



Volume 4

The National Diet & Nutrition Survey: adults aged 19 to 64 years

Nutritional status (anthropometry and blood analytes),
blood pressure and physical activity

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A survey carried out in Great Britain on behalf of the Food Standards Agency and the
Departments of Health by the Office for National Statistics and Medical Research
Council Human Nutrition Research

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Foreword

This survey, of a national sample of adults aged 19 to 64 years, is one of a programme of national surveys with the aim of gathering information about the dietary habits and nutritional status of the British population. The results of the survey will be used to develop nutrition policy and to contribute to the evidence base for Government advice on healthy eating.

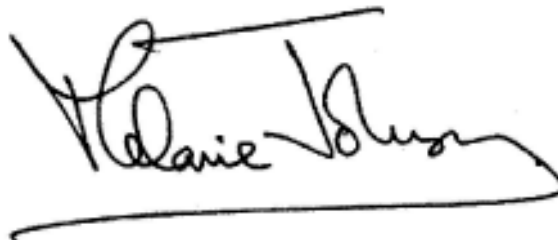
This report covers physical measurements, blood pressure, physical activity levels and a range of biochemical indices of nutritional status derived from analysis of blood samples. It is the fourth in a series on the findings of this survey. The first report, covering foods consumed, was published in December 2002. The second report, covering intakes of energy and macronutrients, and the third, covering vitamin and mineral intakes and urinary analytes, were published in July 2003. A summary report will complete the series later in 2004.

The work described in this series of reports results from a successful collaboration between the Food Standards Agency and the Department of Health, who jointly funded the collection of the survey data, with the Office for National Statistics and the Medical Research Council Human Nutrition Research.

We warmly welcome this fourth report of the latest survey in the National Diet and Nutrition Survey programme and express our thanks to all the respondents who took part.



Sir John Krebs
Chairman
Food Standards Agency



Melanie Johnson
Minister for Public Health
Department of Health

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Notes to the tables

Tables showing percentages

In general, percentages are shown if the base is 30 or more. Where a base number is less than 30, actual numbers are shown within square brackets.

The row or column percentages may add to 99% or 101% because of rounding and weighting.

The varying positions of the bases in the tables denote the presentation of different types of information. Where the base is at the foot of the table, the whole distribution is presented and the individual percentages add to between 99% and 101%. Where the base is given in a column, the figures refer to the proportion of respondents who had the attribute being discussed, and the complementary proportion, to add to 100%, is not shown in the table.

In tables showing cumulative percentages the row labelled 'All' is 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. Actual maximum values are not shown in tables of cumulative percentages, since they could vary for different subgroups being considered within the same tables.

Unless shown as a separate group, or stated in the text or a footnote to a table, estimates have been calculated for the total number of respondents in the subgroup, excluding those not answering. Base numbers shown in the tables are the total number of respondents in the subgroup, including those not answering.

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.

Conventions

The following conventions have been used in the tables:

- .. data not available
- category not applicable; no cases
- 0 values less than 0.5%
- [] numbers inside square brackets are the actual numbers of cases, when the base is fewer than 30.

Tables showing descriptive statistics – mean, percentiles, standard deviation

These are shown in tables to an appropriate number of decimal places.

Significant differences

Differences commented on in the text are shown as being significant at the 95% or 99% confidence levels ($p < 0.05$ and $p < 0.01$). Throughout this volume, the terms 'significant' and 'statistically significant' are used interchangeably. Where differences are shown or described as being 'not statistically significant' or 'ns' this indicates $p > 0.05$. The formulae used to test for significant differences are given in Appendix A, pages 115-131.

As a general indication of those groups showing the largest differences, the differences between all pairs of groups were tested for statistical significance. Because of this 'trawling' approach, real statistical significance levels are lower than indicated here and some of the reported significant differences are likely to be spurious. However, these significance tests can still be validly used for testing hypotheses suggested by earlier work.

Where differences between subgroups are compared for a number of variables, for example differences between respondents in different age groups in mean systolic blood pressure, the significance level shown ($p < 0.05$ or $p < 0.01$) applies to all comparisons, unless otherwise stated.

Standard deviations

Standard deviations for estimates of mean values are shown in the tables and have been calculated for a simple random sample design. In testing for the significant difference between two sample estimates, proportions or means, the sampling error calculated as for a simple random design was multiplied by an assumed design factor of 1.5, to allow for the complex sample design. The reader is referred to Appendix A for an account of the method of calculating true standard errors and for tables of design factors for the main variables and subgroups used throughout this volume. In general, design factors were below 1.5. Therefore although not commented on in the text, there will be some differences in sample proportions and means, that are significantly different, at least at the $p < 0.05$ level.

Weighting

Unless otherwise stated, all proportions and means presented in the tables in the substantive chapters in this volume are taken from data weighted to compensate for the differential probabilities of selection and non-response. Base numbers are presented weighted. All base numbers are given in italics. See Appendix B for unweighted base numbers, and Appendix D of the Technical Report online for more details on the weighting: accessible at <http://www.food.gov.uk/science>.

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1 Background, research design and response

This volume presents findings on physical measurements, blood pressure, blood samples, analysed for a range of biochemical indices of nutritional status, and physical activity, from a survey of the diet and nutrition of adults aged 19 to 64 years living in private households in Great Britain, carried out between July 2000 and June 2001. It is the fourth volume in a series that also covers food and nutrient intake data derived from the analyses of dietary records and the analyses of urine samples¹. This first chapter of this volume describes the background to the National Diet and Nutrition Survey (NDNS) of adults aged 19 to 64 years, its main aims, research designs and methodologies and response. Chapter 2 reports on the anthropometric data – the measurements of height, weight, waist and hip circumferences, and derived indices. Chapter 3 reports on the results of the blood pressure measurements. The results from the analyses of the samples of blood are presented in Chapter 4. Where relevant, the associations between dietary intakes and blood levels are examined. The final substantive chapter reports on the physical activity information collected in the physical activity diaries. Differences are considered by age, sex, region and household receipt of benefits. Where appropriate, comparisons are made between this survey and the Dietary and Nutritional Survey of British Adults aged 16 to 64 years carried out in 1986/87².

A Technical Report containing the methodological chapters and appendices is available online³. Like previous surveys in the NDNS programme, following publication of the final summary volume, a copy of the survey database, containing the full data set will be deposited with The Data Archive at the University of Essex. Independent researchers who wish to carry out their own analyses should apply to the Archive for access⁴.

1.1 The National Diet and Nutrition Survey Programme

The survey forms part of the National Diet and Nutrition Survey (NDNS) programme, which was set up jointly by the Ministry of Agriculture, Fisheries and Food (MAFF)⁵ and the Department of Health in 1992 following the successful Dietary and Nutritional Survey of British Adults aged 16 to 64 years carried out in 1986/87 (1986/87 Adults Survey)². MAFF's responsibility for the NDNS programme has now transferred to the Food Standards Agency.

The NDNS programme aims to provide comprehensive, cross-sectional information on the dietary habits and nutritional status of the population of Great Britain. The results of the surveys within the programme are used to develop nutrition policy at a national and local level, and to contribute to the evidence base for Government advice on healthy eating.

The NDNS programme is intended to:

- provide detailed quantitative information on the food and nutrient intakes, sources of nutrients and nutritional status of the population under study as a basis for Government policy;
- describe the characteristics of individuals with intakes of specific nutrients that are above and below the national average;
- provide a database to enable the calculation of likely dietary intakes of natural toxicants, contaminants, additives and other food chemicals for risk assessment;

- measure blood and urine indices that give evidence of nutritional status or dietary biomarkers and to relate these to dietary, physiological and social data;
- provide height, weight and other measurements of body size on a representative sample of individuals and examine their relationship to social, dietary, health and anthropometric data as well as data from blood analyses;
- monitor the diet of the population under study to establish the extent to which it is adequately nutritious and varied;
- monitor the extent of deviation of the diet of specified groups of the population from that recommended by independent experts as optimum for health, in order to act as a basis for policy development;
- help determine possible relationships between diet and nutritional status and risk factors in later life;
- assess physical activity levels of the population under study; and
- provide information on oral health in relation to dietary intake and nutritional status.

The NDNS programme consists of a planned programme of cross-sectional surveys of representative samples of defined age groups of the population. The surveys of older adults, pre-school children, and young people have been published^{6,7,8}. The last national survey of diet and nutrition in adults was the 1986/87 Adults Survey².

1.2 The sample design and selection

A nationally representative sample of adults aged 19 to 64 years living in private households was required. The sample was selected using a multi-stage random probability design with postal sectors as first stage units. The sampling frame included all postal sectors within mainland Great Britain; selections were made from the small users' Postcode Address File. The frame was stratified by 1991 Census variables. A total of 152 postal sectors was selected as first stage units, with probability proportional to the number of postal delivery points, and 38 sectors were allocated to each of four fieldwork waves. The allocation took account of the need to have approximately equal numbers of households in each wave of fieldwork and for each wave to be nationally representative.

From each postal sector 40 addresses were randomly selected⁹.

Eligibility was defined as being aged between 19 and 64 and not pregnant or breastfeeding at the time of the doorstep sift¹⁰. Where there was more than one adult between the ages of 19 and 64 years living in the same household, only one was selected at random to take part in the survey¹¹. A more detailed account of the sample design is given in Appendix D of the Technical Report³. In keeping with the ONS normal fieldwork procedures, a letter was sent to each household in the sample in advance of the interviewer calling, telling them briefly about the survey (see Appendix A of the Technical Report³).

As in previous surveys in the NDNS series, fieldwork covered a 12-month period, to cover any seasonality in eating behaviour, for example, potential reduction in the consumption of salad vegetables during the winter months, and seasonality in the nutrient content of foods, for example, in the vitamin A content of whole milk. The 12-month fieldwork period was divided into four fieldwork waves, each of three months duration¹². The fieldwork waves were:

Wave 1: July to September 2000

Wave 2: October to December 2000

Wave 3: January to March 2001

Wave 4: April to June 2001

Feasibility work carried out between September and December 1999 by the ONS and the Medical Research Council Human Nutrition Research (HNR) tested all the components of the survey and made recommendations for revisions for the mainstage. For a subgroup of the feasibility study sample, the validity of the dietary recording methodology was tested using the doubly labelled water methodology to compare energy expenditure against reported energy intake. Further details of the design and results of the feasibility study are summarised in Appendix C of the Technical Report³.

Because this survey, in common with other surveys in the NDNS series, includes invasive procedures such as venepuncture to take a blood sample, and measurements with possible clinical significance (that is the results of the blood analysis and measurement of blood pressure) it was necessary to obtain approval for the survey protocol from a Multi-centre Research Ethics Committee (MREC), and the National Health Service Local Research Ethics Committees covering each of the 152

sampled areas. Further details of the ethics approval process are given in Appendix N of the Technical Report³.

1.3 The components of the survey

The survey design included: an interview to provide information about the socio-demographic circumstances of the respondent and their household, their medication and eating and drinking habits; a weighed dietary record of all food and drink consumed over seven consecutive days; a record of bowel movements and a record of physical activity for the same seven days; physical measurements of the respondent (height, weight, waist and hip circumferences); blood pressure measurements; and a request for a sample of blood and a 24-hour urine collection. Respondents were also asked to do a self-count of the number of teeth and amalgam fillings they had, and provide a sample of tap water from their home for analysis of fluoride.

1.3.1 The dietary and post-dietary record interview

The interview comprised two parts. An initial face-to-face interview using computer-assisted personal interviewing methods (CAPI) to collect information about the respondent's household, their usual dietary behaviour, consumption of artificial sweeteners, herbal teas and other drinks; any foods that were avoided and the reasons for doing so, including vegetarianism and dieting behaviours; the use of salt at the table and in cooking; and the use of fluoride preparations and dietary supplements. Information was also collected on: the respondent's health status; their smoking and drinking habits; socio-economic characteristics; and, for women in defined age groups, the use of the contraceptive pill, menopausal state and use of hormone replacement therapy.

There was also a short interview, using CAPI, conducted at the end of the seven dietary recording days (post-dietary record interview). Respondents were asked about any problems they experienced in keeping the diary, whether their consumption of specific foods had changed during the seven days and whether they had been unwell at all during the recording period. Respondents were also asked to complete an eating restraint questionnaire, using computer assisted self-interviewing (CASI) or on paper. Information was also collected on prescribed medications taken during the seven days and levels of physical activity.

The interview questionnaire is reproduced in Appendix A of the Technical Report³.

1.3.2 The dietary record

The survey used a weighed intake methodology since its main aims were to provide detailed quantitative information on the range and distribution of intakes of foods and nutrients for respondents aged 19 to 64 years in Great Britain, and to investigate relationships between nutrient intakes, physical activity levels and various nutritional status and health measures. The advantages and disadvantages of this method and the factors affecting the choice are discussed in Appendix F of the Technical Report³. Appendix F also gives further details on the dietary methodology and the recording and coding procedures.

A feasibility study concluded that it was possible to collect dietary information for a seven-day period from respondents and that the quality of information would be acceptable (see Appendix C of the Technical Report³). Respondents were asked to keep a weighed record of all food and drink they consumed, both in and out of the home, over seven consecutive days. Each respondent was issued with a set of accurately calibrated Soehnle Quanta digital food scales and two recording diaries; the 'Home Record' diary for use when it was possible for foods to be weighed, generally foods eaten in the home; and a smaller 'Eating and Drinking Away From Home' diary (the 'Eating Out' diary) for use when foods could not be weighed, generally foods eaten away from home. The respondent was also issued with a pocket-sized notebook for recording any of this information in circumstances where they were reluctant or it was inappropriate to carry the 'Eating Out' diary. The instruction and recording pages from these documents relating to the dietary information are included in Appendix A of the Technical Report³.

The 'Home Record' diary was the main recording and coding document. For each item consumed over the seven days a description of the item was recorded, including the brand name of the product and, where appropriate, the method of preparation. Also recorded was the weight served and the weight of any leftovers, the time food was eaten, whether it was eaten at home or elsewhere, and whether fruit and vegetables were home grown, defined as being grown in the household's own garden or allotment.

Everything consumed by the respondent had to be recorded, including medicines taken by mouth, vitamin and mineral supplements, and drinks of water. Respondents were encouraged to weigh everything they could and where a served item

could not be weighed, respondents were asked to record a description of the portion size, or to describe the size of the item in some other way. Each separate item of food in a served portion needed to be weighed separately in order that the nutrient composition of each food item could be calculated. In addition, recipes for all home-made dishes were collected.

A large amount of detail needed to be recorded in the dietary record to enable similar foods prepared and cooked by different methods to be coded correctly, as such foods will have different nutrient compositions.

The 'Eating Out' diary was intended to be used only when it was not possible to weigh the food items. In such cases, respondents were asked to write down as much information as possible about each food item consumed, particularly the portion size and an estimate of the amount of any left over.

Where the respondent consumed food or drink items provided by their workplace or college, the interviewer was required to visit the workplace/college canteen to collect further information from the catering manager about, for example, cooking methods, portion sizes and types of fats used (see Appendix A of the Technical Report³).

A food code list, giving code numbers for about 3,500 items and a full description of each item, was prepared by nutritionists at the Food Standards Agency and the ONS, for use by the interviewers. As fieldwork progressed, further codes were added to the food code list for home-made recipe dishes and new products found in the dietary record. A page from the food code list is reproduced in Appendix A of the Technical Report³.

After the interviewers had coded the entries in the dietary records, ONS headquarters coding and editing staff checked the documents. ONS nutritionists carried out initial checks for completeness of the dietary records, dealt with specific queries from interviewers and coding staff, and advised on and checked the quality of coding, with advice from the Food Standards Agency nutritionists. Computer checks for completeness and consistency of information were run on the dietary and questionnaire data. Information from the dietary record was linked to the nutrient databank and nutrient intakes were calculated from quantities of food consumed. This nutrient databank, which was compiled by the Food Standards Agency, holds information on 56 nutrients for each of the 6,000 food codes. Further details of the nutrient databank are provided in Appendix H of the Technical Report³. Each food

code used was also allocated to one of 115 subsidiary food groups; these were aggregated into 57 main food groups and further aggregated into 11 food types (see Appendix G of the Technical Report³).

1.3.3 Anthropometry

One of the main aims of this survey is to provide anthropometric data on a representative sample of adults, which can be related to socio-demographic and dietary data. Anthropometry, the measurement of body size, weight and proportions, is an intrinsic part of any nutritional survey and can be an indicator of health, development and growth. Derived indices, for instance to assess the ratio of waist to hip circumferences, provide additional information.

In deciding which measurements should be taken a number of factors were considered. These included the acceptability of the measurement to the respondent, whether there was equipment suitable for use in the home and whether interviewers could be trained to take the measurements accurately.

All respondents were eligible to have measurements of standing height, weight and waist and hip circumferences taken. Height and weight can also be used to calculate the Quetelet or Body Mass Index ($\text{weight}[\text{kg}]/\text{height}[\text{m}]^2$) or other indices which control for variations in body weight associated with height. The ratio of waist to hip circumference gives indirect information on the distribution of body fat stores. Several studies in adults have shown that the location of body fat is associated with health risks, in particular cardiovascular disease¹³.

ONS interviewers have taken measurements of height, weight and waist and hip circumferences on surveys of adults and young people^{2,7,8,14,15}. All interviewers were trained in accurate measurement techniques at personal briefings. Once trained, any interviewer working on a subsequent, non-consecutive wave of fieldwork attended a one-day refresher briefing where they were retrained in these techniques. Interviewers were able to practise the measurement techniques at the briefings.

Interviewers were allowed to take the measurements at any point after the dietary interview had been completed; it was thought that specifying a particular time to take the measurements could affect response.

Interviewers recorded the measurement, the date on which it was taken, and if there were any

special circumstances which might have affected the accuracy of the measurement (see M1, Appendix A of the Technical Report³). The Department of Health advised on circumstances that were likely to affect the accuracy to such an extent that the measurement should be excluded from the analysis. This included, for example, the respondent being unable to keep the correct posture when standing height was being measured, or their hair being arranged in a 'permanent' style which affected the measurement of standing height. Each measurement was made twice, repeating the same protocol. For further details of the measurement techniques, see Appendix J of the Technical Report³.

Standing height

Height was measured using the Leicester Height Measure¹⁶. This was the instrument of choice for the NDNS of young people aged 4 to 18 years⁹. The Measure consists of a base plate, four measuring rods, which slot together, two stabilising bars and a head plate, which slides up and down the vertical measuring rods. Measurements were made in centimetres and millimetres.

The respondent was asked to remove their shoes and socks and to wear as few clothes as possible. The respondent was positioned with their feet together and flat on the base plate of the Measure, their arms loosely at their side, and with their head and back straight and against the vertical measuring rods. The respondent's head was correctly positioned in the Frankfort plane¹⁷ by the interviewer and the alignment checked using a card. Once the correct position was achieved the interviewer lowered the head plate until it just touched the top of the respondent's head. The interviewer then asked the respondent to take a breath and stand as tall as possible, without lifting their heels off the base plate.

Weight

Weight was taken using Soehnle Quantatron scales, Models 7300 and 7306, calibrated in 100 gram units. The scales were checked for accuracy and calibrated by a specialist contractor prior to the start of fieldwork¹⁸. During the fieldwork period the batteries were regularly changed.

The scale was placed on a hard, level surface. If only a carpeted surface was available then the interviewer noted this. The time of day for taking the measurement was not standardised.

The respondent was asked to wear only light clothing while being weighed; heavy items of clothing, including shoes, trainers and jackets and

any heavy jewellery, keys and money were removed where possible. A record was made of which items of clothing the respondent was wearing while being weighed.

Waist and hip circumferences

The waist is defined as the midway point between the iliac crest and the lower rib. The hip circumference is defined as being the maximum circumference over the buttocks and below the iliac crest.

In preparation for these measurements the respondent was asked to wear only light clothing and to have recently emptied their bladder. In particular they were asked to remove any belts or items in pockets that might affect only one of the circumferences and therefore change the ratio between the waist and hip measurements. Respondents were also asked to adjust the position of their clothing to try to achieve a similar thickness at both measurement positions.

An insertion tape was passed around the circumference, adjusted and checked for horizontal alignment¹⁹. Having achieved satisfactory positioning of the tape the interviewer then asked the respondent to continue breathing normally, that is, not to hold in the breath, and the measurement was made at the end of a normal expiration. Measurements were made and recorded to the nearest millimetre.

Each respondent was given a record card with his or her measurements.

1.3.4 Blood pressure

High blood pressure is an important and known risk factor for cardiovascular disease in adults²⁰. Blood pressure could only be taken if written consent from the respondent to take the measurement was obtained²¹. Consent to notify the respondent's GP of their participation in the survey and signed consent to send a record of the blood pressure measurements to the respondent's GP was also sought, but if not obtained, or the respondent was not registered with a GP, the blood pressure measurement was taken and duty of care passed to the survey doctor. If the respondent did not consent to informing their GP or the survey doctor then a blood pressure measurement was not taken.

Blood pressure was measured using the Dinamap 8100 oscillometric monitor²². This device was previously used to measure blood pressure on the NDNS of young people aged 4 to 18 years⁸ and the Health Survey for England²³, and was the

instrument of choice principally for reasons of methodological comparability between all these surveys, instrument reliability and ease of use. A summary review of studies comparing the Dinamap with other devices, including the standard mercury sphygmomanometer, was reported in the NDNS of young people aged 4 to 18 years⁸. Although the mercury sphygmomanometer is relatively cheap, it requires more training to use correctly than an automated device. For epidemiological purposes, automated devices have the advantage that observers need not be highly trained medical or nursing personnel. ONS interviewers are easily able to learn the technique and the risk of inter-observer bias is reduced.

Measurements were made on the respondent's right arm. Three different size cuffs were available and each had markings to indicate, whether, after wrapping the cuff around the upper arm, the cuff selected was the appropriate size²⁴. The respondent was asked to remove any jacket, jumper or cardigan they were wearing, and if they were wearing a garment with sleeves, to remove their right arm from the sleeve. If they were unwilling to comply with this, and provided their circulation was not impeded, they were asked to roll the sleeve so that it would be above the top edge of the cuff.

The time of day when the measurements were taken was not standardised but when arranging an appointment interviewers asked the respondent not to eat, drink, smoke or exercise in the 30 minutes prior to the measurement being made. Interviewers subsequently checked whether these instructions had been carried out, and if not and they were unable to reschedule the visit they recorded the relevant details on the measurement schedule.

The respondent was seated so that they were relaxed and had their feet flat on the floor. The right arm was rested on a support at a height that brought the antecubital fossa to approximately heart level. The lower edge of the cuff was placed about 2cm above the elbow crease and the arrow marked on the cuff placed over the brachial artery. The cuff was wrapped to a tightness that allowed two fingers to be inserted between it and the respondent's arm at the top and bottom edges of the cuff.

The respondent was then asked to sit quietly for about 5 minutes before the measurements were taken while the interviewer explained what would happen when the Dinamap was switched on. Three measurements were then taken at one-minute intervals, recording diastolic, systolic and mean arterial blood pressure and pulse rate.

The measurements were recorded on the measurement schedule, with details of any difficulties that might have affected the readings.

For further details of the procedures for taking blood pressure measurements see Appendix J of the Technical Report³.

Reporting blood pressure

Immediately after the blood pressure measurements were taken, the interviewer sent a copy of the readings to HNR where they were scrutinised by the survey doctor and then sent with an appropriate covering letter to the respondent's GP (see Appendix L of the Technical Report³). If the respondent did not have a GP or had not consented to their notification the survey doctor would feed the results back to the respondent. Where the readings obtained by the interviewer were unusually high, defined as all three readings being equal to or above 160mmHg systolic pressure and/or equal to or above 90mmHg diastolic pressure, the interviewer immediately delivered a copy of the results with a standard accompanying letter to the respondent's GP. The interviewer also contacted the survey doctor by telephone, to ensure that the survey doctor was sufficiently informed to discuss the readings with the GP should the need arise, and provided respondent details, including age and weight. If the respondent did not have a GP or had not consented to their GP being informed of their participation, then in the case of high blood pressure readings the interviewer would inform the survey doctor immediately and the survey doctor would contact the respondent to discuss and advise him/her on what further action to take.

1.3.5 24-hour urine collection

The relationship between dietary intakes of sodium, present in salt (sodium chloride), and other dietary components and blood pressure has been investigated in relation to the established association between hypertension and cardiovascular disease. The Scientific Advisory Committee on Nutrition in its recent report on salt and health concluded that reducing the average population salt intake would proportionally lower population average blood pressure levels and confer significant public health benefits by contributing to a reduction in the burden of cardiovascular disease²⁵. It was considered important therefore that this survey obtained information on both sodium intakes and blood pressure.

It is not possible to obtain accurate estimates of dietary intake of sodium from weighed food intake information, mainly because it is not possible to

assess accurately the amount of salt added to food in cooking or at the table. Estimates of sodium and potassium intakes can be obtained by measuring their urinary excretion, assuming the body is in balance for these minerals.

Since the rate of excretion of both sodium and potassium varies with intake, the best estimate of intake is obtained from the analysis of a urine sample taken from a complete 24-hour collection, which allows for the fluctuations in intake over the collection period. A spot urine sample is not sufficiently representative to provide a valid long-term estimate of intakes, and hence excretion, of sodium and potassium. There were some concerns about the acceptability of a 24-hour collection among this population following the response in the feasibility study for the NDNS of adults aged 65 or over⁶. However, the feasibility study for this NDNS found the 24-hour collection method to be acceptable to respondents (see Appendix C of the Technical Report³).

The aim was to have a complete collection of urine over a 24-hour period from as many of the respondents as possible, and to analyse a sample from the complete collection for sodium, potassium, creatinine, urea and fluoride.

The collection of a complete 24-hour urine sample is a demanding task, and previous experience has shown that samples are frequently incomplete. Therefore, an additional procedure, 'PABA-check', has been devised. This is designed to monitor the completeness of the collection by asking respondents to take three 80mg tablets of para-aminobenzoic acid (PABA) at intervals during the 24-hour collection period. Measurement of the PABA concentration and total volume of the collected sample permits the calculation of the percentage recovery of the administered PABA, which in turn is a measure of completeness of the 24-hour urine collection. The taking of PABA required signed consent from the respondents.

The use of this procedure in this survey was approved by the Multi-centre and Local Research Ethics Committees and was successfully piloted in the feasibility study. It was included in part of Wave 1 of the mainstage survey. One respondent in Wave 1 exhibited an acute allergic reaction with generalised urticaria and periorbital oedema soon after taking the three PABA doses. Although this occurrence may have been a chance association, the survey doctor decided, after seeking external advice, to recommend the discontinuation of the PABA-check procedure as a precaution²⁶. From part-way through Wave 1 until the end of the survey, all subsequent 24-hour urine collections were made without PABA-check²⁷.

Respondents were provided with an explanation of the procedures for making the 24-hour urine collection and the purpose of this (see L2 and L5, Appendix K of the Technical Report³). They were also provided with instructions (W3) on how to take the subsamples of the urine, under supervision by the interviewer, and a form (M3A) on which to record the date of collection, times of taking the PABA tablets and any problems with the urine collection or PABA procedures. The procedure without PABA was essentially the same, except that all of the equipment, forms and procedural elements that were specific to the PABA-check procedure, were omitted. More detailed information was collected on M3A about missed collections. On the day after starting the collection the interviewer paid another visit to the respondent to weigh the collection and take the sub-samples. For further details on the procedure and equipment provided to respondents and interviewers see Appendix P of the Technical Report³.

Once the 24-hour collection was completed, the urine collection was thoroughly mixed. The interviewer weighed the total collection twice and recorded both measurements on form M3B (see Appendix K of the Technical Report³). The respondent was then asked to take four aliquots, each 10ml, from the total collection using Sarstedt syringes. If the respondent was unable, or unwilling, to take the aliquots themselves, the interviewers were asked to take the subsamples if they were happy to do so. If the collection was tainted with blood no subsamples were taken. The interviewer added pre-printed cryo-labels to the aliquots, added the date to these, and then transferred all four to the postal plastic containers. These were then placed in the cardboard box and then in the Jiffy bag along with completed forms M3A and M3B. The Jiffy bag was sealed with parcel tape and posted to HNR.

Samples were sent by first class post to HNR where they were analysed. On arrival at HNR the samples were stored at -40°C or lower.

If the respondent failed to make a full 24-hour collection ethics approval did not allow for a second attempt. Aliquots were still taken, from the incomplete collection, and a note made of the reasons why a full collection had not been made.

1.3.6 Blood analysis

A further aim of the NDNS programme is to measure haematological and other blood indices that give evidence of nutritional status and to relate these to dietary and social data.

All procedures associated with obtaining and analysing the blood samples were contracted to HNR whose staff worked closely with the ONS

throughout all stages of the survey. All procedures were tested in the feasibility study to ensure that they were safe and acceptable to respondents, those taking the blood samples and to the medical profession (see Appendix C of the Technical Report³). Details of the recruitment and training of the blood takers, and of the recruitment of local laboratories are provided in Appendix N of the Technical Report³.

Explicit formal consent was required for taking the blood sample from respondents. Interviewers were required to tell the respondent at the time they conducted the dietary interview that their consent to a blood sample being taken would be sought. This was to avoid the possibility that having built a rapport with the interviewer, respondents might have felt obliged to consent to the venepuncture procedure against their true wishes. Respondents were given time to consider whether they wished to participate in this component or not. Written consent for the procedure was sought, as well as consent for HNR to inform the respondent's GP of the results for the clinically significant analytes. If the respondent was not registered with a GP, or consent to pass information to the GP was not given, a blood sample could still be taken provided the respondent provided written consent. In these circumstances the duty of care passed to the survey doctor.

Agreement to this aspect of the survey was independent of agreement to other components in the survey, and was not associated with the £10 gift voucher given to the respondent for completing the full seven-day dietary record. Respondents were told that they were free to withdraw their consent to any procedure at any point, even after the consent form had been signed. Further details of the consent procedures are given in Appendix N of the Technical Report³.

Blood was taken by the phlebotomist in the respondent's home with the ONS interviewer present. Screening questions were asked by the phlebotomists before attempting to obtain the sample. Questions were asked to ensure exclusion of any respondents with known clotting or bleeding disorders or those taking anticoagulant drugs. If the respondent volunteered that they were HIV or hepatitis B positive, blood was not taken.

The blood samples were collected by the phlebotomist using the Sarstedt Monovette blood-collection system with butterfly or fixed needle, according to their preference. The Monovette system of blood collection is an enclosed system which allows the safe, spill-free collection of blood which is critical in the home environment. It can

also offer trace element contamination control and is manufactured from plastic which allows the safe transport of the sample, inside an outer rigid plastic container, through the postal system. Ethics approval allowed for a maximum of two attempts to obtain the blood sample (maximum 30ml).

Details of the procedures for taking blood samples and the processing and storage procedures are described in Appendix O of the Technical Report³.

Reporting procedures

Respondents and their GPs, if consent to inform the GP was given, were informed by letter of the results of a selected number of analytes which were of clinical significance (see Appendix L of Technical Report³). This letter also reported the blood pressure measurements for the respondent where these had been taken. Letters to GPs and respondents contained identical results sheets together with information on normal ranges. On request, the survey doctor provided advice to GPs about the need for follow-up tests.

Results for the following assays were reported:

- full blood count (including haemoglobin concentration) and differential blood count
- plasma cholesterol concentration and total cholesterol/HDL ratio
- serum and red cell folate concentration
- serum vitamin B₁₂ concentration
- plasma homocysteine concentration if abnormal
- measures of iron status concentration
- plasma 25-hydroxyvitamin D concentration (a measure of vitamin D status)
- blood mercury concentration

Any abnormality of potential clinical significance in any of the unreported analytes, for example, a toxic selenium concentration, was also reported to the respondent and to their GP if consent was obtained.

1.3.7 Physical activity

The main purpose in collecting information on levels of physical activity was to allow an investigation of the relationships between dietary intakes, particularly energy intake, body composition, that is body mass index, and physical activity levels.

If the body does not use all the energy it takes in as food for activity, growth, thermogenesis, for example then it will be stored. Over time, this will lead to an increase in body weight, which if it continues leads to an increased risk of obesity. The risk of cardio-vascular disease increases with obesity and many other illnesses and conditions are related to being overweight²⁹. This survey provided the opportunity to relate activity levels to energy intake and body size.

Respondents were asked to record their physical activity over the same seven days as the dietary recording period. The feasibility study showed that the seven-day diary method was appropriate for the collection of data for respondents in this survey.

The recording pages for physical activity were included in the 'Diary of Activities and Eating and Drinking Away from Home' (see Appendix A of the Technical Report³). It was felt inappropriate within the context of an already onerous survey to ask respondents to provide detailed information on how all their time was spent, for example, by obtaining a 'time-use' diary. It was considered sufficient to collect information which would allow adults to be classified into broad bands of activity level, for example, very inactive, inactive or active. The diary asked for details of time spent on a list of specified activities. Information was collected on duration and intensity of activity.

Information was collected for each of the seven days on the time spent:

- asleep, including napping;
- at work;
- at college;
- walking briskly or at an average pace;
- in a range of listed household or similar activities – light and heavy housework, gardening, DIY jobs and active caring;
- in a range of listed sports and leisure activities or similar activities, including whether the respondent got 'out of breath and sweaty' doing the activity.

For respondents in employment their hours worked were recorded and they were asked to provide details of what they did in their job so it could be categorised as being of either light, moderate or hard intensity.

Each of the prompted activities has an associated metabolic equivalent value (MET), for example volleyball has a MET value of 4.0³⁰. This was used to group activities into different levels of intensity: sleep, very light/light, moderate or hard/very hard. The total time spent in activities of different levels of intensity was calculated for each diary day. Time spent in very/light or light activities was calculated by subtracting the time spent sleeping and in activities of moderate and hard/very hard intensity from 24 hours. This meant that very light/light activities did not have to be recorded separately.

Multiplying the time spent in an activity by its MET value produces a calculated activity score, representing the level of energy expenditure for that respondent. Further details on the calculated activity score and other derived measures of physical activity are given in Appendix D.

1.4 Response and weighting

Table 1.1 shows response to the dietary interview (the responding sample) and dietary record (the diary sample) overall and by fieldwork wave¹². Of the 5,673 addresses issued³¹ to the interviewers, 35% were ineligible for the survey (see Chapter 2 of the Technical Report³). This high rate of ineligibility is mainly due to the exclusion of those aged under 19 years and those aged 65 or over. Just over one-third of the eligible sample, 37%, refused outright to take part in the survey. Only 2% of the eligible sample were not contacted. Overall, 61% of the eligible sample completed the dietary interview, including 47% who completed a full seven-day dietary record. Overall, 77% of those who completed the dietary interview completed a full seven-day dietary record.

Table 1.2 shows response to the anthropometric measurements and blood pressure by fieldwork wave¹², sex and age of respondent and the social class of the household reference person³². For each of the measurements, at least 77% of the responding sample and 93% of the diary sample had the measurement taken. Table 1.3 shows the proportion of respondents who consented to having a blood sample taken and the proportion of cases where a sample was obtained. Overall, 63% of the responding sample and 78% of the diary sample consented to having a blood sample taken. A blood sample was obtained for 95% of those who consented (60% of the responding sample and 74% of the diary sample).

While there has been a general fall in response to government social surveys over the last decade³², the level of refusal to this NDNS was higher than expected. Steps were taken at an early stage to

improve response, and included reissuing non-productive cases³³, developing the interviewer training to address further response issues, this included providing general guidance on approaching and explaining the survey to respondents, and increased support to the interviewers and their managers. This met with some success so that in Wave 4 a higher proportion of the eligible sample, 67%, completed the dietary interview compared with previous waves, 56% to 60%.

Those who completed the dietary record had a similar demographic profile, by sex, age and social class of the Household Reference Person to those who completed the dietary interview (see also Chapter 2 of the Technical Report³). There were no significant differences by sex and age or by social class of the Household Reference Person in co-operation rates for the anthropometric and blood pressure measurements or in the proportions consenting to a blood sample, where venepuncture was attempted and where a blood sample was obtained.

The potential for bias in any dataset increases as the level of non-response increases. Assessing bias is particularly difficult when there is little or no information on particular subgroups within the study population. An independent evaluation of the potential impact of non-response bias was undertaken by the University of Southampton³⁴. The authors concluded that there was no evidence to suggest serious non-response bias, although this should be interpreted with caution as bias estimates were based upon assumptions about the total refusals and non-contacts for whom there was very little information. The authors recommended population-based weighting by sex, age and region. Indeed, without weighting for the differential response effect, estimates for different groups would be biased estimates because, in particular, they under-represent men and the youngest age group. To correct for this, the data presented in this volume and the other volumes of this survey have been weighted using a combined weight, based on differential sampling probabilities and differential non-response. Bases in tables are weighted bases scaled back to the number of cases in the appropriate sample. Unweighted bases are given in Appendix B on pages 133-135. Further details of the weighting procedures are given in Appendix D of the Technical Report³.

In summary, the estimates presented in this report result from weighting the data as effectively as possible using the available information. However, results should be interpreted with caution, particularly where the sample sizes are low. The

reader should note that the sample size in Scotland is particularly low and therefore standard errors may be large (see Appendix A, pages 115-131, for further details on standard errors).

(Tables 1.1 to 1.3)

References and endnotes

- ¹ The other volumes in this series are:
 - (i) Henderson L, Gregory J, Swan G. *National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 1: Types and quantities of foods consumed*. TSO (London, 2002);
 - (ii) Henderson L, Gregory J, Irving K, Swan G. *National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 2: Energy, protein, carbohydrate, fat and alcohol intake*. TSO (London, 2003);
 - (iii) Henderson L, Irving K, Gregory J, Bates CJ, Prentice A, Perks J, Swan G, Farron M. *National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 3: Vitamin and mineral intake and urinary analytes*. TSO (London, 2003);
 - (iv) Summary report, providing a summary of the key findings from the four volumes, to be published in spring 2004.
- ² Gregory J, Foster K, Tyler H, Wiseman M. *The Dietary and Nutritional Survey of British Adults*. HMSO (London, 1990).
- ³ The Technical Report is available online at <http://www.food.gov.uk/science>.
- ⁴ For further information about the archived data contact:

The Data Archive
University of Essex
Wivenhoe Park
Colchester
Essex CO4 3SQ
United Kingdom
Tel: (UK) 01206 872001
Fax: (UK) 01206 872003
E-mail: archive@essex.ac.uk
Website: www.data-archive.ac.uk
- ⁵ Responsibility for this survey and the National Diet and Nutrition Survey programme transferred from the Ministry of Agriculture, Fisheries and Food to the Food Standards Agency on its establishment in April 2000.
- ⁶ Finch S, Doyle W, Lowe C, Bates CJ, Prentice A, Smithers G, Clarke PC. *National Diet and Nutrition Survey: people aged 65 years and over. Volume 1: Report of the diet and nutrition survey*. TSO (London, 1998).
- ⁷ Gregory JR, Collins DL, Davies PSW, Hughes JM, Clarke PC. *National Diet and Nutrition Survey: children aged 1½ to 4½ years. Volume 1: Report of the diet and nutrition survey*. HMSO (London, 1995).
- ⁸ Gregory JR, Lowe S, Bates CJ, Prentice A, Jackson LV, Smithers G, Wenlock R, Farron M. *National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 1: Report of the diet and nutrition survey*. TSO (London, 2000).
- ⁹ Initially 30 addresses were selected within each postal sector. Results from Wave 1 indicated a higher level of age-related ineligibles than expected and a much lower response rate. In order to increase the actual number of diaries completed and to give interviewers enough work an extra 10 addresses, in each sector, were selected for Waves 2, 3 and 4.
- ¹⁰ The diet and physiology of pregnant or breastfeeding women is likely to be so different from those of other

- similarly aged women as possibly to distort the results. Further, as the number of pregnant or breastfeeding women identified within the overall sample of 2000 would not be adequate for analysis as a single group, it was decided that they should be regarded as ineligible for interview.
- 11 Selecting only one eligible adult per household reduces the burden of the survey on the household and therefore reduces possible detrimental effects on co-operation and data quality. It also reduces the clustering of the sample associated with similar dietary behaviour within the same household and improves the precision of the estimates.
 - 12 As in some cases fieldwork extended beyond the end of the three-month fieldwork wave, or cases were re-allocated to another fieldwork wave, cases have been allocated to a wave for analysis purposes as follows. Any case started more than four weeks after the end of the official fieldwork wave has been allocated to the actual quarter in which it started. For example, all cases allocated to Wave 1 and started July to October 2000 appear as Wave 1 cases. Any case allocated to Wave 1 and started in November 2000 or later appears in a subsequent wave; for example a case allocated to Wave 1 which started in November 2000 is counted as Wave 2. All cases in Wave 4 (April to June 2001) had been started by the end of July 2001.
 - 13 International Obesity Task Force. Obesity: preventing and managing the global epidemic. Report of WHO consultation on obesity, Geneva, 3–5 June 1998. WHO (Geneva, 1998).
 - 14 White A, Nicolaas G, Foster K, Browne F, Carey S. *Health Survey for England 1991*. HMSO (London, 1993). Breeze E, Maidment A, Bennett N, Flatley J, Carey S. *Health Survey for England 1992*. HMSO (London, 1994). Bennett N, Dodd T, Flatley J, Freeth S, Bolling K. *Health Survey for England 1993*. HMSO (London, 1995).
 - 15 Knight I. *The Heights and Weights of Adults in Great Britain*. HMSO (London, 1984).
 - 16 The Leicester Height Measure is available from the Child Growth Foundation, 2 Mayfield Avenue, Chiswick, London W4 1PW, UK.
 - 17 To achieve the correct Frankfurt position, the bottom of the orbital socket should be in a horizontal line with the external auditory meatus.
 - 18 Scales were checked and calibrated by CHASMOR, 18 Camden High Street, London NW1 6JH, UK.
 - 19 Insertion tapes, fitted with a metal buckle and calibrated in centimetres and millimetres, were supplied by CHASMOR, 18 Camden High Street, London NW1 6JH, UK.
 - 20 Prospective Studies Collaboration. Age specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet* 2002; **360**: 1903–13.
 - 21 Details of the consent procedures are given in Appendix N of the Technical Report (see Note 3).
 - 22 Dinamap monitors were supplied by GE Medical Systems, DINAMAP Centre of Excellence, Monitor House, Unit 3 Cherrywood, Chineham Business Park, Basingstoke, Hampshire, RG24 8WKF and maintained by Marquette Hellige, Montagu Court, Kettering Parkway, Kettering, Northamptonshire NN15 6XR, UK.
 - 23 Erens B, Primatesta P, Prior G (Eds) *Health Survey for England The Health of Minority Ethnic Groups 1999: Volume 2: Methodology and Documentation*. TSO (London, 2001).
 - 24 Small adult cuff: 17–25cm; standard adult cuff: 23–33cm; large adult cuff; 31–40cm.
 - 25 Scientific Advisory Committee on Nutrition. Salt and Health. TSO (London, 2003).
 - 26 The respondent was offered the opportunity of a additional test under medical supervision to ascertain any allergic reaction. This challenge test was performed in July 2001 and concluded that PABA was not the cause of the respondent's allergic symptoms.
 - 27 Subsequent to the removal of the PABA check a decision was made to use plasma creatinine as an indicator of the completeness of the 24-hour urine collection. Further details on this and results from the PABA-check and plasma creatinine are given in Volume 3, Chapter 4, sections 4.1.1 and 4.1.2.
 - 28 National Audit Office. *Tackling obesity in England*. TSO (London, 2001).
 - 29 A MET is a multiple of the resting rate of oxygen consumption, or the ratio of working metabolic rate to resting metabolic rate (WMR/RMR). One MET represents the resting metabolic rate, approximately equal to an energy expenditure of one kilocalorie (kcal) per kilogram body weight per hour (kcal/kg/hour). An individual participating in physical activity at 2 METs is consuming oxygen at twice the resting rate. A list of activities with associated MET values can be found in: Ainsworth BE et al. Compendium of Physical Activities: classification of energy costs of human physical activities. *Med. Sci. Sports Exerc.* 1993; **25**(1): 71–80.
 - 30 Initially 1,140 addresses were issued per wave. This was increased in Wave 2 to 1,520 addresses, 40 in each quota of work. In Wave 3, 27 addresses were withdrawn. These were unapproachable due to access restrictions in place because of the foot-and-mouth disease outbreak.
 - 31 This is the member of the household in whose name the accommodation is owned or rented, or is otherwise responsible for the accommodation (see Appendix E – Glossary).
 - 32 Martin J and Matheson J. Responses to declining response rates on government surveys. *Survey Methodology Bulletin* 1999; **45**: 33–37.
 - 33 Non-productive cases are those where the interviewer was unable to make contact with the selected household or respondent (non-contacts) and where the household or selected respondent refused to take part in the survey (refusals). Addresses that were returned to the office coded as refusals or non-contacts were considered for reissue. Where it was thought that a non-productive case might result in at least a dietary interview (for example, where the selected respondent had said they were too busy at the time of the original call but would be available at a later date) these addresses were issued to interviewers working in subsequent waves of fieldwork.
 - 34 Skinner CJ and Holmes D (2001) *The 2000–01 National Diet and Nutrition Survey of Adults Aged 19–64 years: The Impact of Non-response*. University of Southampton. Reproduced as Appendix E of the Technical Report (see Note 3).

Table 1.1

Response to the dietary interview and seven-day dietary record by wave of fieldwork*

Unweighted data

Numbers and percentages

	Wave of fieldwork								All	
	Wave 1: July–September		Wave 2: October–December		Wave 3: January– March		Wave 4: April–June		No.	%
	No.	%	No.	%	No.	%	No.	%		
Set sample = 100%	1098	100	1397	100	1450	100	1728	100	5673	100
Ineligible	382	35	514	37	515	36	558	32	1969	35
Eligible sample = 100%	716	100	883	100	935	100	1170	100	3704	100
Non-contacts	12	2	24	3	23	2	30	3	89	2
Refusals	271	38	369	42	364	39	360	31	1364	37
Co-operation with:										
dietary interview	433	60	490	56	548	59	780	67	2251	61
seven-day dietary record	325	45	385	44	429	46	585	50	1724	47

Note: * For productive cases, fieldwork wave is defined as the wave (quarter) in which the dietary interview took place; for unproductive cases, fieldwork wave is the wave in which the case was issued (or reissued) (see note 12).

Table 1.2

Co-operation with anthropometric measurements and blood pressure by wave of fieldwork, sex and age of respondent and social class of household reference person

Unweighted data													Numbers and percentages	
Wave of fieldwork, sex and age of respondent and social class of household reference person	Height			Weight			Waist and hip circumference			Blood pressure				
	No.	as percentage of:		No.	as percentage of:		No.	percentage of:		No.	as percentage of:			
		responding sample	diary sample		responding sample	diary sample		responding sample	diary sample		responding sample	diary sample		
Fieldwork wave:														
Wave 1	356	82	97	356	82	97	354	82	97	347	80	98		
Wave 2	402	82	96	405	83	96	402	82	96	395	81	95		
Wave 3	433	79	92	432	79	92	426	78	91	408	74	88		
Wave 4	609	78	94	608	78	94	601	77	93	589	76	91		
Men aged (years):														
19-24	65	76	93	65	76	93	64	74	93	62	72	90		
25-34	172	78	94	171	78	94	170	78	94	169	77	94		
35-49	328	83	96	329	84	97	328	83	96	323	82	96		
50-64	249	81	94	250	81	94	246	80	93	244	79	93		
All	814	81	95	815	81	95	808	80	94	798	79	94		
Women aged (years):														
19-24	83	76	87	83	76	87	82	75	87	81	74	87		
25-34	216	78	95	213	77	94	213	77	94	209	75	92		
35-49	393	81	96	396	81	96	387	80	94	374	77	92		
50-64	294	80	94	294	80	94	293	79	94	277	75	91		
All	986	79	94	986	79	94	975	78	94	941	76	91		
Social class of household reference person:														
Non-manual	1024	82	96	1026	82	96	1018	82	95	992	80	94		
Manual	738	78	94	738	78	94	729	77	94	712	75	92		
All	1800	80	95	1801	80	95	1783	79	94	1739	77	93		

Table 1.3

Co-operation with blood sample by wave of fieldwork, sex and age of respondent and social class of household reference person

Unweighted data

Numbers and percentages

	Consent obtained:		Venepuncture attempted:			Blood sample obtained:					
	No.	as percentage of:		No.	as percentage of:		No.	as percentage of:			
		responding sample	diary sample		responding sample	diary sample		consenting sample	responding sample	diary sample	consenting sample
Fieldwork wave:											
Wave 1	290	67	83	284	66	82	98	278	64	80	96
Wave 2	328	67	81	320	65	79	98	313	64	78	95
Wave 3	326	59	73	316	58	71	97	315	57	70	97
Wave 4	475	61	76	459	59	75	97	441	57	71	93
Men aged (years):											
19–24	49	57	74	48	56	72	98	47	55	70	96
25–34	125	57	72	121	55	70	97	120	55	69	96
35–49	262	66	82	256	65	80	98	254	64	79	97
50–64	205	66	81	197	64	78	96	194	63	77	95
All	641	64	79	622	62	77	97	615	61	76	96
Women aged (years):											
19–24	61	56	72	58	53	70	95	53	49	64	87
25–34	163	59	74	161	58	73	99	159	57	72	98
35–49	319	66	79	313	64	77	98	306	63	75	96
50–64	235	64	79	225	61	76	96	214	58	72	91
All	778	63	77	757	61	75	98	732	59	73	94
Social class of household reference person:											
Non-manual	809	65	79	785	63	77	97	771	62	76	95
Manual	579	61	77	764	60	75	132	548	58	73	95
All	1419	63	78	1379	61	76	97	1347	60	74	95

2 Anthropometry

2.1 Introduction

This chapter presents anthropometric data on the height, weight and waist and hip circumferences of adults aged 19 to 64 years. Data are also presented on the derived measures of body mass index (BMI) and waist to hip ratio. Descriptive statistics are presented for men and women separately by age group. Both bivariate and multivariate analyses are presented showing the relationship between variations in the anthropometric measurements and various socio-demographic, behavioural and dietary factors. The rationale for each of the anthropometric measurements and the protocol, equipment and methodologies used are described in Chapter 1 of this report and in Appendix J of the Technical Report¹.

Data from the Dietary and Nutritional Survey of British Adults aged 16 to 64 years carried out in 1986/87 (1986/87 Adults Survey)² and the Health Survey for England 2001 (HSfE)³ are presented for comparison. Data from the 1986/87 Adults Survey are available for height, weight and BMI. Data from the HSfE are available for height, weight, BMI and waist to hip ratio for adults aged 16 to 64 years.

All 2,251 respondents were eligible for measurements, but not all of the respondents co-operated with every measurement. The response rate for each measurement is given in Chapter 1 of this report. The bases shown in the tables within this chapter therefore vary between measurements. The number of cases for which individual measurements were missing was small enough that it was possible to use a single set of weights for all of the measurements⁴. Unweighted bases are presented in Appendix B.

Data are presented for men and women in four age groups. For the purpose of these analyses age was calculated by subtracting the respondent's date of birth from the date when each measurement was made. There was no requirement for all of the anthropometric measurements to be made at the same visit. It is possible that some respondents may be classified in different age groups for the anthropometric measurements than for other components of the survey.

The interviewers were asked to attempt each measurement twice. In the analyses, the mean of the two recorded measurements was taken. Agreement between the two measurements was checked and cases were included where the percentage difference was less than 15%. Not all participants co-operated with both measurements. In the small number of cases where only one measurement was taken, this measurement was used in the analyses.

The interviewers were asked to record if measurements were taken under any special circumstances, for example if the person was unable to stand fully upright while the height measurement was made. In addition, consistency checks were made within the data for each measurement. Where a measurement lay at either extreme of the distribution, all of the anthropometric measurements were scrutinised for inconsistency for that individual. Measurements that were considered unreliable were excluded from the analyses.

2.2 Height

Height measurements were achieved for a total of 1,800 respondents (unweighted). The measurements for one respondent were excluded due to unreliability, as the respondent was unable to stand upright due to an injured back. For another respondent one measurement was taken in an incorrect standing position and therefore was excluded. In this case the other measurement was used.

Table 2.1 shows descriptive statistics for height for men and women by age group. Acceptable measures of height were obtained for 814 men and 985 women (unweighted). Generally, for men and women within each age group, the mean values were close to median values. This indicates that the distribution of data is normal⁵.

The mean height for men was 176cm and the mean height for women was significantly lower at 162cm ($p<0.01$). Men were significantly taller than women in each age group ($p<0.01$).

Men aged 25 to 34 years, with a mean height of 177cm, were significantly taller than men aged 50 to 64 years, 175cm ($p<0.05$). Women aged 19 to 49 years were significantly taller than women aged 50 to 64 years (19 to 24 years: $p<0.01$; 25 to 49 years: $p<0.05$). The lower height of men and women in the oldest group compared with younger groups may reflect either a true loss of height with age as a result of spinal compression, or a shorter adult stature as a result of differences in growth during childhood (see Section 2.8).

(Table 2.1)

2.3 Weight

Weight is a useful measure for inter-group comparisons, but there are a number of difficulties associated with the measurement. The weight of an individual can vary from day to day and at different times of the day for the same individual. There are also problems with the interpretation of the measurement as weight is highly correlated with height. Also, weight alone is not a measure of body fat, since the measurement includes the weights of non-fat tissue, bone and body fluids.

Measurements were achieved for 1,801 respondents, representing 815 men and 986 women (unweighted). None of the measurements taken were considered unreliable and so no exclusions were made. There were no cases where only one measurement was recorded. The weights shown here have not been adjusted to take account of the weight of clothing although a

Clothing Record in the Measurements Schedule was kept to report the items of clothing that were worn while the weight measurement was taken (see Appendix A of the Technical Report¹).

Table 2.2 shows descriptive statistics for weight for men and women by age group. Generally, the mean values were slightly higher than the median values for both men and women within each age group. This indicates that there were a small number of cases within each age group with relatively large weight measurements⁵.

The mean weight for men was 84kg, significantly higher than the mean weight for women, 69kg ($p<0.01$). Men were significantly heavier than women in each age group ($p<0.01$).

Men aged 19 to 24 years were significantly lighter, 79kg, than men aged 50 to 64 years, 87kg ($p<0.05$). Women aged 25 to 34 years were significantly lighter than women aged 50 to 64 years, 67kg compared with 71kg ($p<0.05$).

(Table 2.2)

2.4 Body mass index

Body weight alone is not a good indicator of obesity, or a useful predictor of morbidity or mortality as it is strongly correlated with height. However, weight can be adjusted for height to give an indicator of body shape that is independent of height and provides a measure of 'fatness'.

Of the various indices that standardise weight by height, the most widely used is the Quetelet or Body Mass Index (BMI). To be a useful measure of obesity, BMI should be uncorrelated with height, but there is a low correlation between BMI and height in adults. BMI does have the disadvantage, because it is solely based on measurements of height and weight, of giving a potentially misleading level of fatness in lean individuals with muscular physiques. BMI is calculated as weight (kg) / height (m²) and in adults is customarily grouped as follows⁶:

<i>Descriptor</i>	<i>Index</i>
Underweight	20 or less
Average	over 20 to 25
Overweight	over 25 to 30
Obese	over 30

The data presented here are based on 1,788 respondents who recorded a measurement of both height and weight as previously described. BMI was calculated for 810 men and 978 women (unweighted).

Table 2.3 shows descriptive statistics for BMI for men and women by age group. Generally, for men and women and within each age group, the mean values were higher than the median values⁵. This shows that there were a small number of cases within each age group with a relatively high BMI.

Mean BMI for men was 27.2 and for women was 26.4 ($p < 0.05$). For both men and women BMI increased with age. Men and women aged 19 to 34 years had significantly lower BMI than those aged 50 to 64 years (women aged 19 to 24 years: $p < 0.05$; all others: $p < 0.01$). For example, for men aged 19 to 24 years, the mean BMI was 25.1 compared with 28.4 for men aged 50 to 64 years ($p < 0.01$). For women aged 19 to 24 years, the mean BMI was 24.8 compared with 27.4 for those women aged 50 to 64 years ($p < 0.05$).

The data show that men were significantly more likely than women to be overweight or obese, that is having a BMI of over 25.0, 66% of men and 53% of women ($p < 0.01$). Forty-two per cent of men and 32% of women were classified as overweight ($p < 0.01$) and one in four men, 25%, and one in five women, 20%, were classified as obese, that is having a BMI of over 30.0 (ns).

A significantly lower proportion of men and women aged 19 to 34 years were classified as overweight or obese than the oldest group of men and women (men aged 25 to 34 years: $p < 0.05$; all others: $p < 0.01$). For example, 43% of men and 39% of women aged 19 to 24 years were classified as overweight or obese compared with 78% and 64% of the oldest group of men and women respectively. In addition, a significantly lower proportion of the youngest group of men were classified as at least overweight, 43%, compared with men aged 35 to 49 years, 70% ($p < 0.01$).

A significantly higher proportion of women were classified as underweight compared with men. Seven per cent of women and 3% of men were classified as underweight, that is having a BMI of 20 or less ($p < 0.05$). The proportion of women aged 19 to 24 years classified as underweight, 19%, was significantly higher than for women aged 35 to 64 years, 4% ($p < 0.05$).

(Table 2.3)

2.5 Waist and hip circumferences

There has been increasing interest in the distribution of body fat as an important indicator of increased risk of cardiovascular disease⁶. The potential health risks associated with being

overweight vary depending on where the body fat is distributed. Where fat is deposited centrally around the abdominal region (indicated by a high waist-to-hip ratio) rather than peripherally, around the hip, there is an increased risk of suffering heart disease, diabetes, gallstones, varicose veins and other diseases⁶.

Waist and hip measurements were taken from a total of 1,783 respondents, 808 men and 975 women (unweighted). One respondent admitted to breathing in during the first measurement so this was excluded from the analysis. The second measurement was reliable and therefore included. One female respondent had both hip measurements excluded, as they were estimated values that could not be validated without height and weight data. As a result, waist to hip ratios were calculated for a total of 1,782 respondents, 808 men and 974 women.

Waist circumference

Table 2.4 shows descriptive statistics for waist circumference for men and women by age group. For both men and women in each age group, the mean values were slightly higher than median values for waist circumference⁵. This indicates that there were a small number of cases within each age group with relatively large waist circumferences.

The mean waist circumference for men was 95cm and was significantly smaller for women, 82cm ($p < 0.01$). For all age groups men had a significantly greater waist circumference than women ($p < 0.01$).

For both men and women, waist circumference increased with age. Men and women aged 19 to 49 years had significantly smaller waist circumferences than those aged 50 to 64 years ($p < 0.01$). For example, men and women aged 19 to 24 years had mean waist circumferences of 89cm and 78cm respectively, compared with 100cm and 86cm for men and women aged 50 to 64 years ($p < 0.01$). In addition, both men and women aged 19 to 34 years had significantly smaller waist circumferences than those aged 35 to 49 years (men: $p < 0.01$; women: $p < 0.05$).

The waist circumference can be used as a measure of increased risk of metabolic complications of obesity. Guidelines suggest that for men a waist circumference greater than 102cm, and for women greater than 88cm, indicates a substantially increased risk of metabolic complications of obesity⁷.

Overall, 29% of men had a waist circumference greater than 102cm and 26% of women had a waist circumference greater than 88cm.

Compared with men aged 19 to 49 years, a significantly higher proportion of men in the oldest age group had a waist circumference of greater than 102cm (19 to 24 years: $p<0.05$; all others: $p<0.01$).

A significantly higher proportion of women aged 35 to 64 years compared with women aged 19 to 34 years had a waist circumference of greater than 88cm (35 to 49 years: $p<0.05$; 50 to 64 years: $p<0.01$).

(Table 2.4)

Hip circumference

Table 2.5 shows descriptive statistics for hip circumference for men and women by age group. Generally, within each sex and age group, mean values were higher than median values⁵. This indicates that within each age group there were some respondents with relatively large hip circumferences.

There were no significant sex or age differences in mean hip circumference for men or women.

(Table 2.5)

Waist to hip ratio

The waist to hip ratio is a measure of distribution of body fat (both subcutaneous and intra-abdominal). The ratio is calculated as waist circumference (cm) / hip circumference (cm). Guidelines suggest that for men a waist to hip ratio of 0.95 or greater, and for women 0.85 or greater, indicate a potential health risk⁸.

Table 2.6 shows descriptive statistics for waist to hip ratio for men and women by age group. The distribution of waist to hip ratio was close to a normal distribution for men and women⁵.

Men had a significantly greater mean waist to hip ratio, 0.90, than women, 0.79 ($p<0.01$). This was true for all age groups ($p<0.01$).

Waist to hip ratio increased with increasing age for both men and women. For men and women, all age groups had a significantly greater mean waist to hip ratio than the age group below them, except for those aged 25 to 34 years compared with those aged 19 to 24 years (women aged 35 to 49 years compared with 25 to 34 years: $p<0.05$; all others: $p<0.01$). For example, men and women aged 50 to

64 years had a mean waist to hip ratio of 0.94 and 0.81 respectively, compared with 0.91 and 0.79 respectively for those aged 35 to 49 years ($p<0.01$).

Overall, 23% of men had a waist to hip ratio that was 0.95 or greater and 15% of women had a waist to hip ratio of 0.85 or greater.

A significantly higher proportion of men in the two oldest age groups had a waist to hip ratio that was 0.95 or greater than men in the two youngest age groups (19 to 24 years compared with 35 to 49 years: $p<0.05$; all others: $p<0.01$). For example, 37% of men aged 50 to 64 years had a waist to hip ratio of 0.95 or greater, compared with 12% of men aged 19 to 24 years ($p<0.01$).

A significantly higher proportion of women in the oldest age group, 26%, had a waist to hip ratio that was 0.85 or greater than women aged 19 to 49 years ($p<0.01$).

(Table 2.6)

2.6 Variations in measurements

Table 2.7 shows the relationship between anthropometric measurements and region⁹ for men and women. Table 2.8 shows the relationship between measurements and whether someone in the respondent's household was in receipt of certain state benefits¹⁰ for men and women.

As shown in previous tables (see Tables 2.1 to 2.6), anthropometric measures vary by age and sex. When interpreting data on variation by region or household benefit status, it is important to bear in mind that any significant associations between anthropometric measurements and these variables may be a result of the variation in age distributions.

For further analysis of the association between socio-demographic characteristics and anthropometric measurements see Section 2.7 where the technique of multiple regression was used to identify factors independently associated with BMI and waist to hip ratio.

2.6.1 Variation in height

There were no significant differences in the mean height of men or women according to the region in which they lived.

Men living in households not in receipt of benefits were significantly taller, 176cm, than men living in benefit households, 174cm ($p<0.05$). There was no significant difference in mean height by household benefit status for women.

(Tables 2.7 and 2.8)

2.6.2 Variation in weight

There were no significant differences in mean weight for men or women according to the region in which they lived or household benefit status.

(Tables 2.7 and 2.8)

2.6.3 Variation in BMI

There were no significant regional differences in mean BMI for men. Women in Scotland had a significantly lower mean BMI, 24.9, than women in Central and South West regions of England and in Wales, 27.0 ($p < 0.05$).

There were no statistically significant differences in BMI for men or women according to whether they lived in households in receipt of benefits or not.

(Tables 2.7 and 2.8)

2.6.4 Variation in waist to hip ratio

Men living in Scotland had a significantly greater waist to hip ratio, 0.92, than men living in London and the South East, 0.89 ($p < 0.05$).

Women living in the Northern region had a significantly greater waist to hip ratio than women in any other region (Scotland and Central and South West of England and in Wales: $p < 0.05$; London and the South East: $p < 0.01$).

For men there was no significant difference in waist to hip ratio according to household benefit status. Women in benefit households had a significantly greater waist to hip ratio, 0.80 than women in non-benefit households, 0.78 ($p < 0.01$).

(Tables 2.7 and 2.8)

2.7 Characteristics found to be independently associated with anthropometric measurements

Previous research has shown that various socio-demographic, dietary and physiological factors are associated with variations in body size, and some of these factors are known to be inter-related^{2,3,11}. This section considers the combined effect of various socio-demographic, dietary and physiological characteristics on BMI and waist to hip ratio. The technique of multiple regression is used to build a model from those characteristics which most explain the anthropometric measurements.

As shown in previous tables (see Tables 2.3 and 2.6), there is a strong association between sex and BMI and waist to hip ratios, so each multiple regression analysis is presented separately for men

and women. To control for the effects of age, this variable was included in each regression analysis.

Tables 2.9 and 2.10 show the socio-demographic, dietary and physiological factors which were significantly associated with BMI and waist to hip ratio when bivariate analyses were carried out, in addition to the previously shown relationships with region and household benefit status¹². Those independent variables that were found to be significantly associated with the measurements in a bivariate relationship were then included in the multiple regression model¹³.

(Tables 2.9 and 2.10)

Tables 2.11 to 2.14 give standardised regression coefficients for a number of characteristics, the independent variables, associated with variation in the anthropometric measurements, the dependent variable, produced using the technique of multiple regression. The tables of results identify those characteristics which are related to the measurements after controlling for the effects of the other characteristics included in the analysis. All regression models are only deemed meaningful when a high percentage of the variance in the dependent variable is explained. The technique of multiple regression calculates coefficients based on the number of cases for which there are valid values for all the variables included in the analysis. Further information on the statistical method and interpretation of output from multiple regression analysis is given in Appendix A¹⁴.

(Tables 2.11 to 2.14)

2.7.1 Findings

Characteristics independently associated with BMI

Tables 2.11 and 2.12 show that the best multiple regression models that could be developed using the most relevant independent variables for the dependent variable BMI were able to explain 41% of the variance for men and 33% of the variance for women.

(Tables 2.11 and 2.12)

Characteristics independently associated with waist to hip ratio

Tables 2.13 and 2.14 show that the best multiple regression models that could be developed using the most relevant independent variables for the dependent variable waist to hip ratio were able to explain 48% of the variance for men and 29% of the variance for women.

(Tables 2.13 and 2.14)

2.8 Comparison with 1986/87 Adults Survey

Table 2.15 compares data from this present survey of adults with data on anthropometric measurements from the Dietary and Nutritional Survey of British Adults aged 16 to 64 years carried out in 1986/87 (1986/87 Adults Survey)². Data are presented for men and women by age for height, body weight and body mass index (BMI). Comparisons are made between comparable age groups in the two surveys; no attempt is made to use the data to undertake cohort analysis. It should be noted that in the 1986/87 Adults Survey the youngest age group was aged 16 to 24 years, while in the current NDNS the youngest age group was adults aged 19 to 24 years. This should be borne in mind where there are differences between these groups. A summary of the methodology and findings from the 1986/87 Adults Survey is given in Appendix S of the Technical Report¹.

Table 2.15 shows that the mean height of men overall was higher in the present NDNS, 176cm, than in the 1986/87 Adults Survey, 174cm ($p < 0.01$). Men aged 35 to 49 years and 50 to 64 years were significantly taller in the present study, 176cm and 175cm respectively, than in the 1986/87 Adults Survey, 174cm and 173cm respectively ($p < 0.05$). There were no significant differences in mean height for women overall or in any age group between this survey and the 1986/87 Adults Survey.

For both men and women, mean weight was significantly higher in the present NDNS, 84kg and 69kg respectively, than in the 1986/87 Adults Survey, 76kg for men and 64kg for women respectively ($p < 0.01$). This was true for men in all age groups ($p < 0.01$). For example, in this survey the mean weight of men aged 50 to 64 years was 87kg and in the 1986/87 Adults Survey was 78kg ($p < 0.01$). Only women in the two older age groups (35 to 64 years) had greater mean weight in the present survey than in the 1986/87 Adults Survey (35 to 49 years: $p < 0.01$; 50 to 64 years: $p < 0.05$).

Mean BMI was significantly higher in this survey for both men and women, 27.2 and 26.4 respectively, than in the 1986/87 Adults Survey, 24.9 and 24.6 respectively ($p < 0.01$). This was true for men in all age groups (16/19 to 24 years: $p < 0.05$; all others: $p < 0.01$) and for women aged 25 to 49 years (25 to 34 years: $p < 0.05$; 35 to 49 years: $p < 0.01$). For example, the mean BMI of men and women aged 35 to 49 years in this survey was 27.4 and 26.7 respectively, compared with 25.6 and 24.8 respectively in the 1986/87 Adults Survey ($p < 0.01$).

(Table 2.15)

2.9 Comparison with Health Survey for England 2001

Table 2.16 compares data from this survey for respondents in England only with data on anthropometric measurements from the Health Survey for England 2001 (HSfE)³. The HSfE was based on a multi-stage probability sample of addresses drawn from the Postcode Address File. 15,647 adults aged 16 and over were interviewed. The measurement procedures were similar to the present NDNS, except nurses took the anthropometric measurements in the HSfE whereas trained interviewers took anthropometric measurements on the NDNS. Summaries of the key findings and methodology from the Health Survey for England 2001 are provided in two reports^{15,16}.

Data are presented for men and women by age for height, body weight, body mass index (BMI) and waist to hip ratio. It should be noted that in the HSfE the youngest age group was aged 16 to 24 years, while in the current NDNS the youngest age group was adults aged 19 to 24 years. This should be borne in mind where there are differences between these groups. Age groups for this survey were redefined to match those of the HSfE so that better comparisons could be made: 16/19 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years. It should also be noted that weight measurements from the HSfE shown here have not been adjusted to take account of the weight of clothing. The NDNS follows the same protocol and has not made adjustments to take account of the weight of clothing.

There were no significant differences between the two surveys in mean height or in mean weight by age group for men or women.

There were no significant differences between the two surveys in BMI for men or women overall or by age, or in the proportion of respondents classified as overweight (BMI over 25.0 to 30.0) or obese (BMI over 30.0).

Men aged 45 to 64 years and women aged 25 to 54 years had a lower mean waist to hip ratio in this survey than in the HSfE (women aged 25 to 44 years: $p < 0.05$; all others: $p < 0.01$).

(Table 2.16)

References and endnotes

- 1 The Technical Report is available online at <http://www.food.gov.uk/science>.
- 2 Gregory J, Foster K, Tyler H, Wiseman M. *The Dietary and Nutritional Survey of British Adults*. HMSO (London, 1990).
- 3 Bajekal M, Primatesta P and Prior G. Eds. *Health Survey for England 2001*. TSO (London, 2003).
- 4 Weighting was needed to compensate for unequal probabilities of selection because only one household was selected at multi-household addresses and only one adult was selected for interview from households containing more than one eligible adult (see Appendix D of the Technical Report, see Note 1). Weighting factors were derived to compensate for differential non-response by comparing the proportions of respondents consenting to height measurements by sex, age and region, with the corresponding proportion in the population using population estimates (see Appendix D of the Technical Report). Where other anthropometric measurements were achieved but not height, the weighting factors were calculated using the data for height.
- 5 Distribution of data was evaluated using the skewness statistic in SPSS. If the skewness statistic was less than twice the standard error of the statistic then data were considered to be normally distributed.
- 6 International Obesity Task Force. Obesity: preventing and managing the global epidemic. *Report of WHO consultation on obesity, Geneva, 3-5 June 1998*. WHO (Geneva, 1998).
- 7 Garrow JS, James WPT and Ralph A. *Human Nutrition and Dietetics* (10th Edition). Churchill Livingstone (UK, 2000).
- 8 Although there is no consensus on cut off points for waist to hip ratio, previous health research in England (including Health Survey for England 2001, see Note 3) has used ratios ≥ 0.95 for men and ≥ 0.85 for women based on US/Canadian guidelines (US Department of Agriculture. *Report of the dietary guidelines advisory committee on the dietary guidelines for Americans*. Washington: 1990).
- 9 The areas included in each of the four analysis 'regions' are given in the response chapter, Chapter 2 of the Technical Report (see Note 1). Definitions of 'regions' are given in the Glossary (see Appendix E).
- 10 Households receiving certain benefits are those where someone in the respondent's household was currently receiving Working Families Tax Credit or had, in the previous 14 days, drawn Income Support or (Income-related) Job Seeker's Allowance. Definitions of 'household' and 'benefits (receiving)' are given in the Glossary (see Appendix E).
- 11 Gregory J, Lowe S, Bates CJ, Prentice A, Jackson LV, Smithers G, Wenlock, R, Farron M. *National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 1: Report of the diet and nutrition survey*. TSO (London, 2000).
- 12 Bivariate analyses of continuous variables were carried out using the Pearson correlation coefficient and analyses of categorical variables tested the difference between means. It should be noted that where correlations are statistically significant the relationship between the two variables may not necessarily be causal; other factors may have affected the size of the correlation.
- 13 The regression models are constructed by carrying out bivariate analyses and incorporating variables with significant associations. It should be noted that this method of selection can lead to important variables being left out as additive or interactive effects can only be identified using multiple regression.
- 14 The model is tested by an ANOVA (see Appendix E - Glossary) to determine whether all the regression coefficients are zero in the population, and shows that there are significant linear relationships between the independent variables and the dependent variable.
- 15 Health Survey for England 2001 – Summary of key findings is available online at <http://www.official-documents.co.uk/document/deps/doh/survey01/skf/skf.htm>.
- 16 Health Survey for England 2001 – Methodology and documentation is available online at <http://www.official-documents.co.uk/document/deps/doh/survey01/md/md.htm>.

Table 2.1

Percentage distribution of height by sex and age of respondent

Height (cm)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 150	-	-	-	-	-	2	4	1	5	3
Less than 155	-	-	-	0	0	7	11	10	17	12
Less than 160	1	-	1	1	1	30	36	40	46	40
Less than 165	4	3	4	9	5	64	67	72	75	71
Less than 170	12	13	20	25	19	84	90	91	95	91
Less than 175	31	34	46	49	42	98	98	97	99	98
Less than 180	68	69	72	77	72	100	100	100	100	100
Less than 185	92	87	92	94	92					
Less than 190	97	99	98	99	98					
All	100	100	100	100	100					
Base	112	229	263	264	869	110	220	331	270	930
Mean (average value)	177	177	176	175	176	163	162	162	160	162
Median	178	178	176	176	177	163	163	162	161	162
Lower 2.5 percentile	163	165	161	162	162	150	148	151	148	150
Upper 2.5 percentile	190	188	190	188	188	175	173	175	173	174
Standard deviation	6.6	6.1	6.8	6.9	6.7	5.9	6.3	5.8	6.3	6.1

Table 2.2

Percentage distribution of body weight by sex and age of respondent

Body weight (kg)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 45	-	-	-	-	-	1	1	0	2	1
Less than 50	3	-	-	-	0	12	6	1	4	4
Less than 55	3	1	0	-	1	21	16	12	9	13
Less than 60	8	2	1	1	2	40	34	27	20	28
Less than 65	24	7	5	3	7	61	51	45	35	45
Less than 70	35	12	16	10	16	70	65	58	55	60
Less than 75	46	32	26	23	29	77	77	70	70	72
Less than 80	60	49	38	36	43	84	87	79	81	82
Less than 85	66	63	55	49	57	90	91	85	85	87
Less than 90	74	71	66	63	67	90	94	91	90	91
Less than 100	87	88	87	83	86	94	97	97	97	97
Less than 110	97	99	94	94	96	98	98	99	99	99
All	100	100	100	100	100	100	100	100	100	100
Base	111	228	265	265	870	110	215	334	270	928
Mean (average value)	79	83	85	87	84	66	67	70	71	69
Median	77	81	83	85	82	62	65	67	69	66
Lower 2.5 percentile	50	61	62	65	61	46	47	51	46	47
Upper 2.5 percentile	115	109	119	117	115	112	104	103	106	104
Standard deviation	17.1	13.1	14.4	14.9	14.8	16.3	13.3	15.7	14.0	14.8

Table 2.3

Percentage distribution of body mass index by sex and age of respondent

Body mass index (kg/m ²)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
18.5 or less	7	1	0	-	1	7	4	1	3	3
20.0 or less	9	5	2	1	3	19	9	4	4	7
22.5 or less	38	15	9	6	14	39	30	23	17	25
25.0 or less	57	40	30	22	34	61	56	46	36	47
30.0 or less	82	82	75	68	75	86	84	77	78	80
35.0 or less	97	97	94	92	94	94	95	93	90	93
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	<i>110</i>	<i>227</i>	<i>263</i>	<i>264</i>	<i>864</i>	<i>110</i>	<i>213</i>	<i>331</i>	<i>269</i>	<i>922</i>
Mean (average value)	25.1	26.4	27.4	28.4	27.2	24.8	25.4	26.7	27.4	26.4
Median	24.1	26.0	26.8	27.5	26.5	23.7	24.0	25.4	26.9	25.4
Lower 2.5 percentile	17.0	19.1	20.9	21.3	19.3	18.1	18.2	19.6	17.3	18.3
Upper 2.5 percentile	41.1	35.3	37.2	37.8	37.3	42.9	37.6	41.2	40.9	40.8
Standard deviation	5.22	4.06	4.23	4.83	4.63	5.74	5.00	5.75	5.50	5.58

Table 2.4

Percentage distribution of waist circumference by sex and age of respondent

Waist circumference (cm)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
65 or less	-	-	-	-	-	4	5	2	2	3
70 or less	3	1	1	-	1	26	13	13	5	12
75 or less	13	3	2	0	3	53	37	29	14	29
80 or less	26	12	6	1	9	68	57	46	33	48
85 or less	49	27	14	5	19	77	78	64	56	66
88 or less	54	36	23	9	26	80	84	71	66	74
90 or less	63	42	30	15	33	83	85	75	72	78
95 or less	74	65	53	33	53	91	93	86	80	86
100 or less	78	78	65	52	66	95	95	93	88	92
102 or less	78	82	73	57	71	95	96	95	89	93
110 or less	92	96	89	83	89	99	97	97	94	96
120 or less	99	99	96	95	97	100	100	100	98	99
130 or less	100	100	100	100	100				99	100
All									100	
<i>Base</i>	<i>111</i>	<i>228</i>	<i>263</i>	<i>261</i>	<i>862</i>	<i>110</i>	<i>214</i>	<i>329</i>	<i>269</i>	<i>922</i>
Mean (average value)	89	92	96	100	95	78	80	82	86	82
Median	86	92	94	99	94	74	77	81	84	81
Lower 2.5 percentile	68	74	76	83	74	62	62	65	66	64
Upper 2.5 percentile	120	111	122	124	121	106	111	112	118	112
Standard deviation	13.4	10.3	11.2	10.2	11.7	11.0	10.8	11.6	12.9	12.1

Table 2.5

Percentage distribution of hip circumference by sex and age of respondent

Hip circumference (cm)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 90	2	2	2	-	1	9	5	3	6	5
Less than 95	26	9	9	2	9	27	17	16	12	16
Less than 100	42	30	26	15	26	47	39	37	27	36
Less than 105	67	55	54	43	52	72	64	57	51	59
Less than 110	70	76	77	71	74	82	80	73	73	76
Less than 115	87	90	90	85	88	88	91	86	84	87
Less than 120	94	96	97	97	96	91	94	93	89	92
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	<i>111</i>	<i>228</i>	<i>263</i>	<i>261</i>	<i>862</i>	<i>110</i>	<i>214</i>	<i>329</i>	<i>269</i>	<i>922</i>
Mean (average value)	103	105	105	107	105	102	103	104	106	104
Median	102	104	104	106	104	100	102	103	104	103
Lower 2.5 percentile	90	91	90	95	91	85	87	88	87	87
Upper 2.5 percentile	126	121	122	124	123	130	131	129	134	130
Standard deviation	9.8	8.1	8.2	7.4	8.3	11.6	10.1	10.2	11.4	10.8

Table 2.6

Percentage distribution of waist to hip ratio by sex and age of respondent

Waist to hip ratio	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 0.70	-	1	1	-	0	12	6	4	2	5
Less than 0.75	2	1	1	-	1	46	38	26	17	29
Less than 0.80	15	8	3	1	5	77	73	60	49	62
Less than 0.85	56	29	14	4	20	95	91	87	74	85
Less than 0.90	74	66	45	23	47	100	99	96	90	95
Less than 0.95	88	90	74	63	77		100	99	97	99
Less than 1.00	100	98	93	90	95			100	99	100
All		100	100	100	100				100	
<i>Base</i>	<i>111</i>	<i>228</i>	<i>263</i>	<i>261</i>	<i>862</i>	<i>110</i>	<i>214</i>	<i>329</i>	<i>268</i>	<i>921</i>
Mean (average value)	0.86	0.88	0.91	0.94	0.90	0.76	0.77	0.79	0.81	0.79
Median	0.85	0.88	0.91	0.94	0.90	0.76	0.77	0.78	0.80	0.78
Lower 2.5 percentile	0.75	0.76	0.80	0.83	0.78	0.67	0.66	0.69	0.71	0.68
Upper 2.5 percentile	0.99	0.99	1.05	1.04	1.02	0.87	0.88	0.92	0.96	0.93
Standard deviation	0.062	0.060	0.062	0.050	0.064	0.049	0.056	0.059	0.066	0.062

Table 2.7

Anthropometric measurements by sex of respondent and region

Measurement	Region															
	Scotland				Northern				Central, South West and Wales				London and the South East			
	Mean	Median	sd	Base	Mean	Median	sd	Base	Mean	Median	sd	Base	Mean	Median	sd	Base
Men																
Height (cm)	174	175	6.4	63	176	175	6.5	252	176	177	6.9	306	177	178	6.6	247
Body weight (kg)	86	84	15.5	63	84	82	15.0	251	84	84	14.5	308	83	81	14.8	248
BMI (kg/m ²)	28.3	27.9	4.90	63	27.4	26.7	4.67	249	27.1	26.5	4.42	306	26.7	26.1	4.73	246
Waist circumference (cm)	98	97	11.6	63	96	94	11.4	250	95	94	11.2	303	94	94	12.4	246
Hip circumference (cm)	107	106	8.8	63	105	104	8.8	250	105	104	7.6	303	105	104	8.3	246
Waist to hip ratio	0.92	0.92	0.061	63	0.91	0.90	0.064	250	0.91	0.91	0.064	303	0.89	0.90	0.065	246
Women																
Height (cm)	162	162	5.7	71	162	162	6.4	241	161	161	5.9	338	162	162	6.3	281
Body weight (kg)	65	64	14.4	68	70	66	14.6	241	70	68	15.3	336	68	66	14.5	283
BMI (kg/m ²)	24.9	24.2	5.18	68	26.6	25.4	5.52	240	27.0	26.4	5.88	333	25.8	24.7	5.25	281
Waist circumference (cm)	80	77	11.8	66	84	82	11.6	239	83	81	12.9	335	81	79	11.4	282
Hip circumference (cm)	102	101	10.3	66	104	103	10.5	239	105	103	11.9	335	104	102	9.7	282
Waist to hip ratio	0.78	0.77	0.058	66	0.80	0.80	0.061	239	0.79	0.78	0.063	335	0.78	0.77	0.060	282

Table 2.8

Anthropometric measurements by sex of respondent and whether someone in the respondent's household was receiving certain benefits

Measurement	Whether receiving benefits							
	Receiving benefits				Not receiving benefits			
	Mean	Median	sd	Base	Mean	Median	sd	Base
Men								
Height (cm)	174	174	6.3	118	176	177	6.7	751
Body weight (kg)	84	82	16.6	121	84	83	14.5	749
BMI (kg/m ²)	27.7	27.1	5.35	118	27.1	26.5	4.50	746
Waist circumference (cm)	96	94	13.5	119	95	94	11.3	744
Hip circumference (cm)	105	104	10.0	119	105	105	7.9	744
Waist to hip ratio	0.91	0.91	0.067	119	0.90	0.90	0.064	744
Women								
Height (cm)	161	161	6.1	167	162	162	6.1	764
Body weight (kg)	68	65	15.9	165	69	67	14.6	763
BMI (kg/m ²)	26.3	25.7	6.14	164	26.4	25.4	5.45	758
Waist circumference (cm)	84	83	13.9	164	82	80	11.6	758
Hip circumference (cm)	104	102	13.2	164	104	103	10.2	758
Waist to hip ratio	0.80	0.80	0.061	164	0.78	0.78	0.062	758

Table 2.9

Socio-demographic, dietary and physiological factors associated with BMI in bivariate analysis

Men	Women
Age at measurement (years)**	Age at measurement (years)**
Average calculated activity score	Average calculated activity score
Average daily alcohol intake (g)	Average daily alcohol intake (g)
Average daily total energy intake (MJ)	Average daily total energy intake (MJ)
Current smoking**	Current smoking*
Ethnicity of respondent	Ethnicity of respondent
Gross weekly household income	Gross weekly household income**
Grouped Standard Region	Grouped Standard Region*
Household benefit status	Household benefit status
Household composition*	Household composition
Limited activity due to illness or disability	Limited activity due to illness or disability**
Mean diastolic pressure (mmHg)**	Mean diastolic pressure (mmHg)**
Mean systolic pressure (mmHg)**	Mean systolic pressure (mmHg)**
Percentage food energy from protein**	Percentage food energy from protein**
Percentage food energy from saturated fatty acids	Percentage food energy from saturated fatty acids*
Percentage food energy from total carbohydrate**	Percentage food energy from total carbohydrate
Percentage food energy from total fat	Percentage food energy from total fat*
Percentage total energy from protein**	Percentage total energy from protein**
Percentage total energy from saturated fatty acids	Percentage total energy from saturated fatty acids
Percentage total energy from starch	Percentage total energy from starch**
Percentage total energy from total carbohydrate**	Percentage total energy from total carbohydrate
Percentage total energy from total sugars**	Percentage total energy from total sugars**
Reported dieting to lose weight**	Reported dieting to lose weight**
Self-reported alcohol consumption	Self-reported alcohol consumption
Self-reported physical activity level	Self-reported physical activity level**
Social class of household reference person	Social class of household reference person**
Vegetarian or vegan	Vegetarian or vegan
Waist to hip ratio**	Waist to hip ratio**
Wave of interview	Wave of interview

Note: * $p < 0.05$; ** $p < 0.01$

Table 2.10

Socio-demographic, dietary and physiological factors associated with waist to hip ratio in bivariate analysis

Men	Women
Age at measurement (years)**	Age at measurement (years)**
Average calculated activity score	Average calculated activity score
Average daily alcohol intake (g)	Average daily alcohol intake (g)
Average daily total energy intake (MJ)	Average daily total energy intake (MJ)
BMI (kg/m ²)**	BMI (kg/m ²)**
Current smoking	Current smoking*
Ethnicity of respondent	Ethnicity of respondent
Gross weekly household income	Gross weekly household income**
Grouped Standard Region*	Grouped Standard Region**
Household benefit status	Household benefit status*
Household composition**	Household composition*
Limited activity due to illness or disability	Limited activity due to illness or disability**
Mean systolic pressure (mmHg)**	Mean systolic pressure (mmHg)**
Mean diastolic pressure (mmHg)**	Mean diastolic pressure (mmHg)**
Percentage food energy from total carbohydrate**	Percentage food energy from total carbohydrate
Percentage food energy from total fat	Percentage food energy from total fat**
Percentage food energy from protein**	Percentage food energy from protein
Percentage food energy from saturated fatty acids	Percentage food energy from saturated fatty acids*
Percentage total energy from total carbohydrate**	Percentage total energy from total carbohydrate*
Percentage total energy from protein**	Percentage total energy from protein
Percentage total energy from saturated fatty acids	Percentage total energy from saturated fatty acids
Percentage total energy from starch	Percentage total energy from starch
Percentage total energy from total sugars**	Percentage total energy from total sugars
Reported dieting to lose weight**	Reported dieting to lose weight*
Self-reported alcohol consumption	Self-reported alcohol consumption**
Self-reported physical activity level*	Self-reported physical activity level
Social class of household reference person*	Social class of household reference person**
Vegetarian or vegan	Vegetarian or vegan
Wave of interview	Wave of interview

Note: * $p < 0.05$; ** $p < 0.01$

Table 2.11

Linear regression model for BMI: men

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	-14.031	2.487		-5.642***
Waist to hip ratio	39.319	2.335	0.551	16.836***
Age at measurement (years)	-0.054	0.014	-0.153	-3.876***
Current smoking	-1.249	0.287	-0.127	-4.357***
Percentage total energy from protein[†]	0.188	0.048	0.119	3.910***
Reported dieting to lose weight	1.425	0.426	0.098	3.345**
Systolic blood pressure (mmHg)	0.029	0.012	0.092	2.337*
Diastolic blood pressure (mmHg)	0.023	0.017	0.056	1.313
Household composition				
Living alone	-0.146	0.302	-0.020	-0.484
Living with spouse or partner, no dependent children	0.169	0.228	0.031	0.743
Living with other adults, no spouse or dependent children	-0.346	0.297	-0.051	-1.165
Living with dependent children, with or without spouse	0.322	0.224	0.044	1.439
Percentage total energy from total sugars	-0.016	0.028	-0.022	-0.583
Percentage total energy from total carbohydrate[†]	-0.001	0.025	-0.002	-0.049
Percentage of variance explained		41%		
Number of respondents		765		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] For men, percentage food energy from protein and carbohydrate were significantly correlated with BMI in bivariate analysis, but these variables were not included in the multiple regression models. This is because alcohol intake was not found to be significantly associated with BMI, so percentage of total energy from protein and total carbohydrate, which includes alcohol intake, were chosen preferentially.

Table 2.12
Linear regression model for BMI: women

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	-12.194	3.815		-3.196 **
Waist to hip ratio	27.769	2.974	0.311	9.337 ***
Systolic blood pressure (mmHg)	0.078	0.015	0.234	5.243 ***
Diastolic blood pressure (mmHg)	-0.005	0.021	-0.010	-0.245
Reported dieting to lose weight	2.936	0.405	0.230	7.255 ***
Self-reported physical activity level				
Very physically active	-1.401	0.353	-0.122	-3.965 ***
Fairly physically active	-0.144	0.271	-0.016	-0.530
Not very physically active	0.950	0.323	0.090	2.943 **
Not at all physically active	0.595	0.536	0.052	1.109
Region				
Scotland	-0.645	0.460	-0.068	-1.401
Northern	-0.581	0.304	-0.080	-1.910
Central, South West and Wales	0.733	0.270	0.111	2.716 **
London and the South East	0.492	0.290	0.052	1.696
Percentage total energy from protein ^{††}	0.184	0.062	0.110	2.944 **
Current smoking	-1.067	0.368	-0.092	-2.898 **
Gross weekly household income				
Less than £160	-0.880	0.353	-0.114	-2.495 *
£160 - less than £400	0.705	0.263	0.082	2.681 **
£400 & over	0.175	0.255	0.023	0.689
Percentage total energy from starch [†]	0.098	0.039	0.107	2.490 *
Percentage food energy from saturated fatty acids	0.002	0.001	0.093	2.093 *
Limited activity due to illness or disability	0.611	0.261	0.071	2.337 *
Social class of household reference person				
Non-manual	-0.473	0.375	-0.048	-1.262
Manual	0.636	0.380	0.064	1.674
Unclassified	-0.164	0.668	-0.017	-0.245
Age at measurement (years)	-0.020	0.016	-0.045	-1.209
Percentage total energy from total sugars [†]	0.002	0.036	0.002	0.044
Percentage of variance explained		33%		
Number of respondents		780		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] Percentage food energy from total fat and total carbohydrate were highly correlated with percentage total energy from total sugars, protein and starch (variance inflation factor > 10). It is difficult to distinguish the effects in a multiple regression of highly correlated characteristics if they are all included and the results may be unreliable, so percentage food energy from total fat and total carbohydrate were dropped from the regression.

^{††} For women, percentage food energy from protein was significantly correlated with BMI in bivariate analysis, but this variable was not included in the multiple regression model. This is because alcohol intake was not found to be significantly associated with BMI, so percentage of total energy from protein, which includes alcohol intake, was chosen preferentially.

Table 2.13

Linear regression model for waist to hip ratio: men

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	0.665	0.024		28.048***
Body mass index (kg/m²)	0.007	0.000	0.467	16.033***
Age at measurement (years)	0.002	0.000	0.320	9.111***
Social class of household reference person				
Non-manual	0.008	0.005	0.067	1.690
Manual	0.020	0.005	0.160	4.034***
Unclassified	-0.028	0.009	-0.230	-3.084**
Percentage total energy from protein[†]	-0.002	0.001	-0.073	-2.537*
Self-reported physical activity				
Very physically active	-0.009	0.004	-0.065	-2.445*
Fairly physically active	-0.000	0.003	-0.004	-0.158
Not very physically active	0.009	0.004	0.071	2.618**
Not at all physically active	0.000	0.006	0.000	0.004
Reported dieting to lose weight	0.011	0.006	0.054	1.960*
Percentage total energy from total sugars	-0.001	0.000	-0.056	-1.621
Percentage total energy from total carbohydrate[†]	0.000	0.000	-0.123	-0.367
Systolic blood pressure (mmHg)	0.000	0.000	-0.004	-0.100
Diastolic blood pressure (mmHg)	0.000	0.000	0.065	1.605
Region				
Scotland	0.005	0.005	0.045	1.059
Northern	-0.001	0.003	-0.011	-0.316
Central, South West and Wales	0.002	0.003	0.020	0.556
London and the South East	-0.006	0.003	-0.050	-1.867
Household composition				
Living alone	-0.002	0.004	-0.019	-0.507
Living with spouse or partner, no dependent children	0.000	0.003	0.004	0.112
Living with other adults, no spouse or dependent children	-0.003	0.004	-0.026	-0.646
Living with dependent children, with or without spouse	0.004	0.003	0.041	1.423
Percentage of variance explained		48%		
Number of respondents		764		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] For men, percentage food energy from protein and total carbohydrate were significantly correlated with waist to hip ratio in bivariate analysis, but these variables were not included in the multiple regression model. This is because alcohol intake was not found to be significantly associated with waist to hip ratio, so percentage of total energy from protein and total carbohydrate, which includes alcohol intake, were chosen preferentially.

Table 2.14

Linear regression model for waist to hip ratio: women

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	0.576	0.045		12.944***
Body mass index (kg/m ²)	0.004	0.000	0.326	9.444***
Age at measurement (years)	0.001	0.000	0.240	5.945***
Gross weekly household income				
Less than £160	0.017	0.005	0.201	3.446***
£160 - less than £400	-0.003	0.003	-0.036	-1.111
£400 & over	-0.014	0.004	-0.161	-3.719***
Current smoking	0.017	0.004	0.134	4.064***
Self-reported alcohol consumption				
Non/light drinker	0.005	0.004	0.056	1.466
Within weekly guidelines [†]	-0.007	0.003	-0.090	-2.651 **
Above weekly guidelines [†]	0.002	0.004	0.017	0.439
Region				
Scotland	-0.003	0.005	-0.028	-0.566
Northern	0.008	0.003	0.099	2.293 *
Central, South West and Wales	-0.004	0.003	-0.053	-1.246
London and the South East	-0.001	0.003	-0.010	-0.323
Systolic blood pressure (mmHg)	0.000	0.000	0.035	0.745
Diastolic blood pressure (mmHg)	0.000	0.000	0.085	1.990
Reported dieting to lose weight	0.000	0.005	0.001	0.035
Percentage food energy from total fat	0.000	0.000	0.065	0.871
Percentage food energy from saturated fatty acids	0.000	0.000	-0.066	-1.159
Percentage total energy from total carbohydrate	0.000	0.000	0.043	0.747
Social class of household reference person				
Non-manual	0.003	0.004	-0.026	-0.639
Manual	-0.001	0.005	-0.013	-0.309
Unclassified	0.004	0.008	0.039	0.532
Household composition				
Living alone	0.000	0.005	0.000	0.000
Living with spouse or partner, no dependent children	-0.004	0.004	-0.042	-1.080
Living with other adults, no spouse or dependent children	0.009	0.006	0.061	1.549
Living with dependent children, with spouse	0.000	0.004	-0.001	-0.021
Living with dependent children, without spouse	-0.004	0.006	-0.032	-0.697
Household receiving benefits	0.000	0.007	0.001	0.013
Limited activity due to illness or disability	0.002	0.003	0.023	0.734
Percentage of variance explained		29%		
Number of respondents		778		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] Weekly guidelines were set at a maximum number of 21 units of alcohol a week for men, and 14 units a week for women. Current guidelines are a maximum daily amount of 4 units for men and 3 units for women.

Table 2.15

Comparison of anthropometric measurements with the 1986/87 Adults Survey*

Measurement	Age of respondent (years):									
	1986/87 Adults Survey*				All	2000/01 NDNS				All
	16–24	25–34	35–49	50–64	16–64	19–24	25–34	35–49	50–64	19–64
Men										
Height (cm)										
mean	175	176	174	173	174	177	177	176	175	176
median	175	176	174	172	174	178	178	176	176	177
se/sd**	0.5	0.4	0.3	0.4	0.2	6.6	6.1	6.8	6.9	6.7
Base	223	269	370	298	1160	112	229	263	264	869
Body weight (kg)										
mean	70	76	78	78	76	79	83	85	87	84
median	70	75	77	77	75	77	81	83	85	82
se/sd**	0.7	0.7	0.6	0.6	0.3	17.1	13.1	14.4	14.9	14.8
Base	225	279	379	311	1194	111	228	265	265	870
BMI (kg/m ²)										
mean	22.9	24.6	25.6	25.9	24.9	25.1	26.4	27.4	28.4	27.2
median	22.4	24.4	25.1	25.8	24.6	24.1	26.0	26.8	27.5	26.5
se/sd**	0.22	0.20	0.19	0.19	0.11	5.22	4.06	4.23	4.83	4.63
Base	222	269	369	298	1158	110	227	263	264	864
Women										
Height (cm)										
mean	163	163	162	160	162	163	162	162	160	162
median	163	163	162	159	162	163	163	162	161	162
se/sd**	0.5	0.4	0.3	0.3	0.2	5.9	6.3	5.8	6.3	6.1
Base	194	261	402	306	1163	110	220	331	270	930
Body weight (kg)										
mean	61	63	65	66	64	66	67	70	71	69
median	58	60	63	63	62	62	65	67	69	67
se/sd**	1.0	0.9	0.6	0.8	0.4	16.3	13.3	15.7	14.0	14.8
Base	196	267	411	315	1189	110	215	334	270	928
BMI (kg/m ²)										
mean	22.9	23.9	24.8	26.2	24.6	24.8	25.4	26.7	27.4	26.4
median	21.9	22.5	24.1	24.7	23.6	23.7	24.0	25.4	26.9	25.4
se/sd**	0.35	0.33	0.21	0.33	0.15	5.74	5.00	5.75	5.50	5.58
Base	193	261	402	305	1161	110	213	331	269	922

Note: * Gregory JR et al. *The Dietary and Nutritional Survey of British Adults*. HMSO (London, 1990).

** The 1986/87 survey reported standard errors; the present survey reports standard deviations.

Table 2.16

Comparison of anthropometric measurements with the Health Survey for England 2001*

Measurement	Age of respondent (years):									
	2001 Health Survey for England*					2000/01 NDNS - England only				
	16-24	25-34	35-44	45-54	55-64	19-24	25-34	35-44	45-54	55-64
Men										
Height (cm)										
mean	177	177	176	175	173	177	177	176	176	174
se/sd**	0.3	0.2	0.2	0.2	0.2	6.8	6.1	6.8	6.5	7.1
Base	774	1071	1244	1145	980	105	211	167	155	134
Body weight (kg)										
mean	76	83	86	85	84	78	83	86	86	86
se/sd**	0.5	0.5	0.4	0.4	0.4	16.1	13.0	15.0	13.5	15.7
Base	758	1060	1232	1124	973	104	210	169	155	134
BMI (kg/m ²)										
mean	24.1	26.4	27.4	27.9	27.9	24.9	26.5	27.7	27.5	28.1
se/sd**	0.16	0.13	0.13	0.13	0.13	4.98	4.11	4.53	4.02	5.13
Base	757	1051	1220	1112	958	102	209	167	155	134
Waist to hip ratio										
mean	0.84	0.89	0.91	0.94	0.95	0.86	0.88	0.91	0.92	0.93
se/sd**	0.002	0.002	0.002	0.002	0.002	0.061	0.061	0.060	0.063	0.046
Base	599	863	1055	1005	879	103	209	167	153	134
Women										
Height (cm)										
mean	163	163	162	161	161	164	162	162	161	161
se/sd**	0.2	0.2	0.2	0.2	0.2	5.6	6.3	5.7	6.5	6.3
Base	915	1365	1613	1396	1073	93	192	202	198	133
Body weight (kg)										
mean	65	69	70	72	73	67	66	69	72	70
se/sd**	0.5	0.4	0.4	0.4	0.4	16.4	12.9	15.1	16.0	12.2
Base	863	1227	1524	1342	1056	93	190	203	198	134
BMI (kg/m ²)										
mean	24.1	25.8	26.6	27.6	28.1	25.1	25.3	26.5	27.6	27.1
se/sd**	0.17	0.15	0.14	0.15	0.16	5.79	4.82	5.69	5.88	4.84
Base	856	1221	1513	1331	1038	93	188	202	198	132
Waist to hip ratio										
mean	0.77	0.78	0.80	0.82	0.83	0.77	0.77	0.79	0.80	0.82
se/sd**	0.002	0.002	0.002	0.002	0.002	0.051	0.057	0.059	0.059	0.069
Base	678	1031	1309	1204	950	93	193	200	197	133

Note: * Bajekal M, Primatesta P and Prior G. Eds. Health Survey for England 2001. TSO (London, 2003).

** The 2001 Health Survey for England reported standard errors; the present survey reports standard deviations.

3 Blood pressure

3.1 Introduction

This chapter presents descriptive data on blood pressure for adults aged 19 to 64 years. Both bivariate and multivariate analyses are presented showing the relationship between blood pressure and various socio-demographic and dietary factors.

All 2,251 respondents were eligible for blood pressure measurements, but not all of the respondents co-operated with this component of the survey. The rationale for making blood pressure measurements and the protocol, equipment and methodologies used are described in Chapter 1 of this report and in Appendix J of the Technical Report¹. Information on response is also included in Chapter 1 of this report. Data are presented weighted²; unweighted bases are presented in Appendix B.

3.1.1 Blood pressure measurements used in the analyses

Blood pressure measurements were only made if signed consent had been obtained both to taking the measurements and to passing the readings to the respondent's General Practitioner and/or the survey doctor³. If both these consents were obtained then three measurements of blood pressure were made at pre-set intervals of one minute (see Chapter 1 and Appendix J of the Technical Report¹).

Since the first measurement might have been artificially high, particularly if the respondent was anxious, the first reading from each set of three measurements was excluded and the mean of the subsequent two readings calculated. It is this average value that has been used for analyses and is presented in the tables in this chapter. For two respondents, only the first measurement was successfully achieved and these cases have been excluded from the analysis.

Where it was only possible to make two blood pressure measurements for a respondent, the second reading alone has been used in the analysis. Seven cases had just one measurement included in the analysis. None of the measurements was considered unreliable and so no exclusions were made for this reason⁴.

This method of treating and presenting the data has been used in previous NDNS and other surveys, including major national surveys where blood pressure measurements have been made^{5,6,7}. It is believed to be more likely to approximate to the respondent's usual blood pressure, which in turn is more likely to predict adverse cardiovascular events⁸.

Interviewers were encouraged to report any difficulties they had in making the blood pressure measurements or any unusual circumstances; these were recorded on the measurement schedule M1 (see Appendix A of the Technical Report¹). Difficulty in wrapping the blood pressure cuff, either because the respondent had a conical-shaped upper arm or the circumference of their arm was larger than a cuff of the appropriate width, was reported in about 2% of cases. Where at least two successful measurements were made they have been included in the analyses, even if difficulties were reported.

Of all the respondents who consented to blood pressure measurements, 119 (7%) were taking prescribed anti-hypertensive medication at the time of measurement. Of these, 58 were men, of whom, one was aged 25 to 34

years, 12 were aged 35 to 49 years and 45 were aged 50 to 64 years. For women, a total of 61 were taking anti-hypertensive medication, of whom, four were aged 25 to 34 years, 11 were aged 35 to 49 years and 46 were aged 50 to 64 years. Mean values for all respondents were compared to mean values for respondents excluding those taking prescribed anti-hypertensive medication and little difference was noted⁹. Therefore all respondents have been included in the analyses in this Chapter.

3.1.2 Interpretation of blood pressure levels

As described in Chapter 1 and Appendix J of the Technical Report¹, the Dinamap 8100 automatic monitor used in this survey has been validated in several studies, but compared with measurements made using a mercury sphygmomanometer, the Dinamap has been shown to produce higher systolic and lower diastolic blood pressure levels in adults^{10,11}. The Dinamap 8100 is no longer recommended by the European Society of Hypertension due to its inaccuracies for clinical uses, particularly for diastolic blood pressures¹². It has been used in this survey to allow for comparisons with other health surveys and also to maintain continuity within the National Diet and Nutrition Survey programme.

The differences between blood pressure measurements made using the Dinamap monitor and those which have been made using a different instrument, in particular those using an auscultatory method, mean that direct comparison between measurements are inadvisable. Since the previous Dietary and Nutritional Survey of British Adults aged 16 to 64 years carried out in 1986/87 (1986/87 Adults Survey)⁵ used Accutorr sphygmomanometers, which detect pressures by means of oscillometry, results from this present study and the 1986/87 Adults Survey are not compared. However, the Dinamap 8100 was used to measure blood pressure in the Health Survey for England 2001 (HSfE)⁷ and therefore results from the HSfE are presented for comparison with data for England from the present NDNS in Section 3.5.

In interpreting the blood pressure results for the respondents in this survey, it should be remembered that these are cross-sectional data, in that blood pressure was measured at a single point in time, and blood pressure is likely to vary over time.

There has been much debate on the relative importance of systolic and diastolic blood pressure, and in general, systolic and diastolic blood pressure correlate highly. In epidemiological

studies both are important risk factors for cardiovascular disease¹³, but in practice systolic blood pressure should be regarded as the most important¹⁴.

The latest guidelines on the management of hypertension issued by the World Health Organization (WHO)¹⁵ indicate that both hypertension (defined as 140/90mmHg or above) and 'high normal' blood pressure (between 130/85mmHg and 140/90mmHg) pose a threat to health¹⁶. These guidelines classify optimal blood pressure as less than 120/80mmHg while normal blood pressure is classified as less than 130/85mmHg.

It should be noted that there may be inconsistencies in the data when making comparisons against the WHO guidelines since these were based on mercury sphygmomanometer measurements and are being compared with measurements from the Dinamap 8100 (which can provide inaccurate diastolic blood pressure measurements as described above). This may therefore explain in part why some respondents have optimal systolic and not optimal diastolic blood pressures, and vice versa.

3.2 Systolic and diastolic blood pressure

Blood pressure measurements are presented for 797 men and 939 women (unweighted). Distributions and descriptive statistics are given for measurements of systolic and diastolic pressures by sex and age group. Comparisons with the WHO guidelines are made for each sex and age group. For the purpose of these analyses age was calculated by subtracting the respondent's date of birth from the date when the blood pressure measurement was made.

3.2.1 Systolic blood pressure¹⁷

Table 3.1 shows descriptive statistics for systolic blood pressure for men and women by age group. Generally, the mean values were slightly higher than the median values for both men and women within each age group. This indicates that there were a small number of cases within each age group with relatively high systolic blood pressure measurements¹⁸.

Mean systolic blood pressure for men, 130mmHg, was significantly higher than for women, 122mmHg ($p<0.01$). Men aged 19 to 49 years had significantly higher systolic blood pressure than women of the same age ($p<0.01$).

Both men and women in the oldest age group had significantly higher mean systolic blood pressure than those aged 19 to 49 years ($p < 0.01$). In addition, women aged 35 to 49 years had a significantly higher mean systolic blood pressure of 120mmHg, compared with 114mmHg for those aged 19 to 24 and 25 to 34 years ($p < 0.01$).

Overall, 22% of men and 13% of women had systolic blood pressure that is considered hypertensive and 24% of men and 13% of women had systolic blood pressure that is considered 'high normal' based on the WHO guidelines¹⁵ ($p < 0.01$). Twenty-four per cent of men and 51% of women had systolic blood pressure that is considered optimal (less than 120mmHg) ($p < 0.01$).

Using the guidelines on hypertension issued by the WHO¹⁵, the proportion of both men and women who had systolic blood pressure classified as either hypertensive or 'high normal' increased with age. Conversely, the proportion of both men and women who had mean systolic blood pressure classified as optimal generally decreased with age.

A significantly higher proportion of men and women aged 50 to 64 years had systolic blood pressure that is classified as hypertensive than all younger men and women ($p < 0.01$). In addition, a higher proportion of women aged 35 to 49 years than women aged 19 to 24 years had systolic blood pressure that is classified as hypertensive, 7% and 1% respectively ($p < 0.05$).

A significantly higher proportion of men aged 25 to 34 years, 33%, had systolic blood pressure that is classified as optimal compared with the oldest group of men, 16% ($p < 0.05$). Women aged 50 to 64 years and those aged 35 to 49 years were less likely than women in younger age groups to have optimal systolic blood pressure ($p < 0.01$).

(Table 3.1)

3.2.2 Diastolic blood pressure¹⁷

Table 3.2 shows descriptive statistics for diastolic blood pressure for men and women by age group. Generally, for men and women within each age group, the mean values were close to median values. This indicates that the distribution of data is normal¹⁸.

Mean diastolic blood pressure for men, 73mmHg, was significantly higher than for women, 68mmHg ($p < 0.01$). Men aged 35 to 64 years had significantly higher mean diastolic blood pressures than women of the same age ($p < 0.01$).

Generally, mean diastolic blood pressure increased with age for both men and women; those aged 35 to 64 years had significantly higher mean diastolic blood pressure than those aged 19 to 34 years ($p < 0.01$). In addition, women aged 25 to 34 years had significantly higher diastolic blood pressure than women aged 19 to 24 years, 65mmHg and 62mmHg respectively ($p < 0.05$), and women aged 50 to 64 years had significantly higher diastolic blood pressure, 72mmHg, than women aged 35 to 49 years, 69mmHg ($p < 0.01$).

Overall, 7% of men and 3% of women had diastolic blood pressure that is considered hypertensive, that is at or above 90mmHg, based on the guidelines issued by the WHO¹⁵ ($p < 0.05$). Seventy-one per cent of men and 86% of women had diastolic blood pressure that is considered optimal (less than 80mmHg) ($p < 0.01$).

Using the guidelines on hypertension issued by the WHO¹⁵, the proportion of both men and women who had mean diastolic blood pressure classified as either hypertensive or 'high normal' increased with age. Conversely, the proportion of both men and women who had mean diastolic blood pressure classified as optimal decreased with age.

A higher proportion of men aged 35 to 64 years compared with men aged 25 to 34 years had diastolic blood pressure classified as hypertensive (50 to 64 years: $p < 0.01$; 35 to 49 years: $p < 0.05$).

All men and women aged 19 to 24 years had diastolic blood pressure that is classified as optimal; a significantly higher proportion than men and women aged 25 to 64 years ($p < 0.01$). In addition, a significantly higher proportion of men aged 25 to 34 years compared with men 35 to 64 years had diastolic blood pressure that is classified as optimal ($p < 0.01$). For women, a higher proportion of those aged 25 to 34 years than women in the oldest age group had diastolic blood pressure classified as optimal ($p < 0.01$).

(Table 3.2)

3.3 Variation in blood pressure

In this section, variation in the average blood pressure measurements is considered in relation to socio-demographic and dietary factors. Table 3.3 shows the relationship between blood pressure and region¹⁹, Table 3.4 between blood pressure and whether someone in the respondent's household was in receipt of certain state benefits²⁰ and Table 3.5 shows the relationship between systolic blood pressure and urinary sodium excretion. All three tables present data separately for men and women.

As shown in previous tables (see Tables 3.1 and 3.2), blood pressure varies by sex and age. When interpreting data on variation by region or household benefit status, it is important to bear in mind that any significant associations between blood pressure measurements and these variables may be a result of the variation in age distributions.

For further analysis of the association between socio-demographic and dietary characteristics and blood pressure measurements see Section 3.4 where the technique of multiple regression was used to identify factors independently associated with blood pressure level.

3.3.1 Region and household receipt of benefits

There were no statistically significant differences in mean systolic or diastolic blood pressures for men or women according to the region in which they lived or household benefit status.

(Tables 3.3 and 3.4)

3.3.2 Correlation of systolic blood pressure with urinary sodium excretion

Table 3.5 shows that the correlation coefficients between systolic blood pressure and urinary sodium excretion are generally low for all groups. This indicates that, based on the data from this survey, there was no correlation between systolic blood pressure and urinary sodium.

(Table 3.5)

3.4 Characteristics found to be independently associated with variation in blood pressure

Previous research has shown that various socio-demographic and dietary factors are associated with variations in blood pressure, and some of these factors are known to be inter-related^{5,13,21}. This section considers the combined effect of these variables on blood pressure, using the technique of multiple regression to build a model from those characteristics which most explain the blood pressure measurements.

As shown in previous tables, there is a strong association between sex and blood pressure measurements, so each multiple regression analysis is presented separately for men and women. To control for the effects of age, this variable was included in each regression analysis.

Tables 3.6 and 3.7 show the socio-demographic and dietary factors that were significantly associated with blood pressure when bivariate

analyses were carried out²². Independent variables that were found to be significantly associated with the measurements in a bivariate relationship were included in the multiple regression model²³.

(Tables 3.6 and 3.7)

Tables 3.8 to 3.11 give standardised regression coefficients for a number of characteristics, the independent variables, associated with variation in the blood pressure measurements, the dependent variable, produced using the technique of multiple regression. The tables of results identify those characteristics which are related to the measurements after controlling for the effects of the other characteristics included in the analysis. All regression models are only deemed meaningful when a high percentage of the variance in the dependent variable is explained. The technique of multiple regression calculates coefficients based on the number of cases for which there are valid values for all the variables included in the analysis. Further information on the statistical method and interpretation of output from multiple regression analysis is given in Appendix A²⁴.

(Tables 3.8 to 3.11)

3.4.1 Findings

Characteristics independently associated with systolic blood pressure

Tables 3.8 and 3.9 show that the best multiple regression models that could be developed using the most relevant independent variables for the dependent variable, systolic blood pressure, explained 50% and 59% of the variance for men and women respectively, which still leaves a substantial proportion of variance to be explained. As expected, the variable that contributed most to the estimate of systolic blood pressure in the regression models was diastolic blood pressure, as these variables are known to be highly correlated.

(Tables 3.8 and 3.9)

Characteristics independently associated with diastolic blood pressure

Tables 3.10 and 3.11 show that the best multiple regression models that could be developed using the most relevant independent variables for the dependent variable, diastolic blood pressure, explained 59% and 50% of the variance for men and women respectively, which still leaves a substantial proportion of variance to be explained. As expected, the variable that contributed most to the estimate of systolic blood pressure in the regression models was diastolic blood pressure, as these variables are known to be highly correlated.

(Tables 3.10 and 3.11)

3.5 Comparison with Health Survey for England 2001

Table 3.12 compares data from the present NDNS for respondents in England only with blood pressure data from the Health Survey for England 2001 (HSfE)⁷. The HSfE was based on a multi-stage probability sample of addresses drawn from the Postcode Address File. 15,647 adults aged 16 and over were interviewed. A summary of the key findings and methodology from the Health Survey for England 2001 are provided in two reports^{25, 26}.

The blood pressure measurement procedures used in the present NDNS were similar in the HSfE, but measurements in the NDNS were made by a trained interviewer whereas a nurse made the measurements in the HSfE. Differences in measurement procedures, such as non-standardised time of day for measurement, instrument calibration and choices of cuff sizes, in addition to modest inter-survey differences may result in measurement differences that are of methodological origin.

Data are presented for men and women by age for both systolic and diastolic blood pressure. It should be noted that in the HSfE the youngest age group was aged 16 to 24 years, while in the present NDNS the youngest age group was adults aged 19 to 24 years. This should be borne in mind where there are differences between these groups. Age groups for the present NDNS were redefined to match those of the HSfE so that meaningful comparisons could be made: 16/19 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years.

Mean systolic blood pressure was generally lower in the present NDNS than in the HSfE for each sex/age group. For men aged 25 to 34 years and 45 to 54 years, mean systolic blood pressure was significantly lower in the present NDNS than in the HSfE ($p < 0.01$). For women aged 16/19 to 54 years, mean systolic blood pressure was significantly lower in the present NDNS than in the HSfE (16/19 to 24 years: $p < 0.05$; all others: $p < 0.01$).

Mean diastolic blood pressure was generally lower in the present NDNS than in the HSfE for each sex/age group. For men aged 25 to 34 years and 45 to 64 years, mean diastolic blood pressure was significantly lower in the present survey than in the HSfE ($p < 0.05$). For example, mean diastolic blood pressure for men aged 25 to 34 years in the present NDNS was 68mmHg compared with 71mmHg for men of the same age in the HSfE ($p < 0.05$).

For women aged 25 to 54 years mean diastolic blood pressure was significantly lower in the present survey than in the HSfE (35 to 44 years: $p < 0.05$; all others: $p < 0.01$). For example, women aged 45 to 54 years had mean diastolic blood pressure of 70mmHg in the present NDNS compared with 74mmHg in the HSfE ($p < 0.01$).

Given that the same equipment was used to make the blood pressure measurements, it may be possible that the data from the different surveys illustrate what is frequently referred to as 'the white coat effect', that is a tendency for blood pressure to rise when it is measured by a doctor or nurse^{27, 28}.

(Table 3.12)

References and endnotes

- ¹ The Technical Report is available online at <http://www.food.gov.uk/science>.
- ² Weighting was needed to compensate for unequal probabilities of selection because only one household was selected at multi-household addresses and only one adult was selected for interview from households containing more than one eligible adult (see Appendix D of the Technical Report, see Note 1). Weighting factors were derived to compensate for differential non-response by comparing the proportions, by sex, age and region, of respondents consenting to blood pressure measurements with the corresponding proportion in the population using population estimates (see Appendix D of the Technical Report).
- ³ If the respondent was not registered with a General Practitioner the duty of care passed to the survey doctor and blood pressure measurements could still be taken.
- ⁴ Where systolic or diastolic pressures varied between readings by more than 20%, potential data entry errors were checked by using the recorded Mean Arterial Pressure (MAP) from the M1 (see Appendix A of the Technical Report, see Note 1) with a derived value for MAP which was calculated by adding the level of the diastolic pressure to one third of the difference between the systolic and diastolic pressures.
- ⁵ Gregory J, Foster K, Tyler H, Wiseman M. *The Dietary and Nutritional Survey of British Adults*. HMSO (London, 1990).
- ⁶ Finch S, Doyle W, Lowe C, Bates CJ, Prentice A, Smithers G, Clarke PC. *National Diet and Nutrition Survey: people aged 65 years and over. Volume 1: Report of the diet and nutrition survey*. TSO (London, 1998).
- ⁷ Bajekal M, Primatesta P and Prior G. Eds. *Health Survey for England 2001*. TSO (London, 2003).
- ⁸ Petrie JC, O'Brien ET, Littler WA, de Swiet M. Recommendations on blood pressure measurement. *BMJ* 1986; **293**: 611–615.
- ⁹ For both systolic and diastolic blood pressure, there was less than one per cent difference for men and women in all age groups when comparing mean values for all respondents with mean values for respondents excluding those taking prescribed anti-hypertensive medication.
- ¹⁰ Bolling K. *The Dinamap Calibration Study*. HMSO (London, 1994).
- ¹¹ O'Brien E, Atkins N. Accuracy of the Dinamap portable monitor, model 8100; a review of the evidence for accuracy. *Blood Pressure Monitoring* 1997; **2**: 31–33.

- ¹² O'Brien E, Waeber B, Parati G, Staessen J, Myers MG. BP Measuring Devices: recommendations of the European Society of Hypertension. *BMJ* 2001; **322**: 531–536.
- ¹³ Stamler J, Stamler R, Neaton JD. Blood pressure, systolic and diastolic, and cardiovascular risks. US population data. *Arch Intern Med* 1993; **153**: 598–615.
- ¹⁴ Ramsay LE, Williams B, Johnston DG, MacGregor GA, Poston L, Potter JF *et al*. Guidelines for management of hypertension: report of the third working party of the British Hypertension Society, 1999: summary. *J Hum Hypertens* 1999; **13**: 569–592.
- ¹⁵ Chalmers J *et al*. WHO-ISH Hypertension Guidelines Committee. 1999 World Health Organization – International Society of Hypertension Guidelines for the management of hypertension. *Journal of Hypertension* 1999; **17**: 151–183.
- ¹⁶ Thresholds for treatment intervention can be evaluated independently for systolic and diastolic blood pressure when considering elevated blood pressure levels.
- ¹⁷ Values for systolic and diastolic pressures are *average* values, derived as described in Section 3.1.1 of this chapter. Mean values refer to the mean of the average systolic or diastolic pressures as appropriate.
- ¹⁸ Distribution of data was evaluated using the skewness statistic in SPSS. If the skewness statistic was less than twice the standard error of this statistic then data were considered to be normally distributed.
- ¹⁹ The areas included in each of the four analysis 'regions' are given in the response chapter, Chapter 2 of the Technical Report (see Note 1). Definitions of 'regions' are given in the Glossary (see Appendix E).
- ²⁰ Households receiving certain benefits are those where someone in the respondent's household was currently receiving Working Families Tax Credit or had, in the previous 14 days, drawn Income Support or (Income-related) Job Seeker's Allowance. Definitions of 'household' and 'benefits (receiving)' are given in the Glossary (see Appendix E).
- ²¹ Gregory J, Lowe S, Bates CJ, Prentice A, Jackson LV, Smithers G, Wenlock, R, Farron M. *National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 1: Report of the diet and nutrition survey*. TSO (London, 2000).
- ²² Bivariate analyses of continuous variables were carried out using the Pearson correlation coefficient and analyses of categorical variables tested the difference between means. It should be noted that where correlations are statistically significant the relationship between the two variables may not necessarily be causal; other factors may have affected the size of the correlation.
- ²³ The regression models are constructed by carrying out bivariate analyses and incorporating variables with significant associations. It should be noted that this method of selection can lead to important variables being left out as additive or interactive effects can only be identified using multiple regression.
- ²⁴ The model is tested by an ANOVA (see Appendix E - Glossary) to determine whether all the regression coefficients are zero in the population, and shows that there are significant linear relationships between the independent variables and the dependent variable.
- ²⁵ Health Survey for England 2001 – Summary of key findings is available online at <http://www.official-documents.co.uk/document/deps/doh/survey01/skf/skf.htm>.
- ²⁶ Health Survey for England 2001 – Methodology and documentation is available online at <http://www.official-documents.co.uk/document/deps/doh/survey01/md/md.htm>.
- ²⁷ Tsai P-S. White coat hypertension: understanding the concept and examining the significance. *Journal of Clinical Nursing* 2002; **11(6)**: 715–722.
- ²⁸ Verdecchia P, O'Brien E, Pickering T, Staessen JA, Parati G, Myers M, Palatini P. When can the practising physician suspect white coat hypertension? Statement from the Working Group on Blood Pressure Monitoring of the European Society of Hypertension. *American Journal of Hypertension* 2003; **16(1)**: 87–91.

Table 3.1

Percentage distribution of systolic blood pressure by sex and age of respondent

Cumulative percentages

Systolic blood pressure (mmHg)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 100	-	2	1	0	1	2	7	5	1	4
Less than 105	-	5	2	2	2	12	25	10	6	13
Less than 110	1	10	4	4	5	36	42	24	8	25
Less than 115	11	18	13	7	12	53	58	39	16	39
Less than 120	28	33	24	16	24	74	69	52	24	51
Less than 125	51	50	41	24	40	85	83	67	34	63
Less than 130	67	62	59	36	54	94	93	79	43	74
Less than 140	88	86	82	63	78	99	97	93	67	87
Less than 150	96	98	93	80	91	100	99	98	86	95
Less than 160	100	100	97	92	97		100	99	93	98
All			100	100	100			100	100	100
Base	109	221	255	255	839	105	212	320	260	897
Mean (average value)	127	125	129	136	130	114	114	120	133	122
Median	124	124	128	134	128	114	112	119	132	120
Lower 5.0 percentile	112	104	111	112	109	100	98	100	104	100
Upper 5.0 percentile	148	146	153	166	155	134	136	142	164	149
Standard deviation	10.7	13.0	13.4	16.7	14.7	9.6	11.4	13.8	18.2	16.2

Table 3.2

Percentage distribution of diastolic blood pressure by sex and age of respondent

Cumulative percentages

Diastolic blood pressure (mmHg)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 50	1	2	0	-	1	5	5	2	2	3
Less than 55	9	10	2	2	5	17	13	6	3	8
Less than 60	24	22	7	3	12	42	31	20	13	23
Less than 65	53	43	16	7	25	66	53	36	27	41
Less than 70	80	58	28	15	39	87	71	53	42	58
Less than 75	96	77	44	35	57	95	84	72	60	74
Less than 80	100	88	62	55	71	100	91	85	76	86
Less than 85		96	79	75	85		97	93	88	93
Less than 90		98	91	88	93		98	97	94	97
Less than 95		100	96	95	97		99	99	98	99
All			100	100	100		100	100	100	100
Base	109	221	255	255	839	105	212	320	260	897
Mean (average value)	64	68	76	79	73	62	65	69	72	68
Median	64	67	77	78	73	61	64	68	72	68
Lower 5.0 percentile	53	52	58	63	54	50	50	54	56	52
Upper 5.0 percentile	74	84	94	96	92	76	82	87	90	87
Standard deviation	6.5	10.0	11.4	9.6	11.4	7.6	9.9	10.2	10.7	10.6

Table 3.3

Blood pressure by sex of respondent and region

Blood pressure (mmHg)	Sex of respondent and region							
	Men				Women			
	Scotland	Northern	Central, South West and Wales	London and the South East	Scotland	Northern	Central, South West and Wales	London and the South East
Systolic pressure								
Mean	127	131	131	129	121	123	122	120
Median	127	129	128	129	119	120	120	118
5th percentile	102	108	112	108	100	102	101	100
10th percentile	108	113	115	112	106	106	104	102
90th percentile	143	152	149	145	138	146	144	141
95th percentile	144	163	154	151	144	156	151	146
Standard deviation	12.9	16.7	14.1	13.5	13.9	16.7	17.0	15.4
Diastolic pressure								
Mean	72	74	74	72	69	69	68	67
Median	71	74	74	72	69	69	67	67
5th percentile	54	54	56	53	52	50	53	53
10th percentile	57	60	59	57	55	56	56	56
90th percentile	86	88	88	86	86	82	82	82
95th percentile	89	93	94	89	88	87	86	88
Standard deviation	10.9	11.9	11.4	10.9	11.0	10.8	10.4	10.6
Base	62	242	299	237	67	233	330	266

Table 3.4

Blood pressure by sex of respondent and whether someone in the respondent's household was receiving certain benefits

Blood pressure (mmHg)	Sex of respondent and whether receiving benefits			
	Men		Women	
	Receiving benefits	Not receiving benefits	Receiving benefits	Not receiving benefits
Systolic pressure				
Mean	130	130	120	122
Median	129	128	119	120
5th percentile	108	109	102	100
10th percentile	112	113	103	104
90th percentile	152	148	140	144
95th percentile	156	155	145	151
Standard deviation	15.2	14.6	15.2	16.4
Diastolic pressure				
Mean	72	73	68	68
Median	73	73	68	68
5th percentile	53	55	51	53
10th percentile	56	59	55	56
90th percentile	88	87	80	82
95th percentile	94	92	90	87
Standard deviation	12.2	11.2	10.8	10.6
<i>Base</i>	119	720	163	734

Table 3.5

Pearson correlation coefficients for systolic blood pressure with urinary sodium excretion

Sex and age of respondent	Correlation of systolic blood pressure with:	
	urinary sodium (mmol/24h)*	<i>Base</i>
Men aged (years):		
19–24	0.00	53
25–34	0.13	137
35–49	0.08	174
50–64	–0.16**	189
All men	–0.02	553
Women aged (years):		
19–24	0.23	51
25–34	0.08	128
35–49	0.02	210
50–64	0.12	193
All women	0.01	582

Note: * Only includes samples where a full 24 hour collection was achieved.

** $p < 0.05$

Table 3.6

Socio-demographic, dietary and physiological factors associated with systolic blood pressure in bivariate analysis

Men	Women
Age at measurement (years)**	Age at measurement (years)**
Average calculated activity score	Average calculated activity score*
Average daily alcohol intake (g)**	Average daily alcohol intake (g)
Average daily intake of total cholesterol (mg)	Average daily intake of total cholesterol (mg)**
Current smoking	Current smoking
Eating affected by being unwell	Eating affected by being unwell
Ethnicity of respondent	Ethnicity of respondent
Gross weekly household income	Gross weekly household income*
Grouped Standard Region	Grouped Standard Region
Household benefit status	Household benefit status
Household composition**	Household composition**
Limited activity due to illness or disability	Limited activity due to illness or disability*
Mean diastolic pressure (mmHg)**	Mean diastolic pressure (mmHg)**
Mean body weight (kg)**	Mean body weight (kg)**
Reported dieting to lose weight*	Reported dieting to lose weight
Self-reported physical activity level	Self-reported physical activity level
Social class of household reference person	Social class of household reference person
Urinary potassium: urinary creatinine ratio (mol/mol)	Urinary potassium: urinary creatinine ratio (mol/mol)*
Urinary sodium: urinary creatinine ratio (mol/mol)	Urinary sodium: urinary creatinine ratio (mol/mol)
Urinary sodium excretion (mmol/24h)	Urinary sodium excretion (mmol/24h)
Vegetarian or vegan	Vegetarian or vegan
Wave of interview	Wave of interview
Whether adds salt to cooking	Whether adds salt to cooking
Whether adds salt to food at the table	Whether adds salt to food at the table

Note: * $p < 0.05$; ** $p < 0.01$

Table 3.7

Socio-demographic, dietary and physiological factors associated with diastolic blood pressure in bivariate analysis

Men	Women
Age at measurement (years)**	Age at measurement (years)**
Average calculated activity score*	Average calculated activity score*
Average daily alcohol intake (g)**	Average daily alcohol intake (g)*
Average daily intake of total cholesterol (mg)	Average daily intake of total cholesterol (mg)
Current smoking	Current smoking
Eating affected by being unwell	Eating affected by being unwell
Ethnicity of respondent	Ethnicity of respondent
Gross weekly household income	Gross weekly household income
Grouped Standard Region	Grouped Standard Region
Household benefit status	Household benefit status
Household composition**	Household composition**
Limited activity due to illness or disability	Limited activity due to illness or disability
Mean systolic pressure (mmHg)**	Mean systolic pressure (mmHg)**
Mean body weight (kg)**	Mean body weight (kg)**
Reported dieting to lose weight	Reported dieting to lose weight
Self-reported physical activity level	Self-reported physical activity level
Social class of household reference person	Social class of household reference person*
Urinary potassium: urinary creatinine ratio (mol/mol)*	Urinary potassium: urinary creatinine ratio (mol/mol)**
Urinary sodium: urinary creatinine ratio (mol/mol)	Urinary sodium: urinary creatinine ratio (mol/mol)
Urinary sodium excretion (mmol/24h)	Urinary sodium excretion (mmol/24h)
Vegetarian or vegan	Vegetarian or vegan
Wave of interview	Wave of interview
Whether adds salt to cooking	Whether adds salt to cooking
Whether adds salt to food at the table	Whether adds salt to food at the table

Note: * $p < 0.05$; ** $p < 0.01$

Table 3.8

Linear regression model for systolic blood pressure: men

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	59.695	3.115		19.161 ***
Diastolic blood pressure (mmHg)	0.881	0.039	0.692	22.658 ***
Household composition				
Living alone	0.412	0.884	0.018	0.466
Living with spouse or partner, no dependent children	0.973	0.667	0.056	1.458
Living with other adults, no spouse or dependent children	1.262	0.866	0.059	1.458
Living with dependent children, with or without spouse	-2.647	0.647	-0.113	-4.088 ***
Body weight (kg)	0.092	0.027	0.093	3.381 ***
Reported dieting to lose weight	1.935	1.223	0.042	1.583
Age at measurement (years)	-0.055	0.038	-0.049	-1.450
Average daily alcohol intake (g)	-0.002	0.015	-0.003	-0.102
Percentage of variance explained		50%		
<i>Number of respondents</i>		758		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 3.9

Linear regression model for systolic blood pressure: women

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	41.019	5.510		7.444 ***
Diastolic blood pressure (mmHg)	0.877	0.039	0.584	22.221 ***
Age at measurement (years)	0.352	0.041	0.265	8.674 ***
Gross weekly household income				
Less than £160	3.394	0.940	0.147	3.609 ***
£160 to less than £400	-0.783	0.652	-0.030	-1.202
£400 & over	-2.611	0.669	-0.113	-3.903 ***
Household composition				
Living alone	-1.157	1.130	-0.031	-1.023
Living with spouse or partner, no dependent children	1.745	0.811	0.066	2.151 *
Living with other adults, no spouse or dependent children	5.735	1.168	0.146	4.911 ***
Living with dependent children, with spouse	-2.104	0.801	-0.075	-2.627 **
Living with dependent children, without spouse	-4.220	1.310	-0.113	-3.222 **
Body weight (kg)	0.145	0.028	0.133	5.194 ***
Calculated physical activity score[†]	-0.028	0.102	-0.007	-0.276
Limited activity due to illness	-1.895	1.037	-0.047	-1.828
Average daily cholesterol intake (mg)	0.000	0.004	0.000	-0.018
Urinary potassium: urinary creatinine ratio	-0.128	0.190	-0.018	-0.675
Percentage of variance explained		59%		
<i>Number of respondents</i>		705		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] The calculated physical activity score ranges from 32 to 78, with an overall mean of 42 for women. The higher the score, the more physically active a respondent is. For more information see Appendix D.

Table 3.10

Linear regression model for diastolic blood pressure: men

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	0.466	3.465		0.135
Systolic blood pressure (mmHg)	0.477	0.022	0.613	22.097 ***
Age at measurement (years)	0.226	0.029	0.257	7.911 ***
Household composition				
Living alone	-0.320	0.701	-0.017	-0.457
Living with spouse or partner, no dependent children	0.226	0.522	0.016	0.432
Living with other adults, no spouse or dependent children	-1.659	0.702	-0.095	-2.363 *
Living with dependent children, with or without spouse	1.754	0.515	0.094	3.407 ***
Average daily alcohol intake (g)	0.039	0.012	0.084	3.259 **
Calculated physical activity score [†]	-0.040	0.029	-0.035	-1.367
Urinary potassium: urinary creatinine ratio	0.210	0.192	0.029	1.094
Body weight (kg)	0.015	0.021	0.019	0.716
Percentage of variance explained		59%		
Number of respondents		630		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] The calculated physical activity score ranges from 36 to 100, with an overall mean of 46 for men. The higher the score, the more physically active a respondent is. For more information see Appendix D.

Table 3.11

Linear regression model for diastolic blood pressure: women

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	10.216	4.175		2.447 *
Systolic blood pressure (mmHg)	0.475	0.021	0.717	22.453 ***
Social class of household reference person				
Non-manual	2.382	0.662	0.122	3.596 ***
Manual	1.108	0.687	0.056	1.613
Unclassified	-3.490	1.204	-0.179	-2.899 **
Household composition				
Living alone	-0.330	0.802	-0.013	-0.411
Living with spouse or partner, no dependent children	-0.414	0.539	-0.024	-0.768
Living with other adults, no spouse or dependent children	-2.919	0.854	-0.112	-3.419 ***
Living with dependent children, with spouse	1.379	0.560	0.073	2.463 *
Living with dependent children, without spouse	2.283	0.901	0.090	2.535 *
Average daily alcohol intake (g)	0.056	0.025	0.062	2.277 *
Urinary potassium: urinary creatinine ratio	0.131	0.135	0.027	0.967
Calculated physical activity score [†]	-0.056	0.025	0.062	-0.740
Age at measurement (years)	-0.020	0.031	-0.023	-0.645
Body weight (kg)	0.003	0.021	0.004	0.134
Percentage of variance explained		50%		
Number of respondents		696		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] The calculated physical activity score ranges from 32 to 78, with an overall mean of 42 for women. The higher the score, the more physically active a respondent is. For more information see Appendix D.

Table 3.12

Comparison of blood pressure measurements with the Health Survey for England 2001*

Measurement	Age of respondent (years):									
	2001 Health Survey for England*					2000/01 NDNS - England only				
	16-24	25-34	35-44	45-54	55-64	19-24	25-34	35-44	45-54	55-64
Men										
Systolic pressure (mmHg)										
mean	130	130	130	136	142	127	126	130	130	138
se/sd**	0.5	0.4	0.4	0.5	0.6	10.9	13.1	12.6	14.7	18.1
Diastolic pressure (mmHg)										
mean	64	71	76	81	82	64	68	76	78	79
se/sd**	0.4	0.4	0.3	0.4	0.4	6.7	10.0	11.5	10.6	9.4
Base	516	711	917	877	786	101	203	161	147	131
Women										
Systolic pressure (mmHg)										
mean	120	120	123	132	140	115	114	118	126	137
se/sd**	0.5	0.4	0.4	0.5	0.7	9.8	11.5	13.2	16.2	18.3
Diastolic pressure (mmHg)										
mean	63	68	71	74	75	62	65	69	70	72
se/sd**	0.4	0.3	0.3	0.4	0.4	7.9	9.8	9.8	11.0	10.5
Base	582	896	1144	1056	866	92	190	196	188	130

Note: * Bajekal M, Primatesta P and Prior G. Eds. *Health Survey for England 2001*. TSO (London, 2003).

** The 2001 Health Survey for England reported standard errors; the present survey reports standard deviations.

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4 Blood analytes

4.1 Introduction

This chapter reports on the results from the analysis of the blood samples. Chapter 1 of this report describes the purpose, methodologies and other procedures associated with obtaining venous blood samples from respondents in this survey and response rates. The Technical Report¹ details the procedures for obtaining and processing the samples (Appendix N) and describes the assay techniques and quality assurance data (Appendix O). Appendix M of the Technical Report lists the analytes in priority order for analysis.

4.1.1 Obtaining the blood sample

All 2,251 respondents were asked to consent to give a blood sample. Respondents who consented to giving a blood sample were visited by a phlebotomist to attempt venepuncture, accompanied by an interviewer. In this survey, unlike in some of the previous NDNS surveys^{2,3}, respondents were not asked to provide a fasting blood sample nor was the blood sample necessarily collected in the early morning.

A total of 1,419 respondents consented to having a blood sample taken. Venepuncture was attempted for 1,379 of those who consented to the procedure. Samples were obtained from a total of 1,347 respondents (60% of the responding sample). Reasons for a sample not being obtained, when prior consent had been given, included not being able to find a suitable vein or a vein collapsing during the procedure.

4.1.2 Analysis of the blood samples

Some of the posted blood samples reached the laboratory several days after posting due to delays at sorting centres⁴. The effect of postal delays and subsequent haemolysis of some samples was addressed by applying a correction factor⁵. Appendix O of the Technical Report¹ describes how samples were handled.

As described and shown in Appendix M of the Technical Report¹, the analytes were priority ordered to take account of technical constraints and clinical and policy relevance. Where it was not possible to obtain a sufficient volume of blood for the full range of analytes, the assays were carried out in the order of priority, and thus not all the assays were carried out on all the samples. The base numbers in the tables of results therefore vary for different analytes. The results for some analytes were routinely reported to the respondent and their GP (Appendix N of the Technical Report¹).

As with data presented elsewhere in this report, the results for each of the blood analytes have been weighted at case level for both differential non-response and differential sampling probabilities and the tables present weighted data. The weights were derived for three groups of blood analytes (see Appendix C). Unweighted base numbers are shown in Appendix B.

Data are presented giving distributions and descriptive statistics for the blood analytes by sex and age. For the purpose of these analyses age was calculated by subtracting the respondent's date of birth from the date when the blood sample was obtained. For selected analytes, tables are given showing the variation in analyte concentration between various subgroups in the sample based on region and whether someone in the respondent's household was receiving certain benefits. Again for selected analytes, tables

are also given showing correlation coefficients between the analyte and dietary intake of the relevant nutrient⁶ and other blood analytes. Correlations were run on weighted data, within age groups⁷.

It should be noted that for certain analytes, the mean value was considerably different from the median value for all or some sex/age groups. This indicates that there were a small number of respondents within each age/sex group who had extreme values in relation to the overall distribution⁸.

For convenience of presentation and discussion the analytes are divided into the following main groups:

- haematology, including measures of iron status
- water soluble vitamins and plasma total homocysteine
- fat soluble vitamins and carotenoids
- blood lipids
- other analytes.

No comparison with blood analytes data from the Dietary and Nutritional Survey of British Adults aged 16 to 64 years carried out in 1986/87 (1986/87 Adults Survey)⁹ has been undertaken because differences in the analytical methods used mean that the data from the two surveys are generally not comparable.

4.2 Haematology, including measures of iron status

4.2.1 The analytes and results

Tables 4.1 to 4.7 show the results for haematology analytes, including serum ferritin, for respondents by sex and age.

Haemoglobin concentration (grams /decilitre)

Haemoglobin is the oxygen-carrying, iron-containing molecule in red blood cells. Circulating levels of haemoglobin are indicative of the oxygen-carrying capacity of the blood. A low haemoglobin concentration can indicate iron deficiency. The World Health Organization's (WHO) lower limits for haemoglobin concentration are 13.0g/dl for men and 12.0g/dl for women¹⁰. Concentrations lower than these are indicative of anaemia. The haemoglobin concentrations of women of childbearing age tend to be lower because of menstrual loss. Upper limits of haemoglobin have been set at 18g/dl for men and 16.5g/dl for women¹¹.

Mean haemoglobin concentration was 15.1g/dl for men and significantly lower, 13.4g/dl, for women ($p<0.01$). This difference between men and women was observed within each age group.

For both men and women there were no significant differences in mean haemoglobin concentration by age.

Three per cent of men had a haemoglobin concentration below the WHO lower limit for adult men (13.0g/dl) and 8% of women had a concentration below the WHO lower limit for adult women (12.0g/dl) ($p<0.01$). There were no significant age differences for men or women.

(Table 4.1)

Mean corpuscular volume (MCV) (femtolitres)

The MCV is a measure of the average size of the red blood cells, and for adults is usually between 83fl and 101fl¹¹. A low MCV (microcytosis) is usually an indication of iron deficiency. High MCV (macrocytosis) may be due to alcohol abuse, liver disease, hypothyroidism and folate or vitamin B₁₂ deficiency.

The mean MCV was 92.9fl for men and 93.4fl for women (ns). The two youngest groups of men had a significantly lower mean MCV, 91.0fl and 90.9fl respectively, than the oldest group of men, 95.0fl ($p<0.01$). There were no significant age differences for women.

Three per cent of men and 4% of women had an MCV below 83.0fl, the lower end of the normal range for adults, suggesting iron deficiency. For men and women there were no significant age differences in the proportion with mean MCV below 83.0fl. Seven per cent of men and 11% of women had an MCV at or above 101.0fl (ns).

(Table 4.2)

Haematocrit (packed cell volume – PCV) (litres/litre fractional volume)

The haematocrit is the proportion of the blood volume taken up by the red cells, and is determined by the cell size and number. A lower concentration may indicate abnormal cell development, as shown by abnormally small red blood cells (microcytosis). Cells containing less haemoglobin may also be abnormally pale (hypochromic). Typically, iron deficiency produces a microcytic, hypochromic picture. In men haematocrit is usually between 0.40l/l and 0.50l/l and in women between 0.36l/l and 0.46l/l¹¹.

Overall, and within each age group, men had a significantly higher haematocrit than women, 0.459/l and 0.413/l respectively ($p < 0.01$). There were no significant age differences for men or women.

Overall, four per cent of men and 5% of women (ns) had a haematocrit concentration below the lower limit of the usual range, 0.40/l for men and 0.36/l for women. There were no significant differences by age in the proportions of men and women who had a haematocrit concentration below the lower limit.

(Table 4.3)

Plasma iron (micromoles/litre)

Although it is normal for plasma iron concentration for an individual to vary throughout the day and between days, a low concentration, below $13\mu\text{mol/l}$ in adults, is indicative of iron-deficiency, inflammation, infection, surgery and/or chronic disease. High concentrations are indicative of liver disease, hypoplastic anaemia, ineffective erythropoiesis and/or iron overload. For men and women the normal range is between $13\mu\text{mol/l}$ and $32\mu\text{mol/l}$ ¹¹.

Mean plasma iron concentration for men was $17.0\mu\text{mol/l}$ and for women $16.1\mu\text{mol/l}$ (ns). There were no significant differences by age for either men or women.

Overall, 26% of men and 33% of women (ns) had a plasma iron concentration below $13.0\mu\text{mol/l}$, the lower limit of the normal range. There were no significant age differences in the proportion below this value for either men or women. One per cent of men and 2% of women had a mean concentration of $32\mu\text{mol/l}$ or above, the upper limit of the normal range (ns).

(Table 4.4)

Total iron-binding capacity (TIBC) (micromoles/litre)

Extracellular iron in the blood is bound to the protein, transferrin. The total iron-binding capacity (TIBC) reflects the amount of transferrin that is available to bind iron. The laboratory method measures the amount of iron required to achieve complete saturation of the transferrin. TIBC is raised in iron-deficiency anaemia, but is lowered with infections, malignant disease, renal disease and iron overload¹². For adults the normal range is $45\mu\text{mol/l}$ to $70\mu\text{mol/l}$ ¹¹.

The mean TIBC for men in the survey was $61.5\mu\text{mol/l}$, significantly lower than the mean value

for women, $63.8\mu\text{mol/l}$ ($p < 0.01$). Women in the youngest age group had a significantly higher mean TIBC, $66.1\mu\text{mol/l}$, than those aged 50 to 64 years, $61.7\mu\text{mol/l}$ ($p < 0.05$). There were no significant age differences for men.

One per cent of men and 2% of women had a TIBC below $45.0\mu\text{mol/l}$, the lower limit of the normal adult range (ns). There were no significant age differences for men or women.

A lower proportion of men, 14%, than women, 24%, had a TIBC at or above $70.0\mu\text{mol/l}$, the upper limit of the normal range ($p < 0.01$). The proportion of women with levels at or above the upper limit decreased significantly with age, from 32% of those aged 25 to 34 years to 16% of those aged 50 to 64 years ($p < 0.05$). There were no significant age differences for men.

(Table 4.5)

Percentage saturation of plasma iron (%)

Transferrin is the circulating transport protein for iron. The percentage of transferrin that is saturated with iron is derived from plasma iron and total iron-binding capacity (TIBC). A decrease in percentage saturation is an indicator of a progressive iron deficiency state with depleted iron stores. When the percentage transferrin saturation drops to a certain level haemoglobin formation is likely to be impaired. For adults this level is usually considered to be 15%¹³.

Overall mean plasma iron percentage saturation was 28.1% for men and 26.0% for women ($p < 0.05$). There were no significant differences by age for either men or women.

A significantly higher proportion of women, 16%, than men, 7%, had low plasma iron percentage saturation, that is less than 15% ($p < 0.01$). There were no significant differences by age for men or women.

(Table 4.6)

Serum ferritin (micrograms/litre)

Serum ferritin gives an indication of the level of iron stores as well as being an acute phase reactant that is raised in response to infection or inflammation.

The normal range for serum ferritin is generally taken to be $20\mu\text{g/l}$ to $300\mu\text{g/l}$ for men and $15\mu\text{g/l}$ to $150\mu\text{g/l}$ for women¹¹. Raised serum ferritin concentrations should be interpreted with care as they can result from inflammatory conditions, liver disease or other chronic disorders. Low concentrations indicate low iron stores.

Mean serum ferritin was 120µg/l for men and significantly lower, 53µg/l, for women ($p < 0.01$).

Men and women in the youngest age group had significantly lower mean concentrations of serum ferritin than those in the oldest age group. Mean serum ferritin for those aged 19 to 24 years was 78µg/l for men and 41µg/l for women compared with 145µg/l and 71µg/l respectively for men and women aged 50 to 64 years ($p < 0.01$).

Four per cent of men and 11% of women had a mean serum ferritin concentration below the lower limit of the normal range ($p < 0.01$).

(Table 4.7)

4.2.2 Correlation with dietary intakes and other blood analytes

Table 4.8 gives correlation coefficients for haemoglobin and serum ferritin concentrations with dietary intakes of haem, non-haem and total iron from all sources, including supplements. In addition, Tables 4.9 and 4.10 give correlation coefficients for haemoglobin and serum ferritin concentrations with plasma iron percentage saturation and α_1 -antichymotrypsin.

It should be noted that where correlations are statistically significant the relationship between the analyte and intake may not necessarily be causal; other factors, in particular the respondent's health at the time, may have affected the size of the correlation. Further, multiple tests for significance can suggest associations or differences that may have arisen by chance.

Table 4.8 shows that the correlation coefficients between serum ferritin and dietary intakes of haem, non-haem and total iron, and between haemoglobin and dietary intakes of haem, non-haem and total iron, were very low for all groups. This indicates that, based on the data from this survey, there were no correlations between these measures.

(Table 4.8)

Table 4.9 shows correlation coefficients for serum ferritin and haemoglobin with plasma iron percentage saturation. The correlation coefficients were generally very low in all groups indicating that, based in the data from this survey, there were no correlations between these measures.

(Table 4.9)

Plasma α_1 -antichymotrypsin (α_1 -ACT) is a positive acute phase reactant and is discussed later in this

chapter (see Section 4.6.1). The correlation coefficients between serum ferritin and α_1 -ACT, and between haemoglobin and α_1 -ACT, were very low in all groups indicating that, based on the data from this survey, there were no correlations between these measures.

(Table 4.10)

4.2.3 Variation in the concentrations of haematology analytes and measures of iron status

Results for the main haematology analytes and measures of iron status were examined in relation to the region¹⁴ in which the respondent lived and whether someone in the respondent's household was receiving certain state benefits¹⁵.

There were no significant regional differences or differences by household benefit status for men or women in mean concentrations of any of the haematology analytes or measures of iron status.

(Tables 4.11 and 4.12)

4.3 Water soluble vitamins and plasma total homocysteine

4.3.1 The analytes and results

Plasma vitamin C (micromoles/litre)

Plasma vitamin C concentrations reflect recent dietary intakes of vitamin C, with values of less than 11µmol/l indicative of biochemical depletion¹⁶.

Mean plasma vitamin C concentration was significantly higher for women than for men, 60.9µmol/l and 52.2µmol/l respectively ($p < 0.01$). There were no significant differences by age for men or women.

Overall 5% of men and 3% of women had a plasma vitamin C concentration below 11µmol/l (ns). There were no significant differences by age for men or women.

(Table 4.13)

Red cell folate and serum folate (nanomoles/litre)

The term folate includes several derivatives of the parent molecule folic acid (pteroyl monoglutamic acid). Red cell folate is usually a better measure of long-term status than plasma folate because it reflects body stores at the time of red cell synthesis. The folate status of women of childbearing age is a particular public health issue due to the risk of having babies with neural tube defects¹⁷.

Folate values and normal ranges are assay-method dependent, which makes it difficult to compare values directly between different studies and surveys. The following interpretation of ranges have been suggested¹⁸:

for red cell folate:

deficient	less than 337nmol/l
intermediate	337nmol/l to < 422nmol/l
normal	422nmol/l to 1463nmol/l

for serum folate:

deficient	less than 6.3nmol/l
intermediate	6.3nmol/l to < 7.0nmol/l
normal	7.0nmol/l to 28.1nmol/l

In adults, a red cell folate concentration below 230nmol/l is considered to be severely deficient, while concentrations between 230nmol/l and 345nmol/l indicate marginal status¹⁹. Based on an older assay, the normal range for serum folate concentration in adults is usually considered to be between 7nmol/l and 46nmol/l¹¹. Statistically defined upper limits for nutrients such as folate do not have any well-established or nutritional significance.

The mean concentration of *red cell folate* in the samples provided by men in this survey was 694nmol/l and for women 685nmol/l (ns). For both men and women, mean concentration for those in the oldest group was significantly higher than for those in the youngest group. For example, for the youngest group of men and women mean red cell folate was 561nmol/l and 576nmol/l, respectively, compared with 773nmol/l for men and 768nmol/l for women aged 50 to 64 years ($p < 0.01$).

Concentrations of red cell folate less than 350nmol/l were found in 5% of the samples from both men and women. For women, 8% of those in the youngest age group, 4% of those aged 25 to 34 years and 5% of those aged 35 to 49 years had red cell folate concentrations below 350nmol/l (ns). No more than 1% of any age/sex group had a red cell folate concentration of less than 230nmol/l, indicating that severe red cell folate deficiency is negligible in this sample.

Mean *serum folate* concentration was similar for men and women, 20.8nmol/l and 22.1nmol/l respectively (ns). For men, mean concentration increased significantly from 17.4nmol/l for those aged 19 to 24 years to 22.9nmol/l for those aged 50 to 64 years ($p < 0.01$). There were no significant age differences for women.

One per cent of men and less than 0.5% of women had a serum folate concentration below 7.0nmol/l, the lower level of the normal range.

(Tables 4.14 and 4.15)

Serum vitamin B₁₂ (picomoles/litre)

Serum concentration of vitamin B₁₂ is a good indicator of vitamin B₁₂ status. Vitamin B₁₂, with folate, is required for methyl group transfer during protein metabolism and DNA synthesis. Vitamin B₁₂ is also required to maintain the integrity of the nervous system. Poor vitamin B₁₂ status may be due to low dietary intake, malabsorption or pernicious anaemia. For adults, the lower level of normality for serum vitamin B₁₂ concentration is usually taken as 118pmol/l¹¹.

There was no significant difference between men and women in mean concentration of serum vitamin B₁₂, 298pmol/l and 288pmol/l respectively. For men, there were no significant differences in mean concentration of serum vitamin B₁₂ by age. For women, however, mean concentration increased with age from 247pmol/l for those aged 19 to 24 years and 259pmol/l for those aged 25 to 34 years, to 329pmol/l for those aged 50 to 64 years ($p < 0.05$).

There were no men in the two youngest age groups with a serum vitamin B₁₂ concentration below 118pmol/l, but 2% and 3% of men in the two older groups had concentrations below this, the lower level of normality for adults. Overall, 4% of women had a serum vitamin B₁₂ concentration below 118pmol/l. There were no significant age differences for men or women.

(Table 4.16)

Erythrocyte Transketolase Activation Coefficient (ETKAC)

As with most water-soluble vitamins, there is virtually no recognisable store of non-functional thiamin in the body and the only reserve is that which is functionally bound to enzymes within the tissues. The *Erythrocyte Transketolase Activation Coefficient (ETKAC)* depends on the reactivation of the cofactor-depleted red cell enzyme transketolase *in vitro*. This index is sensitive to the lower to moderate range of intakes of thiamin. For adults, values above 1.25 are indicative of biochemical thiamin deficiency¹³.

Table 4.17 shows that mean ETKAC for men, 1.15, was significantly higher than the mean ratio for women, 1.14 ($p < 0.01$). For both men and women there were no significant age differences.

Three per cent of men and 1% of women (ns) had a mean ETKAC greater than 1.25, indicating thiamin deficiency. In the youngest men there were no cases with an ETKAC greater than 1.25 while in the oldest group 5% had an ETKAC above this threshold ($p < 0.05$). There were no significant age differences for women.

(Table 4.17)

Erythrocyte Transketolase Basal Activity (ETK-B) (micromoles/gram haemoglobin/min)

Prolonged thiamin deficiency *in vivo* or non-ideal storage conditions for the red cell enzyme *in vitro* can lead to a disproportionate loss of cofactor depleted apoenzyme, presumably to a degraded, non-reactivatable form. For this reason it is recommended that the basal activity, that is the activity without added cofactor, as well as the activation coefficient of erythrocyte transketolase is quoted, as two partly independent indices of thiamin status. The basal activity and activation coefficient together are sometimes used to distinguish between acute and chronic thiamin deficiency.

Mean ETK-B was $0.72 \mu\text{mol/g Hb/min}$ for men and $0.76 \mu\text{mol/g Hb/min}$ for women ($p < 0.01$). Women aged 19 to 24 years had a significantly higher mean ETK-B, $0.79 \mu\text{mol/g Hb/min}$, than those aged 35 to 49 years, $0.74 \mu\text{mol/g Hb/min}$ ($p < 0.05$). This was the only significant age difference.

(Table 4.18)

Erythrocyte Glutathione Reductase Activation Coefficient (EGRAC)

The *Erythrocyte Glutathione Reductase Activation Coefficient (EGRAC)* is a measure of red cell enzyme saturation with its riboflavin, vitamin B₂, derived cofactor, flavin adenine dinucleotide (FAD). Riboflavin is needed for the utilisation of energy from food. The coefficient is expressed as the ratio of two activity measures of the enzyme glutathione reductase, with and without the cofactor FAD. The higher the coefficient the lower the saturation *in vitro*. A coefficient of between 1.0 and 1.3 is generally considered to be normal. The test is most sensitive at low levels of riboflavin intake. The EGRAC index is highly sensitive to small degrees of cofactor desaturation, and moderately raised values are not associated with known functional abnormality.

There was no significant difference between men and women in the mean EGRAC ratio, 1.38 and 1.40 respectively. For both men and women, EGRAC decreased significantly with age. Mean EGRAC was 1.45 for men and women aged 19 to

24 years compared with 1.35 and 1.34, respectively, for those aged 50 to 64 years (men: $p < 0.01$; women: $p < 0.05$).

Two-thirds of men and women had an EGRAC ratio greater than 1.30. The proportion of men with an EGRAC greater than 1.30 decreased from 82% of those aged 19 to 24 years to 54% of those aged 50 to 64 years ($p < 0.01$). Similarly for women the proportion with an EGRAC greater than 1.30 decreased from 77% in the youngest age group to 50% in the oldest age group ($p < 0.05$). It should be noted that the apparently high proportion of 'deficient' values, that is greater than 1.30, is a characteristic of the sensitivity of the assay procedure used. The same procedure was used for the earlier surveys in the NDNS programme, of pre-school children²⁰, young people aged 4 to 18 years² and people aged 65 years and over³ but differs in detail from the assay procedure used in the Dietary and Nutritional Survey of British Adults, carried out in 1986/87 (1986/87 Adults Survey)⁹.

(Table 4.19)

Erythrocyte Aspartate Aminotransferase Activation Coefficient (EAATAC)

The *Erythrocyte Aspartate Aminotransferase Activation Coefficient (EAATAC)* is a measure of the saturation of aspartate aminotransferase, a red cell enzyme, with pyridoxal phosphate, a cofactor derived from vitamin B₆. Like other coefficients the test is most sensitive at and below marginal intakes. For adults, values above 2.00 are indicative of biochemical vitamin B₆ deficiency¹¹.

Mean EAATAC for men was 1.79, and for women, 1.77 (ns). For both men and women there were no significant differences in mean EAATAC by age.

Overall, 10% of men and 11% of women had an EAATAC greater than 2.00, suggesting possible vitamin B₆ deficiency. There were no significant differences in the proportion with possible vitamin B₆ deficiency by age.

(Table 4.20)

Plasma total homocysteine (micromoles/litre)

Plasma total homocysteine is a sulphur amino-acid which is a precursor of methionine, requiring both folate and vitamin B₁₂ for its conversion to methionine. It is therefore sensitive to changes in folate and vitamin B₁₂ status, and because of another, vitamin B₆-dependent, turnover pathway, it can also become sensitive to changes in vitamin B₆ status. Relatively high plasma homocysteine concentrations are strongly associated with increased risk of vascular diseases and with some

other, possibly related, disease states²¹. Homocysteine is toxic to certain cell-types *in vitro* and there is other indirect evidence of its cytotoxic properties.

The possibility that improvements in B-vitamin status, for example by improved diet and/or use of B-vitamin supplements, may reduce the risk of some vascular, or other, diseases by reducing circulating and intra-cellular homocysteine concentrations is the subject of ongoing investigations²². For these reasons, in the most recent NDNS surveys²³, plasma homocysteine was included as a functional index of possible disease risk and of adequacy of nutrition for certain B-vitamins. Plasma homocysteine concentrations less than or equal to 12µmol/l are considered normal but concentrations below 10µmol/l are considered optimal^{24,25}.

Mean plasma total homocysteine was significantly higher for men, 11.7µmol/l, than women, 10.1µmol/l ($p<0.01$). There were no significant age differences for men or women.

Sixty-seven per cent of men and 78% of women had a concentration less than or equal to the normal level for homocysteine, 12.0µmol/l ($p<0.01$). A significantly lower proportion of men than women had a mean plasma total homocysteine concentration less than or equal to 10.0µmol/l, 38% and 59% respectively ($p<0.01$). There were no significant age differences for men or women.

(Table 4.21)

4.3.2 Correlation with dietary intakes

Tables 4.22 and 4.23 show correlation coefficients for blood indices of vitamin C and folate with dietary intakes, from all sources, of these vitamins and consumption of fruit and vegetables.

The correlation coefficients between plasma vitamin C and dietary intake of vitamin C, and between plasma vitamin C and fruit and vegetable consumption were generally low in all groups, indicating that these measures were poorly correlated in this dataset.

(Table 4.22)

The correlation coefficients between dietary intake of folate and red cell folate, and between dietary intake of folate and serum folate, were generally low in all groups, indicating that these measures were poorly correlated in this dataset.

(Table 4.23)

4.3.3 Variation in the levels of water soluble vitamins and plasma total homocysteine

Tables 4.24 and 4.25 show the variation in mean analyte levels for water soluble vitamins and homocysteine according to the region in which the respondent lived¹⁴ and whether someone in the respondent's household was receiving certain state benefits¹⁵.

Although there were few statistically significant differences in mean levels between regions, there was a general trend for respondents in Scotland to have lower concentrations of water soluble vitamins compared with those living in other regions.

Men in Scotland had a significantly lower mean plasma vitamin C concentration than men living in London and the South East ($p<0.05$) and a significantly lower mean EAATAC than men in the Northern region and London and the South East ($p<0.01$). In addition, men in Scotland had a significantly higher mean ETK-B concentration than men in any other region.

Women living in Scotland had a significantly lower mean serum folate concentration than those in the three other regions and a significantly higher mean EGRAC than women in the Northern region (all: $p<0.05$). Mean serum folate concentration for women in Scotland was 18.4nmol/l compared with 22.7nmol/l for those in the Northern region, 22.6nmol/l for those in London and the South East and 22.1nmol/l for those in the Central and South West region of England and in Wales ($p<0.05$). In addition, women in Scotland and in the Central and South West region of England and in Wales had a higher ETK-B concentration than those living in London and the South East ($p<0.05$).

There were no significant regional differences for either men or women for mean red cell folate, serum vitamin B₁₂, ETKAC or plasma total homocysteine.

(Table 4.24)

Mean concentrations of plasma vitamin C and red cell folate were significantly lower for men and women living in benefit households compared with those living in non-benefit households. For example, mean plasma vitamin C concentration for men and women living in benefit households was 43.1µmol/l and 49.4µmol/l, respectively, compared with 53.6µmol/l and 63.7µmol/l for those in non-benefit households (plasma vitamin C for women: $p<0.05$; all others: $p<0.01$). Men living in benefit households also had a significantly higher mean

EGRAC than those living in non-benefit households ($p < 0.05$).

There were no significant differences associated with household benefit status for either men or women for mean serum folate, serum vitamin B₁₂, ETKAC, ETK-B, EAATAC or plasma total homocysteine.

(Table 4.25)

4.4 Fat soluble vitamins and carotenoids

4.4.1 The analytes and results

Plasma retinol (vitamin A) (micromoles/litre)

Plasma retinol is related to long-term dietary intake of vitamin A. The plasma concentration is homeostatically controlled with little variation either within or between subjects. For adults, concentrations below 0.35 $\mu\text{mol/l}$ are considered to be severely deficient and concentrations between 0.35 $\mu\text{mol/l}$ and 0.70 $\mu\text{mol/l}$ indicate marginal status¹³.

Mean plasma retinol concentration was significantly higher for men, 2.02 $\mu\text{mol/l}$, than for women, 1.82 $\mu\text{mol/l}$ ($p < 0.01$). Except for those aged 50 to 64 years, this difference was true within all age groups (25 to 34 years: $p < 0.05$; all others: $p < 0.01$).

Mean plasma retinol concentration increased significantly with age. For men in the youngest age group the mean concentration was 1.81 $\mu\text{mol/l}$ and increased to 2.08 $\mu\text{mol/l}$ for those aged 35 to 49 years, and 2.13 $\mu\text{mol/l}$ for those aged 50 to 64 years (35 to 49 years: $p < 0.05$; 50 to 64 years: $p < 0.01$). For women, the mean concentration for those aged 19 to 49 years was 1.75 $\mu\text{mol/l}$ in each group compared with 1.99 $\mu\text{mol/l}$ for those aged 50 to 64 years (19 to 24 years: $p < 0.05$; all others: $p < 0.01$).

There were no men or women with plasma retinol values of less than 0.35 $\mu\text{mol/l}$. The only group to have concentrations between 0.35 $\mu\text{mol/l}$ and 0.70 $\mu\text{mol/l}$, indicating marginal status, were men aged 50 to 64 years, 1% of whom had a concentration between these values.

(Table 4.26)

Plasma α - and β -carotene and α - and β -cryptoxanthin (micromoles/litre)

These are all carotenoids with vitamin A activity and reflect short to medium term intakes over a wide range. Concentration of carotenoids may be influenced by conversion to vitamin A, the

conversion being dependent on vitamin A status and requirements. This may confound comparisons between dietary intakes and blood concentrations.

For both α - and β -carotene, mean concentrations were significantly higher for women than men. The mean α -carotene concentration was 0.064 $\mu\text{mol/l}$ for men and 0.081 $\mu\text{mol/l}$ for women and the mean β -carotene concentration was 0.216 $\mu\text{mol/l}$ and 0.304 $\mu\text{mol/l}$ for men and women respectively ($p < 0.01$).

Mean α -carotene concentrations were significantly lower in the youngest group of men and women, 0.039 $\mu\text{mol/l}$ and 0.048 $\mu\text{mol/l}$ respectively, than in the oldest groups, 0.074 $\mu\text{mol/l}$ and 0.101 $\mu\text{mol/l}$ ($p < 0.01$).

The mean β -carotene concentration for men increased significantly from 0.143 $\mu\text{mol/l}$ for those aged 19 to 24 years to 0.221 $\mu\text{mol/l}$ for those aged 35 to 49 years and 0.248 $\mu\text{mol/l}$ for those aged 50 to 64 years (35 to 49 years: $p < 0.05$; 50 to 64 years: $p < 0.01$). The only significant age difference for women was between those aged 25 to 34 years and the oldest age group, 0.245 $\mu\text{mol/l}$ and 0.384 $\mu\text{mol/l}$ respectively ($p < 0.05$).

(Tables 4.27 and 4.28)

The mean concentration of α -cryptoxanthin was 0.041 $\mu\text{mol/l}$ for men and 0.035 $\mu\text{mol/l}$ for women (ns). There were no significant age differences in mean α -cryptoxanthin concentrations for either men or women.

Overall, mean β -cryptoxanthin concentration was significantly lower for men than for women, 0.118 $\mu\text{mol/l}$ and 0.148 $\mu\text{mol/l}$ respectively ($p < 0.01$).

Mean β -cryptoxanthin concentration was 0.123 $\mu\text{mol/l}$ for women aged 19 to 24 years and increased to 0.181 $\mu\text{mol/l}$ for those women aged 50 to 64 years ($p < 0.05$). For men there were no significant age differences in mean β -cryptoxanthin concentrations.

(Tables 4.29 and 4.30)

Plasma lycopene and plasma lutein and zeaxanthin (micromoles/litre)

Lycopene, lutein and zeaxanthin are also carotenoids but with no provitamin A activity. The main sources of dietary lycopene are tomatoes and processed tomato products. Plasma lutein and zeaxanthin may be a useful marker of green vegetable intake.

Mean plasma lycopene concentration for men was 0.467 $\mu\text{mol/l}$ and for women, 0.463 $\mu\text{mol/l}$ (ns). For

both men and women there were no significant age differences in mean concentration.

Mean concentration of plasma lutein and zeaxanthin was 0.27 $\mu\text{mol/l}$ for men and 0.29 $\mu\text{mol/l}$ for women (ns). Men in the youngest age group had a significantly lower mean concentration than men in all other age groups. Mean plasma lutein and zeaxanthin was 0.20 $\mu\text{mol/l}$ for men aged 19 to 24 years compared with 0.26 $\mu\text{mol/l}$ for men aged 25 to 34 years, 0.28 $\mu\text{mol/l}$ for men aged 35 to 49 years and 0.30 $\mu\text{mol/l}$ for those aged 50 to 64 years (25 to 34 years: $p < 0.05$; 35 to 64 years: $p < 0.01$). There were no significant age differences for women.

(Tables 4.31 and 4.32)

Plasma 25-hydroxyvitamin D (nanomoles/litre)

Plasma 25-hydroxyvitamin D (25-OHD) is derived from ergocalciferol and cholecalciferol which is obtained from the diet and from synthesis in the skin of cholecalciferol during ultraviolet irradiation from sunlight. It is a measure of vitamin D status and reflects the availability of vitamin D in the body from both dietary and endogenous sources. Factors influencing exposure to sunlight, such as the time of year, habit of dress and time spent outdoors should therefore be considered when interpreting 25-OHD results. Vitamin D is required for calcium absorption from the intestine as well as for a range of other metabolic processes. Traditionally 25nmol/l has been used as the lower threshold for plasma 25-OHD²⁶ but this has been questioned recently and there is currently no consensus²⁷.

Mean concentration of plasma 25-OHD for men was 48.3nmol/l and for women 49.6nmol/l (ns). Men in the youngest age group had a significantly lower mean plasma 25-OHD concentration, 40.6nmol/l, than those in the oldest age group, 51.6nmol/l ($p < 0.05$). There were no significant age differences for women. Overall, 14% of men and 15% of women had a plasma 25-OHD concentration lower than 25nmol/l.

(Table 4.33)

Seasonal variation in concentration of plasma 25-OHD

Vitamin D synthesised by the skin in the presence of sunlight is an important source and plasma concentrations of 25-OHD are likely to be higher during the summer months. Plasma 25-OHD concentration was therefore tabulated by the month when the blood sample was taken²⁸.

Table 4.34 and Figure 4.1 illustrate the variation in mean plasma 25-OHD concentration for men and

women by when the blood sample was taken. The mean plasma 25-OHD concentration for both men and women was higher for respondents who provided a sample in the summer months, July to September, than for those who gave a sample at other times of the year (both sexes: $p < 0.01$). Mean concentrations were also significantly higher in samples obtained between October and December than in those obtained between January and March (men: $p < 0.01$; women: $p < 0.05$) and for men, but not women, between samples obtained in October to December compared with those obtained between April and June ($p < 0.05$).

Men who provided a sample of blood during July to September were significantly less likely to have a 25-OHD concentration below 25nmol/l than those who gave a sample at other times of the year (October to December: $p < 0.05$; all others: $p < 0.01$). This was also true for women providing a sample in July to September compared with those providing a sample in January to March or April to June (April to June: $p < 0.05$; January to March: $p < 0.01$). Nearly one quarter of men and women, 24% and 23% respectively, who provided a sample in the months January to March had a 25-OHD concentration below 25nmol/l.

(Table 4.34 and Figure 4.1)

Plasma α - and γ -tocopherol (micromoles/litre)

Plasma tocopherol concentration can be used as a measure of vitamin E status. α -tocopherol is the predominant form in human tissues. It has the highest biological activity and is the most resistant to oxidation. Increased concentration of plasma lipids appears to cause tocopherols to partition out of cellular membranes, thus increasing concentrations of tocopherol and resulting in a correlation between tocopherol and total lipid in the blood, particularly with the cholesterol fraction. For this reason plasma tocopherol can be usefully expressed as a ratio of tocopherol to cholesterol ($\mu\text{mol/mmol}$)²⁹, enabling comparisons to be made between age groups with different plasma lipid levels.

For adults plasma tocopherols below 11.6 $\mu\text{mol/l}$, or a tocopherol to cholesterol ratio of below 2.25 $\mu\text{mol/mmol}$, tend to cause red blood cells to haemolyse after exposure to oxidising agents. This is sometimes considered to be an indicator of biochemical deficiency but is not indicative of a clinical deficiency of vitamin E. The Committee on Medical Aspects of Food and Nutrition Policy (COMA) Panel on Dietary Reference Values considered a tocopherol to cholesterol ratio of 2.25 $\mu\text{mol/mmol}$ to be the lowest satisfactory value for adults³⁰.

Mean α -tocopherol concentration was 21.1 μ mol/l for men and 20.6 μ mol/l for women (ns). Men in the youngest age group had a significantly lower mean α -tocopherol concentration than men in all other age groups. Mean α -tocopherol was 16.6 μ mol/l for men aged 19 to 24 years compared with 19.7 μ mol/l for men aged 25 to 34 years, 22.0 μ mol/l for men aged 35 to 49 years and 23.3 μ mol/l for those aged 50 to 64 years (25 to 34 years: $p < 0.05$; 35 to 64 years: $p < 0.01$). Similarly, mean α -tocopherol concentration was lower for women in the youngest group, 16.6 μ mol/l, compared with 20.3 μ mol/l for those aged 35 to 49 and 24.7 μ mol/l for those in the oldest age group (both: $p < 0.01$).

Overall, 4% of men and women had a mean α -tocopherol concentration below 11.6 μ mol/l, the lower limit of the normal range for adults. There were no significant age differences in the proportions below the normal range.

Mean concentration of γ -tocopherol was 1.26 μ mol/l for men and 1.21 μ mol/l for women (ns). The mean γ -tocopherol concentration for men aged 19 to 24 years, 1.09 μ mol/l, was significantly lower than for men aged 35 to 49 years, 1.29 μ mol/l, and men aged 50 to 64 years, 1.31 μ mol/l (all: $p < 0.05$). There were no significant age differences for women.

(Tables 4.35 and 4.36)

The mean tocopherol to cholesterol ratio was 4.06 μ mol/mmol for men and 3.96 μ mol/mmol for women (ns). For men, the ratio increased from 3.76 μ mol/mmol for those aged 19 to 24 years to 4.22 μ mol/mmol for those aged 50 to 64 years ($p < 0.05$). For women the mean ratio increased from 3.71 μ mol/mmol for those aged 25 to 34 years to 4.03 μ mol/mmol for those aged 35 to 49 years and 4.17 μ mol/mmol for 50 to 64 year olds (35 to 49 years: $p < 0.05$; 50 to 64 years: $p < 0.01$).

One per cent of men and 2% of women had a tocopherol to cholesterol ratio below 2.25 μ mol/mmol, the lowest satisfactory value for adults. There were no significant age differences for men or women in the proportion below this value.

(Table 4.37)

4.4.2 Correlation with dietary intakes

The correlation coefficients between plasma retinol and dietary intakes of α -carotene, β -carotene and vitamin A (expressed as retinol equivalents) were extremely low for all groups. This indicates that, based on the data from this survey, there were no correlations between these measures.

(Table 4.38)

The correlation coefficients between plasma α -carotene and dietary intake of α -carotene were generally low for all groups, indicating that these measures were poorly correlated in this dataset.

The correlation coefficients between plasma β -carotene and dietary intake of β -carotene were generally low for all groups, except for women aged 19 to 24 years, where there was a high positive correlation.

(Tables 4.39 and 4.40)

Tables 4.41 and 4.42 show correlation coefficients between plasma 25-OHD and dietary intake of vitamin D by, respectively, sex and age of the respondent and time of year when the blood sample was taken. The correlation coefficients in both tables were generally low for all groups. This indicates that, based on the data from this survey, there was no correlation between these measures.

(Table 4.41 and 4.42)

The correlation coefficients between the tocopherol to cholesterol ratio and dietary intake of vitamin E were generally low for all groups, indicating that these measures were poorly correlated in this dataset.

(Table 4.43)

4.4.3 Variation in the concentrations of fat soluble vitamins and carotenoids

Tables 4.44 and 4.45 show variations in mean concentrations of fat soluble vitamins and carotenoids according to the region in which the respondent lived¹⁴ and whether someone in the respondent's household was receiving certain state benefits¹⁵.

There were no consistent patterns of differences in mean concentrations of fat soluble vitamins and carotenoids associated with region.

Women living in London and the South East had a higher mean concentration of plasma β -carotene than women in any other region. Mean plasma β -carotene concentration for women in London and the South East was 0.404 μ mol/l compared with 0.255 μ mol/l for those in Scotland, 0.231 μ mol/l in the Northern region and 0.288 μ mol/l in Central and South West regions of England and in Wales (Northern: $p < 0.01$; all others: $p < 0.05$). In addition, women living in London and the South East had a significantly higher mean α -carotene concentration, 0.101 μ mol/l, than those in the Northern region, 0.072 μ mol/l ($p < 0.05$).

Women in Scotland, along with both men and women in London and the South East, had a significantly higher mean concentration of plasma β -cryptoxanthin than those in the Northern region and Central and South West regions of England and in Wales (Central and South West regions of England and Wales compared with London and the South East: $p < 0.01$; all others: $p < 0.05$).

Men in Scotland and both men and women in the Northern region had a significantly lower mean concentration of plasma lutein and zeaxanthin than those in London and the South East (men: $p < 0.05$; women: $p < 0.01$).

The mean plasma tocopherol to cholesterol ratio was significantly lower for women in Scotland, $3.54 \mu\text{mol}/\text{mmol}$, than for women living in Central and South West regions of England and in Wales, $4.04 \mu\text{mol}/\text{mmol}$, and London and the South East, $4.02 \mu\text{mol}/\text{mmol}$ ($p < 0.05$).

There were no significant regional differences for men or women for plasma retinol, plasma α -cryptoxanthin, plasma lycopene, plasma 25-OHD, plasma α - or γ -tocopherol.

(Table 4.44)

For women, mean concentrations of α - and β -carotene, α - and β -cryptoxanthin, lycopene, lutein and zeaxanthin, and plasma 25-hydroxyvitamin D were significantly lower for those in benefit households than for those living in non-benefit households (α -cryptoxanthin and plasma 25-hydroxyvitamin D: $p < 0.05$; all others: $p < 0.01$). For example, mean α -carotene concentration for women living in benefit households was $0.054 \mu\text{mol}/\text{l}$ compared with $0.087 \mu\text{mol}/\text{l}$ for those in non-benefit households. For these analytes, there were no significant differences for men associated with household benefit status.

For both men and women, mean α -tocopherol concentration was lower in benefit households than non-benefit households (men: $p < 0.05$; women: $p < 0.01$). There were no significant differences for men or women for mean concentrations of plasma retinol, γ -tocopherol or tocopherol to cholesterol ratio by household benefit status.

(Table 4.45)

4.5 Blood lipids

4.5.1 The analytes and results

In adults, circulating levels of plasma total cholesterol and its subfractions are among the predictors of coronary heart disease (CHD)³¹. They

vary with age, genetic and environmental influences, including dietary factors, notably the amount of saturated fatty acids in the diet. The absolute risk of CHD increases with age but the interactions of risk factors, including plasma cholesterol, cigarette smoking, high blood pressure and body weight obscure individual relationships with CHD. High levels of total cholesterol occur in some diseases, for example kidney, liver and thyroid disorders or in diabetes.

Cholesterol circulates in the body bound to a variety of proteins, namely the lipoproteins. Cholesterol bound to low density lipoproteins (*LDL cholesterol*) is the major proportion of total circulating cholesterol. In adults, the risk of CHD is positively correlated with concentrations of both total cholesterol and LDL cholesterol. Cholesterol bound to high density lipoproteins (*HDL cholesterol*) is a smaller proportion of the total and may be inversely related to the development of CHD.

It is generally accepted that a plasma total cholesterol concentration below $5.2 \text{mmol}/\text{l}$ represents an optimal level, $5.2 \text{mmol}/\text{l}$ to $6.4 \text{mmol}/\text{l}$ mildly elevated, $6.5 \text{mmol}/\text{l}$ to $7.8 \text{mmol}/\text{l}$ moderately elevated and above $7.8 \text{mmol}/\text{l}$ a severely elevated level³².

In this survey LDL cholesterol was not directly measured but is calculated by subtraction of HDL cholesterol from total cholesterol, uncorrected for plasma triglycerides; for brevity the term *LDL cholesterol* has been used for *non-HDL cholesterol*. Measurement of triglycerides concentration was not attempted in this survey because a fasting blood sample is required for this analyte and results from non-fasting samples would not have been interpretable.

Plasma cholesterol (millimoles/litre)

Table 4.46 shows that mean *plasma total cholesterol* concentration was $5.21 \text{mmol}/\text{l}$ for men and $5.25 \text{mmol}/\text{l}$ for women (ns). There were no significant age differences for men or women.

Over half, 52%, of men and women had plasma total cholesterol concentrations below $5.20 \text{mmol}/\text{l}$, the optimal level for total cholesterol. Over a third, 34%, of men and women had concentrations between $5.20 \text{mmol}/\text{l}$ and $6.50 \text{mmol}/\text{l}$, which indicates mildly elevated cholesterol levels. Twelve per cent of men and 11% of women had moderately elevated cholesterol levels, at $6.50 \text{mmol}/\text{l}$ to $7.80 \text{mmol}/\text{l}$. Two per cent of men and 3% of women had a mean concentration of $7.80 \text{mmol}/\text{l}$ or above, which indicates a severely elevated level of total cholesterol.

For both men and women the proportion with plasma total cholesterol concentration below 5.20mmol/l decreased with age. For example, for the youngest group of men and women 84% and 83%, respectively, had concentrations below 5.20mmol/l compared with 41% of men and 25% of women in the oldest age group (both sexes: $p < 0.01$).

In contrast, no men or women in the 19 to 24 age group had a mean concentration of 7.80mmol/l or above, indicating a severely elevated level of total cholesterol. The proportion of women with a mean plasma total cholesterol concentration of 7.80mmol/l or above increased from 1% of those aged 25 to 34 years to 9% of those aged 50 to 64 years ($p < 0.01$). There were no significant age differences for men.

Table 4.47 shows mean *HDL cholesterol* concentration by age and sex. There was no significant difference in mean concentration between men and women, 1.07mmol/l and 1.28mmol/l respectively. For both sexes there were no significant differences by age.

Overall, men and women had a similar mean LDL cholesterol concentration, 4.15mmol/l and 3.97mmol/l respectively (ns). However, men aged 25 to 34 years and 35 to 49 years had a significantly higher mean concentration than women of the same age. Mean LDL concentration for men aged 25 to 34 years and 35 to 49 years was 4.00mmol/l and 4.34mmol/l respectively, and for women in the same age groups, 3.57mmol/l and 3.85mmol/l (25 to 34 years: $p < 0.05$; 35 to 49 years: $p < 0.01$). There were no significant differences by age for men or women.

(Tables 4.46 to 4.48)

4.5.2 Variation in the concentrations of plasma total, plasma HDL and plasma LDL cholesterol

Tables 4.49 and 4.50 show variations in mean concentrations of plasma total, plasma HDL and plasma LDL cholesterol according to the region in which the respondent lived¹⁴ and whether someone in the respondent's household was receiving certain state benefits¹⁵.

There were no significant regional differences in mean cholesterol concentrations for men and few for women. However, mean HDL cholesterol concentration was significantly higher for women in Scotland, 1.46mmol/l, than for those in the Northern region, 1.24mmol/l, and in Central and South West regions of England and in Wales, 1.23mmol/l ($p < 0.05$). In addition, women in London and the South East had a higher mean HDL

cholesterol concentration than those living in Central and South West regions of England and in Wales ($p < 0.05$).

(Table 4.49)

There were no significant differences in the mean concentration of the blood lipids by household benefit status.

(Table 4.50)

4.6 Other analytes

4.6.1 The analytes and results

Plasma selenium (micromoles/litre), red cell selenium (micromoles/litre) and erythrocyte glutathione peroxidase activity (GSH-Px) (nanomoles/milligram haemoglobin/minute)

Selenium is an essential trace element³³. It forms part of the structure of certain proteins, and plays a key role in a number of metabolic processes including antioxidant systems and thyroid hormone metabolism.

There are well-confirmed pathological syndromes associated with selenium deficiency as well as selenium toxicity. However, there is increasing evidence that relatively high intakes, within the safe range, may have a protective action against some kinds of cancer³⁴, and other studies have explored the relationships between selenium status or indicators and functional indicators such as immune cell function³⁵ or risk of vascular disease³⁶.

Most studies have reported either plasma, serum or red blood cell selenium concentration levels, the latter being considered a longer term indicator of variations in dietary selenium intake³⁷. The largest fraction of selenium, among all components of blood, is in the erythrocytes³⁸. As it has been claimed that plasma selenium may be an acute phase reactant^{39,40}, red cell selenium may be a better measure of selenium status because red cell nutrient levels are less affected by acute phase status than plasma nutrient levels. However, red blood selenium may be influenced by disease states, as well as age⁴¹. Another favoured measure is blood glutathione peroxidase (GSH-Px) (functional index)⁴², a selenoenzyme which can be measured in either blood cells or plasma.

As shown in Table 4.51, mean *plasma selenium* concentration for men and women was 1.11µmol/l and 1.10µmol/l respectively (ns). For both men and women mean concentration increased significantly with age. For example, for the youngest age group the mean concentration was 1.03µmol/l for both

men and women compared with 1.15 μ mol/l for men and 1.17 μ mol/l for women in the oldest age group ($p < 0.01$).

Mean concentration of *red cell selenium* for men was 1.60 μ mol/l and significantly higher, 1.80 μ mol/l, for women ($p < 0.01$). This difference was observed for all age groups except for those aged 50 to 64 years ($p < 0.01$).

For men, mean concentration of red cell selenium was significantly lower for those aged 19 to 24 years than for men in any other age group. The mean concentration for men aged 19 to 24 years was 1.42 μ mol/l compared with 1.60 μ mol/l for those aged 25 to 34 years and 1.64 μ mol/l for those aged 35 to 64 years (19 to 24 years: $p < 0.05$; all others: $p < 0.01$). For women there were no significant age differences.

Mean *GSH-Px* for men was 121.9nmol/mg Hb/min and for women, 127.2nmol/mg Hb/min ($p < 0.05$). There were no significant age differences for men or women.

(Tables 4.51 to 4.53)

Plasma α_1 -antichymotrypsin concentration (grams/litre)

α_1 -antichymotrypsin (α_1 -ACT) is known as a positive acute phase reactant. It is produced in the liver in response to inflammation. Ferritin is also an acute phase reactant and blood α_1 -ACT and ferritin concentrations may be raised in response to infection or inflammation (see Section 4.2.1). The measurement of α_1 -ACT can provide independent evidence of infection or inflammation that can assist in the interpretation of haematology and plasma nutrient index assays, especially plasma ferritin. For adults, the normal upper limit for α_1 -ACT is usually considered to be 0.65g/l⁴³.

Overall, mean α_1 -ACT was significantly lower for men, 0.30g/l, than for women, 0.31g/l ($p < 0.01$). Women aged 19 to 49 years had significantly lower mean concentrations than those in the oldest group. Mean α_1 -ACT was 0.29g/l for women aged 19 to 24 years, 0.30g/l for those aged 25 to 34 years and 0.31g/l for those aged 35 to 49 years compared with 0.34g/l for those aged 50 to 64 years ($p < 0.01$). There were no significant age differences for men.

One per cent of women aged 50 to 64 years had a mean concentration at 0.65g/l or above, the upper α_1 -ACT limit of normality. None of the other age groups had a α_1 -ACT concentration above the upper limit.

(Table 4.54)

Blood mercury (nanomoles/litre)

Whole blood mercury reflects total exposure to mercury. The main source of mercury exposure is methylmercury found in contaminated fish. Mercury vapour from amalgam tooth fillings and ethylmercury in the form of thiomerosal added as an antiseptic to widely used vaccines both contribute smaller amounts⁴⁴. Mercury has no known function in humans and is a toxin⁴⁵.

Current knowledge of normal mercury concentration in blood and plasma is incomplete⁴⁶ and a review of all published data on mercury concentration concluded that only tentative values could be established⁴⁷. Expert opinion suggests that levels above 16nmol/l for non-occupationally exposed individuals are unusual and indicate increased uptake⁴⁸. Opinions differ as to what level suggests excessive exposure or abnormal uptake.

Mean blood mercury concentration was 7.5nmol/l for men and 8.6nmol/l for women (ns). Generally for men, mean blood mercury concentrations appeared to increase with age. The mean concentration for men aged 19 to 24 years, 3.8nmol/l, was significantly lower than for those aged 25 to 34 years, 6.3nmol/l, those aged 35 to 49 years, 8.7nmol/l and those aged 50 to 64 years, 9.0nmol/l (25 to 34 years: $p < 0.05$; others: $p < 0.01$). The only significant age difference for women was between the youngest age group and the oldest age group, where mean concentration increased from 6.1nmol/l to 10.6nmol/l ($p < 0.05$).

Overall, 9% of men and 10% of women had a mercury concentration at or above 16.0nmol/l. The proportion of men with concentrations at 16.0nmol/l or above increased significantly with age, from 1% of those aged 19 to 24 years to 14% of those aged 50 to 64 years ($p < 0.01$). For women there were no significant differences in the proportion with concentrations at 16.0nmol/l or above by age.

(Table 4.55)

4.6.2 Variation in the concentrations and levels of other analytes

Table 4.56 shows the variation in concentrations and levels of other analytes for men and women associated with the region in which the respondent lived¹⁴. There were no consistent patterns of differences in mean concentrations or levels associated with region.

Both mean concentrations of plasma selenium and red cell selenium were significantly higher for women living in London and the South East than for those in the Northern region and in Central and

South West regions of England and in Wales (red cell selenium in Central and South West regions of England and in Wales: $p < 0.01$; others: $p < 0.05$).

The mean GSH-Px was significantly lower for men living in Scotland compared with those living in all other regions (Northern region: $p < 0.05$; others: $p < 0.01$). For women, those living in Scotland had lower mean GSH-Px than women living in London and the South East ($p < 0.01$).

Men living in London and the South East had a significantly higher mean blood mercury concentration, 9.4nmol/l, than those in Central and South West regions of England and in Wales, 6.7nmol/l ($p < 0.05$).

There were no significant differences for men or women in mean α_1 -ACT concentrations associated with region.

(Table 4.56)

Table 4.57 shows the variation in levels of other analytes according to whether the respondent lived in a household which was receiving certain state benefits or not¹⁵.

Men and women living in benefit households had a significantly lower mean plasma selenium concentration and a lower mean blood mercury concentration than those in non-benefit households (plasma selenium and men: $p < 0.05$; blood mercury and women: $p < 0.05$; others: $p < 0.01$). In addition, women in benefit households had a significantly lower mean concentration of red cell selenium, 1.65 μ mol/l, than those in non-benefit households, 1.84 μ mol/l ($p < 0.01$).

There were no significant differences for men or women in mean α_1 -ACT concentrations or mean GSH-Px by household benefit status.

(Table 4.57)

References and endnotes

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- 4 Some of the posted blood samples reached Great Ormond Street Haematology Laboratory several days after posting. About 60% of all samples were delayed by 24 hrs or more and about 30% were delayed by 48 hrs or

more. Different analytes have different sensitivities to the effects of delay.

- 5 For some of the analytes measured in samples that had been sent through the post there was a significant linear correlation between the assay values and the magnitude of the delay time, and in some there was also a small but significant difference in values obtained from the small number of slightly haemolysed samples. In order to correct for these two potential errors, the following mathematical corrections were employed. For each analyte where there was a significant correlation with delay time, each result was corrected (up or down) by the product of number of hours delay and the slope of the overall rate of change per hour. For each analyte where there was a significant effect of haemolysis, the results from the haemolysed samples were multiplied by a correction factor (between 0.969 and 1.023) which represented the ratio of the overall mean values of the haemolysed and non-haemolysed samples.

- 6 When interpreting results, it should be noted that there was a time lag between the blood sample being obtained and the original dietary recording period (mean 14 days). It should also be noted that the results of the blood sample analyses measure nutritional status in the longer term which may not necessarily be reflected by dietary intake over the relatively short period of seven days.

- 7 Pearson correlation coefficients were calculated in SPSS. Weighting factors, for non-response and sampling probability, were scaled (normalised) to the original, unweighted sample size before running the SPSS procedure on weighted data. Pearson correlation coefficients are robust to departures from normally distributed data, that is skewed data, provided the value of the population coefficient is low, which it is for these data. See:

Gayen AK. The distribution of Student's t in random samples of any size drawn from non-normal universes. *Biometrika* 1949; **36**: 353.

Gayen AK. The distribution of the variance ratio in random samples of any size drawn for non-normal universes. *Biometrika* 1950; **37**: 236.

Gayen AK. Significance of difference between the means of two non-random samples. *Biometrika* 1950; **37**: 399.

Gayen AK. The frequency distribution of the product-moment correlation coefficient in random samples of any size drawn for non-normal universes. *Biometrika* 1951; **38**: 219.

- 8 Distribution of data was evaluated using the skewness statistic in SPSS. If the skewness statistic is less than twice the standard error of the statistic then data were considered to be normally distributed.

For all age/sex groups, plasma vitamin C was found to be normally distributed. All other blood analytes were found to be not normally distributed for at least one age/sex group. For all age/sex groups, the following analytes were found to be skewed: Red cell folate, serum vitamin B₁₂, erythrocyte glutathione peroxidase, blood mercury, total iron-binding capacity, plasma total homocysteine, plasma 25-hydroxyvitamin D, plasma α -tocopherol to total cholesterol ratio, plasma α -antichymotrypsin, plasma β -carotene, plasma β -cryptoxanthin, plasma lycopene, and plasma lutein and zeaxanthin.

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- 10 World Health Organization. *Nutritional Anaemias*. Technical Report Series: 503. WHO (Geneva, 1972).
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- ¹⁴ The areas included in each of the four analysis 'regions' are given in the response chapter, Chapter 2 of the Technical Report (see Note 1). Definitions of 'regions' are given in the glossary (see Appendix E).
- ¹⁵ Households receiving certain benefits are those where someone in the respondent's household was currently receiving Working Families Tax Credit or had, in the previous 14 days, drawn Income Support or (Income-related) Job Seeker's Allowance. Definitions of 'household' and 'benefits (receiving)' are given in the Glossary (see Appendix E).
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Table 4.1

Percentage distribution of haemoglobin concentration by sex and age of respondent

Haemoglobin concentration (g/dl)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 11.0	-	1	0	0	0	3	-	2	2	2
Less than 12.0	-	1	1	0	1	7	8	10	7	8
Less than 12.5	-	1	1	0	1	16	14	18	16	16
Less than 13.0	-	2	4	3	3	32	34	35	31	33
Less than 13.5	6	6	5	9	6	45	61	54	51	54
Less than 14.0	8	10	9	15	11	58	78	74	67	71
Less than 14.5	17	24	22	29	24	84	88	90	80	86
Less than 15.0	36	41	43	49	43	96	95	97	89	94
Less than 16.0	83	78	77	86	81	100	100	100	99	100
Less than 17.0	97	99	97	98	98				100	
All	100	100	100	100	100					
<i>Base</i>	83	170	191	194	638	81	162	243	196	683
Mean (average value)	15.2	15.1	15.1	14.9	15.1	13.5	13.3	13.3	13.5	13.4
Median	15.3	15.2	15.2	15.0	15.2	13.7	13.2	13.3	13.4	13.4
Lower 2.5 percentile	13.0	13.0	12.7	12.8	12.9	10.8	11.5	10.9	11.2	11.1
Upper 2.5 percentile	17.2	16.9	17.0	16.8	16.9	15.0	15.1	15.1	15.7	15.3
Standard deviation	0.96	1.04	1.05	1.04	1.04	1.05	0.91	1.03	1.14	1.04

Table 4.2

Percentage distribution of mean corpuscular volume by sex and age of respondent

Mean corpuscular volume (fl)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 79.0	2	2	1	0	1	3	3	1	2	2
Less than 83.0	7	4	3	0	3	4	5	4	4	4
Less than 86.0	15	13	9	5	10	9	9	12	8	9
Less than 89.0	31	29	22	14	23	27	22	22	18	22
Less than 92.0	63	57	40	28	44	41	48	38	36	40
Less than 95.0	79	81	64	51	67	67	71	59	60	63
Less than 99.0	94	95	84	78	87	88	84	80	83	83
Less than 101.0	97	98	92	87	93	88	92	87	90	89
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	83	170	191	194	638	81	162	243	196	683
Mean (average value)	91.0	90.9	93.3	95.0	92.9	92.8	92.7	93.9	93.7	93.4
Median	90.5	91.3	93.4	94.9	92.7	93.3	92.1	93.7	93.8	93.4
Lower 2.5 percentile	80.8	74.1	80.9	85.4	82.4	71.9	78.8	81.6	80.4	80.4
Upper 2.5 percentile	102.1	100.0	106.1	106.6	103.8	106.3	107.3	106.5	104.8	106.3
Standard deviation	5.11	5.15	6.01	5.58	5.79	6.77	6.07	6.55	5.95	6.30

Table 4.3

Percentage distribution of haematocrit by sex and age of respondent

Haematocrit (l/l)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 0.360	-	2	1	-	1	10	5	4	3	5
Less than 0.375	-	3	1	0	1	13	12	12	8	11
Less than 0.400	4	4	4	4	4	24	31	29	26	28
Less than 0.425	13	11	14	14	13	64	68	67	63	65
Less than 0.450	45	44	47	44	45	87	90	93	85	89
Less than 0.475	69	70	67	71	69	95	98	98	94	97
Less than 0.500	86	91	85	85	87	96	100	100	98	99
All	100	100	100	100	100	100			100	100
Base	83	170	191	194	638	81	162	243	196	683
Mean (average value)	0.460	0.457	0.460	0.460	0.459	0.416	0.411	0.411	0.417	0.413
Median	0.460	0.460	0.460	0.460	0.460	0.420	0.410	0.410	0.410	0.410
Lower 2.5 percentile	0.380	0.356	0.380	0.390	0.380	0.340	0.350	0.340	0.350	0.340
Upper 2.5 percentile	0.511	0.520	0.534	0.520	0.520	0.501	0.470	0.470	0.480	0.480
Standard deviation	0.0308	0.0333	0.0363	0.0341	0.0341	0.0372	0.0316	0.0314	0.0352	0.0334

Table 4.4

Percentage distribution of plasma iron by sex and age of respondent

Plasma iron ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 8.0	-	6	2	3	3	10	9	10	5	8
Less than 10.0	2	15	5	9	9	33	16	19	10	17
Less than 13.0	27	33	21	26	26	41	36	34	25	33
Less than 16.0	50	54	48	50	50	47	49	55	49	51
Less than 20.0	68	74	74	71	72	76	73	79	81	78
Less than 25.0	83	93	91	89	90	91	88	90	93	91
Less than 30.0	92	98	98	99	97	98	95	97	97	97
Less than 32.0	97	100	99	99	99	100	96	98	99	98
All	100		100	100	100		100	100	100	100
Base	81	165	190	190	627	77	158	238	194	668
Mean (average value)	17.8	16.2	17.3	17.1	17.0	15.6	16.5	15.9	16.3	16.1
Median	16.1	15.6	16.2	16.1	16.0	17.0	16.2	15.2	16.0	15.9
Lower 2.5 percentile	10.0	6.7	8.6	6.2	7.6	4.0	4.6	5.7	7.2	5.6
Upper 2.5 percentile	33.8	30.5	29.7	28.7	30.5	28.9	33.4	30.5	31.4	30.9
Standard deviation	6.69	5.80	5.54	6.53	6.08	6.60	7.17	6.60	5.54	6.45

Table 4.5

Percentage distribution of total iron-binding capacity by sex and age of respondent

Cumulative percentages

Total iron-binding capacity ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 45.0	–	2	2	1	1	–	1	4	2	2
Less than 50.0	12	9	5	6	8	3	3	8	7	6
Less than 55.0	17	21	16	23	20	5	12	19	22	16
Less than 60.0	44	49	42	46	45	20	27	41	49	37
Less than 65.0	70	67	71	68	69	57	49	61	68	60
Less than 70.0	83	83	88	88	86	67	68	79	84	76
Less than 75.0	93	91	96	94	94	86	80	89	94	88
Less than 80.0	97	96	99	97	97	92	91	94	96	93
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	<i>81</i>	<i>165</i>	<i>188</i>	<i>189</i>	<i>624</i>	<i>77</i>	<i>158</i>	<i>238</i>	<i>193</i>	<i>666</i>
Mean (average value)	61.8	61.8	61.2	61.5	61.5	66.1	66.8	62.8	61.7	63.8
Median	61.2	60.1	61.0	61.1	61.0	63.0	65.2	61.9	60.2	62.8
Lower 2.5 percentile	47.5	46.1	45.1	47.3	46.9	49.3	48.9	43.8	44.8	45.1
Upper 2.5 percentile	81.3	81.3	75.9	82.1	80.9	86.8	90.3	84.7	82.9	86.2
Standard deviation	8.39	9.38	8.00	9.01	8.72	8.82	11.36	10.14	9.75	10.38

Table 4.6

Percentage distribution of plasma iron % saturation by sex and age of respondent

Cumulative percentages

Plasma iron % saturation (%)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 10.0	–	1	0	3	1	8	7	7	3	6
Less than 15.0	6	13	3	6	7	27	17	18	8	16
Less than 20.0	17	25	17	22	20	42	36	32	22	31
Less than 25.0	47	47	40	41	43	51	56	47	44	49
Less than 30.0	66	69	62	60	64	61	70	66	67	67
Less than 35.0	71	81	77	77	77	85	83	78	83	82
Less than 40.0	82	92	89	87	88	92	89	88	92	90
Less than 45.0	87	94	94	93	93	96	94	96	95	95
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	<i>81</i>	<i>165</i>	<i>188</i>	<i>189</i>	<i>624</i>	<i>77</i>	<i>158</i>	<i>238</i>	<i>192</i>	<i>665</i>
Mean (average value)	29.7	26.6	28.5	28.2	28.1	24.3	25.3	26.1	27.1	26.0
Median	25.1	26.3	27.1	27.3	26.7	24.4	22.6	25.5	27.1	25.3
Lower 2.5 percentile	12.7	10.8	13.7	9.0	12.1	5.4	6.3	7.9	9.1	7.8
Upper 2.5 percentile	64.1	50.3	50.8	51.3	52.0	46.6	50.2	50.3	52.3	50.2
Standard deviation	13.17	9.77	9.29	10.02	10.24	11.20	11.47	11.15	9.82	10.88

Table 4.7

Percentage distribution of serum ferritin by sex and age of respondent

Serum ferritin ($\mu\text{g/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 15	-	-	2	2	1	16	8	12	8	11
Less than 20	4	0	6	5	4	30	18	24	15	21
Less than 25	7	1	7	8	6	33	27	32	18	27
Less than 40	15	10	11	14	12	59	59	57	32	51
Less than 50	18	18	18	19	18	70	73	67	42	62
Less than 60	30	24	23	23	24	78	77	76	50	69
Less than 75	42	36	33	32	35	88	89	84	63	79
Less than 100	77	57	52	45	55	97	94	91	79	89
Less than 150	96	78	73	65	75	100	99	97	91	96
All	100	100	100	100	100		100	100	100	100
<i>Base</i>	<i>85</i>	<i>169</i>	<i>186</i>	<i>194</i>	<i>633</i>	<i>80</i>	<i>156</i>	<i>238</i>	<i>195</i>	<i>670</i>
Mean (average value)	78	101	129	145	120	41	43	49	71	53
Median	78	89	96	109	92	34	34	37	60	40
Lower 2.5 percentile	18	26	14	17	18	10	9	6	4	7
Upper 2.5 percentile	177	201	512	505	371	102	144	170	232	163
Standard deviation	34.2	52.2	109.7	157.9	112.1	26.2	30.8	46.7	54.4	45.6

Table 4.8

Pearson correlation coefficients for serum ferritin and haemoglobin with dietary intake of iron

	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
Serum ferritin with dietary intakes of:										
Haem iron	0.28*	0.11	0.24**	0.09	0.16**	-0.11	0.05	0.08	0.21**	0.15**
Non-haem iron	0.08	-0.08	0.01	0.02	0.03	0.00	-0.02	-0.05	-0.03	-0.03
Total iron	0.11	-0.07	0.04	0.02	0.05	-0.01	-0.02	-0.05	-0.02	-0.03
<i>Base</i>	<i>80</i>	<i>154</i>	<i>177</i>	<i>190</i>	<i>600</i>	<i>74</i>	<i>150</i>	<i>224</i>	<i>191</i>	<i>639</i>
Haemoglobin with dietary intakes of:										
Haem iron	-0.07	-0.10	-0.02	0.12	0.00	0.21	0.12	-0.02	0.13	0.10*
Non-haem iron	-0.27*	0.25**	-0.08	0.04	0.02	0.10	-0.11	-0.13	0.05	-0.07
Total iron	-0.28*	0.24**	-0.08	0.05	0.02	0.11	-0.10	-0.13	0.06	-0.06
<i>Base</i>	<i>78</i>	<i>155</i>	<i>181</i>	<i>190</i>	<i>604</i>	<i>76</i>	<i>155</i>	<i>229</i>	<i>192</i>	<i>652</i>

Note: * $p < 0.05$; ** $p < 0.01$

Table 4.9

Pearson correlation coefficients for serum ferritin and haemoglobin with plasma iron % saturation

	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
Serum ferritin with:										
Plasma iron % saturation	0.06	0.15	0.19*	0.38**	0.23**	0.43**	0.22**	0.25**	0.13	0.22**
Base	83	164	179	189	614	71	154	234	187	646
Haemoglobin with:										
Plasma iron % saturation	0.24*	0.21**	0.16*	0.26**	0.21**	0.15	0.28**	0.37**	0.28**	0.30**
Base	81	165	183	189	619	73	159	238	189	658

Note: * $p < 0.05$; ** $p < 0.01$

Table 4.10

Pearson correlation coefficients for serum ferritin and haemoglobin with plasma α_1 -antichymotrypsin

	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
Serum ferritin with:										
Plasma α_1 -antichymotrypsin	-0.12	0.14	-0.05	-0.13	-0.03	0.11	-0.12	-0.01	0.06	0.08*
Base	83	161	171	180	595	71	151	229	185	636
Haemoglobin with:										
Plasma α_1 -antichymotrypsin	-0.12	-0.21**	0.10	-0.18*	-0.12**	0.05	0.21**	0.12	0.05	0.12**
Base	81	162	174	181	599	73	156	233	187	648

Note: * $p < 0.05$; ** $p < 0.01$

Table 4.11 This table is spread over 2 pages. Altogether there is one spread (2 pages).

Haematology analytes by sex of respondent and region

Sex of respondent and analytes	Units	Region							
		Scotland				Northern			
		Mean	Median	sd	Base	Mean	Median	sd	Base
Men									
Haemoglobin concentration	g/dl	15.1	15.1	0.85	53	15.1	15.1	0.99	178
Mean corpuscular volume	fl	93.5	92.5	6.26	53	92.7	92.7	5.80	178
Haematocrit	l/l	0.455	0.460	0.0325	53	0.460	0.460	0.0354	178
Plasma iron	μmol/l	17.5	16.8	5.59	54	17.5	15.8	6.15	169
Total iron-binding capacity	μmol/l	62.9	60.4	8.86	54	62.4	61.1	8.30	168
Iron % saturation	%	28.6	28.1	10.62	54	28.4	26.6	10.07	168
Serum ferritin	μg/l	139	103	108.1	53	111	86	93.6	176
Women									
Haemoglobin concentration	g/dl	13.6	13.8	0.98	53	13.4	13.5	1.01	178
Mean corpuscular volume	fl	94	93	4.9	53	94	94	5.8	178
Haematocrit	l/l	0.415	0.420	0.0303	53	0.416	0.411	0.0336	178
Plasma iron	μmol/l	17.4	15.5	7.12	50	16.2	15.5	6.38	175
Total iron-binding capacity	μmol/l	64.6	62.7	11.18	50	63.5	62.8	9.16	175
Iron % saturation	%	28.4	28.6	13.33	50	26.1	24.9	10.70	174
Serum ferritin	μg/l	51	28	58.5	51	58	44	47.0	175

Central, South West and Wales				London and the South East				Sex of respondent and analytes	Units
Mean	Median	sd	Base	Mean	Median	sd	Base		
15.1	15.1	0.94	226	15.0	15.2	1.23	181	Men	
92.9	92.4	5.08	226	92.8	92.8	6.48	181	Haemoglobin concentration	g/dl
0.458	0.460	0.0316	226	0.460	0.460	0.0364	181	Mean corpuscular volume	fl
16.7	15.8	6.37	227	16.7	15.7	5.78	176	Haematocrit	l/l
60.7	61.2	8.33	226	61.3	60.5	9.49	176	Plasma iron	µmol/l
28.0	27.0	10.69	226	27.6	26.3	9.73	176	Total iron-binding capacity	µmol/l
115	92	100.3	225	128	99	140.1	179	Iron % saturation	%
								Serum ferritin	µg/l
13.4	13.3	1.06	258	13.2	13.2	1.05	194	Women	
94	94	6.7	258	93	93	6.5	194	Haemoglobin concentration	g/dl
0.414	0.410	0.0343	258	0.410	0.410	0.0326	194	Mean corpuscular volume	fl
16.3	16.2	6.67	250	15.5	15.7	6.01	192	Haematocrit	l/l
63.6	62.1	10.98	250	64.3	63.3	10.48	191	Plasma iron	µmol/l
26.4	26.2	11.05	250	24.7	23.9	10.02	191	Total iron-binding capacity	µmol/l
52	41	41.7	249	50	37	45.4	194	Iron % saturation	%
								Serum ferritin	µg/l

Table 4.12

Haematology analytes by sex of respondent and whether someone in the respondent's household was receiving certain benefits

Sex of respondent and analytes	Units	Whether receiving benefits								
		Receiving benefits				Not receiving benefits				
		Mean	Median	sd	Base	Mean	Median	sd	Base	
Men										
Haemoglobin concentration	g/dl	15.0	15.0	1.23	86	15.1	15.2	1.00	552	
Mean corpuscular volume	fl	92.5	92.6	7.22	86	92.9	92.7	5.54	552	
Haematocrit	l/l	0.457	0.460	0.0352	86	0.459	0.460	0.0340	552	
Plasma iron	µmol/l	16.9	16.3	5.95	85	17.0	15.9	6.11	542	
Total iron-binding capacity	µmol/l	61.3	61.6	7.79	85	61.5	60.9	8.87	539	
Iron % saturation	%	28.3	26.9	10.98	85	28.0	26.7	10.12	539	
Serum ferritin	µg/l	97	78	76.7	84	123	94	116.2	549	
Women										
Haemoglobin concentration	g/dl	13.4	13.4	1.20	131	13.4	13.3	1.00	552	
Mean corpuscular volume	fl	93.5	92.9	7.14	131	93.4	93.4	6.09	552	
Haematocrit	l/l	0.416	0.410	0.0393	131	0.413	0.410	0.0318	552	
Plasma iron	µmol/l	15.9	15.0	7.69	129	16.2	15.9	6.12	538	
Total iron-binding capacity	µmol/l	65.2	64.4	10.76	129	63.5	62.5	10.28	537	
Iron % saturation	%	25.4	23.5	13.41	129	26.1	25.8	10.19	536	
Serum ferritin	µg/l	47	33	41.2	126	55	42	46.5	543	

Table 4.13

Percentage distribution of plasma vitamin C by sex and age of respondent

Plasma vitamin C (µmol/l)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 11.0	7	5	4	5	5	4	3	4	3	3
Less than 30.0	12	20	22	25	21	9	14	15	15	14
Less than 50.0	39	42	50	48	46	26	37	36	30	33
Less than 60.0	57	57	66	63	62	46	44	47	44	45
Less than 70.0	81	72	79	73	76	73	59	65	60	63
Less than 80.0	84	88	91	85	88	84	75	78	78	78
Less than 90.0	89	93	97	91	93	91	84	91	89	89
Less than 100.0	95	97	99	96	97	92	90	95	92	93
All	100	100	100	100	100	100	100	100	100	100
Base	79	156	180	178	593	72	151	234	188	644
Mean (average value)	54.6	54.2	50.0	51.6	52.2	60.1	62.9	58.8	62.2	60.9
Median	59.0	56.6	49.8	50.8	52.6	62.1	63.5	61.0	63.6	63.0
Lower 2.5 percentile	6.8	8.1	7.2	6.6	7.0	5.2	9.1	8.5	9.9	9.5
Upper 2.5 percentile	101.9	109.2	98.1	108.4	103.1	109.1	119.2	108.5	109.4	109.9
Standard deviation	24.42	25.81	22.79	27.85	25.40	23.54	30.00	26.49	27.15	27.24

Table 4.14

Percentage distribution of red cell folate by sex and age of respondent

Red cell folate (nmol/l)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 230	-	1	1	-	1	-	-	-	0	0
Less than 350	13	4	5	2	5	8	4	5	6	5
Less than 425	19	20	12	10	14	22	14	15	10	14
Less than 500	50	29	21	20	27	31	34	28	20	28
Less than 600	73	46	38	37	44	61	56	49	35	48
Less than 800	89	70	76	64	73	85	84	72	58	72
Less than 1000	93	86	93	78	86	97	94	85	81	87
Less than 1200	95	91	96	88	92	100	97	93	91	94
All	100	100	100	100	100	100	100	100	100	100
Base	83	170	189	194	636	81	161	243	197	683
Mean (average value)	561	688	677	773	694	576	630	691	768	685
Median	492	629	644	688	633	526	562	612	696	610
Lower 2.5 percentile	231	319	278	360	287	283	332	319	317	320
Upper 2.5 percentile	1338	1319	1245	1531	1426	1016	1255	1448	1651	1392
Standard deviation	261.6	281.4	244.8	319.7	288.2	194.4	274.6	293.4	317.4	293.0

Table 4.15

Percentage distribution of serum folate by sex and age of respondent

Serum folate (nmol/l)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 6.3	-	1	1	1	1	-	-	0	-	0
Less than 7.0	-	1	1	1	1	-	-	1	-	0
Less than 10.0	12	7	3	6	6	6	7	5	5	6
Less than 15.0	42	30	27	21	28	32	30	27	21	27
Less than 20.0	68	60	56	47	56	53	52	48	38	47
Less than 25.0	82	74	72	62	71	75	71	63	58	65
Less than 28.1	92	83	80	67	78	79	83	72	65	73
Less than 30.0	93	87	84	73	83	83	86	78	70	78
Less than 35.0	100	94	93	88	93	94	93	91	87	90
Less than 40.0		99	99	96	98	100	99	98	99	99
All		100	100	100	100		100	100	100	100
Base	83	169	188	196	636	81	159	240	197	678
Mean (average value)	17.4	20.1	20.9	22.9	20.8	20.6	21.2	21.9	23.7	22.1
Median	16.4	18.8	19.0	21.4	18.8	19.7	19.5	20.6	22.6	21.0
Lower 2.5 percentile	7.2	8.8	9.4	7.8	8.1	9.2	8.4	8.6	9.3	8.9
Upper 2.5 percentile	32.9	38.5	37.6	40.3	39.4	35.6	38.3	38.9	39.6	39.2
Standard deviation	7.07	8.16	8.02	9.40	8.55	8.03	11.13	8.95	9.00	9.46

Table 4.16

Percentage distribution of serum vitamin B₁₂ by sex and age of respondent

Serum vitamin B ₁₂ (pmol/l)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 118	-	-	2	3	2	5	5	4	3	4
Less than 150	3	2	8	8	6	17	14	8	7	10
Less than 200	27	16	21	19	20	31	34	29	19	27
Less than 250	44	33	40	37	38	57	54	47	36	47
Less than 300	62	60	55	59	59	73	75	61	57	65
Less than 350	78	73	72	71	73	87	85	74	72	78
Less than 450	90	95	94	87	92	96	93	91	85	91
Less than 550	96	97	97	94	96	100	97	97	95	97
All	100	100	100	100	100		100	100	100	100
<i>Base</i>	<i>84</i>	<i>168</i>	<i>187</i>	<i>193</i>	<i>632</i>	<i>79</i>	<i>158</i>	<i>239</i>	<i>191</i>	<i>667</i>
Mean (average value)	286	298	294	308	298	247	259	288	329	288
Median	261	279	281	276	276	233	237	255	285	263
Lower 2.5 percentile	138	139	121	95	128	111	85	99	110	104
Upper 2.5 percentile	614	581	575	665	614	525	590	613	691	573
Standard deviation	111.2	101.8	108.1	155.1	123.2	91.3	121.9	145.4	273.9	185.3

Table 4.17

Percentage distribution of erythrocyte transketolase activation coefficient (ETKAC) by sex and age of respondent

ETKAC (ratio)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Greater than 1.25	-	3	2	5	3	-	1	2	1	1
Greater than 1.20	18	23	14	19	19	7	8	14	9	10
Greater than 1.18	21	28	22	23	24	10	14	17	13	14
Greater than 1.15	58	45	43	45	46	36	40	33	29	34
Greater than 1.13	80	71	64	59	66	52	58	55	45	53
Greater than 1.10	96	92	91	89	91	88	86	86	79	84
Greater than 1.05	100	99	97	97	98	100	98	97	99	98
All		100	100	100	100		100	100	100	100
<i>Base</i>	<i>83</i>	<i>164</i>	<i>189</i>	<i>192</i>	<i>628</i>	<i>74</i>	<i>162</i>	<i>241</i>	<i>195</i>	<i>672</i>
Mean (average value)	1.16	1.16	1.15	1.15	1.15	1.14	1.15	1.14	1.13	1.14
Median	1.16	1.15	1.15	1.15	1.15	1.14	1.14	1.14	1.13	1.14
Lower 2.5 percentile	1.09	1.06	1.05	1.04	1.06	1.07	1.06	1.04	1.06	1.06
Upper 2.5 percentile	1.24	1.26	1.25	1.27	1.26	1.22	1.25	1.25	1.23	1.24
Standard deviation	0.040	0.047	0.049	0.064	0.053	0.036	0.060	0.057	0.049	0.054

Table 4.18

Percentage distribution of erythrocyte transketolase basal activity (ETK-B) by sex and age of respondent

ETK-B ($\mu\text{mol/g Hb/min}$)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 0.50	2	2	2	4	2	-	-	3	1	1
Less than 0.60	14	15	12	10	12	3	9	11	7	9
Less than 0.65	36	28	29	25	28	12	20	24	16	19
Less than 0.70	57	44	44	39	44	18	28	39	31	32
Less than 0.75	69	55	60	55	58	30	42	50	49	46
Less than 0.80	83	74	80	74	77	50	62	69	62	63
Less than 0.90	95	90	95	96	94	86	88	91	86	88
Less than 1.00	100	97	99	100	99	95	97	98	96	97
All		100	100		100	100	100	100	100	100
Base	83	167	191	192	633	74	162	242	195	673
Mean (average value)	0.70	0.73	0.71	0.73	0.72	0.79	0.76	0.74	0.77	0.76
Median	0.69	0.71	0.72	0.73	0.72	0.80	0.76	0.75	0.75	0.76
Lower 2.5 percentile	0.51	0.51	0.48	0.48	0.49	0.57	0.50	0.47	0.55	0.51
Upper 2.5 percentile	0.95	1.16	0.96	0.92	0.95	1.03	1.00	1.00	1.05	1.02
Standard deviation	0.107	0.151	0.124	0.104	0.125	0.110	0.124	0.128	0.128	0.126

Table 4.19

Percentage distribution of erythrocyte glutathione reductase activation coefficient (EGRAC) by sex and age of respondent

EGRAC (ratio)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Greater than 1.70	6	5	2	3	4	10	8	6	4	6
Greater than 1.60	17	12	9	9	11	19	19	11	10	13
Greater than 1.50	25	20	16	15	18	35	35	20	16	24
Greater than 1.40	59	40	37	30	38	66	53	40	33	44
Greater than 1.30	82	70	67	54	66	77	78	69	50	66
Greater than 1.20	100	96	86	84	90	91	95	91	82	90
All		100	100	100	100	100	100	100	100	100
Base	83	167	191	192	633	74	162	242	195	673
Mean (average value)	1.45	1.40	1.37	1.35	1.38	1.45	1.44	1.40	1.34	1.40
Median	1.44	1.37	1.36	1.32	1.36	1.47	1.41	1.36	1.31	1.38
Lower 2.5 percentile	1.22	1.16	1.10	1.12	1.12	1.08	1.12	1.09	1.08	1.09
Upper 2.5 percentile	1.77	1.88	1.69	1.78	1.77	1.98	1.89	1.88	1.79	1.85
Standard deviation	0.132	0.163	0.176	0.171	0.169	0.194	0.179	0.206	0.179	0.194

Table 4.20

Percentage distribution of erythrocyte aspartate aminotransferase activation coefficient (EAATAC) by sex and age of respondent

EAATAC (ratio)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Greater than 2.10	1	4	6	5	5	3	5	6	5	5
Greater than 2.00	4	10	13	11	10	12	8	12	13	11
Greater than 1.90	29	23	25	22	24	20	23	22	27	24
Greater than 1.80	55	48	45	39	45	29	39	39	43	39
Greater than 1.70	77	78	70	61	70	51	66	58	66	61
Greater than 1.60	95	97	89	86	91	78	88	81	83	83
Greater than 1.50	99	98	95	95	96	98	97	94	91	94
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	83	167	191	192	633	74	162	242	195	673
Mean (average value)	1.81	1.81	1.80	1.77	1.79	1.74	1.78	1.77	1.79	1.77
Median	1.84	1.78	1.79	1.74	1.78	1.71	1.75	1.75	1.76	1.75
Lower 2.5 percentile	1.56	1.53	1.45	1.38	1.46	1.47	1.48	1.28	1.41	1.41
Upper 2.5 percentile	2.07	2.19	2.21	2.31	2.19	2.23	2.27	2.20	2.17	2.22
Standard deviation	0.134	0.156	0.195	0.204	0.182	0.183	0.177	0.232	0.241	0.218

Table 4.21

Percentage distribution of plasma total homocysteine by sex and age of respondent

Plasma total homocysteine ($\mu\text{mol/l}$)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Greater than 18.0	13	6	5	6	7	3	1	3	5	3
Greater than 14.0	23	14	16	19	17	12	5	10	12	10
Greater than 12.0	41	26	31	37	33	16	20	20	29	22
Greater than 10.0	66	57	56	70	62	34	39	38	49	41
Greater than 9.0	77	74	74	83	77	42	54	54	65	56
Greater than 8.0	85	87	88	94	89	53	69	74	79	72
Greater than 6.0	100	100	100	99	100	79	94	96	94	93
All				100		100	100	100	100	100
<i>Base</i>	81	162	179	181	603	77	154	233	190	654
Mean (average value)	12.5	11.1	11.1	12.4	11.7	9.3	9.6	10.4	10.6	10.1
Median	11.1	10.2	10.5	11.4	10.6	8.6	9.2	9.2	9.9	9.4
Lower 2.5 percentile	6.5	6.9	6.8	6.9	6.8	5.2	4.4	5.8	5.1	5.2
Upper 2.5 percentile	26.5	19.9	19.7	25.9	22.3	21.9	15.8	20.6	19.2	19.2
Standard deviation	5.37	4.00	3.21	5.52	4.55	3.86	2.93	6.56	3.40	4.76

Table 4.22

Pearson correlation coefficients for plasma vitamin C with dietary intake of vitamin C and fruit and vegetable intake[†]

Sex and age of respondent	Correlation of plasma vitamin C with:		
	Dietary intake of vitamin C	Fruit and vegetable consumption	Base
Men aged (years):			
19–24	0.36**	0.39**	75
25–34	0.36**	0.34**	141
35–49	0.16*	0.25**	171
50–64	0.48**	0.41**	174
All men	0.25**	0.29**	560
Women aged (years):			
19–24	0.17	0.08	66
25–34	0.41**	0.32**	144
35–49	0.42**	0.44**	221
50–64	0.55**	0.33**	184
All women	0.41**	0.33**	615

Note: * $p < 0.05$; ** $p < 0.01$

[†] Average daily consumption of fruit and vegetables (grams) including composite dishes (all fruit juice counted as one portion; all baked beans and other pulses counted as one portion). See Volume 1, Chapter 2, Section 2.4 for methodology for deriving fruit and vegetable consumption (Henderson L, Gregory J, Swan G. National Diet and Nutrition survey: adults aged 19 to 64 years. Volume 1: Types and quantities of foods consumed. TSO (London, 2002)).

Table 4.23

Pearson correlation coefficients for dietary intakes of folate with red cell folate and serum folate

Sex and age of respondent	Correlation of dietary intakes of folate with:			
	Red cell folate	Base	Serum folate	Base
Men aged (years):				
19–24	0.37**	78	0.28 *	78
25–34	0.30**	155	0.30 **	154
35–49	0.26**	179	0.29 **	178
50–64	0.36**	190	0.40 **	192
All men	0.32**	603	0.33 **	602
Women aged (years):				
19–24	0.39**	76	0.35 **	76
25–34	0.42**	154	0.33 **	153
35–49	0.53**	229	0.46 **	227
50–64	0.22**	192	0.21 **	192
All women	0.33**	651	0.28 **	648

Note: * $p < 0.05$; ** $p < 0.01$

Table 4.24 This table is spread over 2 pages. Altogether there is one spread (2 pages).

Water soluble vitamins and plasma total homocysteine by sex of respondent and region

Sex of respondent and analytes	Units	Region							
		Scotland				Northern			
		Mean	Median	sd	Base	Mean	Median	sd	Base
Men									
Plasma vitamin C	μmol/l	42.0	42.8	23.48	48	50.7	51.1	25.45	155
Red cell folate	nmol/l	719	646	327.1	53	698	644	288.2	177
Serum folate	nmol/l	19.0	16.5	8.61	53	21.3	19.9	7.86	176
Serum vitamin B ₁₂	pmol/l	304	305	85.4	51	302	278	116.7	175
ETKAC*	ratio	1.14	1.14	0.053	54	1.15	1.15	0.053	171
ETK-B**	μmol/g Hb/min	0.78	0.78	0.102	54	0.72	0.72	0.104	171
EGRAC***	ratio	1.40	1.38	0.165	54	1.37	1.35	0.177	171
EAATAC****	ratio	1.69	1.67	0.142	54	1.81	1.79	0.195	171
Plasma total homocysteine	μmol/l	12.8	10.4	8.31	53	11.2	10.1	3.68	167
Women									
Plasma vitamin C	μmol/l	62.9	66.6	28.07	54	57.6	62.5	25.08	170
Red cell folate	nmol/l	684	574	351.6	53	705	632	281.0	179
Serum folate	nmol/l	18.4	18.1	6.62	54	22.7	19.9	11.33	179
Serum vitamin B ₁₂	pmol/l	279	273	95.3	53	281	265	134.9	173
ETKAC*	ratio	1.14	1.13	0.038	54	1.14	1.14	0.052	177
ETK-B**	μmol/g Hb/min	0.78	0.77	0.085	54	0.76	0.75	0.124	177
EGRAC***	ratio	1.46	1.46	0.202	54	1.37	1.35	0.173	177
EAATAC****	ratio	1.71	1.72	0.153	54	1.79	1.76	0.267	177
Plasma total homocysteine	μmol/l	10.4	9.2	4.14	50	9.9	9.3	3.17	174

Note: * erythrocyte transketolase activation coefficient.

** erythrocyte transketolase basal activity.

*** erythrocyte glutathione reductase activation coefficient.

**** erythrocyte aspartate aminotransferase activation coefficient.

Central, South West and Wales				London and the South East				Sex of respondent and analytes	Units
Mean	Median	sd	Base	Mean	Median	sd	Base		
51.9	51.5	26.25	220	56.8	57.2	23.88	169	Men	
678	629	292.0	226	704	626	272.2	181	Plasma vitamin C	µmol/l
20.1	18.6	8.72	226	21.8	19.3	8.87	181	Red cell folate	nmol/l
280	264	111.9	227	316	290	147.7	179	Serum folate	nmol/l
1.16	1.16	0.045	228	1.16	1.15	0.061	175	Serum vitamin B ₁₂	pmol/l
0.72	0.71	0.127	229	0.72	0.72	0.141	179	ETKAC*	ratio
1.38	1.36	0.169	229	1.38	1.37	0.163	179	ETK-B**	µmol/g Hb/min
1.79	1.79	1.790	229	1.80	1.79	0.177	179	EGRAC***	ratio
11.9	11.0	4.53	218	11.5	10.9	3.52	166	EAATAC****	ratio
								Plasma total homocysteine	µmol/l
62.5	64.1	29.09	243	61.2	60.6	26.28	178	Women	
668	605	272.1	256	690	614	313.3	194	Plasma vitamin C	µmol/l
22.1	22.2	8.73	253	22.6	21.4	8.97	191	Red cell folate	nmol/l
277	245	126.7	249	311	265	281.6	192	Serum folate	nmol/l
1.14	1.14	0.047	250	1.15	1.14	0.065	192	Serum vitamin B ₁₂	pmol/l
0.77	0.78	0.121	250	0.73	0.73	0.139	192	ETKAC*	ratio
1.39	1.37	0.173	250	1.42	1.39	0.229	192	ETK-B**	µmol/g Hb/min
1.76	1.74	0.202	250	1.79	1.78	0.200	192	EGRAC***	ratio
10.6	9.4	6.24	244	9.8	9.2	3.78	186	EAATAC****	ratio
								Plasma total homocysteine	µmol/l

Table 4.25

Water soluble vitamins and plasma total homocysteine by sex of respondent and whether someone in the the respondent's household was receiving certain benefits

Sex of respondent and analytes	Units	Whether receiving benefits							
		Receiving benefits				Not receiving benefits			
		Mean	Median	sd	Base	Mean	Median	sd	Base
Men									
Plasma vitamin C	µmol/l	43.1	41.9	24.70	82	53.6	54.8	25.23	510
Red cell folate	nmol/l	617	544	245.7	85	706	643	292.6	551
Serum folate	nmol/l	19.1	17.7	8.04	85	21.1	19.0	8.61	551
Serum vitamin B ₁₂	pmol/l	275	257	99.9	85	302	279	126.2	547
ETKAC*	ratio	1.17	1.16	0.044	85	1.15	1.15	0.054	543
ETK-B**	µmol/g Hb/min	0.71	0.70	0.110	85	0.73	0.72	0.127	548
EGRAC***	ratio	1.43	1.38	0.164	85	1.37	1.36	0.169	548
EAATAC****	ratio	1.82	1.79	0.206	85	1.79	1.78	0.178	548
Plasma total homocysteine	µmol/l	12.4	11.0	5.37	81	11.6	10.6	4.40	523
Women									
Plasma vitamin C	µmol/l	49.4	48.2	28.33	126	63.7	65.5	26.23	518
Red cell folate	nmol/l	616	563	249.8	130	701	623	300.1	552
Serum folate	nmol/l	20.7	19.0	8.79	129	22.4	21.4	9.59	548
Serum vitamin B ₁₂	pmol/l	262	258	100.0	128	294	265	199.9	539
ETKAC*	ratio	1.14	1.14	0.051	129	1.14	1.14	0.054	542
ETK-B**	µmol/g Hb/min	0.75	0.75	0.124	129	0.76	0.76	0.127	543
EGRAC***	ratio	1.42	1.41	0.191	129	1.39	1.37	0.195	543
EAATAC****	ratio	1.76	1.73	0.216	129	1.78	1.75	0.218	543
Plasma total homocysteine	µmol/l	10.7	9.9	3.96	127	10.0	9.2	4.93	527

Note: * erythrocyte transketolase activation coefficient.

** erythrocyte transketolase basal activity.

*** erythrocyte glutathione reductase activation coefficient.

**** erythrocyte aspartate aminotransferase activation coefficient.

Table 4.26

Percentage distribution of plasma retinol by sex and age of respondent

Plasma retinol (µmol/l)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 0.70	-	-	-	1	0	-	-	-	-	-
Less than 1.00	1	2	2	2	2	2	3	1	1	2
Less than 1.20	6	4	4	3	4	15	10	6	5	8
Less than 1.50	22	14	13	9	13	29	30	28	20	26
Less than 1.83	63	42	35	32	40	59	63	61	44	57
Less than 2.00	75	59	47	45	53	65	71	76	59	68
Less than 2.15	78	72	59	52	63	74	80	83	66	77
Less than 2.50	87	90	79	75	82	99	92	95	84	92
Less than 3.00	100	98	95	92	96	100	100	100	93	98
All		100	100	100	100				100	100
Base	75	152	175	175	576	72	146	219	179	616
Mean (average value)	1.81	1.94	2.08	2.13	2.02	1.75	1.75	1.75	1.99	1.82
Median	1.71	1.88	2.04	2.12	1.96	1.68	1.71	1.72	1.88	1.76
Lower 2.5 percentile	1.03	1.01	1.14	1.15	1.04	1.00	0.94	1.07	1.08	1.01
Upper 2.5 percentile	2.82	2.92	3.22	3.37	3.19	2.45	2.65	2.68	3.85	2.89
Standard deviation	0.451	0.456	0.549	0.565	0.529	0.426	0.456	0.404	0.630	0.505

Table 4.27

Percentage distribution of plasma α -carotene by sex and age of respondent

Plasma α -carotene ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 0.010	6	2	4	2	3	-	2	3	2	2
Less than 0.020	24	12	12	8	12	17	10	9	4	9
Less than 0.030	46	21	25	20	25	33	20	14	13	17
Less than 0.040	66	37	40	29	39	50	34	25	22	29
Less than 0.060	96	68	62	51	65	80	60	52	52	57
Less than 0.080	100	82	79	66	79	90	75	65	59	69
Less than 0.100		87	84	74	84	97	80	70	61	73
Less than 0.120		97	93	86	93	100	90	84	76	85
All		100	100	100	100		100	100	100	100
Base	75	152	175	175	576	72	146	219	179	616
Mean (average value)	0.039	0.059	0.067	0.074	0.064	0.048	0.075	0.080	0.101	0.081
Median	0.040	0.050	0.050	0.060	0.050	0.045	0.060	0.060	0.060	0.060
Lower 2.5 percentile	0.010	0.011	0.010	0.020	0.010	0.020	0.016	0.010	0.020	0.020
Upper 2.5 percentile	0.080	0.160	0.159	0.180	0.160	0.100	0.180	0.190	0.320	0.230
Standard deviation	0.0170	0.0322	0.0913	0.0458	0.0599	0.0200	0.0914	0.0582	0.1028	0.0808

Table 4.28

Percentage distribution of plasma β -carotene by sex and age of respondent

Plasma β -carotene ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 0.050	12	6	6	4	6	8	6	3	2	4
Less than 0.100	37	27	25	20	26	41	25	17	11	20
Less than 0.150	62	47	46	42	47	58	40	29	26	34
Less than 0.250	86	64	72	66	70	80	67	55	45	58
Less than 0.350	97	84	83	77	83	90	84	69	61	73
Less than 0.450	98	92	91	85	90	94	91	81	71	82
Less than 0.550	98	96	93	90	94	94	95	87	76	86
All	100	100	100	100	100	100	100	100	100	100
Base	75	152	175	175	576	72	146	219	179	616
Mean (average value)	0.143	0.209	0.221	0.248	0.216	0.233	0.245	0.301	0.384	0.304
Median	0.120	0.160	0.150	0.180	0.160	0.125	0.180	0.230	0.281	0.210
Lower 2.5 percentile	0.030	0.040	0.030	0.033	0.030	0.030	0.036	0.040	0.050	0.040
Upper 2.5 percentile	0.485	0.590	0.787	0.830	0.690	2.502	0.751	1.010	1.410	1.118
Standard deviation	0.1340	0.1532	0.2408	0.2149	0.2024	0.4795	0.3417	0.2653	0.3396	0.3401

Table 4.29

Percentage distribution of plasma α -cryptoxanthin by sex and age of respondent

Cumulative percentages

Plasma α -cryptoxanthin ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 0.008	2	-	3	2	2	-	-	1	2	1
Less than 0.014	11	7	10	25	14	14	12	16	24	17
Less than 0.020	45	29	33	46	38	28	38	43	55	43
Less than 0.030	67	54	58	69	62	58	65	72	73	69
Less than 0.040	80	73	79	82	78	77	78	82	83	81
Less than 0.060	93	86	93	91	91	95	91	93	93	93
Less than 0.080	94	92	97	95	95	100	95	94	95	96
Less than 0.100	94	93	97	96	95		95	95	96	96
All	100	100	100	100	100		100	100	100	100
<i>Base</i>	75	152	175	175	576	72	146	219	179	616
Mean (average value)	0.052	0.047	0.039	0.035	0.041	0.034	0.039	0.037	0.032	0.035
Median	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.020	0.030
Lower 2.5 percentile	0.009	0.010	0.000	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Upper 2.5 percentile	0.434	0.200	0.146	0.190	0.203	0.077	0.194	0.170	0.130	0.167
Standard deviation	0.0947	0.0570	0.0420	0.0375	0.0547	0.0166	0.0387	0.0415	0.0315	0.0359

Table 4.30

Percentage distribution of plasma β -cryptoxanthin by sex and age of respondent

Cumulative percentages

Plasma β -cryptoxanthin ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 0.030	6	1	4	10	6	2	3	6	5	4
Less than 0.040	17	4	11	15	11	5	7	10	11	9
Less than 0.080	41	30	35	38	35	37	37	33	31	34
Less than 0.120	65	71	65	66	67	76	57	59	50	58
Less than 0.160	86	84	83	79	82	83	71	73	65	71
Less than 0.220	96	91	92	89	91	93	86	85	77	84
Less than 0.280	100	95	95	94	95	93	91	93	82	90
All		100	100	100	100	100	100	100	100	100
<i>Base</i>	75	152	175	175	576	72	146	219	179	616
Mean (average value)	0.103	0.122	0.119	0.119	0.118	0.123	0.141	0.134	0.181	0.148
Median	0.090	0.100	0.100	0.100	0.100	0.100	0.110	0.110	0.130	0.110
Lower 2.5 percentile	0.020	0.040	0.030	0.020	0.020	0.033	0.030	0.030	0.020	0.030
Upper 2.5 percentile	0.233	0.420	0.382	0.340	0.350	0.430	0.488	0.370	0.670	0.530
Standard deviation	0.0540	0.0818	0.0818	0.0837	0.0794	0.0859	0.1063	0.0957	0.1779	0.1281

Table 4.31

Percentage distribution of plasma lycopene by sex and age of respondent

Plasma lycopene ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 0.125	5	4	7	9	7	5	6	4	5	5
Less than 0.250	30	25	25	29	27	22	29	20	26	24
Less than 0.375	50	41	46	57	49	48	56	44	45	48
Less than 0.500	64	57	61	72	64	65	68	61	62	63
Less than 0.625	73	66	69	81	72	79	80	73	79	77
Less than 0.750	92	74	77	87	81	90	88	85	85	86
Less than 0.875	93	87	88	92	90	90	92	93	88	91
All	100	100	100	100	100	100	100	100	100	100
Base	75	152	175	175	576	72	146	219	179	616
Mean (average value)	0.442	0.514	0.487	0.416	0.467	0.452	0.426	0.474	0.484	0.463
Median	0.360	0.410	0.400	0.340	0.380	0.395	0.330	0.420	0.410	0.390
Lower 2.5 percentile	0.087	0.120	0.100	0.080	0.090	0.100	0.106	0.110	0.092	0.100
Upper 2.5 percentile	1.260	1.200	1.247	1.260	1.211	1.360	1.202	1.150	1.467	1.276
Standard deviation	0.2798	0.3098	0.3092	0.2794	0.2988	0.2878	0.2769	0.2662	0.3309	0.2914

Table 4.32

Percentage distribution of plasma lutein and zeaxanthin by sex and age of respondent

Plasma lutein and zeaxanthin ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 0.10	9	0	2	3	3	2	3	2	1	2
Less than 0.15	29	13	14	12	15	14	15	13	7	12
Less than 0.20	49	37	30	25	33	30	27	32	14	25
Less than 0.25	76	60	52	44	55	63	53	56	32	49
Less than 0.30	84	69	66	55	66	78	72	67	41	62
Less than 0.35	92	81	77	71	78	86	89	79	56	75
Less than 0.40	100	86	84	80	85	91	93	85	68	83
Less than 0.45		92	89	86	91	93	94	90	80	88
All		100	100	100	100	100	100	100	100	100
Base	75	152	175	175	576	72	146	219	179	616
Mean (average value)	0.20	0.26	0.28	0.30	0.27	0.26	0.25	0.27	0.37	0.29
Median	0.20	0.23	0.25	0.27	0.24	0.23	0.25	0.24	0.33	0.26
Lower 2.5 percentile	0.07	0.10	0.11	0.08	0.09	0.09	0.08	0.09	0.11	0.10
Upper 2.5 percentile	0.37	0.68	0.65	0.69	0.65	0.66	0.53	0.56	0.85	0.71
Standard deviation	0.082	0.134	0.145	0.156	0.142	0.126	0.116	0.125	0.854	0.164

Table 4.33

Percentage distribution of plasma 25-hydroxyvitamin D by sex and age of respondent

Plasma 25-hydroxyvitamin D (nmol/l)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 12.0	-	1	1	0	1	-	2	1	1	1
Less than 20.0	15	7	7	5	8	15	9	8	4	8
Less than 25.0	24	16	12	9	14	28	13	15	11	15
Less than 30.0	35	25	19	15	22	28	24	26	22	25
Less than 40.0	61	40	41	32	41	54	40	43	35	41
Less than 50.0	70	57	58	49	57	67	50	57	49	54
Less than 60.0	83	72	73	68	72	78	66	72	64	69
Less than 70.0	90	80	85	85	84	83	76	84	78	80
Less than 80.0	95	86	93	91	91	93	85	89	88	88
Less than 100.0	98	98	99	97	98	96	95	98	98	97
All	100	100	100	100	100	100	100	100	100	100
Base	81	165	190	190	627	78	158	239	194	670
Mean (average value)	40.6	48.8	47.8	51.6	48.3	44.5	51.9	47.9	51.8	49.6
Median	34.1	44.9	44.8	50.7	45.5	39.3	49.8	43.6	51.5	46.5
Lower 2.5 percentile	13.5	17.7	13.5	16.1	14.6	12.8	12.6	13.5	14.4	13.3
Upper 2.5 percentile	89.0	96.4	88.7	105.5	97.1	103.9	113.4	96.6	99.8	102.6
Standard deviation	21.93	23.33	21.03	21.16	22.02	23.77	26.94	22.75	22.55	23.96

Table 4.34

Percentage distribution of plasma 25-hydroxyvitamin D by date blood sample taken and sex of respondent

Plasma 25-hydroxyvitamin D (nmol/l)	Wave 1: July-September		Wave 2: October-December		Wave 3: January-March		Wave 4: April-June		All	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum%	cum%
Less than 12.0	-	0	1	1	1	3	0	1	1	1
Less than 20.0	1	4	6	3	12	16	10	8	8	8
Less than 25.0	1	6	12	13	24	23	16	17	14	15
Less than 30.0	2	11	22	22	37	36	24	29	22	25
Less than 40.0	13	19	38	42	63	55	45	47	41	41
Less than 50.0	25	29	57	55	75	70	67	61	57	54
Less than 60.0	44	41	70	73	88	81	83	78	72	69
Less than 70.0	61	59	88	84	93	92	93	85	84	80
Less than 80.0	75	72	92	90	97	95	97	93	91	88
Less than 100.0	95	92	97	98	99	100	100	98	98	97
All	100	100	100	100	100		100	100	100	100
Base	153	161	120	140	168	152	186	218	627	670
Mean (average value)	64.9	64.5	48.4	48.4	38.7	40.8	43.3	45.5	48.3	49.6
Median	64.2	65.6	45.7	43.2	33.9	36.7	41.3	41.2	45.5	46.5
Lower 2.5 percentile	30.0	18.4	15.8	18.5	13.2	9.5	16.2	15.5	14.6	13.3
Upper 2.5 percentile	114.6	121.3	107.3	99.4	85.6	93.1	82.3	96.4	97.1	102.6
Standard deviation	21.59	25.37	21.31	21.02	18.70	20.78	17.70	21.84	22.02	23.96

Table 4.35

Percentage distribution of plasma α -tocopherol by sex and age of respondent

Cumulative percentages

Plasma α -tocopherol ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 11.6	8	3	3	4	4	9	10	2	1	4
Less than 15.0	38	20	16	10	18	44	27	12	5	17
Less than 18.0	67	42	33	20	36	65	57	36	14	38
Less than 21.0	91	60	52	40	56	84	75	61	29	58
Less than 25.0	95	80	68	64	74	97	90	86	58	80
Less than 30.0	96	98	88	88	92	100	99	93	82	92
Less than 35.0	96	100	95	92	95		100	97	92	97
All	100		100	100	100			100	100	100
<i>Base</i>	75	152	175	175	576	72	146	219	179	616
Mean (average value)	16.6	19.7	22.0	23.3	21.1	16.6	17.8	20.3	24.7	20.6
Median	15.7	19.0	20.3	22.4	20.2	16.3	17.2	20.3	24.0	19.7
Lower 2.5 percentile	9.6	10.5	11.3	10.6	10.7	7.6	9.7	12.0	13.9	10.6
Upper 2.5 percentile	39.2	31.2	38.7	43.8	38.0	28.6	28.6	35.4	41.7	36.0
Standard deviation	5.62	5.30	7.53	7.34	7.05	4.53	4.67	5.54	6.70	6.32

Table 4.36

Percentage distribution of plasma γ -tocopherol by sex and age of respondent

Cumulative percentages

Plasma γ -tocopherol ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 0.75	10	2	1	2	3	5	5	6	5	5
Less than 1.00	35	27	20	15	22	44	32	26	31	31
Less than 1.15	70	48	43	37	46	73	59	48	49	54
Less than 1.25	80	61	53	47	57	78	68	61	55	63
Less than 1.50	92	83	76	79	81	92	88	80	78	83
Less than 2.00	96	94	96	96	95	97	99	95	97	97
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	75	152	175	175	576	72	146	219	179	616
Mean (average value)	1.09	1.25	1.29	1.31	1.26	1.16	1.14	1.24	1.24	1.21
Median	1.04	1.17	1.22	1.26	1.19	1.01	1.11	1.18	1.17	1.14
Lower 2.5 percentile	0.43	0.73	0.81	0.79	0.71	0.73	0.45	0.55	0.72	0.59
Upper 2.5 percentile	2.58	2.33	2.35	2.12	2.25	3.96	1.91	2.23	2.01	2.06
Standard deviation	0.389	0.378	0.367	0.362	0.377	0.591	0.310	0.403	0.394	0.410

Table 4.37

Percentage distribution of tocopherol to cholesterol ratio* by sex and age of respondent

Tocopherol to cholesterol ratio ($\mu\text{mol}/\text{mmol}$)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 2.25	1	1	1	1	1	-	2	1	3	2
Less than 3.25	24	22	25	19	22	27	33	21	14	22
Less than 3.75	58	53	44	36	46	56	58	42	40	47
Less than 4.25	75	67	64	58	64	79	79	67	63	70
Less than 4.75	88	82	79	77	80	93	90	82	80	85
Less than 5.25	92	90	86	82	87	97	94	91	87	91
Less than 6.25	99	98	95	95	96	100	99	97	95	97
All	100	100	100	100	100		100	100	100	100
Base	81	156	170	173	580	72	149	222	183	626
Mean (average value)	3.76	3.97	4.11	4.22	4.06	3.69	3.71	4.03	4.17	3.96
Median	3.55	3.75	3.94	4.06	3.85	3.70	3.63	3.92	3.95	3.81
Lower 2.5 percentile	2.74	2.48	2.44	2.50	2.48	2.38	2.28	2.52	2.11	2.38
Upper 2.5 percentile	6.21	7.38	7.41	7.01	7.06	6.15	6.01	6.35	8.46	6.35
Standard deviation	0.851	1.022	1.292	1.115	1.122	0.787	0.872	1.025	1.243	1.054

Note: * α -tocopherol to total cholesterol ratio.

Table 4.38

Pearson correlation coefficients for plasma retinol with dietary intake of α -carotene, β -carotene and vitamin A (retinol equivalents)

Sex and age of respondent	Correlation of plasma retinol with dietary intake of:			
	α -carotene	β -carotene	vitamin A (retinol equivalents)	Base
Men aged (years):				
19–24	0.17	0.09	-0.01	70
25–34	-0.01	0.11	-0.07	139
35–49	-0.08	-0.03	0.10	166
50–64	-0.18*	-0.11	0.03	171
All men	-0.05	0.02	0.08*	546
Women aged (years):				
19–24	0.11	-0.10	-0.09	68
25–34	0.06	0.10	0.17*	138
35–49	-0.05	0.01	-0.01	207
50–64	-0.03	0.01	0.06	176
All women	0.02	0.03	0.08*	590

Note: * $p < 0.05$

Table 4.39

Pearson correlation coefficients for plasma α -carotene with dietary intake of α -carotene

Sex and age of respondent	Correlation of plasma α -carotene with:	
	Dietary intake of α -carotene	Base
Men aged (years):		
19–24	0.24*	70
25–34	0.20*	139
35–49	0.06	166
50–64	0.26**	171
All men	0.16**	546
Women aged (years):		
19–24	0.11	68
25–34	0.52**	138
35–49	0.32**	207
50–64	0.49**	176
All women	0.44**	590

Note: * $p < 0.05$; ** $p < 0.01$

Table 4.40

Pearson correlation coefficients for plasma β -carotene with dietary intake of β -carotene

Sex and age of respondent	Correlation of plasma β -carotene with:	
	Dietary intake of β -carotene	Base
Men aged (years):		
19–24	-0.04	70
25–34	0.13	139
35–49	0.11	166
50–64	0.29**	171
All men	0.20**	546
Women aged (years):		
19–24	0.91**	68
25–34	0.45**	138
35–49	0.44**	207
50–64	0.38**	176
All women	0.54**	590

Note: ** $p < 0.01$

Table 4.41

Pearson correlation coefficients for plasma 25-hydroxyvitamin D with dietary intake of vitamin D

Sex and age of respondent	Correlation of plasma 25-hydroxyvitamin D with:	
	Dietary intake of vitamin D	Base
Men aged (years):		
19–24	0.59**	77
25–34	0.14	150
35–49	0.16*	181
50–64	0.17*	186
All men	0.21**	594
Women aged (years):		
19–24	0.12	73
25–34	0.25**	151
35–49	0.23**	225
50–64	0.33**	191
All women	0.24**	640

Note: * $p < 0.05$; ** $p < 0.01$

Table 4.42

Pearson correlation coefficients for plasma 25-hydroxyvitamin D with dietary intake of vitamin D by date blood sample taken

Date blood sample taken	Correlation of plasma 25-hydroxyvitamin D with:	
	Dietary intake of vitamin D	Base
July to September		
Men	0.16	153
Women	0.29**	147
October to December		
Men	0.29**	116
Women	0.24**	132
January to March		
Men	0.34**	160
Women	0.34**	148
April to June		
Men	0.26**	173
Women	0.18**	212

Note: ** $p < 0.01$

Table 4.43

Pearson correlation coefficients for tocopherol to cholesterol ratio[†] with dietary intake of vitamin E

Sex and age of respondent	Correlation of tocopherol to cholesterol ratio with:	
	Dietary intake of vitamin E	Base
Men aged (years):		
19–24	0.17	77
25–34	0.25**	142
35–49	0.11	162
50–64	0.17*	168
All men	0.15**	549
Women aged (years):		
19–24	0.02	68
25–34	0.17*	141
35–49	0.41**	210
50–64	0.41**	181
All women	0.38**	600

Note: * $p < 0.05$; ** $p < 0.01$

[†] α -tocopherol to total cholesterol ratio.

Table 4.44 This table is spread over 2 pages. Altogether there is one spread (2 pages).

Fat soluble vitamins and carotenoids by sex of respondent and region

Sex of respondent and analytes	Units	Region							
		Scotland				Northern			
		Mean	Median	sd	Base	Mean	Median	sd	Base
Men									
Plasma retinol	μmol/l	2.09	2.06	0.446	51	1.99	1.95	0.516	155
Plasma α-carotene	μmol/l	0.063	0.056	0.0504	51	0.059	0.05	0.0371	155
Plasma β-carotene	μmol/l	0.177	0.13	0.1631	51	0.221	0.16	0.1925	155
Plasma α-cryptoxanthin	μmol/l	0.054	0.03	0.0741	51	0.035	0.03	0.0505	155
Plasma β-cryptoxanthin	μmol/l	0.128	0.1	0.0999	51	0.114	0.1	0.085	155
Plasma lycopene	μmol/l	0.469	0.368	0.3351	51	0.527	0.47	0.3297	155
Plasma lutein and zeaxanthin	μmol/l	0.23	0.21	0.114	51	0.25	0.23	0.111	155
Plasma 25-hydroxyvitamin D	nmol/l	43.7	44	20.58	54	50.9	47.5	24.76	169
Plasma α-tocopherol	μmol/l	20.4	19.1	6.27	51	21.4	20.5	7.39	155
Plasma γ-tocopherol	μmol/l	1.27	1.21	0.411	51	1.27	1.21	0.381	155
Plasma α-tocopherol to total cholesterol ratio	μmol/mmol	3.87	3.58	0.932	53	4.09	3.84	1.086	162
Women									
Plasma retinol	μmol/l	1.86	1.81	0.46	47	1.82	1.78	0.534	161
Plasma α-carotene	μmol/l	0.075	0.06	0.0471	47	0.072	0.06	0.0515	161
Plasma β-carotene	μmol/l	0.255	0.19	0.2176	47	0.231	0.19	0.1732	161
Plasma α-cryptoxanthin	μmol/l	0.047	0.03	0.0466	47	0.037	0.02	0.0448	161
Plasma β-cryptoxanthin	μmol/l	0.194	0.17	0.1151	47	0.131	0.1	0.1039	161
Plasma lycopene	μmol/l	0.431	0.32	0.2961	47	0.44	0.36	0.2736	161
Plasma lutein and zeaxanthin	μmol/l	0.3	0.28	0.158	47	0.26	0.23	0.121	161
Plasma 25-hydroxyvitamin D	nmol/l	42.5	35.3	20.62	52	52.4	48.2	24.36	176
Plasma α-tocopherol	μmol/l	19.5	19	5.97	47	20.7	19.7	6.22	161
Plasma γ-tocopherol	μmol/l	1.17	1.11	0.389	47	1.17	1.11	0.392	161
Plasma α-tocopherol to total cholesterol ratio	μmol/mmol	3.54	3.66	0.746	48	3.89	3.8	0.949	165

Central, South West and Wales				London and the South East				Sex of respondent and analytes	Units
Mean	Median	sd	Base	Mean	Median	sd	Base		
								Men	
2.05	1.95	0.545	212	1.99	1.94	0.545	159	Plasma retinol	μmol/l
0.061	0.05	0.0361	212	0.071	0.06	0.0954	159	Plasma α-carotene	μmol/l
0.203	0.15	0.1762	212	0.24	0.18	0.249	159	Plasma β-carotene	μmol/l
0.042	0.03	0.0503	212	0.044	0.03	0.0569	159	Plasma α-cryptoxanthin	μmol/l
0.107	0.09	0.0647	212	0.133	0.12	0.0822	159	Plasma β-cryptoxanthin	μmol/l
0.444	0.359	0.2908	212	0.437	0.36	0.2569	159	Plasma lycopene	μmol/l
0.28	0.23	0.154	212	0.3	0.27	0.154	159	Plasma lutein and zeaxanthin	μmol/l
48.6	45.7	20.84	227	46.7	44.8	20.93	159	Plasma 25-hydroxyvitamin D	nmol/l
21.2	20.5	6.93	212	20.8	19.6	7.12	159	Plasma α-tocopherol	μmol/l
1.25	1.18	0.373	212	1.25	1.18	0.369	159	Plasma γ-tocopherol	μmol/l
4.12	3.86	1.223	210	4	3.9	1.076	155	Plasma α-tocopherol to total cholesterol ratio	μmol/mmol
								Women	
1.84	1.75	0.534	230	1.78	1.74	0.448	178	Plasma retinol	μmol/l
0.073	0.06	0.0578	230	0.101	0.06	0.1216	178	Plasma α-carotene	μmol/l
0.288	0.2	0.35	230	0.404	0.264	0.4332	178	Plasma β-carotene	μmol/l
0.033	0.03	0.0302	230	0.034	0.03	0.0297	178	Plasma α-cryptoxanthin	μmol/l
0.126	0.1	0.0984	230	0.18	0.13	0.1694	178	Plasma β-cryptoxanthin	μmol/l
0.45	0.37	0.3004	230	0.509	0.46	0.2911	178	Plasma lycopene	μmol/l
0.29	0.26	0.181	230	0.33	0.29	0.17	178	Plasma lutein and zeaxanthin	μmol/l
51.1	49.5	25.05	250	46.9	44.8	22.43	192	Plasma 25-hydroxyvitamin D	nmol/l
20.6	19.6	6.22	230	20.8	19.7	6.64	178	Plasma α-tocopherol	μmol/l
1.24	1.14	0.467	230	1.21	1.17	0.347	178	Plasma γ-tocopherol	μmol/l
4.04	3.85	1.165	233	4.02	3.89	1.043	181	Plasma α-tocopherol to total cholesterol ratio	μmol/mmol

Table 4.45

Fat soluble vitamins and carotenoids by sex of respondent and whether someone in the respondent's household was receiving certain benefits

Sex of respondent and analytes	Units	Whether receiving benefits							
		Receiving benefits				Not receiving benefits			
		Mean	Median	sd	Base	Mean	Median	sd	Base
Men									
Plasma retinol	µmol/l	1.94	1.96	0.525	76	2.03	1.96	0.529	500
Plasma α-carotene	µmol/l	0.054	0.040	0.0347	76	0.065	0.050	0.0627	500
Plasma β-carotene	µmol/l	0.199	0.130	0.1686	76	0.218	0.160	0.2071	500
Plasma α-cryptoxanthin	µmol/l	0.046	0.030	0.0838	76	0.041	0.030	0.0489	500
Plasma β-cryptoxanthin	µmol/l	0.111	0.090	0.0893	76	0.119	0.100	0.0778	500
Plasma lycopene	µmol/l	0.409	0.366	0.2831	76	0.475	0.390	0.3004	500
Plasma lutein and zeaxanthin	µmol/l	0.24	0.20	0.140	76	0.28	0.25	0.142	500
Plasma 25-hydroxyvitamin D	nmol/l	42.3	36.4	21.79	85	49.2	46.9	21.92	542
Plasma α-tocopherol	µmol/l	18.8	18.1	6.02	76	21.4	20.4	7.13	500
Plasma γ-tocopherol	µmol/l	1.20	1.15	0.356	76	1.27	1.21	0.379	500
Plasma α-tocopherol to total cholesterol ratio	µmol/mmol	3.84	3.59	1.014	77	4.09	3.88	1.135	504
Women									
Plasma retinol	µmol/l	1.82	1.79	0.494	120	1.82	1.74	0.508	496
Plasma α-carotene	µmol/l	0.054	0.050	0.0363	120	0.087	0.060	0.0871	496
Plasma β-carotene	µmol/l	0.189	0.150	0.1593	120	0.332	0.230	0.3655	496
Plasma α-cryptoxanthin	µmol/l	0.028	0.020	0.0271	120	0.037	0.030	0.0375	496
Plasma β-cryptoxanthin	µmol/l	0.114	0.090	0.0920	120	0.156	0.120	0.1341	496
Plasma lycopene	µmol/l	0.364	0.310	0.2254	120	0.487	0.420	0.3005	496
Plasma lutein and zeaxanthin	µmol/l	0.25	0.22	0.139	120	0.30	0.27	0.168	496
Plasma 25-hydroxyvitamin D	nmol/l	43.5	35.3	23.94	129	51.1	48.7	23.75	541
Plasma α-tocopherol	µmol/l	18.8	18.2	5.52	120	21.0	19.9	6.43	496
Plasma γ-tocopherol	µmol/l	1.14	1.10	0.336	120	1.22	1.15	0.424	496
Plasma α-tocopherol to total cholesterol ratio	µmol/mmol	3.77	3.72	0.895	121	4.00	3.85	1.085	505

Table 4.46

Percentage distribution of plasma total cholesterol by sex and age of respondent

Cumulative percentages

Plasma total cholesterol (mmol/l)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 3.00	-	2	2	1	1	4	1	0	1	1
Less than 3.50	10	7	4	3	5	11	5	3	2	4
Less than 4.00	32	18	12	8	15	33	17	12	12	13
Less than 4.50	69	35	19	19	30	47	38	25	7	25
Less than 5.20	84	59	44	41	52	83	68	52	25	52
Less than 5.80	90	78	64	60	70	93	87	78	41	71
Less than 6.50	100	90	85	78	86	100	94	92	67	86
Less than 7.80		98	98	98	98		99	99	91	97
All		100	100	100	100		100	100	100	100
Base	81	164	186	187	618	77	157	234	192	659
Mean (average value)	4.40	5.04	5.38	5.56	5.21	4.46	4.84	5.13	6.06	5.25
Median	4.29	4.93	5.41	5.56	5.14	4.55	4.69	5.16	6.05	5.18
Lower 2.5 percentile	3.20	2.99	3.06	3.35	3.20	2.83	3.01	3.44	4.16	3.31
Upper 2.5 percentile	6.33	7.80	7.47	7.76	7.64	6.04	6.92	7.17	8.69	8.02
Standard deviation	0.839	1.139	1.124	1.126	1.155	0.800	0.970	0.995	1.225	1.180

Table 4.47

Percentage distribution of plasma high density lipoprotein cholesterol by sex and age of respondent

Plasma high density lipoprotein cholesterol (mmol/l)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 0.70	7	6	9	8	8	-	3	3	2	2
Less than 0.80	15	17	19	16	17	5	3	5	5	5
Less than 1.00	43	44	46	42	44	24	20	22	18	21
Less than 1.20	77	77	77	69	74	52	42	45	38	43
Less than 1.40	92	91	89	84	89	76	68	71	64	69
Less than 1.60	100	98	95	92	96	90	86	84	79	84
All		100	100	100	100	100	100	100	100	100
Base	81	164	186	186	617	77	157	234	192	659
Mean (average value)	1.06	1.04	1.04	1.12	1.07	1.21	1.26	1.27	1.34	1.28
Median	1.07	1.02	1.01	1.04	1.02	1.18	1.24	1.24	1.31	1.25
Lower 2.5 percentile	0.68	0.61	0.56	0.64	0.64	0.75	0.66	0.70	0.69	0.73
Upper 2.5 percentile	1.49	1.58	1.87	1.85	1.74	1.71	1.97	2.34	2.36	2.28
Standard deviation	0.219	0.244	0.295	0.411	0.316	0.264	0.322	0.391	0.400	0.367

Table 4.48

Percentage distribution of plasma low density lipoprotein cholesterol* by sex and age of respondent

Plasma low density lipoprotein cholesterol (mmol/l)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 2.00	3	2	2	-	2	3	3	1	1	2
Less than 2.70	22	10	7	7	10	23	16	12	2	11
Less than 3.00	40	20	14	10	18	26	21	19	7	17
Less than 3.40	60	30	23	18	28	57	49	35	13	34
Less than 4.10	81	61	42	39	51	86	77	63	31	60
Less than 4.80	89	78	65	61	71	96	90	83	57	79
Less than 5.50	100	90	85	81	87	100	96	94	80	91
Less than 6.20		94	96	94	96		98	98	88	95
All		100	100	100	100		100	100	100	100
Base	81	164	186	187	618	77	157	234	192	659
Mean (average value)	3.35	4.00	4.34	4.44	4.15	3.26	3.57	3.85	4.72	3.97
Median	3.18	3.84	4.39	4.37	4.09	3.24	3.43	3.79	4.59	3.82
Lower 2.5 percentile	1.84	1.86	2.00	2.25	2.10	1.86	1.94	2.20	2.71	2.09
Upper 2.5 percentile	5.37	6.77	6.78	6.64	6.62	4.98	5.84	6.00	7.22	6.84
Standard deviation	0.880	1.171	1.166	1.140	1.179	0.750	0.980	0.998	1.229	1.162

Note: * Calculated as non-high density lipoprotein cholesterol (non-HDL).

Table 4.49

This table is spread over 2 pages. Altogether there is one spread (2 pages).

Blood lipids by sex of respondent and region

Sex of respondent and analytes	Units	Region								
		Scotland				Northern				
		Mean	Median	sd	Base	Mean	Median	sd	Base	
Men										
Plasma total cholesterol	mmol/l	5.27	5.20	0.872	54	5.24	5.26	1.261	169	
Plasma high density lipoprotein cholesterol	mmol/l	1.10	1.01	0.355	54	1.05	1.05	0.266	169	
Plasma low density lipoprotein cholesterol*	mmol/l	4.17	4.09	0.948	54	4.19	4.29	1.322	169	
Women										
Plasma total cholesterol	mmol/l	5.50	5.44	1.108	50	5.34	5.20	1.108	175	
Plasma high density lipoprotein cholesterol	mmol/l	1.46	1.38	0.382	50	1.24	1.21	0.370	175	
Plasma low density lipoprotein cholesterol*	mmol/l	4.04	3.94	1.136	50	4.10	3.89	1.131	175	

Note: * Calculated as non-high density lipoprotein cholesterol (non-HDL).

Central, South West and Wales				London and the South East				Sex of respondent and analytes	Units
Mean	Median	sd	Base	Mean	Median	sd	Base		
5.18	4.97	1.097	222	5.21	5.20	1.203	172	Men	
1.07	1.02	0.376	222	1.07	1.04	0.262	172	Plasma total cholesterol	mmol/l
4.11	3.91	1.081	222	4.15	4.07	1.222	172	Plasma high density lipoprotein cholesterol	mmol/l
								Plasma low density lipoprotein cholesterol*	mmol/l
5.18	5.15	1.206	246	5.20	4.96	1.223	188	Women	
1.23	1.19	0.346	246	1.34	1.31	0.366	188	Plasma total cholesterol	mmol/l
3.95	3.84	1.182	246	3.86	3.63	1.166	188	Plasma high density lipoprotein cholesterol	mmol/l
								Plasma low density lipoprotein cholesterol*	mmol/l

Table 4.50

Blood lipids by sex of respondent and whether someone in the respondent's household was receiving certain benefits

Sex of respondent and analytes	Units	Whether receiving benefits							
		Receiving benefits				Not receiving benefits			
		Mean	Median	sd	Base	Mean	Median	sd	Base
Men									
Plasma total cholesterol	mmol/l	4.97	5.02	1.184	82	5.25	5.15	1.147	535
Plasma high density lipoprotein cholesterol	mmol/l	1.03	0.96	0.308	82	1.07	1.04	0.317	535
Plasma low density lipoprotein cholesterol*	mmol/l	3.94	4.04	1.282	82	4.18	4.09	1.160	535
Women									
Plasma total cholesterol	mmol/l	5.07	4.98	1.259	129	5.30	5.20	1.156	530
Plasma high density lipoprotein cholesterol	mmol/l	1.22	1.20	0.370	129	1.30	1.25	0.365	530
Plasma low density lipoprotein cholesterol*	mmol/l	3.85	3.80	1.209	129	4.00	3.83	1.149	530

Note: * Calculated as non-high density lipoprotein cholesterol (non-HDL).

Table 4.51

Percentage distribution of plasma selenium by sex and age of respondent

Plasma selenium ($\mu\text{mol/l}$)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 0.60	-	-	-	-	-	-	-	-	-	-
Less than 0.70	3	0	0	1	1	2	1	1	-	1
Less than 0.80	6	2	3	3	3	4	5	4	2	4
Less than 0.90	15	8	10	8	9	21	17	12	8	13
Less than 1.00	38	24	24	19	24	42	38	29	21	30
Less than 1.10	74	57	44	39	50	65	65	56	45	56
Less than 1.20	91	81	65	62	72	88	78	78	68	76
Less than 1.30	95	89	87	82	87	97	90	90	84	89
Less than 1.40	95	93	93	93	93	100	95	94	91	94
All	100	100	100	100	100	100	100	100	100	100
Base	83	169	190	195	636	76	159	244	195	674
Mean (average value)	1.03	1.10	1.13	1.15	1.11	1.03	1.07	1.09	1.17	1.10
Median	1.04	1.07	1.11	1.14	1.10	1.04	1.05	1.07	1.11	1.07
Lower 2.5 percentile	0.65	0.84	0.78	0.79	0.79	0.72	0.74	0.75	0.82	0.77
Upper 2.5 percentile	1.46	1.47	1.58	1.50	1.49	1.32	1.46	1.52	1.84	1.53
Standard deviation	0.150	0.160	0.182	0.199	0.182	0.151	0.205	0.176	0.332	0.240

Table 4.52

Percentage distribution of red cell selenium by sex and age of respondent

Red cell selenium ($\mu\text{mol/l}$)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 1.00	8	-	2	1	2	1	-	1	-	0
Less than 1.25	25	9	11	14	13	2	7	8	11	8
Less than 1.40	50	36	25	29	32	14	15	21	23	19
Less than 1.50	63	49	37	41	45	27	24	29	32	29
Less than 1.75	86	67	67	67	70	47	48	49	59	52
Less than 2.00	96	89	85	84	87	87	71	70	75	74
Less than 2.50	100	99	97	97	98	100	92	93	92	93
All		100	100	100	100		100	100	100	100
<i>Base</i>	<i>81</i>	<i>163</i>	<i>182</i>	<i>191</i>	<i>617</i>	<i>74</i>	<i>158</i>	<i>237</i>	<i>189</i>	<i>658</i>
Mean (average value)	1.42	1.60	1.64	1.64	1.60	1.73	1.83	1.80	1.82	1.80
Median	1.40	1.51	1.60	1.59	1.55	1.75	1.76	1.76	1.68	1.73
Lower 2.5 percentile	0.82	1.11	1.03	1.03	1.03	1.26	1.05	1.08	1.08	1.08
Upper 2.5 percentile	2.11	2.40	2.53	2.50	2.46	2.31	3.05	2.79	3.46	3.04
Standard deviation	0.286	0.328	0.356	0.422	0.369	0.276	0.453	0.457	0.816	0.569

Table 4.53

Percentage distribution of blood glutathione peroxidase (GSH-Px) by sex and age of respondent

Blood glutathione peroxidase (nmol/mg Hb/min)	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
Less than 60.0	-	-	-	-	-	-	1	-	-	0
Less than 70.0	-	1	1	-	1	-	1	-	-	0
Less than 80.0	4	6	3	4	4	-	3	1	1	2
Less than 90.0	11	12	10	10	11	9	12	8	3	8
Less than 100.0	24	26	25	24	25	14	23	19	11	17
Less than 110.0	39	40	40	36	39	30	32	37	25	32
Less than 120.0	55	56	53	45	52	37	52	46	42	45
Less than 130.0	69	67	62	60	64	45	65	60	54	58
Less than 140.0	83	76	71	70	74	57	76	70	66	69
Less than 160.0	97	90	88	88	90	82	90	87	87	87
Less than 180.0	97	97	94	97	96	93	97	94	97	96
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	<i>81</i>	<i>163</i>	<i>184</i>	<i>187</i>	<i>615</i>	<i>74</i>	<i>161</i>	<i>237</i>	<i>188</i>	<i>661</i>
Mean (average value)	118.5	119.5	123.4	124.1	121.9	134.0	122.5	126.8	129.2	127.2
Median	116.0	114.0	116.0	123.0	117.0	132.0	119.0	121.0	124.0	121.0
Lower 2.5 percentile	73.0	75.8	78.0	77.5	77.0	84.0	76.0	81.1	83.7	81.0
Upper 2.5 percentile	183.6	184.0	198.2	184.0	190.0	264.0	185.9	200.0	189.0	193.2
Standard deviation	24.20	27.45	31.06	29.36	28.79	36.39	30.49	31.93	27.85	31.14

Table 4.54

Percentage distribution of plasma α_1 -antichymotrypsin by sex and age of respondent

Cumulative percentages

Plasma α_1 -antichymotrypsin (g/l)	Men aged (years):				All men	Women aged (years):				All women
	19-24	25-34	35-49	50-64		19-24	25-34	35-49	50-64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 0.18	1	3	3	2	2	-	-	0	-	0
Less than 0.22	23	11	15	11	14	17	10	6	3	7
Less than 0.25	32	26	23	17	23	34	18	15	6	16
Less than 0.30	73	62	52	44	55	52	51	45	28	42
Less than 0.35	92	89	86	81	86	86	83	82	67	78
Less than 0.45	98	96	99	95	97	93	99	98	95	97
Less than 0.65	100	100	100	100	100	100	100	100	99	100
All									100	
<i>Base</i>	<i>81</i>	<i>162</i>	<i>179</i>	<i>181</i>	<i>603</i>	<i>77</i>	<i>154</i>	<i>233</i>	<i>190</i>	<i>654</i>
Mean (average value)	0.28	0.29	0.29	0.31	0.30	0.29	0.30	0.31	0.34	0.31
Median	0.28	0.28	0.29	0.31	0.29	0.28	0.29	0.30	0.33	0.31
Lower 2.5 percentile	0.20	0.17	0.17	0.16	0.18	0.18	0.20	0.20	0.22	0.20
Upper 2.5 percentile	0.39	0.50	0.43	0.53	0.49	0.51	0.41	0.45	0.50	0.47
Standard deviation	0.065	0.073	0.066	0.079	0.072	0.074	0.058	0.061	0.073	0.068

Table 4.55

Percentage distribution of blood mercury by sex and age of respondent

Blood mercury (nmol/l)	Cumulative percentages									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
Less than 0.5	6	4	-	1	2	8	5	1	1	3
Less than 1.0	19	4	1	2	4	8	7	2	2	4
Less than 2.5	55	18	14	11	20	31	23	10	9	15
Less than 4.0	72	43	28	26	37	49	40	25	21	30
Less than 7.0	84	67	53	55	61	64	66	50	56	57
Less than 10.0	89	77	69	70	74	84	78	71	70	74
Less than 13.0	97	91	84	81	87	91	87	82	82	84
Less than 16.0	99	96	90	86	91	91	92	90	88	90
All	100	100	100	100	100	100	100	100	100	100
<i>Base</i>	<i>81</i>	<i>169</i>	<i>190</i>	<i>195</i>	<i>636</i>	<i>80</i>	<i>160</i>	<i>246</i>	<i>198</i>	<i>683</i>
Mean (average value)	3.8	6.3	8.7	9.0	7.5	6.1	7.2	8.6	10.6	8.6
Median	2.3	4.8	6.6	6.3	5.5	4.3	4.7	7.0	6.6	6.2
Lower 2.5 percentile	0.2	0.4	1.0	1.0	0.5	0.1	0.1	0.9	1.3	0.4
Upper 2.5 percentile	14.4	23.9	33.7	32.6	27.1	22.6	33.8	28.9	57.4	33.4
Standard deviation	4.28	5.09	8.66	8.37	7.50	6.05	7.41	7.06	15.99	10.53

Table 4.56

This table is spread over 2 pages. Altogether there is one spread (2 pages).

Other analytes by sex of respondent and region

Sex of respondent and analytes	Units	Region								
		Scotland				Northern				
		Mean	Median	sd	Base	Mean	Median	sd	Base	
Men										
Plasma selenium	μmol/l	1.09	1.10	0.184	54	1.12	1.10	0.215	176	
Red cell selenium	μmol/l	1.65	1.69	0.316	53	1.59	1.56	0.322	171	
Erythrocyte glutathione peroxidase activity	nmol/mg Hb/min	104.0	99.0	25.54	51	120.3	115.0	26.69	171	
Plasma α ₁ -antichymotrypsin	g/l	0.29	0.29	0.053	53	0.30	0.29	0.062	167	
Blood mercury	nmol/l	7.4	5.9	5.52	54	6.8	4.9	6.43	176	
Women										
Plasma selenium	μmol/l	1.07	1.08	0.150	52	1.08	1.07	0.160	178	
Red cell selenium	μmol/l	1.87	1.85	0.488	50	1.76	1.71	0.367	175	
Erythrocyte glutathione peroxidase activity	nmol/mg Hb/min	115.3	107.0	27.63	52	125.8	120.0	32.55	174	
Plasma α ₁ -antichymotrypsin	g/l	0.30	0.30	0.061	50	0.32	0.31	0.076	174	
Blood mercury	nmol/l	7.4	6.5	5.52	52	7.5	5.6	7.64	179	

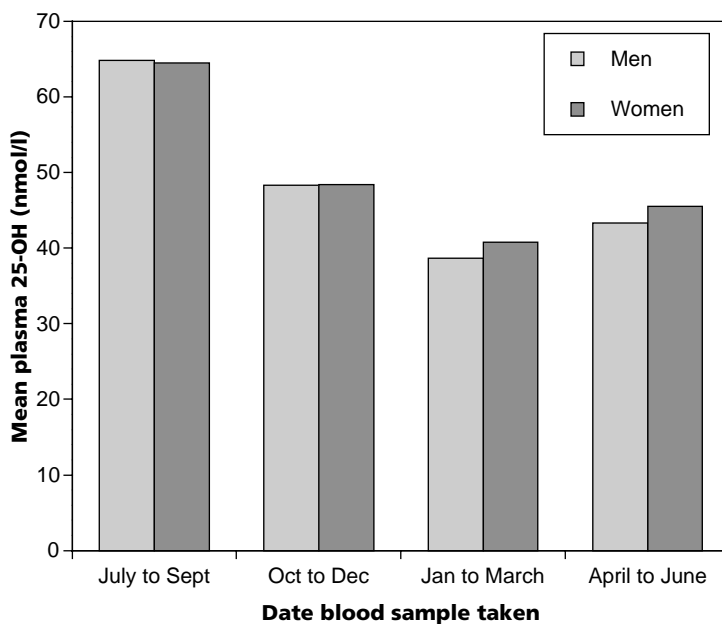
Central, South West and Wales				London and the South East				Sex of respondent and analytes	Units
Mean	Median	sd	Base	Mean	Median	sd	Base		
1.10	1.08	0.162	226	1.13	1.12	0.168	179	Men	
1.56	1.48	0.410	218	1.65	1.60	0.369	175	Plasma selenium	µmol/l
126.7	127.0	26.91	222	122.7	117.0	31.88	172	Red cell selenium	µmol/l
0.29	0.29	0.076	218	0.30	0.29	0.082	166	Erythrocyte glutathione peroxidase activity	nmol/mg Hb/min
6.7	4.9	6.29	228	9.4	6.5	9.80	178	Plasma α ₁ -antichymotrypsin	g/l
								Blood mercury	nmol/l
1.07	1.05	0.200	252	1.16	1.09	0.340	192	Women	
1.70	1.62	0.439	244	1.96	1.87	0.809	190	Plasma selenium	µmol/l
124.5	120.0	28.27	245	135.3	133.0	32.57	190	Red cell selenium	µmol/l
0.31	0.31	0.067	244	0.31	0.30	0.063	186	Erythrocyte glutathione peroxidase activity	nmol/mg Hb/min
8.2	6.2	11.46	259	10.3	6.6	12.26	194	Plasma α ₁ -antichymotrypsin	g/l
								Blood mercury	nmol/l

Table 4.57

Other analytes by sex of respondent and whether someone in the respondent's household was receiving certain benefits

Sex of respondent and analytes	Units	Whether receiving benefits							
		Receiving benefits				Not receiving benefits			
		Mean	Median	sd	Base	Mean	Median	sd	Base
Men									
Plasma selenium	μmol/l	1.05	1.02	0.193	86	1.12	1.10	0.178	550
Red cell selenium	μmol/l	1.54	1.44	0.347	81	1.61	1.57	0.372	536
Erythrocyte glutathione peroxidase activity	nmol/mg Hb/min	119.8	117.0	25.78	84	122.3	117.0	29.24	531
Plasma α ₁ -antichymotrypsin	g/l	0.31	0.30	0.071	81	0.29	0.29	0.072	523
Blood mercury	nmol/l	5.3	3.5	4.95	86	7.9	5.7	7.77	550
Women									
Plasma selenium	μmol/l	1.01	0.98	0.171	131	1.12	1.08	0.249	543
Red cell selenium	μmol/l	1.65	1.61	0.362	130	1.84	1.77	0.603	528
Erythrocyte glutathione peroxidase activity	nmol/mg Hb/min	123.3	119.0	32.26	129	128.2	122.0	30.82	532
Plasma α ₁ -antichymotrypsin	g/l	0.32	0.31	0.079	127	0.31	0.30	0.065	527
Blood mercury	nmol/l	6.4	4.2	7.25	131	9.1	6.6	11.11	552

Figure 4.1

Comparison of mean plasma 25-OHD levels by date of blood sample taken by sex of respondent

5 Physical activity

5.1 Introduction

This chapter reports on the results from the analysis of the physical activity data. All respondents were asked to record detailed information on their daily activities over the same seven-day period as the dietary record. This was recorded in the 'Diary of Activities and Eating and Drinking Away from Home' (see Appendix A of the Technical Report¹). Chapter 1 of this report gives further details of the methodology. Appendix D gives further details of the data editing process, data quality and the derivation of different measures of physical activity.

The Health Development Agency and Health Survey for England give the following definitions of physical activity^{2,3}.

Physical activity

Any force exerted by skeletal muscle that results in energy expenditure above resting level.

Exercise

A subset of physical activity, which is volitional, planned, structured, repetitive and aimed at improvement or maintenance of any aspect of fitness or health.

Moderate intensity physical activity

Activities with an energy cost of at least 5 kcal/min but less than 7.5 kcal/min, usually equivalent to brisk walking, which might be expected to leave the participant feeling warm or slightly out of breath.

Vigorous intensity physical activity

Activities with an energy cost of at least 7.5 kcal/min, usually equivalent to at least slow jogging, which might be expected to leave the participant feeling out of breath and sweaty.

The main purpose in collecting physical activity information was to allow an investigation of the relationships between physical activity levels and dietary intakes, particularly energy intake and body composition. If the body does not use all the energy it takes in as food for activity, growth and thermogenesis, for example, then it will be stored. Over time this will lead to an increase in body weight, which if it continues leads to an increased risk of obesity. Obesity can increase the risk of chronic diseases in later life including coronary heart disease and diabetes^{4,5}.

There is a wealth of data on the health benefits of physical activity, including the prevention or delay of high blood pressure, reduction in the risk of some cancers and maintenance of bone density, therefore helping prevent osteoporosis⁶. There is general consensus on the amount and type of physical activity that is beneficial to health⁷. The Department of Health (DH) recommendation for adults is^{2,3}:

At least 30 minutes of physical activity on five or more days of the week. This physical activity should be of at least moderate intensity – similar to brisk walking. Activity can be taken in bouts of 10 to 15 minutes, allowing for accumulation of activity throughout the day.

Data from this survey on energy intake show that mean daily total energy intakes were below Estimated Average Requirements (EARs)⁸ for each sex and age group (see Volume 2, Chapter 2⁹). It has been suggested that this disparity could arise from an inadequate energy intake, a biased low estimate of intake due to respondents mis-reporting their actual intake or modifying their diet during the recording period, or an overestimate of energy requirements^{10,11}. This survey provided the opportunity to estimate energy expenditure from records of physical activity and relate this to energy intake and body size (BMI and waist to hip ratio).

5.2 Findings

5.2.1 Measures of physical activity

Self-reported levels of physical activity were asked in the dietary interview. All respondents were asked whether they considered themselves to be very physically active, fairly physically active, not very physically active or not at all physically active.

Complete seven-day physical activity diaries were obtained from 1,658 respondents, 741 men and 917 women. From these diaries, the duration of participation in different activities of varying intensity can be estimated. The time spent in activities of moderate and vigorous/very vigorous intensity during the seven-day recording period were calculated, and added together to give the total time spent in activities of 'at least moderate intensity'. Data are presented on the various measures derived from the physical activity data, including mean hours spent in activities of at least moderate intensity per day and mean hours spent in activities of vigorous/very vigorous intensity per day.

Data for these measures are presented for both men and women separately by age group. Tables are also presented showing the breakdown between physical activity and the region in which the respondent lived and whether someone in the respondent's household was in receipt of certain benefits. In addition, bivariate¹² and multivariate analyses are presented showing the relationship between the measures of physical activity and key socio-demographic, physiological and behavioural factors. Data on the number of days per week on which respondents spent 30 minutes or more in activities of at least moderate intensity are given for the NDNS and the Health Survey for England (HSfE)¹³ and discussed in relation to the DH recommendation noted above.

5.2.2 Self-reported levels of physical activity

Table 5.1 gives the distributions for self-reported levels of physical activity from the dietary interview. Over half of men and women in the responding sample, 51% and 52% respectively, reported that they were fairly physically active, and around a fifth of men and women, 21% and 17% respectively, reported that they were very physically active. Just under a quarter of men and women reported that they were not very physically active, 23% and 24% respectively, and 5% of men and 6% of women reported being not at all physically active. There were no significant sex or age differences in the proportion of respondents who reported each level of physical activity.

(Table 5.1)

5.2.3 Time spent in activities of at least moderate intensity and vigorous/very vigorous intensity

Table 5.2 shows that, overall, 17% of men and 16% of women did not record spending any time in activities of at least moderate intensity during the seven-day recording period (ns). Men and women aged 50 to 64 years were significantly more likely to have not recorded any time in activities of at least moderate intensity, 24% and 20% respectively, than those aged 25 to 34 years, 9% and 10% respectively (men: $p < 0.01$; women: $p < 0.05$).

Table 5.2 also shows the mean hours spent in activities of at least moderate intensity. On average, men spent 2.2 hours per day and women 1.2 hours per day in activities of at least moderate intensity (medians 0.6 hours and 0.5 hours) ($p < 0.01$). Within each age group, men spent significantly more time than women in activities of at least moderate intensity (19 to 24 years: $p < 0.05$; all others: $p < 0.01$).

Generally, for men, mean hours spent in activities of at least moderate intensity decreased with age. Men aged 19 to 34 years spent significantly more time in activities of at least moderate intensity than the oldest group of men (19 to 24: $p < 0.05$; 25 to 34: $p < 0.01$). Men aged 19 to 24 years spent, on average, 2.9 hours per day and those aged 25 to 34 years spent 2.7 hours per day in activities of at least moderate intensity compared with 1.5 hours for those aged 50 to 64 years. There were no significant age differences for women.

For all sex/age groups, the mean time spent in activities of at least moderate intensity was

considerably higher than the median value. This indicates that there were a small number of respondents within each sex/age group who recorded spending relatively long periods of time in activities of at least moderate intensity¹⁴. For instance, at the upper 2.5 percentile, the time spent in activities of at least moderate intensity recorded by men was more than 8.0 hours and by women more than 6.0 hours. It is likely that the large amounts of time spent in activities of at least moderate intensity at the upper end of the distribution are due to the respondent working in occupations categorised as moderate or hard/very hard work (see Appendix D).

(Table 5.2)

Table 5.3 shows that 39% of men and 28% of women recorded spending some time in activities of vigorous/very vigorous intensity over the seven-day recording period ($p < 0.01$). Generally, the proportion of men and women who recorded spending time in activities of vigorous/very vigorous intensity decreased with age. For men, 53% of those aged 25 to 34 years recorded spending time in activities of vigorous/very vigorous intensity compared with 22% of those aged 50 to 64 years ($p < 0.01$). Similarly, the youngest group of women were significantly more likely than the oldest group of women to have recorded taking part in vigorous/very vigorous activity during the seven-day recording period, 41% compared with 18% ($p < 0.05$).

Overall, men spent significantly more time, on average, in activities of vigorous/very vigorous intensity than women, 0.5 hours and 0.1 hours respectively (medians 0.0 hours for both sexes) ($p < 0.01$). This difference between men and women was true for age groups 25 to 34 years and 35 to 49 years ($p < 0.01$).

Men aged 25 to 34 years, and women aged 19 to 24 years, spent significantly longer in activities of vigorous/very vigorous intensity, 0.8 hours and 0.2 hours respectively, than men and women aged 50 to 64 years, 0.3 hours and 0.1 hours respectively ($p < 0.05$).

For all sex/age groups, the mean time spent in activities of vigorous/very vigorous intensity was higher than the median value. This indicates that there were a small number of respondents within each sex/age group who recorded spending a lot of time in activities of vigorous/very vigorous intensity¹⁴. For instance, at the upper 2.5 percentile the amount of time spent in activities of vigorous/very vigorous intensity ranged from 4.4 hours for the oldest group of men to 8.6 hours for those

aged 25 to 34 years. As for time spent in activities of at least moderate intensity, it is likely that the large amount of time spent in activities of vigorous/very vigorous intensity at the upper end of the distribution is due to the respondent working in occupations categorised as hard/very hard work, for example hard physical labour (see Appendix D).

(Table 5.3)

The DH recommendation for adults is that they should participate in at least 30 minutes of at least moderate activity on at least five days of the week^{2,3}. Table 5.4 shows data on the number of days per week respondents spent 30 minutes or more in activities of at least moderate intensity.

Overall, 36% of men and 26% of women spent 30 minutes or more per day in activities of at least moderate intensity on five or more days ($p < 0.01$). For men, the proportion who spent 30 minutes or more in activities of at least moderate intensity on five or more days was 49% of the youngest age group and 46% of those aged 25 to 34 years compared with 24% of those aged 50 to 64 years (19 to 24 years: $p < 0.05$; 25 to 34 years: $p < 0.01$). There were no significant age differences for women.

(Table 5.4)

5.3 Variation in physical activity

In this section, variation in measures of physical activity is considered in relation to socio-demographic and dietary factors, and anthropometric and blood pressure measurements.

5.3.1 Region and household receipt of benefits

Table 5.5 shows the mean number of hours spent in activities of at least moderate intensity per day in relation to the region in which the respondent lived¹⁵.

For women, there were no significant regional differences in the mean hours spent in activities of at least moderate intensity. The only significant difference for men was for those living in Central and South West regions of England and in Wales who spent longer in activities of at least moderate intensity than those in London and the South East, 2.6 hours compared with 1.7 hours ($p < 0.05$).

(Table 5.5)

Table 5.6 shows mean hours spent in activities of at least moderate intensity per day according to whether someone in the respondent's household

was receiving certain state benefits¹⁶. There were no significant differences by household benefit status for men or women.

(Table 5.6)

5.3.2 Correlations with energy and macronutrient intakes, anthropometric measurements and blood pressure

Table 5.7 gives correlation coefficients for the relationships between the time spent in activities of at least moderate intensity and dietary intake, as measured by average daily total energy intake, percentage food energy from total fat, protein, total carbohydrate and non-milk extrinsic sugars and percentage total energy from alcohol. The tables are restricted to those respondents who completed a seven-day dietary and physical activity diary.

Tables 5.8 and 5.9 give correlation coefficients for the relationships between the time spent in activities of at least moderate intensity per day and, respectively, anthropometric measurements indicating body size¹⁷ and blood pressure.

It should be noted that where correlations are statistically significant the relationship between the two variables may not necessarily be causal; other factors, for example, the respondent's health at the time, may have affected the size of the correlation.

Tables 5.7, 5.8 and 5.9 show that the correlation coefficients between time spent in activities of at least moderate intensity and these variables are extremely low for all groups. This indicates that, based on the data from this survey, there was no correlation between the time spent in activities of at least moderate intensity and the measures of average intake of energy and macronutrients, anthropometric measurements and blood pressure.

(Tables 5.7 to 5.9)

5.4 Characteristics found to be independently associated with measures of physical activity

Various socio-demographic, physiological and behavioural factors have been shown to be associated with physical activity, defined as time spent in activities of at least moderate intensity (see Sections 5.2 and 5.3) but some of these factors are known to be inter-related. This section considers the combined effect of these variables on time spent in activities of at least moderate intensity. The technique of multiple regression is used to build a model from those characteristics which most explain the physical activity measurements.

As noted above (see Section 5.2.3), there is a strong association between sex and physical activity, so each multiple regression analysis is presented separately for men and women. To control for the effects of age, this variable was included in each regression analysis.

Table 5.10 shows the socio-demographic, dietary and physiological factors which were significantly associated with time spent in activities of at least moderate intensity when bivariate analyses were carried out, in addition to the previously shown relationships with region and household benefit status¹⁸. Those independent variables that were found to be significantly associated with the measurements in a bivariate relationship were then included in the multiple regression model¹⁹.

(Table 5.10)

Tables 5.11 and 5.12 give standardised regression coefficients for a number of characteristics, the independent variables, associated with variation in the physical activity measure, the dependent variable, produced using the technique of multiple regression. The tables of results identify those characteristics which are related to the measurements after controlling for the effects of the other characteristics included in the analysis. All regression models are deemed meaningful when a high percentage of the variance is explained. The technique of multiple regression calculates coefficients based on the number of cases for which there are valid values for all the variables included in the analysis. Further information on the statistical method and interpretation of output from multiple regression analysis is given in Appendix A²⁰.

5.4.1 Findings

Tables 5.11 and 5.12 show that the best multiple regression models that could be developed using the most relevant independent variables for the dependent variable, time spent in activities of at least moderate intensity, were able to explain 23% and 5% of the variance for men and women respectively.

(Tables 5.11 and 5.12)

5.5 Comparison with Health Survey for England 1998

Table 5.13 compares data from the present NDNS for respondents in England only with physical activity data from the Health Survey for England 1998 (HSfE)³. The HSfE was based on a multi-stage probability sample of addresses drawn from the Postcode Address File. 15,908 adults aged 16

and over were interviewed. A summary of the key findings and methodology from the Health Survey for England 1998 is provided in two volumes²¹.

There are several important differences between the HSfE and the NDNS in terms of the data collection method for physical activity; these are described in Appendix I of the Technical Report¹. In particular it should be noted that the HSfE used a seven-day recall compared with the NDNS which used a seven-day diary. In addition, for the HSfE activities lasting less than 15 minutes were excluded whereas activities in the NDNS lasting less than 10 minutes were excluded.

Data are presented for men and women by age. It should be noted that in the HSfE the youngest age group was aged 16 to 24 years, while in the present NDNS the youngest age group was adults aged 19 to 24 years. This should be borne in mind where there are differences between these groups. Age groups for the present NDNS were redefined to match those of the HSfE so that meaningful comparisons could be made: 16/19 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years.

5.5.1 Findings

The following discussion focuses on differences between the two surveys in relation to the DH recommendation for adults discussed in Section 5.2.3.

Table 5.13 shows that for men aged 35 to 44 and 55 to 64 years the proportion who recorded spending at least 30 minutes in activities of at least moderate intensity on five days a week or more was significantly lower in the NDNS than in the HSfE, 32% and 21% compared with 43% and 32% ($p < 0.01$). For women, there were no significant age differences between the NDNS and HSfE.

For both men and women there were no significant differences by age between the NDNS and the HSfE in the proportion reporting participating in activities of at least moderate intensity for 30 minutes or more on at least one day during the reference period.

(Table 5.13)

References and endnotes

- 1 The Technical Report is available online at <http://www.food.gov.uk/science>.
- 2 Health Development Agency. *Physical Activity*. Online: <http://www.hda-online.org.uk/html/research/physicalactivity.html>.
- 3 Prior G. 'Physical Activity' In: *Health Survey for England: Cardiovascular Disease*. TSO (London, 1998).
- 4 National Audit Office. *Tackling obesity in England*. TSO (London, 2001).
- 5 National Heart Forum. *Physical activity and coronary heart disease*. Online: <http://www.heartforum.org.uk/physicalactivity.html>.
- 6 Health Development Agency. *Physical activity: health benefits*. Online: http://www.hda-online.org.uk/html/research/pa_healthbenefits.html.
- 7 U.S. Department of Health and Human Services. *Physical activity and health: A report of the Surgeon General*. National Centre for Chronic Disease Prevention and Health Promotion (Atlanta, GA: U.S. 1994).
- 8 Estimates of energy requirements of different population groups are termed 'Estimated Average Requirements' (EARs) and are defined as the energy intake estimated to meet the average requirements of the population group.
Department of Health. Report on Health and Social Subjects: 41. *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom*. HMSO (London, 1991).
- 9 Henderson L, Gregory J, Irving K, Swan G. *The National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 2: Energy, protein, carbohydrate, fat and alcohol intake*. TSO (London, 2003).
- 10 Finch S, Doyle W, Lowe C, Bates CJ, Prentice A, Smithers G, Clarke PC. *National Diet and Nutrition Survey: people aged 65 years and over. Volume 1: Report of the diet and nutrition survey*. TSO (London, 1998).
- 11 Gregory J, Lowe S, Bates CJ, Prentice A, Jackson LV, Smithers G, Wenlock R, Farron M. *National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 1: Report of the diet and nutrition survey*. TSO (London, 2000).
- 12 It should be noted that statistically significant correlation results do not necessarily indicate any direct health or clinical meaning.
- 13 See Note 3. This was the most recent year that physical activity data were available for the general population.
- 14 Distribution of data was evaluated using the skewness statistic in SPSS. If the skewness statistic was less than twice the standard error of this statistic then data were considered to be normally distributed.
- 15 The areas included in each of the four analysis 'regions' are given in the response chapter, Chapter 2 of the Technical Report (see Note 1). Definitions of 'regions' are given in the Glossary (see Appendix E).
- 16 Households receiving certain benefits are those where someone in the respondent's household was currently receiving Working Families Tax Credit or had, in the previous 14 days, drawn Income Support or (Income-related) Job Seeker's Allowance. Definitions of 'household' and 'benefits (receiving)' are given in the Glossary (see Appendix E).
- 17 It should be noted that anthropometric measurements used are reflections of body composition in the longer term which may not necessarily be reflected by self-reported physical activity levels over a short term period.

- ¹⁸ Bivariate analyses of continuous variables were carried out using the Pearson correlation coefficient and analyses of categorical variables tested the difference between means. It should be noted that where correlations are statistically significant the relationship between the two variables may not necessarily be causal; other factors may have affected the size of the correlation.
- ¹⁹ The regression models are constructed by carrying out bivariate analyses and incorporating variables with significant associations. It should be noted that this method of selection can lead to important variables being left out as additive or interactive effects can only be identified using multiple regression.
- ²⁰ The model is tested by an ANOVA (see Appendix E - Glossary) to determine whether all the regression coefficients are zero in the population, and shows that there are significant linear relationships between the independent variables and the dependent variable.
- ²¹ Health Survey for England 1998 - Volume 1 provides a summary of key findings and Volume 2 details the methodology. Both are available online at <http://www.archive.official-documents.co.uk/document/doh/survey98/hse98.htm>.

Table 5.1

Percentage distribution of self-reported levels of physical activity by sex and age of respondent

Reported level of activity at dietary interview	Responding sample									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	%	%	%	%	%	%	%	%	%	%
Not at all physically active	7	4	5	5	5	8	6	5	8	6
Not very physically active	24	23	25	20	23	27	23	26	22	24
Fairly physically active	43	53	52	53	51	53	57	48	52	52
Very physically active	26	21	18	21	21	12	15	20	18	17
<i>Base</i>	<i>142</i>	<i>284</i>	<i>329</i>	<i>330</i>	<i>1085</i>	<i>136</i>	<i>275</i>	<i>415</i>	<i>336</i>	<i>1162</i>

Table 5.2

Percentage distribution of mean hours spent in activity of at least moderate intensity* per day by sex and age of respondent

Hours spent in activity of at least moderate intensity per day during the 7-day recording period	Respondents who completed physical activity diary									
	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %	cum %
None**	20	9	16	24	17	19	10	16	20	16
Less than quarter of an hour	25	19	33	39	30	31	30	31	42	34
Less than half an hour	38	35	45	54	44	54	46	50	56	51
Less than one hour	43	49	63	69	58	67	64	68	73	68
Less than an hour and a half	51	58	69	74	66	74	74	78	81	77
Less than two hours	54	62	73	79	70	78	77	82	84	81
Less than three hours	64	66	75	85	74	85	85	87	91	87
Less than four hours	64	70	77	86	76	91	92	90	94	92
Less than six hours	72	81	87	88	84	96	96	95	97	96
Less than eight hours	96	91	96	96	95	99	98	99	100	99
All	100	100	100	100	100	100	100	100		100
<i>Base</i>	<i>104</i>	<i>211</i>	<i>243</i>	<i>243</i>	<i>801</i>	<i>100</i>	<i>202</i>	<i>305</i>	<i>249</i>	<i>857</i>
Mean (average value)	2.9	2.7	2.0	1.5	2.2	1.3	1.3	1.2	1.0	1.2
Median	1.4	1.1	0.6	0.4	0.6	0.4	0.6	0.5	0.4	0.5
Lower 2.5 percentile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Upper 2.5 percentile	8.3	9.6	9.4	8.4	9.0	6.3	7.4	7.0	6.2	6.4
Standard deviation	3.00	3.10	2.81	2.45	2.86	1.77	1.92	1.87	1.52	1.78

Note: * Includes moderate, vigorous and very vigorous activity.

** This category includes respondents who did not participate in any moderate, vigorous or very vigorous activity during the recording period.

Table 5.3

Percentage distribution of mean hours spent in vigorous or very vigorous activity per day by sex and age of respondent

Respondents who completed physical activity diary

Cumulative percentages

Hours spent in vigorous or very vigorous activity per day during the 7-day recording period	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	cum %	cum %	cum %	cum %		cum %	cum %	cum %	cum %	
None*	56	47	60	78	61	59	65	74	82	72
Less than quarter of an hour	64	64	75	85	74	74	85	86	91	86
Less than half an hour	75	76	84	93	84	90	95	95	97	95
Less than one hour	88	88	92	97	92	98	99	99	100	99
Less than an hour and a half	91	91	93	97	93	98	99	100		100
All	100	100	100	100	100	100	100			
<i>Base</i>	<i>104</i>	<i>211</i>	<i>243</i>	<i>243</i>	<i>801</i>	<i>100</i>	<i>202</i>	<i>305</i>	<i>249</i>	<i>857</i>
Mean (average value)	0.7	0.8	0.6	0.3	0.5	0.2	0.1	0.1	0.1	0.1
Median	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lower 2.5 percentile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Upper 2.5 percentile	7.2	8.6	6.5	4.4	7.1	1.0	0.7	0.6	0.6	0.6
Standard deviation	1.66	2.11	1.69	1.11	1.67	0.29	0.24	0.32	0.15	0.26

Note: * This category includes respondents who did not participate in any vigorous or very vigorous activity during the recording period. Respondents in this category may still have taken part in moderate intensity activity.

Table 5.4

Participation in at least 30 minutes of activity of at least moderate intensity* per day by sex and age of respondent

Respondents who completed physical activity diary

Percentages

Number of days per week that 30 minutes or more per day spent in activity of at least moderate intensity	Men aged (years):				All men	Women aged (years):				All women
	19–24	25–34	35–49	50–64		19–24	25–34	35–49	50–64	
	%	%	%	%		%	%	%	%	
None	21	12	20	30	21	20	14	21	24	20
One or two days a week	14	21	27	28	24	36	29	29	34	31
Three or four days a week	17	21	19	18	19	15	26	24	21	23
Five or more days a week	49	46	34	24	36	29	30	25	22	26
<i>Base</i>	<i>104</i>	<i>211</i>	<i>243</i>	<i>243</i>	<i>801</i>	<i>100</i>	<i>202</i>	<i>305</i>	<i>249</i>	<i>857</i>

Note: * Includes moderate, vigorous and very vigorous activity.

Table 5.5

Mean hours spent in activities of at least moderate intensity* per day by sex of respondent and region

Region	Sex of respondent							
	Men				Women			
	Mean	Median	sd	Base	Mean	Median	sd	Base
Scotland	2.1	0.4	2.98	59	1.3	0.4	1.93	65
Northern	2.0	0.6	2.76	229	1.0	0.4	1.58	218
Central, South West and Wales	2.6	1.0	3.08	279	1.3	0.6	1.88	313
London and the South East	1.7	0.6	2.56	234	1.1	0.4	1.77	261

Note: * Includes moderate, vigorous and very vigorous activity.

Table 5.6

Mean hours spent in activities of at least moderate intensity* per day by sex of respondent and whether someone in the respondent's household was receiving certain benefits

Sex of respondent	Whether receiving benefits							
	Receiving benefits				Not receiving benefits			
	Mean	Median	sd	Base	Mean	Median	sd	Base
Men	2.0	0.5	2.76	105	2.2	0.6	2.87	696
Women	1.2	0.7	1.48	147	1.2	0.5	1.84	710

Note: * Includes moderate, vigorous and very vigorous activity.

Table 5.7

Pearson correlation coefficients for hours spent in activities of at least moderate intensity[†] per day with energy and macronutrient intakes

Sex and age of respondent	Correlation of hours spent in activities of at least moderate intensity with:						Base
	Average daily total energy intake (MJ)	Percentage of total energy from alcohol	Percentage food energy from:				
			Total fat	Protein	Total carbohydrate	Non-milk extrinsic sugars	
Men aged (years):							
19–24	0.14	0.04	0.25 *	-0.16	-0.17	-0.13	102
25–34	0.20 **	-0.16 *	0.06	-0.04	-0.02	-0.06	207
35–49	0.19 **	-0.03	0.03	-0.11	0.03	-0.02	235
50–64	0.24 **	-0.02	0.08	-0.06	-0.04	-0.09	240
All men	0.19 **	-0.05	0.09 *	-0.09 **	-0.02	-0.03	784
Women aged (years):							
19–24	-0.05	-0.03	-0.12	-0.02	0.11	0.08	98
25–34	-0.09	-0.10	0.02	0.00	-0.02	-0.02	201
35–49	0.04	-0.15 *	0.02	0.03	-0.03	-0.08	299
50–64	0.14 *	-0.06	0.01	-0.10	0.04	0.05	248
All women	0.02	-0.10 **	0.00	-0.03	0.01	-0.01	847

Note: * $p < 0.05$; ** $p < 0.01$

[†] Includes moderate, vigorous and very vigorous activity.

Table 5.8

Pearson correlation coefficients for hours spent in activities of at least moderate intensity[†] per day with anthropometric measurements

Sex and age of respondent	Correlation of hours spent in activities of at least moderate intensity with:			
	Body mass index (kg/m ²)	Base	Waist to hip ratio	Base
Men aged (years):				
19–24	0.10	95	0.21 *	97
25–34	0.21 **	199	0.14 *	199
35–49	-0.04	236	0.01	236
50–64	0.04	233	0.06	230
All men	0.02	762	0.00	763
Women aged (years):				
19–24	0.07	93	0.14	93
25–34	0.13	190	0.01	190
35–49	0.04	294	-0.01	293
50–64	-0.07	231	-0.03	232
All women	0.03	807	-0.02	808

Note: * $p < 0.05$; ** $p < 0.01$

[†] Includes moderate, vigorous and very vigorous activity.

Table 5.9

Pearson correlation coefficients for hours spent in activities of at least moderate intensity[†] per day with blood pressure

Sex and age of respondent	Correlation of hours spent in activities of at least moderate intensity with:		
	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)	Base
Men aged (years):			
19–24	0.15	0.04	93
25–34	0.11	-0.01	201
35–49	-0.14 *	-0.08	235
50–64	0.02	0.02	226
All men	-0.04	-0.11 **	754
Women aged (years):			
19–24	-0.01	0.03	93
25–34	0.00	-0.04	185
35–49	-0.03	-0.07	284
50–64	-0.15 *	-0.10	223
All women	-0.08 *	-0.07 *	786

Note: * $p < 0.05$; ** $p < 0.01$

[†] Includes moderate, vigorous and very vigorous activity.

Table 5.10

Socio-demographic, dietary and physiological factors associated with hours spent in activities of at least moderate intensity[†] in bivariate analysis

Men	Women
Age (years)**	Age (years)*
Average daily alcohol intake (g)	Average daily alcohol intake (g)
Average daily total energy intake (MJ)**	Average daily total energy intake (MJ)
BMI (kg/m ²)	BMI (kg/m ²)
Current smoking	Current smoking
Employment status**	Employment status**
Ethnicity of respondent	Ethnicity of respondent
Gross weekly household income**	Gross weekly household income*
Grouped Standard Region*	Grouped Standard Region
Household benefit status	Household benefit status
Household composition*	Household composition
Limited activity due to illness or disability*	Limited activity due to illness or disability*
Mean diastolic pressure (mmHg)**	Mean diastolic pressure (mmHg)*
Mean systolic pressure (mmHg)	Mean systolic pressure (mmHg)*
Percentage food energy from protein**	Percentage food energy from protein
Percentage food energy from total carbohydrate	Percentage food energy from total carbohydrate
Percentage food energy from total fat*	Percentage food energy from total fat
Percentage total energy from alcohol	Percentage total energy from alcohol**
Percentage total energy from protein*	Percentage total energy from protein
Percentage total energy from total carbohydrate	Percentage total energy from total carbohydrate
Percentage total energy from total fat*	Percentage total energy from total fat
Percentage total energy from total sugars	Percentage total energy from total sugars
Reported dieting to lose weight	Reported dieting to lose weight
Self-reported alcohol consumption	Self-reported alcohol consumption
Self-reported physical activity level**	Self-reported physical activity level**
Social class of household reference person**	Social class of household reference person*
Vegetarian or vegan	Vegetarian or vegan
Waist to hip ratio	Waist to hip ratio
Wave of interview	Wave of interview

Note: * $p < 0.05$; ** $p < 0.01$

[†] Includes moderate, vigorous and very vigorous activity.

Table 5.11

Linear regression model for time spent in activities of at least moderate intensity per day: men

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	0.463	1.098		0.422
Social class of household reference person				
Non-manual	-0.284	0.269	-0.053	-1.053
Manual	1.466	0.264	0.266	5.557 ***
Unclassified	-1.182	0.485	-0.219	-2.437 *
Age (years)	-0.039	0.010	-0.177	-3.972 ***
Self-reported physical activity level				
Very physically active	0.880	0.200	0.148	4.400 ***
Fairly physically active	-0.083	0.167	-0.017	-0.500
Not very physically active	-0.807	0.195	-0.139	-4.143 ***
Not at all physically active	0.011	0.342	0.002	0.032
Gross weekly household income				
Less than £160	-0.816	0.281	-0.187	-2.906 **
£160 - less than £400	0.534	0.186	0.104	2.864 **
£400 & over	0.282	0.197	0.065	1.432
Employment status				
In employment	0.689	0.253	0.162	2.727 **
Unemployed	-0.487	0.354	-0.067	-1.375
Economically inactive	-0.202	0.257	-0.048	-0.785
Average daily total energy intake (MJ)	0.152	0.042	0.129	3.655 ***
Household composition				
Living alone	-0.276	0.224	-0.060	-1.229
Living with spouse or partner, no dependent children	0.232	0.172	0.067	1.350
Living with other adults, no spouse or dependent children	-0.160	0.218	-0.037	-0.734
Living with dependent children, with or without spouse	0.204	0.164	0.044	1.246
Region				
Scotland	0.281	0.278	0.055	1.014
Northern	-0.164	0.175	-0.043	-0.940
Central, South West and Wales	0.193	0.165	0.054	1.173
London and the South East	-0.311	0.172	-0.061	-1.802
Percentage total energy from total fat[†]	0.024	0.017	0.048	1.436
Limited activity due to illness or disability	-0.126	0.259	-0.017	-0.485
Diastolic blood pressure (mmHg)	-0.004	0.009	-0.016	-0.435
Percentage total energy from protein[†]	0.010	0.035	0.010	0.284
Percentage of variance explained		23%		
Number of respondents		732		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] For men, percentage food energy from protein and percentage food energy from total fat were significantly correlated with average time spent in activities of at least moderate intensity at the bivariate stage but these variables were not included in the multiple regression model. This is because alcohol intake was not found to be significantly associated with time spent in activities of at least moderate intensity, therefore percentage of total energy from protein and percentage of total energy from total fat, which includes alcohol intake, were chosen preferentially.

Table 5.12

Linear regression model for time spent in activities of at least moderate intensity per day: women

Characteristic	Unstandardised coefficient (B)	Standard error of B	Standardised regression coefficient (β)	T-value
Constant	1.938	0.530		3.658 ***
Self-reported physical activity level				
Very physically active	0.327	0.137	0.090	2.395 *
Fairly physically active	0.180	0.104	0.063	1.729
Not very physically active	0.136	0.124	0.040	1.102
Not at all physically active	-0.644	0.203	-0.176	-3.172 **
Social class of household reference person				
Non-manual	-0.436	0.141	-0.140	-3.092 **
Manual	-0.099	0.143	-0.031	-0.693
Unclassified	0.535	0.250	0.172	2.140 *
Percentage total energy from alcohol	-0.027	0.012	-0.080	-2.176 *
Limited activity due to illness or disability	-0.321	0.162	-0.074	-1.979 *
Employment status				
In employment	0.173	0.164	0.088	1.055
Unemployed	0.005	0.287	0.001	0.017
Economically inactive	-0.177	0.168	-0.090	-1.055
Gross weekly household income				
Less than £160	-0.111	0.145	-0.045	-0.768
£160 - less than £400	0.132	0.104	0.069	1.271
£400 & over	-0.021	0.103	-0.009	-0.206
Age (years)	-0.005	0.006	-0.036	-0.819
Diastolic blood pressure (mmHg)	0.001	0.008	0.004	0.079
Systolic blood pressure (mmHg)	-0.003	0.006	-0.030	-0.556
Percentage of variance explained		5%		
<i>Number of respondents</i>		749		

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 5.13

Participation in at least 30 minutes of activity of at least moderate intensity* per day by sex and age of respondent compared with the Health Survey for England 1998**

Percentages

Number of days per week that 30 minutes or more per day spent in activity of at least moderate intensity*	Men aged (years):					Women aged (years):				
	16/19–24***	25–34	35–44	45–54	55–64	16/19–24***	25–34	35–44	45–54	55–64
	%	%	%	%	%	%	%	%	%	%
2000/01 NDNS – England only†										
None	20	14	20	25	27	23	15	21	24	29
One or two days a week	13	21	28	27	30	36	28	30	27	31
Three or four days a week	17	22	21	18	23	15	29	23	27	18
Five or more days a week	50	44	32	30	21	26	29	26	22	22
<i>Base</i>	<i>96</i>	<i>191</i>	<i>150</i>	<i>143</i>	<i>126</i>	<i>88</i>	<i>177</i>	<i>185</i>	<i>179</i>	<i>125</i>
1998 Health Survey for England††										
None	10	11	15	22	34	20	15	16	21	29
Less than one day a week****	6	11	12	11	10	13	13	14	13	13
One or two days a week	15	19	20	21	17	22	26	25	23	26
Three or four days a week	11	11	9	10	7	13	15	14	13	12
Five or more days a week	58	48	43	36	32	32	31	32	30	21
<i>Base</i>	<i>875</i>	<i>1338</i>	<i>1305</i>	<i>1289</i>	<i>987</i>	<i>1006</i>	<i>1630</i>	<i>1573</i>	<i>1484</i>	<i>1148</i>

Note: * Includes moderate, vigorous and very vigorous activity.

** Erens B, Primatesta P. Eds. Health Survey for England: Cardiovascular Disease 1998. TSO (London, 1999).

*** Health Survey for England figures include respondents aged 16 to 24.

**** The total number of activity days each respondent reported in the past four weeks was divided by four to produce a weekly figure. A comparable category for the present NDNS is not meaningful.

† Figures based on participation for at least 10 minutes.

†† Figures based on participation for at least 15 minutes.

Appendix A Sampling errors and statistical methods

1 Sampling errors

This section examines the sources of error associated with survey estimates and presents sampling errors of survey estimates, referred to as standard errors, and design factors for a number of key variables shown in this volume. It should be noted that tables showing standard errors in the main part of this volume have assumed a simple random sample design. In testing for the significance of the differences between two survey estimates, proportions or means, the standard error calculated as for a simple random sample design was multiplied by an assumed, conservative, design factor of 1.5 to allow for the complex sample design.

The estimates presented in the main part of this volume are based on data weighted to correct both for differential sampling probability and for differential non-response. The sampling errors presented in this appendix were calculated after applying a weight to compensate for differential sampling probability and differential non-response. The sample was also post-stratified, so that it matched the population distribution in terms of age, sex and region¹.

1.1 The accuracy of survey results

Survey results are subject to various sources of error. The total error in a survey estimate is the difference between the estimate derived from the data collected and the true value for the population. It can be thought of as being comprised of random and systematic errors, and each of these two main types of error can be subdivided into error from a number of different sources.

1.1.1 Random error

Random error is the part of the total error which would be expected to average zero if a number of repeats of the same survey were carried out based on different samples from the same population.

An important component of random error is sampling error, which arises because the estimate is based on a survey rather than a census of the population. The results of this or any other survey would be expected to vary from the true population values. The amount of variation depends on both the size of the sample and the sample design.

Random error may also arise from other sources such as the respondent's interpretation of the questions. As with all surveys carried out by the ONS, considerable efforts were made on this survey to minimise these effects through interviewer training and through feasibility work; however it is likely some will remain that are not possible to quantify.

1.1.2 Systematic error

Systematic error, or bias, applies to those sources of error that will not average to zero over a number of repeats of the survey. The category includes, for example, bias due to omission of certain parts of the population from the sampling frame, or bias due to interviewer or coder variation. A substantial effort is put into avoiding systematic errors but it is likely that some will remain.

Non-response bias is a systematic error that is of particular concern. It occurs if non-respondents to the survey, or to particular components of the survey, differ significantly in some respect from respondents, so that the responding sample is not representative of the total population. Non-response can be minimised by training interviewers in how to deal with potential refusals and with strategies to minimise non-contacts. However, a certain level of non-response is inevitable in any voluntary survey. The resulting bias is, however, dependent not only on the absolute level of non-response, but on the extent to which non-respondents differ from respondents in terms of the measures that the survey aims to estimate.

Although respondents were encouraged to take part in all components of the survey, some refused certain components. Chapter 2 of the Technical Report² examines the characteristics of groups responding to the different parts of the survey package. The analysis of the region, sex and age profile of respondents compared with population estimates showed evidence of some response bias. In particular, there was an under representation of men, and of people aged 19 to 24 years. The data for the main part of this volume (and all volumes in the series) were therefore weighted for differential non-response by sex, age and region.

1.2 Standard errors for estimates for the NDNS of adults aged 19 to 64 years

As described in Chapter 1 and Appendix D of the Technical Report², this survey used a complex sample design, which involved both clustering and stratification. In considering the accuracy of estimates, standard errors calculated on the basis of a simple random sample design will be incorrect because of the complex sample design.

The sample for this survey was clustered using postcode sectors as primary sampling units (PSUs). Clustering can increase standard errors if there is a lot of variation in characteristics between the PSUs, but little variation within them. By contrast, stratification tends to reduce standard errors especially where the stratification factors are correlated to the survey estimate. Stratifying the sample ensures that certain sections of the population are represented in the sample. The main stratifier used on this survey was Standard Statistical Region (SSR). The PSUs were further stratified by population density, socio-economic group and car ownership (see Appendix D of the Technical Report²).

In a complex sample design, the size of the standard error of any estimate depends on how the characteristic of interest is spread within and between PSUs and strata: this is taken into account by pairing adjacent PSUs from the same strata. The squared differences in the estimates between successive PSUs from the same strata are calculated and summed to produce the standard error.

The majority of estimates in this survey take the form of ratio estimates, either means or proportions. The formula to calculate the standard error of these is:

$$se(r) = \frac{1}{x} [\text{var}(y) + r^2 \text{var}(x) - 2r \text{cov}(y,x)]^{1/2}$$

where the ratio $r = y/x$.

The method explicitly allows for the fact that the percentages and means are actually ratios of two survey estimates, both of which are subject to random error. The value $se(r)$ is the estimate of the standard error of the ratio, r , expressed in terms of $se(y)$ and $se(x)$ which are the estimated standard errors of y and x , and $cov(y,x)$ which is their estimated covariance. The resulting estimate is slightly biased and only valid if the denominator is not too variable³. The ratio means for age groups have standard errors equal to zero for the full sample because both the numerator and the denominator have been set to equal the population totals and thus cannot vary for any selected sample.

The method of standard error estimation compares the successive differences between totals of the characteristic of interest for adjacent PSUs (postal sectors)⁴. The characteristic is the numerator, for example body mass index, and the sample size is the denominator in the ratio estimate⁵. The ordering of PSUs reflects the ranking of postal sectors on the stratifiers used in the sample design.

Tables A1 to A4 give standard errors, taking account of the complex sample design used on this survey, for the key variables presented in this volume. Standard errors for estimates by household benefit status and region, are shown separately for men and women to reflect the way they are presented in the main part of the volume.

1.3 Estimating standard errors for other survey estimates

Although standard errors can be calculated readily by computer, there are practical problems in

presenting a large number of survey estimates. One solution is to calculate standard errors for selected variables and, from these, identify design factors appropriate for the specific survey design and for different types of survey variable. The standard error of other survey measures can then be estimated using an appropriate design factor, together with the sampling error assuming a simple random sample.

1.3.1 The Design Factor (deft)

The effect of a complex sample design can be quantified by comparing the observed variability in the sample with the expected variability had the survey used a simple random sample. The most commonly used statistic is the design factor (*deft*), which is calculated as a ratio of the standard error for a survey estimate allowing for the full complexity of the sample design (including weighting), to the standard error assuming that the result has come from a simple random sample. The *deft* can be used as a multiplier to the standard error based on a simple random sample, $se(p)_{srs}$, to give the standard error of the complex design, $se(p)$, by using the following formula:

$$se(p) = \text{deft} \times se(p)_{srs}$$

Tables A1 to A4 show *deft* values for certain measures for respondents who completed that component of the survey. The *deft* value varies between survey variables, reflecting the degree to which the characteristic is clustered within PSUs or is distributed between strata. Variables which are highly correlated to the post-strata should also have reduced *deft* values. For a single variable, the *deft* value can also vary according to the size of the subgroup on which the estimate is based because smaller subgroups can be less affected by clustering.

Table A1 shows *deft* values for age group, region and household benefit status for the diary sample, Table A2 for physiological measurements, Tables A3(a) and (b) for blood analytes and Table A4 for measures of physical activity. For age group, region and household benefit status, where geographic clustering would be expected, six out of ten of the *deft* values for men and eight out of ten for women are less than 1.2. *Deft* values of this order are considered to be small and they indicate that, in this survey, the characteristic is not markedly clustered geographically. Two of these *deft* values are above 1.5 for both sexes.

For women, 61% of the *deft* values presented in Tables A2 to A4 are less than 1.2, while for men 43% are less than 1.2. For women, 2% of the *deft*

values are greater than 1.5, while for men, 6% are greater than 1.5.

(Tables A1 to A4)

1.3.2 Testing differences between means and proportions

Standard errors can be used to test whether an observed difference between two proportions or means in the sample is likely to be due to sampling error. An estimate for the standard error of a difference between percentages, from the same sample, assuming a simple random sample is:

$$se_1(p_1 - p_2) = \sqrt{[(p_1 q_1 / n_1) + (p_2 q_2 / n_2)]}$$

where p_1 and p_2 are the observed percentages for the two subsamples, q_1 and q_2 are respectively $(100 - p_1)$ and $(100 - p_2)$, and n_1 and n_2 are the subsample sizes.

The equivalent formula for the standard error of the difference between the means for subsamples 1 and 2 is:

$$se_2(\text{diff}) = \sqrt{(se_1^2 + se_2^2)}$$

Allowance for the complex sample design is then made by multiplying the standard errors se_1 and se_2 from the above formula by the appropriate *deft* values.

In this volume the calculation of the difference between proportions and means assumed a *deft* of 1.5 across all survey estimates. The calculation of complex sampling errors and design factors for key characteristics show that this was a conservative estimate for some characteristics for some age and sex groups, but was an optimistic estimate for other characteristics. Therefore there will be some differences in sample proportions and means which are not commented on in the text, but that are significantly different, at least at the $p < 0.05$ level. Equally, there will be some differences that are described as significant in the text, but that are not significantly different when the complex sampling design is taken into account. An indication of the characteristics for which significance tests are likely to provide false-positives or false-negatives can be gained by looking at the size of the *deft* values in the tables in this appendix.

Confidence intervals can be calculated around a survey estimate using the standard error for that estimate. For example, the 95% confidence interval is calculated as 1.96 times the standard error on either side of the estimated proportion or mean value. At the 95% confidence level, over many

repeats of the survey under the same conditions, 95% of these confidence intervals would contain the population estimate. However, when assessing the results of a survey, it is usual to assume that there is only a 5% chance that the true population value will fall outside the 95% confidence interval calculated for the survey estimate.

2 Multiple Regression

The substantive chapters of this volume present results from multiple regression analyses. These analyses were carried out in SPSS version 10.1 using the 'enter' method.

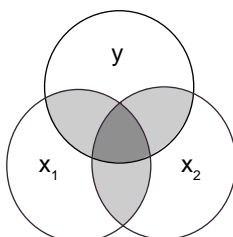
In each analysis age was always included as an independent variable and the regression analyses were run separately for men and women. For each regression the procedure was first run to identify any collinear variables. After excluding one from the pair of any collinear variables the procedure was run again. All the regression analyses were carried out using weights for the dependent variable in the analysis⁶.

2.1 The multiple regression analysis method⁷

Most of the tables shown in this volume are based on bivariate analysis. These tables show the relationship between two reported or measured variables, for example, the proportion of respondents living in different regions with different mean body weight. What these tables do not show, however, is how other factors may interrelate with the independent variable; for example, how age, sex and household composition interrelate to explain variations in diastolic blood pressure.

Figure A1 shows how each of the variables, x_1 and x_2 , make an independent contribution to the dependent variable, y , but that there is an area of x_1 that overlaps with x_2 . By carrying out a multiple regression analysis the overlap between x_1 and x_2 is eliminated, so that the contribution x_1 makes to y can be measured after controlling for (eliminating) the overlapping contribution of x_2 .

Figure A1



Multiple regression is a multivariate statistical technique that describes the relationship between one survey variable, the dependent variable, for example the diastolic blood pressure of the respondent and several other variables, the independent variables, for example, age, sex and household composition. For example, Table 3.10 of this volume shows the results of regression where the dependent variable is the diastolic blood pressure for a man aged between 19 and 64 years. The regression calculates a coefficient for each independent variable which quantifies the effect that a change in that variable will have on the predicted diastolic blood pressure, leaving all other variables in the regression unchanged (see Section 2.3 below).

When running regression the interest is in testing whether, for a given model, there is a relationship between the dependent variable and the independent variables in the population. This is done by testing whether the coefficient for the independent variable is equal to zero. A variable is judged to be statistically different from zero if it is significant at the 95% level or above. This means that if there were no relationship in the population between the dependent and the independent variable, there would be a probability of 5% or less that the regression would have estimated a coefficient that was different from zero.

2.1.1 Assumptions for multiple regression analysis

The technique of multiple regression requires a number of conditions of the data to be met or assumed; some are appropriate only to the analysis of particular types of dataset, for example time series, and are not presented here. The assumptions made in respect of the NDNS data for multiple regression analysis were as follows:

- *Linearity and normal distribution*

The technique of multiple regression calculates coefficients that describe linear relationships between variables and assume that the residuals (the difference between the actual value of the dependent variable and that predicted by the model) are normally distributed. If the residuals are not normally distributed, the significance tests will not be valid. In order to facilitate normally distributed residuals, where the NDNS data for any of the dependent variables included in the analysis were strongly skewed⁸ they were transformed by taking the natural log (ln) before being added to the analysis model.

- *Values for the independent variables in repeated samples are fixed*

The assumption is that if multiple samples are drawn, an independent variable will take the same value in each sample. Chapter 2 of the Technical Report² shows that for several of the socio-demographic variables used in the multiple regression analysis, the NDNS sample gave comparable results to those found in other surveys.

- *Collinearity (or multicollinearity)*

The assumption is that no two independent variables are close or exact linear combinations of one another. When two variables are strongly positively correlated (collinear), the standard errors will be inflated, making the significance tests misleading. In SPSS, the multiple regression analysis produces a Pearson correlation matrix and two 'collinearity statistics': the *tolerance* and the *variance inflation factor (VIF)*. The *tolerance* of a variable is $1 - R_i^2$ where R_i is the multiple correlation coefficient when the i th independent variable is predicted from the other independent variables. The *VIF* is $1/\textit{tolerance}$. A value of 10 or more for the *VIF* indicates the presence of significant collinearity between the independent variable against which it appears and one or more of the other independent variables included in the model. The Pearson correlation coefficient matrix gives correlation coefficients for the relationship between each of the independent variables and is used to identify which are strongly correlated.

For each multiple regression analysis carried out, all of the independent variables considered important in explaining the dependent variable were included in an initial regression analysis. The output from this initial analysis identified independent variables with a *VIF* value of greater than 10, and the Pearson correlation matrix was used to show which variables were strongly correlated so that one or more could be excluded from the analysis. The decision about which variable(s) to exclude from the regression analysis was made with reference to which might be the more important factor, either in terms of predictive value or in terms of policy relevance.

2.1.2 Preparing variables for multiple regression analysis

In a multiple regression analysis the dependent variable must be continuous and the independent

variables either continuous or dichotomous. Independent categorical variables with more than two categories must be transformed into dichotomous ('dummy') variables before being included in the analysis.

For categorical variables with two categories, the two possible 'dummy' variables are complementary. For example, for whether the respondent 'smoked cigarettes at all nowadays' the two possible 'dummy' variables are:

smoke cigarettes at all nowadays? yes = 1, no = 0
smoke cigarettes at all nowadays? yes = 0, no = 1

The SPSS multiple regression program tests the independent variables for multicollinearity, as described above. Where there is a strong correlation between two variables, the statistics produced by the analysis are not valid and one of the collinear variables must be excluded. However, where there is an exact correlation between two variables, for example where two 'dummy' variables are complementary parts of the same variable, SPSS automatically excludes one from the analysis and uses it as the 'reference category'. For a dichotomous variable the regression coefficient gives the expected difference of being in one category (the category that takes the value 1) rather than the other (the category that takes the value 0).

For categorical variables with more than two categories, dichotomous 'dummy' variables need to be created. For example, for region with four categories, four 'dummy' variables need to be created to indicate whether or not the respondent lived in each region. Thus the first 'dummy' variable would be categorised 'Living in Scotland' and 'Not living in Scotland', the second 'Living in Northern region' and 'Not living in Northern region' and so on. If all four 'dummy' variables for regions are included in the analysis, one is automatically treated as the reference category and the unstandardised coefficients are interpreted with reference to that category. However, to provide correlation coefficients that can be interpreted as deviations from the average effect of all categories, it is necessary to use the 'enter' method for the procedure and to run two versions of each regression analysis.

For example for 'region' in the NDNS dataset two sets of 'dummy' variables were created with one (reference) category coded as -1 and one category excluded:

Set 1:

'Dummy' 1 = (Scotland = 1) (Northern = 0) (Central and South West of England and Wales = 0) (London and South East = -1)

'Dummy' 2 = (Scotland = 0) (Northern = 1) (Central and South West of England and Wales = 0) (London and South East = -1)

'Dummy' 3 = (Scotland = 0) (Northern = 0) (Central and South West of England and Wales = 1) (London and South East = -1)

Set 2:

'Dummy' A = (Scotland = -1) (Northern = 1) (Central and South West of England and Wales = 0) (London and South East = 0)

'Dummy' B = (Scotland = -1) (Northern = 0) (Central and South West of England and Wales = 1) (London and South East = 0)

'Dummy' C = (Scotland = -1) (Northern = 0) (Central and South West of England and Wales = 0) (London and South East = 1)

Note that for the first set the London and the South East category is set to -1 and there is no 'dummy' variable for London and the South East. In the second set, Scotland is set to -1 and there is no 'dummy' variable for Scotland. Any two categories could have been excluded.

The same procedure was used for all categorical variables for which there were more than two categories, producing two sets of 'dummy' variables that were run in two versions of the same multiple regression analysis. It is only necessary to run the regressions twice, no matter how many categorical variables are included. Where a 'dummy' variable appears in both versions of the analysis, the coefficients and standard errors are the same and the constant term has increased by the same amount. Having run both versions of the regression analysis, the results can be summarised in a single table.

2.2 The interpretation of statistics produced by multiple regression analysis

The **constant** is the predicted value of the dependent variable when all of the independent variables are held at zero.

The **unstandardised coefficient (B)** quantifies the *effect* that a change in the independent variable will have on the dependent variable, *holding all other variables in the regression analysis constant*.

This coefficient should not be used to indicate which independent variable is the best predictor of the dependent variable as the magnitude of the coefficients depends on the units in which the variables are measured.

The **adjusted R²** is an assessment of the overall fit of the model and is interpreted as the percentage of the variance in the dependent variable that is explained by all of the independent variables included in the regression model. The adjusted R² is used in place of the R² value because the number of variables in the model does not affect it.

The **standardised coefficient (Beta, β)** is standardised for the units of measurement of the independent variable. It shows what the relative effect of each independent variable would be if they were all measured using the same scale. It indicates which independent variable is the best predictor of the dependent variable, with the highest value being the best predictor.

SPSS also gives **t values** and **significance levels** identifying those variables where the regression coefficients are significantly related to the dependent variable after controlling the effects of the other variables included in the analysis. The tables given in this volume show the significance level for each coefficient ($p < 0.05$, $p < 0.01$ or $p < 0.001^9$). Unstandardised and standardised regression coefficients are only shown in the tables in this volume for variables significantly related to the dependent variable.

2.3 Predicting values from a multiple regression analysis

For categorical variables the coefficients quantify the effect that having a particular characteristic will have on the dependent variable. For a dichotomous variable, the regression coefficient gives the expected difference of being in one category (the category that takes the value 1) rather than the other (the one that takes the value 0). For categorical variables with more than two categories the constant plus the value of the unstandardised coefficient for the independent variable gives the predicted value of the dependent variable for someone with that characteristic, when the values of all the other independent variables in the regression analysis are set to zero.

For continuous variables the value of the coefficient represents the contribution to the dependent variable per unit of the independent variable. For example, for 'body weight' this would be per kilogram if the unit for the variable was kilograms, or per gram if the unit for the variable

was grams. The coefficient is multiplied by the value of the continuous variable for which the prediction is being made before being added to the constant. For example, if body weight = 50kg and the value of the unstandardised coefficient B = 0.45, then a value of 22.5 (equal to 0.45 * 50) is added to the constant.

A worked example is given below to show how systolic blood pressure can be predicted from a multiple regression analysis where diastolic blood pressure, household composition and body weight were all found to be statistically independently related to systolic blood pressure.

For example, from Table 3.8, a man who had a diastolic blood pressure of 82mmHg and weighed 91.5kg who lived with dependent children and his spouse/partner would have a predicted systolic blood pressure of:

$$56.70 + (0.88 \times 82) - 2.65 + (0.09 \times 91.5) = 134\text{mmHg}$$

where 56.70 (constant)

+0.88(per mmHg diastolic blood pressure)
-2.65(living with dependent children and spouse)
+0.09(per kg body weight).

As explained previously, the adjusted R² is used as an assessment of the overall fit of the model and is interpreted as the percentage of the variance in the dependent variable that is explained by all of the independent variables included in the regression model. It is generally expected that the amount of variance in the dependent variable which can be explained by a model will be low when analysing 'real-life' health data.

References and endnotes

¹ Weighting for different sampling probabilities results in larger sampling errors than for an equal-probability sample without weights. However, using population totals to control for differential non-response tends to lead to a reduction in the errors. The method used to calculate the sampling errors identifies the weighting for unequal sampling probabilities and to the population separately and adjusts the sampling errors accordingly.

² The Technical Report is available online at <http://www.food.gov.uk/science>.

³ This variability of the denominator can be measured by the coefficient of variation of x , denoted by $cv(x)$, which is the standard error of x expressed as a proportion of x .

$$cv(x) = \frac{se(x)}{x}$$

It has been suggested that the ratio estimator should not be used if $cv(x)$ is greater than 0.2. For the standard errors produced here, the denominators for the ratios were number of men and number of women. Both of these totals were constant, determined by the post-stratification and, therefore, there is no variation in these denominators and hence the cv of the denominator will be zero.

⁴ The calculation of standard errors and design factors for this survey used the package STATA. For further details of the method of calculation see: Elliot D. A comparison of software for producing sampling errors on social surveys. *Survey Methodology Bulletin* 1999; **44**: 27–36.

⁵ For a survey of this kind the sample size is subject to random fluctuation, both within each PSU and overall. This is because the number of adults identified in each PSU is dependent on which households are sampled and there will be differing amounts of non-response. There is more control in the (weighted) sample sizes of subgroups such as age and sex since these variables were used as post-stratifiers.

⁶ These weights adjusted for differential sampling probability and differential non-response.

⁷ For a more detailed description of multiple regression analysis using SPSS, see *Chapter 18, SPSS for Windows. Base Systems User's Guide*. SPSS Inc. (Chicago, 1993).

⁸ A skewness value of +1.0 represents extreme positive skewness and a value of -1.0 extreme negative skewness. Loether HJ, McTavish DG. *Descriptive and inferential statistics: an introduction*. 2nd edition. Allyn and Bacon (Massachusetts, 1980).

⁹ In the tables presenting results from multiple regression, variables that are significantly different at the 95%, 99% and 99.9% levels are indicated by one, two and three asterisks respectively.

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Table A1

True standard errors and design factors for socio-demographic characteristics of the diary sample by sex of respondent

Diary sample	Men		Women		Numbers	
	% (p)	Standard error of p*	Design factor	% (p)		Standard error of p*
Age group						
19–24 years	13	0.00	0.00	12	0.00	0.00
25–34 years	26	0.00	0.00	24	0.00	0.00
35–49 years	30	0.00	0.00	36	0.00	0.00
50–64 years	30	0.00	0.00	29	0.00	0.00
Region						
Scotland	8	0.92	0.98	7	0.86	0.98
Northern	28	1.14	0.73	26	0.96	0.65
Central, South West and Wales	35	2.54	1.54	37	2.62	1.62
London and the South East	29	2.48	1.58	30	2.57	1.67
Household receipt of benefits						
Receiving benefits	13	1.47	1.25	17	1.47	1.17
Not receiving benefits	87	1.47	1.25	83	1.47	1.17
Sample size		833			891	

Note: * The ratio means for age groups for the diary sample have standard errors equal to zero because both the numerator and the denominator have been set to equal the population totals and thus cannot vary for any selected sample.

Table A2

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True standard errors and design factors for physiological measurements by sex and age of respondent

Physiological measurements	Age (years):											
	19–24				25–34				35–49			
	Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base
Men												
<i>Anthropometric measurements</i>												
Height (cm)	177	0.9	1.45	112	177	0.5	1.18	229	176	0.4	0.98	263
Body weight (kg)	79	2.2	1.35	111	83	0.8	1.28	228	85	0.8	0.87	265
Waist circumference (cm)	89	1.8	1.42	111	92	0.8	1.18	228	96	0.6	0.82	263
Hip circumference (cm)	103	1.3	1.38	111	105	0.7	1.25	228	105	0.5	0.90	263
BMI (kg/m ²)	25.1	0.64	1.29	110	26.4	0.35	1.32	227	27.4	0.21	0.81	263
Waist to hip ratio	0.86	0.009	1.50	111	0.88	0.005	1.31	228	0.91	0.004	0.92	263
<i>Blood pressure</i>												
Systolic blood pressure (mmHg)	127	1.6	1.59	109	125	1.0	1.12	221	129	0.9	1.03	255
Diastolic blood pressure (mmHg)	64	0.9	1.38	109	68	0.8	1.21	221	76	0.7	0.97	255
Women												
<i>Anthropometric measurements</i>												
Height (cm)	163	0.7	1.27	110	162	0.5	1.10	220	162	0.3	1.05	331
Body weight (kg)	66	2.1	1.35	110	67	1.0	1.05	215	70	0.8	0.95	334
Waist circumference (cm)	78	1.4	1.35	110	80	0.7	0.99	214	82	0.6	1.00	329
Hip circumference (cm)	102	1.4	1.29	110	103	0.7	1.07	214	104	0.5	0.98	329
BMI (kg/m ²)	24.8	0.71	1.30	110	25.4	0.38	1.11	213	26.7	0.30	0.95	331
Waist to hip ratio	0.76	0.006	1.34	110	0.77	0.004	0.98	214	0.79	0.003	1.07	329
<i>Blood pressure</i>												
Systolic blood pressure (mmHg)	114	1.3	1.43	105	114	1.0	1.28	212	120	0.8	1.08	320
Diastolic blood pressure (mmHg)	62	1.0	1.38	105	65	0.8	1.21	212	69	0.5	0.95	320

								Numbers
								Physiological measurements
50-64				All				
Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base	
								Men
								<i>Anthropometric measurements</i>
175	0.5	1.11	264	176	0.3	1.26	869	Height (cm)
87	1.1	1.17	265	84	0.6	1.18	870	Body weight (kg)
100	0.6	0.97	261	95	0.4	1.11	862	Waist circumference (cm)
107	0.5	1.05	261	105	0.3	1.13	862	Hip circumference (cm)
28.4	0.32	1.08	264	27.2	0.17	1.09	864	BMI (kg/m ²)
0.94	0.003	0.99	261	0.90	0.002	1.13	862	Waist to hip ratio
								<i>Blood pressure</i>
136	1.3	1.25	255	130	0.6	1.21	839	Systolic blood pressure (mmHg)
79	0.7	1.15	255	73	0.4	1.06	839	Diastolic blood pressure (mmHg)
								Women
								<i>Anthropometric measurements</i>
160	0.4	1.10	270	162	0.2	1.14	930	Height (cm)
71	1.0	1.13	270	69	0.6	1.19	928	Body weight (kg)
86	0.9	1.09	269	82	0.4	1.10	922	Waist circumference (cm)
106	0.7	1.14	269	104	0.4	1.13	922	Hip circumference (cm)
27.4	0.41	1.23	269	26.4	0.22	1.21	922	BMI (kg/m ²)
0.81	0.004	1.06	268	0.79	0.002	1.10	921	Waist to hip ratio
								<i>Blood pressure</i>
133	1.3	1.12	260	122	0.6	1.15	897	Systolic blood pressure (mmHg)
72	0.6	0.98	260	68	0.4	1.05	897	Diastolic blood pressure (mmHg)

Table A3(a)

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True standard errors and design factors for selected blood analytes by age of respondent: men

Blood analytes	Men aged (years):											
	19–24				25–34				35–49			
	Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base
Haemoglobin concentration (g/dl)	15.2	0.14	1.39	83	15.1	0.10	1.21	170	15.1	0.07	0.99	191
Mean cell volume (fl)	91.0	0.74	1.34	83	90.9	0.40	1.02	170	93.3	0.54	1.24	191
Haematocrit (l/l)	0.460	0.0047	1.39	83	0.457	0.0032	1.25	170	0.460	0.0031	1.19	191
Plasma iron (µmol/l)	17.8	1.03	1.39	81	16.2	0.55	1.22	165	17.3	0.35	0.88	190
Total iron-binding capacity (µmol/l)	61.8	1.33	1.44	81	61.8	0.93	1.28	165	61.2	0.52	0.90	188
Iron % saturation (%)	29.7	2.09	1.44	81	26.6	0.89	1.17	165	28.5	0.64	0.94	188
Serum ferritin (µg/l)	78	5.2	1.39	85	101	5.6	1.41	169	129	7.9	0.99	186
Plasma vitamin C (µmol/l)	54.6	4.22	1.54	79	54.2	2.79	1.35	156	50.0	1.47	0.87	180
Red cell folate (nmol/l)	561	37.9	1.33	83	688	28.6	1.33	170	677	16.8	0.95	189
Serum folate (nmol/l)	17.4	1.05	1.36	83	20.1	0.81	1.29	169	20.9	0.51	0.88	188
Serum vitamin B ₁₂ (pmol/l)	286	17.0	1.41	84	298	10.6	1.35	168	294	8.4	1.07	187
ETKAC(ratio)*	1.16	0.007	1.59	83	1.16	0.004	1.16	164	1.15	0.003	0.92	189
ETK-B (µmol/g Hb/min)**	0.70	0.019	1.66	83	0.73	0.017	1.48	167	0.71	0.008	0.91	191
EGRAC(ratio)***	1.45	0.020	1.39	83	1.40	0.018	1.40	167	1.37	0.012	0.98	191
EAATAC(ratio)****	1.81	0.023	1.58	83	1.81	0.014	1.16	167	1.80	0.013	0.90	191
Plasma total homocysteine (µmol/l)	12.5	0.86	1.46	81	11.1	0.38	1.23	162	11.1	0.19	0.77	179
Plasma retinol (µmol/l)	1.81	0.078	1.51	75	1.94	0.052	1.41	152	2.08	0.047	1.13	175
Plasma α-carotene (µmol/l)	0.039	0.0027	1.39	75	0.059	0.0036	1.36	152	0.067	0.0074	1.08	175
Plasma β-carotene (µmol/l)	0.143	0.0206	1.34	75	0.209	0.0171	1.38	152	0.221	0.0211	1.16	175
Plasma α-cryptoxanthin (µmol/l)	0.052	0.0129	1.18	75	0.047	0.0060	1.31	152	0.039	0.0033	1.05	175
Plasma β-cryptoxanthin (µmol/l)	0.103	0.0092	1.48	75	0.122	0.0080	1.20	152	0.119	0.0056	0.91	175
Plasma lycopene (µmol/l)	0.442	0.0467	1.45	75	0.514	0.0372	1.48	152	0.487	0.0302	1.29	175
Plasma lutein and zeaxanthin (µmol/l)	0.20	0.013	1.39	75	0.26	0.013	1.24	152	0.28	0.011	0.98	175
Plasma 25-hydroxyvitamin D (nmol/l)	40.6	3.77	1.56	81	48.8	2.57	1.42	165	47.8	1.83	1.21	190
Plasma α-tocopherol (µmol/l)	16.6	0.91	1.42	75	19.7	0.54	1.27	152	22.0	0.54	0.95	175
Plasma γ-tocopherol (µmol/l)	1.09	0.065	1.45	75	1.25	0.040	1.32	152	1.29	0.027	0.96	175
Plasma α-tocopherol to total cholesterol ratio (µmol/mmol)	3.76	0.131	1.40	81	3.97	0.112	1.37	156	4.11	0.107	1.08	170
Plasma total cholesterol (mmol/l)	4.40	0.134	1.45	81	5.04	0.112	1.26	164	5.38	0.070	0.84	186
Plasma high density lipoprotein cholesterol (mmol/l)	1.06	0.036	1.48	81	1.04	0.024	1.25	164	1.04	0.022	1.01	186
Plasma low density lipoprotein cholesterol (mmol/l)*****	3.35	0.140	1.44	81	4.00	0.117	1.28	164	4.34	0.069	0.81	186
Plasma selenium (µmol/l)	1.03	0.027	1.66	83	1.10	0.016	1.27	169	1.13	0.014	1.05	190
Red cell selenium (µmol/l)	1.39	0.055	1.50	83	1.57	0.030	1.10	169	1.62	0.029	0.97	190
Blood glutathione peroxidase (nmol/mg Hb/min)	118.5	3.97	1.49	81	119.5	2.78	1.30	163	123.4	3.70	1.62	184
Plasma α ₁ -antichymotrypsin (g/l)	0.28	0.011	1.47	81	0.29	0.006	1.08	162	0.29	0.004	0.79	179
Blood mercury (nmol/l)	3.8	0.58	1.24	81	6.3	0.48	1.23	169	8.7	0.74	1.18	190

Note: * erythrocyte transketolase activation coefficient.

** erythrocyte transketolase basal activity.

*** erythrocyte glutathione reductase activation coefficient.

**** erythrocyte aspartate aminotransferase activation coefficient.

***** calculated as non-high density lipoprotein cholesterol (non-HDL).

								Numbers
								Blood analytes
50–64				All men				
Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base	
14.9	0.09	1.23	194	15.1	0.05	1.26	638	Haemoglobin concentration (g/dl)
95.0	0.46	1.16	194	92.9	0.29	1.26	638	Mean cell volume (fl)
0.460	0.0032	1.31	194	0.459	0.0020	1.47	638	Haematocrit (l/l)
17.1	0.53	1.11	190	17.0	0.30	1.26	627	Plasma iron (µmol/l)
61.5	0.65	1.00	189	61.5	0.37	1.07	624	Total iron-binding capacity (µmol/l)
28.2	0.79	1.09	189	28.1	0.53	1.28	624	Iron % saturation (%)
145	12.2	1.08	194	120	5.6	1.25	633	Serum ferritin (µg/l)
51.6	2.14	1.03	178	52.2	1.18	1.13	593	Plasma vitamin C (µmol/l)
773	28.9	1.26	194	694	12.1	1.06	636	Red cell folate (nmol/l)
22.9	0.79	1.19	196	20.8	0.39	1.16	636	Serum folate (nmol/l)
308	11.7	1.05	193	298	6.3	1.28	632	Serum vitamin B ₁₂ (pmol/l)
1.15	0.005	1.01	192	1.15	0.003	1.26	628	ETKAC(ratio)*
0.73	0.009	1.23	192	0.72	0.007	1.47	633	ETK-B (µmol/g Hb/min)**
1.35	0.014	1.17	192	1.38	0.008	1.19	633	EGRAC(ratio)***
1.77	0.015	0.99	192	1.79	0.007	1.04	633	EAATAC(ratio)****
12.4	0.42	1.03	181	11.7	0.20	1.06	603	Plasma total homocysteine (µmol/l)
2.13	0.049	1.14	175	2.02	0.031	1.41	576	Plasma retinol (µmol/l)
0.074	0.0041	1.18	175	0.064	0.003	1.20	576	Plasma α-carotene (µmol/l)
0.248	0.0187	1.15	175	0.216	0.0124	1.47	576	Plasma β-carotene (µmol/l)
0.035	0.0036	1.28	175	0.041	0.0033	1.44	576	Plasma α-cryptoxanthin (µmol/l)
0.119	0.0073	1.15	175	0.118	0.0043	1.31	576	Plasma β-cryptoxanthin (µmol/l)
0.416	0.0264	1.25	175	0.467	0.0225	1.81	576	Plasma lycopene (µmol/l)
0.30	0.013	1.08	175	0.27	0.007	1.22	576	Plasma lutein and zeaxanthin (µmol/l)
51.6	1.70	1.11	190	48.3	1.35	1.54	627	Plasma 25-hydroxyvitamin D (nmol/l)
23.3	0.62	1.12	175	21.1	0.38	1.29	576	Plasma α-tocopherol (µmol/l)
1.31	0.030	1.10	175	1.26	0.021	1.32	576	Plasma γ-tocopherol (µmol/l)
4.22	0.102	1.21	173	4.06	0.071	1.53	580	Plasma α-tocopherol to total cholesterol ratio (µmol/mmol)
5.56	0.099	1.21	187	5.21	0.053	1.14	618	Plasma total cholesterol (mmol/l)
1.12	0.038	1.28	186	1.07	0.015	1.19	617	Plasma high density lipoprotein cholesterol (mmol/l)
4.44	0.101	1.21	187	4.15	0.052	1.11	618	Plasma low density lipoprotein cholesterol (mmol/l)*****
1.15	0.013	0.92	195	1.11	0.008	1.15	636	Plasma selenium (µmol/l)
1.61	0.038	1.20	195	1.57	0.020	1.24	638	Red cell selenium (µmol/l)
124.1	2.57	1.20	187	121.9	2.26	1.95	615	Blood glutathione peroxidase (nmol/mg Hb/min)
0.31	0.006	0.96	181	0.30	0.003	1.13	603	Plasma α ₁ -antichymotrypsin (g/l)
9.0	0.71	1.19	195	7.5	0.34	1.14	636	Blood mercury (nmol/l)

Table A3(b)

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True standard errors and design factors for selected blood analytes by age of respondent: women

Blood analytes	Women aged (years):											
	19–24				25–34				35–49			
	Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base
Haemoglobin concentration (g/dl)	13.5	0.16	1.38	81	13.3	0.08	1.15	162	13.3	0.07	1.08	243
Mean cell volume (fl)	92.8	1.10	1.48	81	92.7	0.65	1.37	162	93.9	0.45	1.07	243
Haematocrit (l/l)	0.416	0.0056	1.36	81	0.411	0.0032	1.30	162	0.411	0.0022	1.10	243
Plasma iron (µmol/l)	15.6	1.02	1.37	77	16.5	0.58	1.02	158	15.9	0.41	0.96	238
Total iron-binding capacity (µmol/l)	66.1	1.44	1.44	77	66.8	0.92	1.02	158	62.8	0.7	1.07	238
Iron % saturation (%)	24.3	1.79	1.41	77	25.3	0.93	1.02	158	26.1	0.77	1.06	238
Serum ferritin (µg/l)	41	4.0	1.36	80	43	2.9	1.19	156	49	2.8	0.92	238
Plasma vitamin C (µmol/l)	60.1	3.25	1.18	72	62.9	2.82	1.16	151	58.8	2.13	1.23	234
Red cell folate (nmol/l)	576	33.4	1.56	81	630	24.7	1.14	161	691	19.6	1.04	243
Serum folate (nmol/l)	20.6	1.23	1.39	81	21.2	0.97	1.11	159	21.9	0.6	1.04	240
Serum vitamin B ₁₂ (pmol/l)	247	13.6	1.33	79	259	11.6	1.20	158	288	8.6	0.91	239
ETKAC (ratio)*	1.14	0.005	1.26	74	1.15	0.004	0.96	162	1.14	0.004	1.04	241
ETK-B (µmol/g Hb/min)**	0.79	0.017	1.35	74	0.76	0.014	1.40	162	0.74	0.01	1.18	242
EGRAC (ratio)***	1.45	0.029	1.28	74	1.44	0.016	1.12	162	1.40	0.015	1.15	242
EAATAC (ratio)****	1.74	0.031	1.46	74	1.78	0.016	1.18	162	1.77	0.017	1.14	242
Plasma total homocysteine (µmol/l)	9.3	0.57	1.30	77	9.6	0.29	1.24	154	10.4	0.37	0.86	233
Plasma retinol (µmol/l)	1.75	0.070	1.41	72	1.75	0.044	1.17	146	1.75	0.026	0.97	219
Plasma α-carotene (µmol/l)	0.048	0.0039	1.48	72	0.075	0.0082	1.09	146	0.080	0.0045	1.16	219
Plasma β-carotene (µmol/l)	0.233	0.0737	1.31	72	0.245	0.0304	1.08	146	0.301	0.0216	1.21	219
Plasma α-cryptoxanthin (µmol/l)	0.034	0.0026	1.32	72	0.039	0.0041	1.30	146	0.037	0.0031	1.10	219
Plasma β-cryptoxanthin (µmol/l)	0.123	0.0170	1.69	72	0.141	0.0096	1.10	146	0.134	0.0062	0.96	219
Plasma lycopene (µmol/l)	0.452	0.0504	1.50	72	0.426	0.0252	1.10	146	0.474	0.0204	1.14	219
Plasma lutein and zeaxanthin (µmol/l)	0.26	0.022	1.49	72	0.25	0.010	1.08	146	0.27	0.01	1.17	219
Plasma 25-hydroxyvitamin D (nmol/l)	44.5	3.85	1.44	78	51.9	2.80	1.31	158	47.9	1.62	1.10	239
Plasma α-tocopherol (µmol/l)	16.6	0.73	1.37	72	17.8	0.38	0.98	146	20.3	0.34	0.91	219
Plasma γ-tocopherol (µmol/l)	1.16	0.109	1.58	72	1.14	0.032	1.27	146	1.24	0.028	1.01	219
Plasma α-tocopherol to total cholesterol ratio (µmol/mmol)	3.69	0.132	1.43	72	3.71	0.078	1.09	149	4.03	0.067	0.98	222
Plasma total cholesterol (mmol/l)	4.46	0.122	1.35	77	4.84	0.076	0.99	157	5.13	0.059	0.91	234
Plasma high density lipoprotein cholesterol (mmol/l)	1.21	0.042	1.41	77	1.26	0.028	1.11	157	1.27	0.03	1.16	234
Plasma low density lipoprotein cholesterol (mmol/l)*****	3.26	0.110	1.29	77	3.57	0.080	1.02	157	3.85	0.065	0.99	234
Plasma selenium (µmol/l)	1.03	0.024	1.40	76	1.07	0.018	1.11	159	1.09	0.013	1.16	244
Red cell selenium (µmol/l)	1.76	0.053	1.34	78	1.80	0.043	1.17	160	1.76	0.032	0.99	246
Blood glutathione peroxidase (nmol/mg Hb/min)	134.0	6.27	1.49	74	122.5	2.98	1.25	161	126.8	3.02	1.46	237
Plasma α ₁ -antichymotrypsin (g/l)	0.29	0.011	1.36	77	0.30	0.006	1.22	154	0.31	0.004	0.97	233
Blood mercury (nmol/l)	6.1	0.85	1.27	80	7.2	0.75	1.28	160	8.6	0.44	0.97	246

Note: * erythrocyte transketolase activation coefficient.

** erythrocyte transketolase basal activity.

*** erythrocyte glutathione reductase activation coefficient.

**** erythrocyte aspartate aminotransferase activation coefficient.

***** calculated as non-high density lipoprotein cholesterol (non-HDL).

Numbers

50-64				All women				Blood analytes
Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base	
13.5	0.09	1.10	196	13.4	0.05	1.21	683	Haemoglobin concentration (g/dl)
93.7	0.47	1.11	196	93.4	0.31	1.27	683	Mean cell volume (fl)
0.417	0.0029	1.14	196	0.413	0.0017	1.36	683	Haematocrit (l/l)
16.3	0.46	1.16	194	16.1	0.29	1.17	668	Plasma iron ($\mu\text{mol/l}$)
61.7	0.90	1.29	193	63.8	0.42	1.06	666	Total iron-binding capacity ($\mu\text{mol/l}$)
27.1	0.86	1.22	192	26.0	0.49	1.17	665	Iron % saturation (%)
71	4.2	1.08	195	53	1.7	0.95	670	Serum ferritin ($\mu\text{g/l}$)
62.2	2.18	1.10	188	60.9	1.33	1.24	644	Plasma vitamin C ($\mu\text{mol/l}$)
768	24.1	1.07	197	685	12.4	1.11	683	Red cell folate (nmol/l)
23.7	0.62	0.96	197	22.1	0.44	1.20	678	Serum folate (nmol/l)
329	25.4	1.28	191	288	9.2	1.28	667	Serum vitamin B ₁₂ (pmol/l)
1.13	0.003	0.81	195	1.14	0.002	0.89	672	ETKAC (ratio)*
0.77	0.010	1.11	195	0.76	0.007	1.46	673	ETK-B ($\mu\text{mol/g Hb/min}$)**
1.34	0.013	1.02	195	1.40	0.009	1.21	673	EGRAC (ratio)***
1.79	0.023	1.32	195	1.77	0.012	1.45	673	EAATAC (ratio)****
10.6	0.27	1.11	190	10.1	0.18	0.97	654	Plasma total homocysteine ($\mu\text{mol/l}$)
1.99	0.050	1.07	179	1.82	0.026	1.29	616	Plasma retinol ($\mu\text{mol/l}$)
0.101	0.0069	0.90	179	0.081	0.0028	0.85	616	Plasma α -carotene ($\mu\text{mol/l}$)
0.384	0.0247	0.98	179	0.304	0.0179	1.31	616	Plasma β -carotene ($\mu\text{mol/l}$)
0.032	0.0026	1.10	179	0.035	0.0021	1.46	616	Plasma α -cryptoxanthin ($\mu\text{mol/l}$)
0.181	0.0149	1.12	179	0.148	0.0062	1.20	616	Plasma β -cryptoxanthin ($\mu\text{mol/l}$)
0.484	0.0269	1.09	179	0.463	0.0170	1.45	616	Plasma lycopene ($\mu\text{mol/l}$)
0.37	0.019	1.17	179	0.29	0.008	1.24	616	Plasma lutein and zeaxanthin ($\mu\text{mol/l}$)
51.8	1.94	1.20	194	49.6	1.34	1.44	670	Plasma 25-hydroxyvitamin D (nmol/l)
24.7	0.49	0.99	179	20.6	0.26	1.01	616	Plasma α -tocopherol ($\mu\text{mol/l}$)
1.24	0.032	1.10	179	1.21	0.021	1.30	616	Plasma γ -tocopherol ($\mu\text{mol/l}$)
4.17	0.101	1.11	183	3.96	0.054	1.28	626	Plasma α -tocopherol to total cholesterol ratio ($\mu\text{mol/mmol}$)
6.06	0.086	0.98	192	5.25	0.038	0.83	659	Plasma total cholesterol (mmol/l)
1.34	0.029	1.00	192	1.28	0.015	1.06	659	Plasma high density lipoprotein cholesterol (mmol/l)
4.72	0.086	0.97	192	3.97	0.041	0.90	659	Plasma low density lipoprotein cholesterol (mmol/l)*****
1.17	0.029	1.21	195	1.10	0.011	1.17	674	Plasma selenium ($\mu\text{mol/l}$)
1.79	0.070	1.15	198	1.78	0.026	1.12	681	Red cell selenium ($\mu\text{mol/l}$)
129.2	2.45	1.21	188	127.2	2.12	1.75	661	Blood glutathione peroxidase (nmol/mg Hb/min)
0.34	0.006	1.08	190	0.31	0.003	1.18	654	Plasma α_1 -antichymotrypsin (g/l)
10.6	1.49	1.31	198	8.6	0.54	1.34	683	Blood mercury (nmol/l)

Table A4

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True standard errors and design factors for measures of physical activity by sex and age of respondent

Physical activity diary sample

Measures of physical activity	Age (years):											
	19–24				25–34				35–49			
	Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base
Men												
Hours spent in activities of at least moderate intensity per day	2.86	0.401	1.37	104	2.69	0.267	1.25	211	2.01	0.198	1.10	243
Hours spent in activities of vigorous intensity per day	0.67	0.215	1.33	104	0.82	0.191	1.32	211	0.55	0.114	1.05	243
Women												
Hours spent in activities of at least moderate intensity per day	1.27	0.188	1.07	100	1.34	0.14	1.04	202	1.24	0.121	1.13	305
Hours spent in activities of vigorous intensity per day	0.17	0.04	1.31	100	0.10	0.02	1.00	202	0.09	0.02	0.82	305

								Numbers
								Measures of physical activity
50–64				All				
Mean r	Standard error of r	Design factor	Base	Mean r	Standard error of r	Design factor	Base	
1.52	0.201	1.28	243	2.15	0.127	1.26	801	Men
0.25	0.090	1.27	243	0.55	0.077	1.30	801	Hours spent in activities of at least moderate intensity per day
								Hours spent in activities of vigorous intensity per day
0.97	0.113	1.17	249	1.19	0.072	1.18	857	Women
0.05	0.010	1.12	249	0.09	0.008	0.85	857	Hours spent in activities of at least moderate intensity per day
								Hours spent in activities of vigorous intensity per day

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Appendix B Unweighted base numbers

Table B1

Unweighted base numbers: dietary interview, seven-day dietary record and physical activity record by sex of respondent

	Dietary interview	Seven-day weighed dietary record	Seven-day physical activity record
Age			
Men aged (years):			
19–24	86	61	61
25–34	219	160	155
35–49	394	303	296
50–64	309	242	229
All men	1008	766	741
Women aged (years):			
19–24	109	78	75
25–34	277	211	206
35–49	487	379	358
50–64	370	290	278
All women	1243	958	917
Region			
Men			
Scotland	80	53	47
Northern	267	195	191
Central, South West and Wales	337	274	262
London and the South East	324	244	241
Women			
Scotland	111	70	69
Northern	341	256	248
Central, South West and Wales	436	350	330
London and the South East	355	282	270
Household receipt of benefits*			
Men			
Receiving benefits	145	106	102
Not receiving benefits	863	660	639
Women			
Receiving benefits	283	199	193
Not receiving benefits	960	759	724
All	2251	1724	1658

Note: * Receipt of benefits was asked of the respondent about themselves, their partner or anyone else in the household. Benefits asked about were Working Families Tax Credit, Income Support and (Income-related) Job Seeker's Allowance.

Table B2

Unweighted base numbers: anthropometry and blood pressure by sex of respondent

	Height	Weight	BMI	Waist circumference	Hip circumference and waist to hip ratio	Blood pressure
Age						
Men aged (years):						
19–24	65	65	64	64	64	62
25–34	171	170	169	170	170	168
35–49	329	330	328	328	328	324
50–64	249	250	249	246	246	243
All men	814	815	810	808	808	797
Women aged (years):						
19–24	82	82	82	82	82	80
25–34	217	214	212	213	213	210
35–49	391	395	391	387	387	373
50–64	295	295	293	293	292	276
All women	985	986	978	975	974	939
Region						
Men						
Scotland	52	52	52	52	52	51
Northern	212	212	210	210	210	207
Central, South West and Wales	290	291	290	287	287	286
London and the South East	260	260	258	259	259	253
Women						
Scotland	75	73	73	71	71	70
Northern	268	268	267	264	264	254
Central, South West and Wales	353	352	349	349	348	342
London and the South East	289	293	289	291	291	273
Household receipt of benefits*						
Men						
Receiving benefits	115	117	115	115	115	116
Not receiving benefits	699	698	695	693	693	681
Women						
Receiving benefits	214	214	211	211	210	208
Not receiving benefits	771	772	767	764	764	731
All	1799	1801	1788	1783	1782	1736

Note: * Receipt of benefits was asked of the respondent about themselves, their partner or anyone else in the household. Benefits asked about were Working Families Tax Credit, Income Support and (Income-related) Job Seeker's Allowance.

Table B3

Unweighted base numbers: blood analytes by sex of respondent

	Blood sample*		
	Plasma retinol	Haemoglobin	Plasma iron
Age			
Men aged (years):			
19–24	45	45	45
25–34	107	119	115
35–49	213	245	243
50–64	168	191	189
All men	533	600	592
Women aged (years):			
19–24	44	53	47
25–34	146	157	154
35–49	278	298	296
50–64	191	210	206
All women	659	718	703
Region			
Men			
Scotland	45	45	46
Northern	140	155	148
Central, South West and Wales	191	211	214
London and the South East	157	189	184
Women			
Scotland	46	50	48
Northern	177	191	189
Central, South West and Wales	245	272	263
London and the South East	191	157	203
Household receipt of benefits**			
Men			
Receiving benefits	76	85	84
Not receiving benefits	457	515	508
Women			
Receiving benefits	149	162	159
Not receiving benefits	510	556	544
All	1192	1318	1295

Note: * Blood analytes shown are those used to derive weighting factors for groups of analytes with similar numbers of reported results.

** Receipt of benefits was asked of the respondent about themselves, their partner or anyone else in the household. Benefits asked about were Working Families Tax Credit, Income Support and (Income-related) Job Seeker's Allowance.

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Appendix C Weights for results from analysis of blood samples

Weights were derived for results from the analysis of blood samples. Three weighting factors were calculated based on similar numbers of reported results for different analytes and similarity of socio-demographic characteristics.

The three groups were as follows:

Group 1: Non-response weight based on the number of haemoglobin results

Applies to:

- Haemoglobin
- Mean corpuscular volume (MCV)
- Haematocrit
- Serum ferritin
- Plasma vitamin C
- Red cell folate
- Serum folate
- Serum vitamin B₁₂
- Erythrocyte Transketolase Activation Coefficient (ETKAC)
- Erythrocyte Transketolase Basal Activity (ETK-B)
- Erythrocyte Glutathione Reductase Activation Coefficient (EGRAC)
- Erythrocyte Aspartate Aminotransferase Activation Coefficient (EAATAC)
- Plasma selenium
- Red cell selenium
- Erythrocyte glutathione peroxidase
- Blood mercury

Group 2: Non-response weight based on the number of results for plasma iron

Applies to:

- Plasma iron
- Plasma total iron-binding capacity (TIBC)
- Plasma iron % saturation
- Plasma total homocysteine
- Plasma 25-hydroxyvitamin D (25-OHD)
- Plasma α -tocopherol to total cholesterol ratio
- Plasma total cholesterol
- HDL cholesterol
- LDL cholesterol
- Plasma α_1 -antichymotrypsin (α_1 - ACT)

Group 3: Non-response weight based on the number of plasma retinol results

Applies to:

- Plasma retinol
- Plasma α -carotene
- Plasma β -carotene
- Plasma α -cryptoxanthin
- Plasma β -cryptoxanthin
- Plasma lycopene
- Plasma lutein and zeaxanthin
- Plasma α -tocopherol
- Plasma γ -tocopherol

Appendix D Physical activity

1 Introduction

This appendix describes the editing of the physical activity data, data quality and provides additional information on the derived measures of physical activity. Details of the methodology for collecting information on physical activity are given in Chapter 1 of this report and in Appendix I of the Technical Report¹.

2 Editing the data on physical activities

Interviewers entered the physical activity diary data into their laptop computer and internal consistency checks were applied to avoid mis-keying, for example to check that the time spent in all activities did not add up to more than 24 hours. Data were subsequently assessed at HQ on a number of criteria.

The following checks were carried out on all physical activity diaries.

- Coding of occupation activity level.
- Time went to bed and got up on any diary day.
- Correct use of 24-hour clock, particularly in recording time went to bed/ got up on any diary day.
- If less than one hour or more than 12 hours of sleep were recorded on any diary day.
- If less than 60 minutes of very light/light activity was calculated on any diary day.
- If the time spent in any 'other' activity was greater than 3 hours.
- Any recorded activities less than 10 minutes.

Respondents were asked during the post-dietary recording period interview whether they had done any paid or voluntary work during the recording period and, if so, what tasks were involved in this work. The activity level was then coded according to whether it involved very light/light work, e.g. mainly sitting, standing or walking, the use of light tools, light assembly or repair, but no heavy lifting or carrying; moderate work, e.g. mainly walking, lifting or carrying light loads; or hard/very hard work, e.g. mainly hard physical labour. All occupations that were coded as moderate or hard/very hard were checked for accuracy of coding against the Physical Activity Diary Coding Guide for Occupations (see Appendix I of the Technical Report¹). This led to a downward revision of the activity code for main occupation in 184 of 812 cases (23%) and for the second occupation in 15 of 54 cases (28%). If the respondent did not complete the post-dietary interview or did not answer the questions on occupation activity level, their occupation activity level was coded at HQ using information on industry and occupation collected during the dietary interview, in line with the Physical Activity Diary Coding Guide for Occupations.

The time the respondent went to bed and got up each day is required in order to calculate time spent sleeping. All cases were checked for completeness of this information. If time went to bed and/or time got up was missing an estimate was made based on the time recorded for other days in

the diary. In total, 12 cases were missing this information on at least one day. Where information about sleep was missing for more than two days of the seven-day recording period, this case was checked for completeness of other information, for example, whether the respondent went to work, how long they spent at work, participation in activities. In two cases, there appeared to be no data recorded and the case was removed from analysis of physical activity data. In seven cases, the time went to bed on one of the diary days was equal to the time recorded for getting up. In five of the seven cases, this was due to a data keying error. In the other two cases the respondent was working shifts and as they had slept during the day had recorded their time sleeping under the question 'spent any other time asleep today' and then recorded the same time for going to bed and getting up. In 495 cases the time the respondent went to bed on the last day of the recording period was not recorded on the diary. Values were imputed based on the time the respondent recorded going to bed over the preceding seven days.

All cases were checked for appropriate use of the 24-hour clock. In 30 cases, the data entered for the time the respondent went to bed and got up, along with other information on activity, suggested that the 24-hour clock had not been used. For example, where the time went to bed last night was entered as 11:30, but the time he/she got up was entered as 7:00. In such cases the time went to bed was changed to reflect the 24-hour clock.

If the time recorded participating in any activity on any day of the diary was less than 10 minutes then this was checked for accuracy of keying². If the figure had been keyed correctly then this entry was deleted.

The time spent in very light/light activities is calculated as the time leftover from 24 hours after time spent sleeping and time spent in moderate and vigorous/very vigorous activities is deducted. In 25 cases the derived time spent in very light/light activities was less than 60 minutes. In the majority of these cases, this was due to errors in data keying, for example, 600 minutes brisk walking entered instead of 60 minutes, or to duplication in recorded activities, for example, someone who worked as a childminder recording eight hours at work and also eight hours active childcare for the same day. Duplication errors were most frequent where time spent at work was entered both for work and either a prompted activity or an 'other' activity, or where time spent in an activity was recorded both for a prompted

activity and an 'other' activity. Entries were only edited where duplication was clear and in deciding which entry to delete priority was given firstly to time at work and then to activities which were on the prompted list.

All 'other' household and sports activities were checked. Where possible, 'other' activities were recoded into the prompted list of activities. 'Other' activities that were coded to the wrong intensity level were recoded to the correct level and those that were not of at least moderate intensity were deleted. Most wrongly categorised activities over-estimated the intensity level, for example, including time spent shopping as a moderate or vigorous activity when it should have been coded as a light activity.

After editing, 'other' activities that remained, included:

- less common sports activities, for example, canoeing, horse riding;
- playing with or exercising pets, in particular dogs;
- active hobbies, for example, woodwork, bell ringing.

3 Data quality

After editing, some preliminary analysis was carried out to investigate the quality of the final information on activities. Figures D1 and D2 show the mean number of different activities of at least moderate intensity participated in by diary day and day of the week respectively. Figure D1 shows that the mean number of activities recorded decreased over the seven days of record keeping, with the greatest mean number of activities recorded on Day 1 and the fewest recorded on Day 5. This suggests possible over-reporting of physical activity in the first few days of recording. Figure D2 shows that on average more activities of at least moderate intensity were recorded on Tuesdays, Wednesdays and Fridays than were recorded on other days of the week. The lowest mean number of activities was recorded on Sundays.

Although there was no strict protocol for which days the diaries were started, practical fieldwork reasons meant that diaries were less likely to be started on weekend days than on weekdays. Analysis showed that Day 1 of record keeping was most frequently a Tuesday (22%), Wednesday (21%) or Thursday (20%) and least frequently a Monday (7%) or Sunday (3%) (table not shown).

Figures D1 and D2 therefore suggest either that respondents were more active mid-week compared with the weekend or that as the seven-day recording period progressed they tended to omit to record all their activities.

4 Derived measures of physical activity

Two measures of level of physical activity were derived from the available data; the mean hours spent in activities of at least moderate intensity per day and the calculated activity score. These measures are derived in part from information on duration of activity. Any upward rounding of activity time will therefore result in an overestimate of energy expenditure as represented by the calculated activity score. However, this may in part be offset by any under-recording of the number of activities participated in.

4.1 Calculating time spent in activities of moderate and vigorous/very vigorous intensity

In order to collect data on activities of moderate and vigorous/very vigorous intensity, the diary page provided a list of common activities against which the respondent could record any time spent that day. Activities were grouped according to whether they were household activities (including walking) or sports activities. Respondents were able to record activities participated in that were not already listed, prompts were provided to establish the intensity level involved.

On each diary day respondents were asked if they had gone to work and the hours worked per day were recorded. The activity level of the respondent's occupation was recorded during the post-dietary recording period interview.

To allow comparisons between the activity of respondents in the present NDNS, the Department of Health recommendations and data from the Health Survey for England, the time spent in all activities of moderate, vigorous and very vigorous intensity was combined to give the category 'at least moderate intensity'.

4.2 Calculating the activity score

For all respondents for whom physical activity data were available, a physical activity score was calculated using data on intensity and duration of activity following the procedure proposed by Blair (1984) for the 7-Day Recall Physical Activity Questionnaire³. These data were added to the database but the results are not presented in Chapter 5. This is because the results suggest

that when compared to the physical activity data derived from the mean hours spent in activities of at least moderate intensity per day, the activity score overestimates the level of physical activity for this dataset.

The advantage of the calculated activity score method is that since very light/light activity is obtained by subtraction from 24 hours, most individuals have to account only for time spent asleep and for relatively brief periods of time engaged in moderate and vigorous/very vigorous activities. The assumption underlying the calculation of the activity score is that most adults spend most of their waking hours in light activity.

Activities can be classified by their 'energy cost' measured in metabolic equivalents (METs⁴) into the following intensity levels:

Sleep	= average 1.0 MET
Very light/light activity	= average 2.0 METs (e.g. sitting, watching television, light household chores)
Moderate activity	= average 4.0 METs (e.g. heavy household chores, badminton, swimming)
Vigorous/very vigorous	= average 7.5 METs (e.g. basketball, athletics)

Resting metabolism, defined as 1 MET, is approximately equal to an energy expenditure of one kilocalorie (kcal) per kilogram per hour (kcal/kg/hour). For adults an average body weight of 60kg is assumed and therefore for an average adult 1 MET is equal to 60kcal/hour or 1kcal/min. For adults METs are therefore taken as numerically equivalent to energy expenditure. An example of how the calculated activity score is derived for one day is given in table D1.

The score is derived by multiplying the duration of each activity (hours) by the average MET score for the intensity of the activity. The total for each day is taken and the average daily total energy expenditure calculated.

As with the previous NDNS survey of younger people⁵, the categories 'very light' and 'light' have been combined into a single 'very light/light'

Table D1 Example of calculated activity score for one day:

Type of activity	Total time spent (hours)	MET value for the type of activity	Activity score
Sleep	9.0	1.0	9.00
Very light/light activities	13.5	2.0	27.00
Moderate activities	1.0	4.0	4.00
Vigorous/very vigorous activities	0.5	7.5	3.75
Total	24.0		43.75

category. In the current survey, the categories vigorous and very vigorous have also been combined into a 'vigorous/very vigorous' category. This approach is suggested by Blair (1984) for simplified self-administered physical activity instruments³. The MET values for the categories are calculated as an average for the activities corresponding to that category. For example, vigorous/very vigorous activities have MET values ranging from 6.0 to 10.0. An average of 7.5 was taken based on the type of activities that could be coded as vigorous/very vigorous.

For adults, calculated activity scores of 40 or above indicate a relatively active lifestyle, scores in the mid to high 30s indicate an inactive lifestyle and those in the low 30s indicate a very inactive lifestyle³. Overall, 84% of men and 74% of women in this NDNS had a calculated activity score indicative of a relatively active lifestyle, and no men and less than 0.5% of women an inactive lifestyle (data not shown).

References and endnotes

- ¹ The Technical Report is available online at <http://www.food.gov.uk/science>.
- ² Respondents were asked to record only activities they had done for at least 10 minutes. Time was recorded to the nearest 10 minutes.
- ³ Blair SN. How to assess exercise habits and physical fitness. In: Matarazzo JD et al. Eds. *Behavioural Health: A Handbook of Health Enhancement and Disease Prevention*. Wiley & Sons (New York, 1984).
- ⁴ A MET is a multiple of the resting rate of oxygen consumption, or the ratio of working metabolic rate to resting metabolic rate (WMR/RMR). One MET represents the resting metabolic rate, so that an individual participating in physical activity at 2 METs is consuming oxygen at twice the resting rate.
- ⁵ Gregory J, Lowe S, Bates CJ, Prentice A, Jackson LV, Smithers G, Wenlock R, Farron M. *National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 1: Report of the diet and nutrition survey*. TSO (London, 2000).

Figure D1

The mean number of activities of at least moderate intensity in which respondents participated by diary day

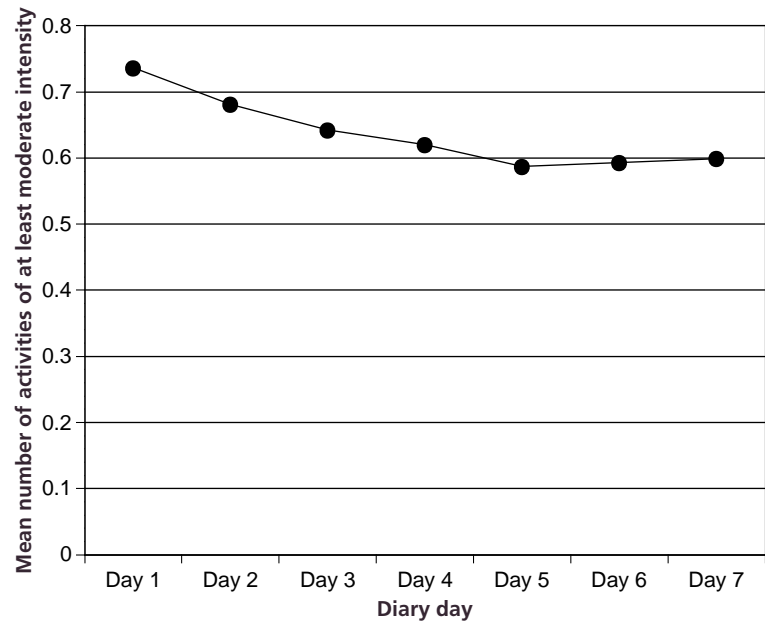
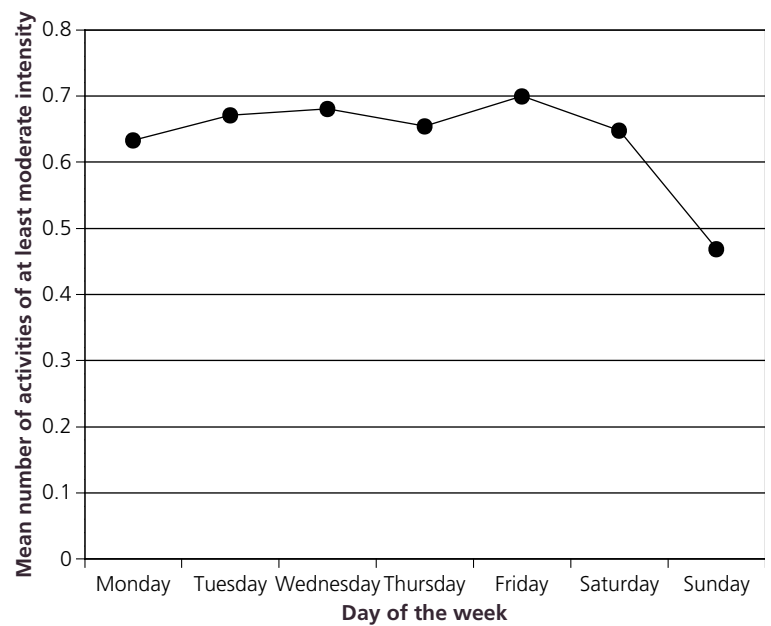


Figure D2

The mean number of activities of at least moderate intensity in which respondents participated by the day of the week



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Appendix E Glossary of abbreviations, terms and survey definitions

ANOVA	Analysis of variance. This identifies those factors which are independently associated with the variable of interest by allowing the effect on the variable of a number of characteristics to be considered simultaneously. It identifies those characteristics and factors which explain a significant amount of the total variation in the variable of interest after allowing for the other variables.
Benefits (receiving)	Receipt of Working Families Tax Credit by the respondent or anyone in their household at the time of the interview, or receipt of Income Support, or (Income-related) Job Seeker's Allowance by the respondent or anyone in their household in the 14 days prior to the date of interview.
BMI	See Body Mass Index
Body Mass Index	A measure of body 'fatness' which standardises weight for height: calculated as [weight(kg)/height(m ²)]. Also known as the Quetelet Index.
COMA	The Committee on Medical Aspects of Food and Nutrition Policy.
CAPI	Computer assisted personal interviewing.
CASI	Computer assisted self-interviewing. The respondent is given the opportunity to enter their responses directly onto the laptop. This technique is used to collect data of a sensitive or personal nature, for example, information on contraception.
Cum %	Cumulative percentage (of a distribution).
Deft	Design factor; see Notes to Tables and Appendix A.
DH	The Department of Health.
Diary sample	Respondents for whom a seven-day dietary record was obtained.
Doubly labelled water method (DLW)	A method for assessing total energy expenditure, used to validate dietary assessment methods by comparison with estimated energy intake. The respondent drinks a measured dose of water labelled with the stable isotopes ² H ₂ and ¹⁸ O and collects urine samples over the next 10 to 15 days. Energy expenditure is calculated from the excretion rates of the isotopes.

Dna	Does not apply.
EAATAC	The erythrocyte aspartate aminotransferase activation coefficient, an index of vitamin B ₆ status.
EGRAC	The erythrocyte glutathione reductase activation coefficient, an index of riboflavin status.
ETKAC	The erythrocyte transketolase activation coefficient, an index of thiamin status.
ETK-B	The erythrocyte transketolase basal activity.
GSH-Px	The erythrocyte glutathione peroxidase activity.
HDL cholesterol	High density lipoprotein cholesterol.
HNR	Medical Research Council Human Nutrition Research, Cambridge.
Household	The standard definition used in most surveys carried out by the ONS and comparable with the 1991 Census definition of a household was used in this survey. A household is defined as a single person or group of people who have the accommodation as their only or main residence and who either share one main meal a day or share the living accommodation. (See McCrossan E. <i>A Handbook for interviewers</i> . HMSO: London 1991.)
HRP	Household Reference Person. This is the member of the household in whose name the accommodation is owned or rented, or is otherwise responsible for the accommodation. In households with a sole householder that person is the household reference person, in households with <i>joint</i> householders the person with the <i>highest income</i> is taken as the household reference person, if both householders have exactly the same income, the <i>older</i> is taken as the household reference person. This differs from Head of Household in that female householders with the highest income are now taken as the HRP, and in the case of joint householders, income then age, rather than sex then age is used to define the HRP.
HSfE	Health Survey for England.
LDL (-calc) cholesterol	Low density lipoprotein cholesterol. LDL cholesterol was not measured in this survey. Total serum cholesterol minus <i>HDL cholesterol</i> is taken as an approximation of LDL cholesterol, uncorrected for triglycerides. For brevity the term LDL (-calc) cholesterol is used for non-HDL cholesterol.

MAFF	The Ministry of Agriculture, Fisheries and Food.
Manual social class	Respondents living in households where the household reference person was in an occupation ascribed to <i>Social Classes III manual, IV or V</i> .
MAP	Mean arterial pressure.
Mean	The average value.
Median	See Percentiles.
MET	Metabolic equivalent. For adults, metabolic equivalents are taken as numerically equivalent to energy expenditure. For an average adult, 1 MET is equal to 60kcal/hour or 1 kcal/min.
MCV	Mean corpuscular volume.
MRC	The Medical Research Council.
na	Not available, not applicable.
NDNS	The National Diet and Nutrition Survey.
No.	Number (of cases).
Non-manual social class	Respondents living in households where the household reference person was in an occupation ascribed to <i>Social Class I, II or III non-manual</i> .
ns	Not statistically significant.
ONS	Office for National Statistics.
PAF	Postcode Address File; the sampling frame for the survey.
Percentiles	The percentiles of a distribution divide it into equal parts. The median of a distribution divides it into two equal parts, such that half the cases in the distribution fall, or have a value, above the median, and the other half fall, or have a value below the median.
Physical activity sample	Those respondents for whom a seven-day physical activity diary was obtained.
Plasma 25-hydroxyvitamin D; plasma 25-OHD	The biochemical index of vitamin D.
Plasma ascorbate	The biochemical index of vitamin C.
PSU	Primary Sampling Unit; for this survey, postcode sectors.
Quetelet index	See Body Mass Index.

Region	<p>Based on the Standard regions and grouped as follows:</p> <p>Scotland</p> <p>Northern North Yorkshire and Humberside North West</p> <p>Central, South West and Wales East Midlands West Midlands East Anglia South West Wales</p> <p>London and the South East London South East</p> <p>The regions of England are as constituted after local government reorganisation on 1 April 1974. The regions as defined in terms of counties are listed in Chapter 2 of the Technical report (see www.food.gov.uk/science).</p>
Responding sample	Respondents who completed the dietary interview and may/may not have co-operated with other components of the survey.
sd/Std Dev	Standard deviation. An index of variability which is calculated as the square root of the variance and is expressed in the same units used to calculate the <i>mean</i> .
se	Standard error. An indication of the reliability of an estimate of a population parameter, which is calculated by dividing the <i>standard deviation</i> of the estimate by the square root of the sample size.
Social class	Based on the Registrar General's Standard Occupational Classification, Volume 4, TSO (2001). Social class was ascribed on the basis of the occupation of the household reference person. The classification used in the tables is as follows:

	Description	Social Class
	<i>Non-manual</i>	
	Professional and intermediate Skilled occupations, non-manual	I and II III non-manual
	<i>Manual</i>	
	Skilled occupations, manual Partly-skilled and unskilled occupations	III manual IV and V
TIBC	Total iron-binding capacity.	
Wave; Fieldwork wave	The 3-month period in which fieldwork was carried out.	
	Wave 1: July to September 2000 Wave 2: October to December 2000 Wave 3: January to March 2001 Wave 4: April to June 2001	
WHO	World Health Organization.	

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