson L, Gregory J, Irving K, Swan G. The National Diet & Nutrition Survey: adults aged 19 to 64 years. Volume 2: Energy, protein, carbohydrate, fat and alcohol intake. London: The Stationery Office, 2003.
22. Nelson M, Erens B, Bates B, Church S, Brosher T. 2007. Low Income Diet and Nutrition Survey. Food Consumption. Nutrient intake. London, The Stationery Ofiice.
23. Englyst HN and Cummings JH. An improved method for the measurement of dietary fibreas the non-starch polysaccharides in plant foods. J Assoc Off Anal Chem 1988;71:808-814.
24. Englyst HN, Quigley ME and Hudson JG. Determination of dietary fiber as nonstarch polysaccharides with gas-liquid-chromatographic, high performance liquid-chromatographic or spectrophotometric measurement of constituent sugars. Analyst 1994;119:1497-1509.
25. Department of Health. 1991. Dietary Reference Values for Food Energy and Nutrients for the United Kingdom. Report of the panel of Dietary Reference Values of the Committee on Medical Aspects of Food Policy. Report on Health and Social Subjects 41. HMSO: London.

26. Nishida C, Nocito, FM and Mann J. 2007. Joint FAO/WHO Scientific update on carbohydrates in Human Nutrition. Eur J Clin Nutr 61:Suppl 1 S1-S137.
27. Food and Agriculture Organisation. (1998). Carbohydrates in human nutrition. Report of the Expert Panel meeting Rome April 1997 Rome. FAO, Rome.
28. IGD. Report of the IGD/PIC Technical Working Group on Guideline Daily Amounts (GDAs). Review of existing and development of new GDAs: Decisions and Rationale. June 2005
29. Williams CL. (1995) Importance of dietary fiber in childhood. J Am Diet Assoc. 95:1140-6, 1149.
30. Altman DG. (1991). Practical Statistics for Medical Research. London: Chapman and Hall.
31. Black AE. (2000) Critical evaluation of energy intake using the Goldberg cut-off for energy intake: basal metabolic rate. A practical guide to its calculation, use and limitations. Int J Obes Relat Metab Disord. 24:1119-30

Appendix A

A.1 Introduction

The sample was drawn from the 'small user' Postcode Address File (PAF), a list of all addresses in Britain. 1,840 addresses were drawn in two stages; at the first stage 80 Primary Sampling Units[1] (PSUs) were drawn with probability proportional to the number of addresses within them. In each selected PSU 23 addresses were then selected at random.

This design gives each address the same probability of selection and address selection weights are not needed. Once selected the addresses were each allocated to one of two sub-samples. The method used to collect dietary data varied according to which sub-sample the address had been allocated to.

A.2 Weighting scheme

The data was weighted separately by sub-group. In effect each sub-group has been treated as a separate sample, which has then been weighted back to the population. The weighting design used here is the design we propose to use for the main stage of the NDNS, hence we are in effect showing what the weighted estimates would be for each sub-sample had that particular dietary collection method been used on the main stage NDNS. This allows us to make comparisons between the two methods. It also removes any differences between the two sub-groups in the age/sex or Government Office Region (GOR) distributions, which means any differences in the food estimates by sub-group cannot be attributed to differences in these variables.

Once generated, the weights were then scaled separately so the mean of the weights was equal to 1 and the sum of the weights equalled the number of respondents. This allowed the weights to be combined to give a set of weights that permit analyses to be carried out on the whole sample. The different stages of weighting are described in more detail below, the following method was carried out separately for each sub-group.

A.2.1 Dwelling Unit selection weight

Some addresses contain more than one Dwelling Unit (DU). At each selected address the interviewer enumerated the number of DUs and selected one at random. A DU selection weight is required to prevent DUs at addresses containing multiple DUs being under represented in the sample. The DU weight is equivalent to the number of DUs at the address. Large weights are trimmed to a maximum value of 3 to avoid inflating standard errors.

A.2.2 Household selection weight

Within each selected DU the interviewer counts the number of households and selects one at random. These households require a selection weight as households in DUs with multiple households will otherwise be under-represented. The household weight is equivalent to the number of households at the selected DU. As before large weights will be trimmed to a maximum of three.

The composite household selection weight (w_1) is the product of the DU and household selection weights.

A.2.3 Household non-response weight

Calibration weighting was used to generate weights for the households that participated in the NDNS Comparison Study. Calibration is used to generate a set of weights that make the distribution of the (weighted) sample match that of the population for a set of key variables. The achieved household sample was calibrated so that the distributions for age/sex and GOR of all household members matched the 2005 mid-year household population estimates[2] produced by the Office of National Statistics and General Register Office for Scotland. Using this method the calibration weight generated for a particular household depends upon the age/sex profile of the household members (i.e. the household type) and the Region in which it is situated[3].

The aim of the calibration weighting was to reduce non-response bias resulting from differential non-response at the household level. The calibration weights generated (w_2) were re-scaled so that the sum of the weights equalled the number of participating households in the sub-group. The scaled weights are the household weights (wt_hhld). Any analyses carried out at household level should be weighted by wt_hhld. This weight can be used for sub-group comparisons as well as analyses of the combined sample. The distribution for unweighted and weighted samples and the population is given in Table A1 below.

A.2.4 Individual selection weight

Within each household/CU one adult aged 19+ and (where applicable) one child aged 4-18 was selected for the diary/24-hour recalls. Individual selection weights (w_3) are needed to prevent individuals from larger households being under- represented in the sample. Individual selection weights are equal to the number of eligible individuals in the household. For adults this is the number of eligible adults aged 19 or over in the household. For children this is the number of eligible children aged 4-18 in the household. Large weights were trimmed to a maximum of four.

A.2.5 Individual non-response

Individuals needed to complete at least three dietary recall/diary days to be counted as fully responding. Households were counted as responding if at least one selected individual had fully responded. There were 847 responding households, containing 1,112 selected individuals. Of these, 1,067 individuals (96%) went on to be fully productive respondents. Despite the high level of participation a further adjustment was made to the responding individuals to ensure the distribution of the final sample matched the population of persons aged four and older in terms of age, sex and region. This adjustment takes account of any biases due to natural variation caused by the selection procedure or non-response. The distribution of the population and sample is given in Table A2.

As before, the sample was calibrated to age/sex and GOR[4]. The resulting weight was scaled so that the sum of the weights equalled the number of fully responding individuals in the sub-group. This weight was used for all analyses at the individual level, sub-group and combined.

A.2.6 DLW/ ActiGraph™

The DLW/ ActiGraph™ sub-sample is a quota sample to which fully responding individuals were purposively allocated according to their age, sex and dietary collection method. The sub-sample is relatively small. Whilst individuals were asked to do both activities, differential response means the ActiGraph™ sample contains 154 respondents and the DLW sample contains 157. Similarly eligible respondents replaced those that refused to participate. As such additional non-response weights are not appropriate for the DLW/ ActiGraph™ sub-sample; the individual weight (wt_ind) was used for analyses.

In addition to the DLW sample all fully productive11-15 year olds that completed the physical activity module were also asked to wear an ActiGraph™. The responding sample of 1,067 individuals contained 81 eligible 11-15 year olds. Of these 39 (48%) provided complete ActiGraph™ data. This sub-sample does not necessitate additional non-response weights due to its small size. The individual weight (wt_ind) was used during analysis of these respondents.

A.3 Effective sample size

The effect of the sample design on the precision of survey estimates is indicated by the effective sample size (neff). The effective sample size measures the size of an (unweighted) simple random sample needed to provide the same precision (standard error) as the design being implemented. If the effective sample size is close to the actual sample size then we have an efficient design with a good level of precision. The lower the effective sample size is the lower the level of precision. The efficiency of a sample is given by the ratio of the effective sample size to the actual sample size. Samples that select one person per household tend to have lower efficiency than samples that select all household

members, as do smaller samples. The effective sample size of this sample is 713, with an efficiency of 67%. The distribution of the weights is given in Table A3.

Table A1 Distribution of the Population and all individuals in responding households by GOR and age/sex

	Population	Sample (all individuals in responding households) unweighted	Sample (all individuals in responding households) weighted by household weight
	%	%	%
North East	4.4	5.0	4.4
North West	11.7	11.9	11.7
Yorks and Humber	8.7	9.7	8.7
East Mids	7.4	9.0	7.4
West Mids	9.2	10.6	9.2
East of Eng	9.5	9.3	9.5
London	12.9	10.0	12.9
South East	13.9	13.5	13.9
South West	8.6	9.1	8.6
Wales	5.1	2.5	5.1
Scotland	8.7	9.3	8.7
Male	49.0	48.0	49.0
Female	51.0	52.0	51.0
Male aged 0-10	6.7	7.3	6.7
Male aged 11-18	5.3	6.6	5.3
Male aged 19-29	6.8	4.8	6.9
Male aged 30-39	7.3	6.3	7.3
Male aged 40-49	7.2	7.5	7.2
Male aged 50-59	6.3	6.4	6.3
Male aged 60-69	4.8	4.7	4.8
Male aged 70 +	4.7	4.4	4.7
Female aged 0-10	6.3	8.1	6.3
Female aged 11-18	5.0	5.5	5.0
Female aged 19-29	6.8	5.7	6.8

Female aged 30-39	7.5	8.0	7.5
Female aged 40-49	7.4	7.5	7.4
Female aged 50-59	6.5	7.1	6.5
Female aged 60-69	5.1	5.4	5.1
Female aged 70 +	6.4	4.7	6.4
Total (unweighted)	57,406,392	2,024	2,024

Table A2 Distribution of the Population and all responding individuals by GOR and age/sex

	Population aged 4+	All individuals aged 4+ in responding households	All responding individuals	All responding individuals
	Unweighted	Weighted by household weight	Weighted by hhold and trimmed selection wt	Weighted by final calibrated individual weight
	%	%	%	%
North East	4.4	4.5	4.4	4.4
North West	11.7	11.8	11.9	11.7
Yorks and Humber	8.7	8.7	8.9	8.7
East Mids	7.4	7.5	7.8	7.4
West Mids	9.2	9.4	9.7	9.2
East of Eng	9.5	9.6	9.5	9.5
London	12.9	12.5	11.0	12.9
South East	13.9	13.8	14.1	13.9
South West	8.6	8.5	8.6	8.6
Wales	5.1	4.9	5.1	5.1
Scotland	8.8	8.8	9.0	8.7
Male	48.9	48.9	47.0	48.9
Female	51.1	51.1	53.0	51.1
Male aged 4-10	4.5	4.3	4.8	4.5
Male aged 11-18	5.5	5.6	5.6	5.5
Male aged 19-29	7.2	7.2	6.5	7.2
Male aged 30-39	7.7	7.7	7.4	7.7
Male aged 40-49	7.5	7.6	6.6	7.5
Male aged 50-59	6.6	6.6	6.5	6.6
Male aged 60-69	5.0	5.0	5.2	5.0
Male aged 70+	4.9	4.9	4.2	4.9
Female aged 4-10	4.3	4.1	3.7	4.3
Female aged 11-18	5.3	5.3	4.8	5.3
Female aged 19-29	7.2	7.2	6.2	7.2
Female aged 30-39	7.8	7.9	8.1	7.8
Female aged 40-49	7.7	7.8	9.2	7.7
Female aged 50-59	6.8	6.8	7.2	6.8

Female aged 60-69	5.3	5.3	6.2	5.3
Female aged 70+	6.7	6.7	7.4	6.7
Total (unweighted)	54,734,928	1,112	1,067	1,067

Table A3 Distribution of the weights

	Minimum weight	Maximum weight	Mean weight	Actual sample size	Effective sample size	Efficiency
Final calibrated individual weight (wt_ind)	0.10	10.17	1.00	1067	713	67%
Household and individual selection weight	0.11	8.90	1.00	1067	733	69%
Household weight (wt_hld)	0.18	3.62	1.00	847	704	83%

[1] PSUs are postcode sectors or groups of postcode sectors.
[2] Unable to use 2006 as data for Scotland is not yet available.

[3] The weights are generated in SAS using a package called CALMAR. The procedure works by taking an initial weight (in this instance the composite CU selection weights (w_1)) and adjusting it to produce a final weight that makes the weighted distribution of the sample match the

population. The criteria for the adjustment is that the initial and final weight be as close as possible.

[4] The starting weight was the product of the household weight and the individual selection weight: wt_hhld x w_3. This weight was then adjusted by the calibration procedure to produce the final individual weight.

Appendix B Development and cognitive testing of the new questionnaires

B.1.1 Overview

Full details of the development procedure and pre testing of the new physical activity questionnaires are given in the cognitive report of findings provided to the Agency in August 2006.[1] This section therefore gives a brief overview of the changes to the questionnaire, the questionnaire sources and rationale for inclusion.

B.1.2 Adults

The NDNS questionnaire was developed from scratch but it used elements from other questionnaires.[1] Table B1 summarises the main features of the NDNS physical activity questionnaire for adults.

Table B1 Main features of the NDNS physical activity questionnaire for adults

Questionnaire item	Rationale	Source
Occupational activity questions	These questions were adapted from the English version of the long IPAQ (International physical activity questionnaire).	www.ipaq.ki.se/ipaq.htm
Housework and Gardening	Adapted from the Health Survey for England (HSE) questionnaire	
Walking questions	Adapted from the HSE questionnaire, but included bouts lasting 5 minutes or more	
Sports and organised activities - duration	Adapted from the HSE questionnaire, but included bouts lasting 5 minutes or more	
Sedentary activity questions	No such questions included in the NDNS questionnaire	

B.1.3 Children

The table below (B2) documents the broad question areas developed for the new children's physical activity module, briefly describes the rationale for inclusion and, where appropriate, details original source material.

Table B2 Main features of the NDNS physical activity questionnaire for children

Questionnaire item	Rationale	Source
School time-related activities	School breaks and transportation to school offer important opportunities for children to be active.	
Travel to and from school	A new set of questions were developed to look at active transportation to and from school to capture this data. This has policy importance in that it captures both domain information (activity for transportation) and is a useful recall technique by breaking down potential periods of activity by linking it specifically to a particular purpose or time period.	New questions developed as we did not locate any questionnaires for children that were appropriate for NDNS
Active during school breaks	The rationale for this is the same as for transportational activity in that it offers important opportunities for children to be active and this information has not been captured by any existing questionnaires.	New questions as we did not locate any questionnaires for children that were appropriate for NDNS
Active play	It is widely recognised that play activities contribute to overall activity levels.	New questions as we did not locate any questionnaires for children that were appropriate for NDNS
Non-school based, formal, sports activities	Again, the distinction between this grouping of activities and active play activities has been widely recognised to be important and has been made on most child/adolescent physical activity questionnaires.	Modelled after adults' HSE sports section but tailored for children's activities
Sedentary activity questions	No such questions for NDNS	

[1] MacKenzie H, Collins D, Kitchen S. National Diet and Nutrition Survey. Development of physical activity and sun exposure questions: findings from cognitive interviews. London: NatCen, 2006.