



Public Health  
England



# National Diet and Nutrition Survey Results from Years 1, 2, 3 and 4 (combined) of the Rolling Programme (2008/2009 – 2011/2012)

A survey carried out on behalf of Public Health England and the Food Standards Agency

**NatCen**  
Social Research that works for society



## About Public Health England

Public Health England's mission is to protect and improve the nation's health and to address inequalities through working with national and local government, the NHS, industry and the voluntary and community sector. PHE is an operationally autonomous executive agency of the Department of Health.

Public Health England  
133-155 Waterloo Road  
Wellington House  
London SE1 8UG  
Tel: 020 7654 8000  
[www.gov.uk/phe](http://www.gov.uk/phe)  
Twitter: @PHE\_uk  
Facebook: [www.facebook.com/PublicHealthEngland](http://www.facebook.com/PublicHealthEngland)

Prepared by: (Editors) Beverley Bates, Alison Lennox, Ann Prentice, Chris Bates, Polly Page, Sonja Nicholson and Gillian Swan  
For queries relating to this document, please contact: [phe.enquiries@phe.gov.uk](mailto:phe.enquiries@phe.gov.uk)

© Crown copyright 2014

You may re-use this information (excluding logos) free of charge in any format or medium, under the terms of the Open Government Licence v2.0. To view this licence, visit OGL or email [psi@nationalarchives.gsi.gov.uk](mailto:psi@nationalarchives.gsi.gov.uk). Where we have identified any third party copyright information you will need to obtain permission from the copyright holders concerned.

Published May 2014

PHE publications gateway number: 2014051



## **Authors' acknowledgements**

We would like to thank all of those who gave up their time to be interviewed and who welcomed interviewers and nurses into their homes. We would also like to acknowledge the professionalism and commitment of interviewers and nurses who worked on the survey and who are so important to the survey's success.

We would like to thank everyone who contributed to the survey and the production of this report. In particular, we would like to thank:

- colleagues at Natcen: Olu Alaka, Pauline Burge, Sam Clemens, Claire Deverill, Steve Edwards, Lynne Gold and Coral Lawson
- members of the teams at HNR:
  - reporting: Nida Ziauddeen
  - programmers and data management: Iain Bayes, Darren Cole, Alison James and Jonathan Last
  - the dietary assessment team: Sarah Elsey, Clare Evans, Anna Harvey, Rachael Mack, Kirsty Trigg and Jenny Winster
  - laboratory and analytical personnel: Veronica Bell, Karen Chamberlain, Marc Fleming, Kate Guberg, Dagmar Koller, Abhilash Krishnankutty, Tabasum Makhdoomi, Marilena Papanikolaou, Priya Singh and Edyta Telega
  - other colleagues at HNR: Yvette Edwards
- team members no longer at HNR:
  - Laura Angell, Steve Austin, Falai Baldeh, Karen Binks, Gemma Bramwell, Sue Bryant, Carmen Canas, Mark Chatfield, Christine Clewes, Kate Edgecombe, Debbie Harman, Lindi Holmes, Katie Lamb, Kerry Lambert, Michelle Lewin, Tsz Ning Mak, Adrian Mander, Ian Mather, Adam Messenger, Hanneke Mfuni, Natalie Momen, Melanie Nester, Maria Pinheiro, Gerda Pot, Carl Ruffel, Deepti Sood, Dorothy Singer, Oliver Tunnacliffe, Vijay Vaja, Josie Webber, Peter Winship, Rachel Woodward and Antony Wright
- colleagues at UCL: Barbara Carter-Szatynska and Emmanouil Stamatakis
- Stuart Bennett and colleagues at the Northern Ireland Statistics and Research Agency for organising and carrying out fieldwork in Northern Ireland
- colleagues at Addenbrooke's for carrying out blood analyses

- Professor Elaine Gunter (Specimen Solutions, LLC) for an independent review of the laboratory procedures and analyses
- Soren Brage and colleagues at the MRC Epidemiology Unit for their physical activity expertise
- members of the NDNS Project Board: Professor Julie Lovegrove and Professor Hilary Powers and external advisors, in particular the late Professor Sheila Bingham, Dr Ailsa Welch and Dr Wendy Wrieden
- the professional staff at Public Health England, in particular: Mark Bush, Mary Day, Sakhi Dodhia, Melanie Farron-Wilson, Katharine Roberts, Alison Tedstone
- the professional staff at Department of Health: Jane Barratt, Andrew James, Frederick Wheeler
- Sheela Reddy, formerly at Department of Health
- the professional staff at the Food Standards Agency: Fiona Comrie, Sinead Furey, Clifton Gay, Maria Jennings, Anne Milne, Heather Peace, Gillian Purdon and Joseph Shavila
- the professional staff at the Welsh Government: Sarah Rowles and Chris Roberts

## Notes to text and tables

- 1 The data used in the report have been weighted. The weighting is described in Appendix B of this report. Unweighted sample sizes are shown at the foot of each table.
- 2 The NDNS RP requires weights to adjust for differences in sample selection and response. The weights adjust for:
  - differential selection probabilities of addresses, households and individuals
  - non-response to the individual questionnaire
  - non-response to the nurse visit
  - non-response of participants aged 16 years and older to the physical activity self-completion questionnaire (the RPAQ)
  - non-response to providing a blood sample
  - non-response to providing a 24-hour urine sample
  - non-response to wearing an ActiGraph
- 3 The data were analysed in SPSS as follows:
  - chapter 3: with the complex surveys module (SPSS version 18.0)
  - chapter 4: with the complex surveys module (SPSS version 20.0)
  - chapters 7: (SPSS version 22), 9 and 10 section 1 (version 21) using R essentials for SPSS which used the survey package in the statistical software R (version 2.14.2)
  - chapters 5, 8 and 10 section 2: (SPSS version 21)
  - chapter 6 and Appendices Q, S and T: (SPSS version 22)
- 4 The following conventions have been used in tables:
  - no observations (zero value)
  - 0 non-zero values of less than 0.5% and thus rounded to zero
  - [ ] unless stated otherwise data and bases for a variable with a cell size between 30-49 are presented in square brackets. For cell sizes below 30, bases have been presented in square brackets, but data has not been presented. The 2.5<sup>th</sup> and 97.5<sup>th</sup> percentiles have only been presented for a variable with a cell size of 50 or greater.
- 5 Because of rounding, row or column percentages may not add exactly to 100%.
- 6 A percentage may be quoted in the text for a single category that aggregates two or more of the percentages shown in a table. The percentage for the single category may, because of rounding, differ by one percentage point from the sum of the percentages in the table.

- 7 Values for means, medians, percentiles and standard deviations and standard errors are shown to an appropriate number of decimal places. For reasons of space, Standard Error may sometimes be abbreviated to SE and Standard Deviation to sd.
  
- 8 'Missing values' occur for several reasons, including refusal or inability to answer a particular question; refusal to co-operate in an entire section of the survey (such as the nurse visit or a self-completion questionnaire); and cases where the question is not applicable to the participant. In general, missing values have been omitted from all tables and analyses.
  
- 9 The group to whom each table refers is stated at the upper left corner of the table.
  
- 10 The term 'significant' refers to statistical significance (at the 95% level) and is not intended to imply substantive importance.

# Contents

<b>Executive summary</b> .....	<b>11</b>
<b>1 Background and purpose</b> .....	<b>35</b>
1.1 Introduction .....	35
1.2 Background, aims and uses .....	36
<b>2 Methodology and response</b> .....	<b>41</b>
2.1 Overview of methodology .....	41
2.2 Sample design .....	42
2.2.1 Selecting addresses .....	42
2.2.2 Selecting participants.....	42
2.3 Ethics approval .....	43
2.4 Fieldwork.....	43
2.5 Overview of survey components and fieldwork procedures .....	43
2.5.1 Stage 1: the interviewer visits.....	44
2.5.1.1 Computer Assisted Personal Interview (CAPI) programme .....	45
2.5.1.2 Collection of dietary data: the four-day food diary.....	45
2.5.1.3 Selection of food diary start day .....	46
2.5.1.4 Collection of physical activity data.....	47
2.5.2 Stage 2: the nurse visit .....	47
2.5.2.1 Measurements taken by the nurse .....	48
2.5.2.2 Blood sample .....	48
2.5.2.3 24-hour urine sampling.....	49
2.5.3 Feedback to participants and GPs .....	49
2.6 Fieldwork quality control .....	50
2.6.1 Project specific training for interviewers and nurses .....	50
2.6.2 Training for interviewers .....	50
2.6.3 Training for nurses .....	51
2.7 Key methodological changes between Years 3 and 4 .....	51
2.8 Response rates.....	51
2.8.1 Household level response .....	52
2.8.2 Individual level response .....	52
2.9 Weighting the survey data .....	53
<b>3 Socio-demographic characteristics of the NDNS RP sample</b> .....	<b>56</b>
3.1 Introduction.....	56
3.2 Sex.....	56
3.3 Age.....	56
3.4 National Statistics Socio-economic Classification (NS-SEC), housing tenure, education and qualifications.....	56
3.5 Vegetarian and vegan diets .....	57
3.6 Smoking .....	57
3.7 Alcohol consumption.....	58
3.7.1 Drinking behaviour amongst adults aged 16 years and older .....	58
3.7.2 Drinking behaviour amongst children aged 8 to 15 years .....	59
<b>4 Physical measurements and physical activity</b> .....	<b>62</b>

4.1	Physical measurements.....	62
4.1.1	Introduction .....	62
4.1.2	Anthropometry .....	62
4.1.2.1	Measurements .....	62
4.1.3	Obesity.....	63
4.1.3.1	Adults.....	63
4.1.3.2	Children .....	64
4.1.4	Comparisons with other surveys .....	64
4.2	Blood pressure.....	65
4.2.1	Measurement of blood pressure.....	65
4.2.2	Results .....	66
4.2.3	Comparisons with other surveys.....	66
4.3	Physical activity .....	67
4.3.1	Introduction .....	67
4.3.2	Physical activity in adults .....	68
4.3.2.1	Estimation of physical activity.....	68
4.3.2.2	Results .....	68
4.3.2.3	Comparisons with other surveys .....	69
4.3.3	Physical activity in children .....	69
4.3.3.1	Measurement of physical activity.....	69
4.3.3.2	Results.....	69
4.3.3.3	Comparisons with other surveys .....	70
<b>5</b>	<b>Dietary intakes.....</b>	<b>74</b>
5.1	Introduction .....	74
5.2	Foods consumed .....	76
5.3	Cereals and cereal products.....	76
5.4	Milk and milk products .....	77
5.4.1	Fat spreads.....	77
5.4.2	Meat and meat products and dishes .....	77
5.4.3	Fish and fish dishes .....	77
5.4.4	Fruit and vegetables .....	78
5.4.5	Sugar, confectionery and snacks .....	78
5.4.6	Beverages.....	79
5.5	Vegetable, fruit, meat and fish consumption, including from composite dishes .....	79
5.6	Energy and macronutrient intake and percentage contribution of food groups to intake .....	81
5.6.1	Energy.....	81
5.6.2	Protein.....	82
5.6.3	Carbohydrate .....	82
5.6.4	Non-milk extrinsic sugars.....	83
5.6.5	Non-starch polysaccharides .....	83
5.6.6	Total fat .....	84
5.6.7	Saturated fatty acids .....	84
5.6.8	<i>Trans</i> fatty acids .....	85
5.6.9	Unsaturated fatty acids .....	85
5.7	Alcohol .....	86
5.8	Vitamins and minerals and percentage contribution of food groups to micronutrient intakes.....	87
5.8.1	Vitamins .....	88
5.8.1.1	Vitamin A and retinol .....	88
5.8.1.2	Thiamin .....	89
5.8.1.3	Riboflavin .....	89
5.8.1.4	Niacin equivalents .....	90
5.8.1.5	Vitamin B <sub>6</sub> .....	90
5.8.1.6	Vitamin B <sub>12</sub> .....	90
5.8.1.7	Folate.....	91

5.8.1.8	Vitamin C .....	91
5.8.1.9	Vitamin D .....	91
5.8.1.10	Vitamin E .....	92
5.8.2	Vitamin intakes for supplement takers vs non-supplement takers .....	92
5.8.3	Minerals .....	93
5.8.3.1	Iron.....	93
5.8.3.2	Calcium.....	94
5.8.3.3	Magnesium .....	94
5.8.3.4	Sodium.....	95
5.8.3.5	Potassium.....	95
5.8.3.6	Zinc.....	96
5.8.3.7	Copper.....	96
5.8.3.8	Selenium.....	97
5.8.3.9	Iodine.....	97
5.8.4	Mineral intakes for supplement takers vs non-supplement takers .....	98
5.9	Dietary supplements .....	98
5.10	Summary.....	99

## **6 Blood analytes ..... 102**

6.1	Introduction .....	102
6.1.1	Obtaining the blood sample .....	103
6.1.1.1	Blood Response .....	104
6.1.2	Fasted blood samples.....	104
6.1.3	Transport and storage of blood samples .....	104
6.1.4	Analysis of the blood samples .....	105
6.2	Haemoglobin and ferritin.....	106
6.2.1	Haemoglobin concentration ( <i>grams/litre, g/L</i> ).....	106
6.2.2	Plasma ferritin (micrograms/litre, $\mu\text{g/L}$ ).....	107
6.2.3	Combined index: Haemoglobin concentration ( <i>grams/litre, g/L</i> ) and plasma ferritin ( <i>micrograms/litre, <math>\mu\text{g/L}</math></i> ) 108	
6.3	Water-soluble vitamins .....	109
6.3.1	Plasma vitamin C (micromoles/litre, $\mu\text{mol/L}$ ) .....	109
6.3.2	Serum vitamin B <sub>12</sub> (picomoles/litre, $\text{pmol/L}$ ) .....	109
6.3.3	Erythrocyte Transketolase Activation Coefficient (ETKAC) for thiamin status ( <i>ratio</i> ).....	110
6.3.4	Erythrocyte Glutathione Reductase Activation Coefficient (EGRAC) for riboflavin status ( <i>ratio</i> ).....	111
6.3.5	Plasma pyridoxal-5-phosphate (PLP) ( <i>nanomoles/litre, nmol/L</i> ) .....	112
6.4	Fat-soluble vitamins and carotenoids .....	113
6.4.1	Plasma retinol (vitamin A) ( <i>micromoles/litre, <math>\mu\text{mol/L}</math></i> ) .....	113
6.4.2	Plasma $\alpha$ - and $\beta$ -carotene and $\alpha$ - and $\beta$ -cryptoxanthin ( <i>micromoles/litre, <math>\mu\text{mol/L}</math></i> ) .....	114
6.4.3	Plasma lycopene and plasma lutein and zeaxanthin ( <i>micromoles/litre, <math>\mu\text{mol/L}</math></i> ).....	115
6.4.4	Plasma 25-hydroxyvitamin D ( <i>nanomoles/litre, nmol/L</i> ) .....	115
6.4.4.1	Seasonal variation in concentration of plasma 25-hydroxyvitamin D ( <i>nanomoles/litre, nmol/L</i> ).....	116
6.4.5	Plasma $\alpha$ -tocopherol (micromoles/litre, $\mu\text{mol/L}$ ).....	117
6.5	Blood lipids.....	118
6.5.1	Total cholesterol, high density lipoprotein (HDL) cholesterol and low density lipoprotein (LDL) cholesterol ( <i>millimoles/litre, mmol/L</i> ) .....	118
6.6	Selenium and zinc .....	120
6.6.1	Plasma selenium (micromoles/litre, $\mu\text{mol/L}$ ).....	120
6.6.2	Plasma zinc (micromoles/litre, $\mu\text{mol/L}$ ).....	120
6.7	Summary of the nutritional status of the UK population .....	121

## **7 24-hour urine analyses: Sodium excretion and estimated salt intake....**

7.1	Introduction .....	124
-----	--------------------	-----

7.2	Urine collection and processing.....	127
7.3	Results used in the data analysis .....	128
7.4	Assessment of completeness of collection.....	128
7.4.1	Standard criteria for classifying complete collections .....	129
7.4.2	Alternative criterion for classifying complete collections from children aged 4 to 10 years .....	129
7.5	Sodium excretion and estimated salt intake results .....	129

## **8 Detailed age breakdowns for young people and adults for key nutrients and disaggregated foods ..... 133**

8.1	Introduction .....	133
8.2	Energy and macronutrient intake.....	133
8.3	Alcohol .....	134
8.4	Vitamins and minerals .....	135
8.5	Vegetable, fruit, meat and fish consumption, including from composite dishes .....	136

## **9 Comparison of equivalised income quintiles for key nutrients and disaggregated foods ..... 138**

9.1	Introduction .....	138
9.2	Energy and key macronutrient intake by equivalised household income.....	139
9.3	Alcohol intake by equivalised household income .....	141
9.4	Vitamins and minerals by equivalised household income .....	142
9.5	Vegetables, fruit, meat and fish consumption, including from composite dishes, by equivalised household income	144
9.6	Summary of main findings by equivalised household income.....	145

## **10 Comparisons within the NDNS Rolling Programme (RP) and between the RP and previous NDNS surveys..... 148**

10.1	Introduction .....	148
10.2	Comparison of NDNS RP Years 1 and 2 combined (Y1&2) with NDNS RP Years 3 and 4 combined (Y3&4)	148
10.2.1	Background.....	148
10.2.2	Energy and macronutrient intake.....	150
10.2.3	Vitamins and minerals .....	152
10.2.5	Vegetables, fruit, meat and fish consumption, including from composite dishes. ....	153
10.3	Comparison with previous surveys for key nutrients .....	154
10.3.1	Background.....	154
10.3.2	Energy and macronutrient intake.....	156
10.3.3	Vitamins and minerals .....	157

# Executive summary

## **Erratum note: Correction to the salt intake data**

This Executive Summary has been updated in 2017 since first publication (in May 2014) to take account of corrections to salt intake values due to bias detected in the original analytical data. Further details are provided in chapter 7.

## **Introduction**

The National Diet and Nutrition Survey (NDNS) is designed to assess the diet, nutrient intake and nutritional status of the general population aged 1.5 years and over living in private households in the UK. The NDNS is jointly funded by Public Health England (PHE), an executive agency of the Department of Health, and the UK Food Standards Agency (FSA)<sup>1,2</sup> and carried out by a consortium of three organisations: NatCen Social Research (NatCen), MRC Human Nutrition Research (HNR) and the University College London Medical School (UCL).<sup>3</sup>

The NDNS provides the only source of high quality nationally representative data on the types and quantities of foods consumed by individuals, from which estimates of nutrient intake for the population are derived.<sup>4</sup> Results are used by Government to develop policy and monitor progress on diet and nutrition objectives of UK Health Departments, for example those set out in the Healthy Lives, Healthy People White Paper in England.<sup>5</sup> The food consumption data are also used by FSA to assess exposure to chemicals in food, as part of the risk assessment and communication process in response to a food emergency or to inform negotiations on setting regulatory limits for contaminants.

The NDNS programme began in 1992 as a series of cross-sectional surveys, each covering a different age group: pre-school children (aged 1.5 to 4.5 years);<sup>6</sup> young people (aged 4 to 18 years);<sup>7</sup> adults (aged 19 to 64 years)<sup>8</sup> and older adults (aged 65 years and over).<sup>9</sup> Methods used in the NDNS are continually reviewed to ensure they remain the best practical methods available. Since 2008, the NDNS has been a rolling programme (RP) covering adults and children aged 1.5 years and over.

This report presents combined results from Years 1, 2, 3 and 4 of the RP (2008/09 – 2011/12) for a sample of the UK population designed to be nationally representative.<sup>10</sup> This report supersedes and replaces previous reports for the NDNS RP,<sup>11</sup> providing a larger sample size. For the first time, comparisons within the RP are made (i.e. Years 3 & 4 (Y3&4) combined is compared with Years 1 & 2 (Y1&2) combined). This report also includes findings from blood indices of nutritional status and salt intakes from 24-hour urinary sodium in young children and older adults for the first time in the RP. Analysis is also presented by household income and with a more detailed age breakdown for adults.

### **Overview of key findings from NDNS RP Years 1 to 4 (2008/09-2011/12)**

- In the population as a whole, mean saturated fat, non-milk extrinsic sugars (NMES) and salt intakes were above dietary recommendations, and the mean intakes of fruit and vegetables, non-starch polysaccharides (NSP) and oily fish were below recommendations. Overall mean total fat and trans-fatty acids intakes were in line with recommendations.
- On average, intakes of the majority of vitamins were adequate (excluding vitamin D, see below), as indicated by dietary intakes and biochemical indices of nutritional status. Intakes below the Lower Reference Nutrient Intake (LRNI)<sup>12</sup> were found in a proportion of the 11 to 18 years age group for vitamin A, riboflavin and folate (girls only). Women aged 19 to 64 years also had intakes below the LRNI for riboflavin. For vitamin A, there was no indication from the biochemical status data that this age group was at risk of vitamin A deficiency. This discrepancy is likely to be due to the infrequent consumption of vitamin A-rich foods meaning that a longer recording period is needed to assess the customary vitamin A intake of an individual.<sup>13</sup> For riboflavin, blood results indicate a high proportion of the population with low biochemical status but the health implications of this are unclear. Results for blood measures of folate status have been delayed due to problems with the laboratory analysis and publication is expected in 2015.
- Vitamin D is obtained both from skin synthesis and from the diet; the status indicator plasma 25-hydroxyvitamin D is used to assess adequacy. There was evidence of an increased risk of vitamin D deficiency in all age/sex groups. Year-round, the proportion of children with a serum 25-OHD concentration below 25nmol/L at the time of venepuncture ranged from 7.5% for children aged 1.5 to 3 years to 24.4% for girls aged

11 to 18 years and for adults this ranged from 16.9% for men aged 65 years and over to 24.1% for women aged 65 years and over. The proportion of participants with a serum 25-OHD concentration below 25nmol/L was higher in the winter months.

- For iron, both the dietary intake and biochemical status data indicated an increased risk of iron deficiency in girls aged 11 to 18 years and women aged 19 to 64 years.
- There was evidence of intakes below the LRNI in a substantial proportion of older children and adults for some minerals, particularly magnesium, potassium and selenium. However the health implications of this are unclear.
- Analysis by equivalised income quintile showed some evidence of income differences in diet and nutrient intake with those in lower income quintiles tending to have poorer diets, particularly with respect to fruit and vegetable consumption. With the exception of those aged 65 years and over, mean fruit and vegetable consumption was significantly lower in all age/sex groups in the lowest income quintile compared with the highest quintile. There was evidence of a similar pattern for NSP, and for some vitamins and minerals. However, there was no consistent pattern in energy or macronutrient intakes across income groups. Where intakes failed to meet recommendations this was the case for all income quintiles.
- Mean intakes of energy, total fat and saturated fat tended to be lower in Y3&4 than in Y1&2 and the differences reached statistical significance for some age groups. Intakes expressed as a percentage of energy tended to be higher for carbohydrate and lower for total fat in Y3&4 than in Y1&2 with the differences reaching statistical significance for some age/sex groups. There was some evidence that intakes of some micronutrients were slightly lower in Y3&4 compared with Y1&2 but differences were small and not consistent across age groups. Total and red meat consumption tended to be lower in Y3&4 compared with Y1&2 but there were no differences in fruit and vegetable consumption.
- Comparisons between the RP and previous NDNS carried out in between 1992 and 2000/01 should be interpreted with caution due to methodological differences between the current RP and the older surveys. While some differences were seen in energy and nutrient intakes, these were generally small and the direction of the difference varied by age group. In general, total fat tended to make a smaller contribution to total energy, and protein a greater contribution in the RP than in previous NDNS surveys. Mean

intakes of saturated fat, *trans* fatty acids and NMES were lower and NSP intake was higher than in previous surveys. The proportion of the population at risk of vitamin or mineral deficiencies was similar in the RP to previous surveys.

### **Sample and response rates**

A random sample of 21,573 addresses from 799 postcode sectors, drawn from the UK Postcode Address File, was issued between April 2008 and March 2011. Where there were multiple households at an address, a single household was selected at random. For each household, either one adult (aged 19 years and over) and one child (aged 1.5 to 18 years), or one child only were randomly selected to take part.<sup>14</sup> Selected individuals were asked to complete a diary of food and drink consumption over four consecutive days (with the start date randomly allocated) and an interview was conducted to collect background information on dietary habits, socio-demographic status, lifestyle and physical activity (stage one).

Participants who agreed to a nurse visit (stage two) were asked to provide a blood sample to assess biochemical indices of nutritional status and those who were aged four years and older were asked to provide a 24-hour urine collection to assess salt intake. Physical measurement data were also collected.

The response rate for completion of the diary was 56% for Years 1 to 4 combined.<sup>15</sup> A total of 6,828 individuals aged 1.5 years and older completed at least three days<sup>16</sup> of the food and drink diary (3,450 adults aged 19 years and over and 3,378 children aged 1.5 to 18 years). Fewer participants agreed to be visited by a nurse and a further percentage declined to give a blood or a 24-hour urine sample.<sup>17</sup> Overall in Years 1 to 4 combined, 51% of adults (1,769) and 27% of children (902) who had completed a diary went on to give a blood sample. Sixty per cent of adults (2,074) and 58% of children aged 4 to 18 years (1,602) who completed a diary agreed to provide a 24-hour urine sample.<sup>18</sup>

The data are weighted to minimise any bias in the observed results which may be due to differences in the probability of households and individuals being selected to take part; and to attempt to reduce non-response bias.<sup>19</sup> See appendix B for more information on sampling and weighting.

## Contents of the report

The results in the report update information published in previous reports on food consumption, nutrient intakes and blood analytes.<sup>11</sup> Blood analyte results from the RP for older adults (aged 65 years and over) and younger children (aged 1.5 to 10 years) are published for the first time. The report also contains results for salt intake estimated from urinary sodium excretion for children and adults aged 65 years and over.<sup>20</sup> Contextual information on the physical measurements, blood pressure, physical activity and socio-demographic characteristics of the participants is also included.

The results in the report cover the following areas:

- Types and quantities of foods consumed based on food and composite dishes as eaten (chapter 5)
- Consumption of meat, fish, fruit and vegetables, including the contribution from composite dishes (based on disaggregated data)<sup>21</sup> (chapter 5)
- The number of portions of fruit and vegetables consumed, including the contribution from composite dishes, and the proportion of participants meeting the “5-a-day” recommendation<sup>22</sup> (chapter 5)
- Intakes of energy, macronutrients (protein, fat and fatty acids, carbohydrates) and alcohol; comparison of energy and nutrient intakes with UK Dietary Reference Values (DRVs)<sup>23,24</sup> (chapter 5)
- Intakes of vitamins and minerals, including and excluding the contribution from dietary supplements; comparison of intakes with UK DRVs (chapter 5)
- Percentage contributions of major food groups to energy, macronutrient and micronutrient intakes (chapter 5)
- Use of dietary supplements and intakes of vitamins and minerals from the diet for supplement users compared with non-users (chapter 5)
- Status indices measured in blood for micronutrients and blood lipids (chapter 6).<sup>25</sup> Additional blood indices assayed are reported in appendix Q

- Salt intake estimated from urinary sodium excretion (chapter 7). Additional urinary indices assayed are reported in appendix S.

This report included additional analyses on food consumption and nutrient intakes for a number of key foods and nutrients selected on the basis of public health interest (chapters 8-10).

- Intakes of selected foods and nutrients for young people and adults presented by narrower age bands (chapter 8)
- Statistical comparison of intakes of selected foods and nutrients by equivalised household income<sup>26</sup> (chapter 9)
- Statistical comparisons between Y1&2 and Y3&4 of the NDNS RP for selected foods and nutrients (chapter 10)
- Informal comparison between Years 1 to 4 of the NDNS RP and previous NDNS for selected nutrients (chapter 10).

### Current UK diet and nutrition recommendations

The NDNS RP findings are compared to the UK recommendations for food and nutrient intakes. Current UK recommendations for consumption of fruit and vegetables, red and processed meat and oily fish are shown below.

Food	Recommendation
Fruit and vegetables	At least 5 portions per day for those aged 11 years and over <sup>22</sup>
Red and processed meat <sup>a</sup>	Should not exceed 70g per day for adults <sup>27</sup>
Oily fish <sup>b</sup>	At least 1 portion per week for all ages (140g) <sup>28</sup>

<sup>a</sup> Red meat includes beef, lamb, pork, sausages, burgers and kebabs, offal, processed red meat and other red meat.

<sup>b</sup> Oily fish includes anchovies, carp, trout, mackerel, herring, jack fish, pilchards, salmon (including canned), sardines, sprats, swordfish, tuna (fresh only) and whitebait

The DRVs for key macronutrients are shown below. These indicate the average or the maximum contribution that these nutrients should make to the population average intakes of these nutrients. In addition, biochemical measures of blood lipids are compared with clinical thresholds to provide an indication of the proportion of the population at increased risk of vascular disease.

<b>Macronutrient</b>	<b>Dietary Reference Value<sup>29</sup></b>
Total fat	Population average no more than 35% of food energy for those aged 5 years and over
Saturated fatty acids	Population average no more than 11% food energy for those aged 5 years and over
<i>Trans</i> fatty acids	Population average no more than 2% food energy
Non-milk extrinsic sugars (NMES)	Population average no more than 11% food energy for all ages
Non-starch polysaccharides (NSP)	Adult population average at least 18g per day

Population adequacy of micronutrient intake is assessed by comparing intake with the age and sex specific DRV for each vitamin and mineral. Mean intake is compared with the Reference Nutrient Intake (RNI)<sup>30</sup> and an estimate is made of the proportion with intake below the Lower Reference Nutrient Intake (LRNI).<sup>12</sup> The RNI and LRNI for each vitamin and mineral are given in tables 5.14 and 5.32 of the report. In addition, biochemical indices of micronutrient status are compared with threshold values, where they have been set, to give an estimate of the proportion of the population at greater risk of deficiency due to depleted body stores or tissue concentrations.

The RNIs<sup>23</sup> for sodium, set in 1991 by the Committee on Medical Aspects of Food and Nutrition Policy's (COMA) Panel on Dietary Reference Values,<sup>29</sup> are presented in the table below for the different NDNS age groups covered in the report. The table also shows the corresponding recommended maximum salt intake per day for adults, which was set by COMA<sup>31</sup> and

endorsed by the Scientific Advisory Committee on Nutrition in its report on Salt and Health (2003) and the recommended maximum intakes set by SACN (2003) for children.<sup>32</sup>

<b>NDNS age group</b>	<b>RNI<sup>23,29</sup> mmol sodium per day*</b>	<b>Recommended maximum salt intake<sup>Error! Bookmark not defined.</sup>,<sup>Error! Bookmark not defined.</sup> g per day**</b>
4 to 6 years	30	3
7 to 10 years	50	5
11 to 18 years	70	6
19 to 64 years***	70	6
65 years and over	70	6

\*1g salt contains 17.1mmol sodium

\*\* These are the maximum daily dietary targets.

\*\*\* results for this age group have been previously published elsewhere

## Key findings

### *Food consumption and nutrient intakes (chapter 5)*

- Adults aged 19 to 64 years on average consumed 4.1 portions of fruit and vegetables per day, while adults aged 65 years and over consumed 4.6 portions per day.<sup>22</sup> Thirty per cent of adults and 41% of older adults met the “5-a-day” recommendation.<sup>33</sup>
- Mean consumption of fruit and vegetables for children aged 11 to 18 years was 3.0 portions per day for boys and 2.7 portions per day for girls. Ten per cent of boys and 7% of girls in this age group met the “5-a-day” recommendation.
- Mean consumption of oily fish in all age groups was well below the recommended one portion (140g) per week. For example, mean consumption in adults aged 19 to 64 years was 54g per week (52g for men and 54g for women) and for adults aged 65 years and over mean consumption was 90g per week (103g for men and 81g for women).<sup>34</sup>

- Mean consumption of red meat for adults aged 19 to 64 years was 71g per day (86g for men and 56g for women) and for adults aged 65 years or over was 63g per day (75g for men and 54g for women).
- Mean reported total energy intake was 4.75 MJ/day (1126 kcal/day) for children aged 1.5 to 3 years and 6.46 MJ/day (1532 kcal/day) for children aged 4 to 10 years. For children aged 11 to 18 years, mean total energy intake was 8.30 MJ/day (1972 kcal/day) for boys and 6.60 MJ/day (1569 kcal/day) for girls. For adults aged 19 to 64 years, mean total energy intake was 8.88 MJ/day (2111 kcal/day) for men and 6.78 MJ/day (1613 kcal/day) for women. For older adults, mean total energy intake was 8.14 MJ/day (1935 kcal/day) for men and 6.35 MJ/day (1510 kcal/day) for women. Mean energy intakes were below the Estimated Average Requirement (EAR) for adults and children aged 11 years and over. However it should be borne in mind that the doubly labelled water (DLW) sub-study showed evidence of under-reporting of energy intakes in these age groups. 'Cereals and cereal products' was the main contributor to energy intake in all age groups. 'Meat and meat products' and 'milk and milk products' were the other major contributors with 'milk and milk products' making a larger contribution in younger children.
- Mean intake of total fat met the DRV (no more than 35% food energy) in all age/sex groups except for men aged 65 years and over, for whom, on average, total fat provided 36.0% food energy. 'Cereals and cereal products' and 'meat and meat products' were the main contributors to total fat intake, except in children under four years, for whom 'milk and milk products' was the largest contributor.
- Mean intake of saturated fat exceeded the DRV (no more than 11% food energy) in all age/sex groups. For example, mean saturated fat intake for adults aged 19 to 64 years was 12.6% food energy. 'Milk and milk products', 'cereals and cereal products', and 'meat and meat products' made similar contributions to saturated fat intake in adults and older children while in younger children 'milk and milk products' was the largest contributor
- Mean intake of *trans* fatty acids provided 0.6-0.7% of food energy for all age/sex groups, and thus met the DRV (no more than 2% food energy). 'Milk and milk products', 'meat and meat products' and 'cereals and cereal products' were the main contributors to

intake, partly from naturally occurring trans fats in dairy products and the meat of ruminant animals.

- Mean NMES intake exceeded the DRV (no more than 11% food energy) for all age/sex groups most notably for children aged 4 to 10 years and 11 to 18 years where mean intake provided 14.7% and 15.6% of food energy respectively. For children, the main source of NMES was 'non-alcoholic beverages' (soft drinks and 'fruit juice' – soft drinks alone provided 30% of NMES intake in the 11 to 18 years age group). 'Cereals and cereal products' was the other major contributor in children mainly from cakes, biscuits and breakfast cereals. For adults, 'table sugar and confectionery', 'non-alcoholic beverages' (soft drinks and 'fruit juice') and 'cereals and cereal products' (mainly cakes and 'biscuits') made similar contributions to intake.
- Fifty-eight per cent of adults aged 19 to 64 years and 51% of adults aged 65 years and over reported consuming alcohol during the four-day recording period. On average, adults aged 19 to 64 years who consumed alcohol during the four-day recording period obtained 8.4% of energy intake from alcohol and older adult consumers obtained 6.4%.
- Mean intake of non-starch polysaccharide (NSP) for adults aged 19 to 64 years and 65 years and over was 13.7-13.9g per day, below the DRV set for adults of at least 18g per day. 'Cereals and cereal products' and 'vegetables and potatoes' were the main sources of NSP.
- Mean intakes of vitamins (except vitamin D) from food sources were close to or above the RNI for all age/sex groups. Mean intake of vitamin D was below the RNI for children aged 1.5 to 3 years and for adults aged 65 years and over, both with and without the contribution of supplements.<sup>35</sup> For children aged 11 to 18 years, 13% and 15% had vitamin A and riboflavin intake below the LRNI respectively; 8% of girls aged 11 to 18 years had folate intake below the LRNI.
- Mean intakes of minerals from food sources were below the RNI for some age/sex groups, in particular children aged 11 to 18 years. A substantial proportion of this age group, especially girls, had intakes of some minerals below the LRNI. For example, mean iron intakes were below the RNI for both women aged 19 to 64 years and girls aged 11 to 18 years and 23% of women and 46% of girls had iron intake below the LRNI. Mean intakes of calcium, zinc (and iodine for girls only) were also below the RNI

in the 11 to 18 years age group and about a fifth of girls aged 11 to 18 years fell below the LRNI.

- Mean intakes of potassium, magnesium and selenium were below the RNI in all age groups except children aged under 11 years and substantial proportions fell below the LRNI. It should be noted that the DRVs for these minerals are based on limited data so caution should be used when assessing adequacy of intake using the LRNI.
- Mean intakes of all minerals were close to or above the RNI for children aged under 11 years and few children in this age group had intakes below the LRNI.
- Seventeen per cent of men and 27% of women aged 19 to 64 years, and 35% of men and 47% of women aged 65 years and over reported taking at least one dietary supplement during the four-day recording period.
- In general, supplement takers had higher intakes of vitamins and minerals from food sources than those who did not take supplements. The contribution from supplements had little effect on the proportion of participants below the LRNI, indicating that supplement takers generally had adequate intakes of vitamins and minerals from the diet.

#### *Biochemical indices of nutritional status (chapter 6)*

- Approximately a third of adults had a serum total cholesterol concentration between 5.2 and 6.4mmol/litre, indicating a marginally increased risk of cardiovascular disease. In slightly more than 10% of adults, total serum cholesterol concentration was between 6.4 and 7.8mmol/litre indicating moderately elevated cardiovascular risk, and in approximately 2% of adults it was above 7.8mmol/l indicating high risk.<sup>36</sup> The association of elevated serum cholesterol concentration with an increased risk of cardiovascular disease is well established.<sup>37</sup>
- Over two thirds of those aged 4 to 64 years and almost half of those in other age groups had riboflavin status values above the generally accepted upper threshold of normal status indicating biochemical depletion.<sup>38</sup> However, there is uncertainty about whether these are associated with functional consequences. To aid future population monitoring, additional information on the distribution of riboflavin status values has been included in

the report to provide a baseline against which any future change in the dietary adequacy of this vitamin can be assessed.<sup>39</sup>

- There was evidence of low vitamin D status at the time the blood sample was taken in a proportion of participants in all reported age/sex groups. The proportion of children who, at the time of venepuncture, had a 25-hydroxyvitamin D (25-OHD) concentration below the lower threshold for vitamin D adequacy ranged from 7.5% for children aged 1.5 to 3 years to 24.4% for girls aged 11 to 18 years. For adults this ranged from 16.9% for men aged 65 years and over to 24.1% for women aged 65 years and over. People obtain vitamin D from two sources: endogenous synthesis when their skin is exposed to ultra violet B (UVB) radiation and their diet. There was marked seasonal variation in the proportion of participants with a 25-OHD below the threshold of adequacy at the time of venepuncture, in line with the known seasonal variation in the UVB content of sunshine in the UK. When subdivided by season, the proportion below the lower threshold for vitamin D adequacy in the winter months (January to March) when UK sunshine lacks UVB ranged from 29.3% for adults aged 65 years and over to 40.0% for children aged 11 to 18 years. This contrasted with the summer months (July to September) when the proportion below the lower threshold was much smaller, ranging from 1.7% for children aged 4 to 10 years to 13.4% for children aged 11 to 18 years. Low vitamin D status has implications for bone health, (increasing the risk of rickets and osteomalacia).
- There was evidence of anaemia (as indicated by low haemoglobin levels) plus low iron stores (plasma ferritin) in a proportion of older girls aged 11 to 18 years (4.9%) and women aged 19 to 64 years (4.7%), indicative of iron deficiency.
- There was little evidence of low status for other micronutrients where normal ranges or thresholds of adequacy have been set. Mean values for vitamin C, B<sub>12</sub>, thiamin, retinol (vitamin A)<sup>40</sup> and vitamin E fell within the normal range and the proportion falling outside established thresholds indicating low status, where these have been set, was low.

#### *Estimated salt intake (chapter 7)*

**Erratum note:** The results presented in this section have been corrected to take account of bias in the sodium concentrations originally published in 2014.

- Estimated salt intake for children, based on urinary sodium excretion, exceeded the SACN recommendations for each age group<sup>41</sup> except for girls aged 7 to 10 years (by standard criteria only). Mean estimated salt intake for children aged 4 to 6 years was 3.9g/day. In children aged 7 to 10 years mean intake was 5.7g/day for boys and 4.8g/day for girls and for the 11 to 18 years age group mean intake was 7.4g/day for boys and 6.5g/day for girls.
- Estimated mean salt intake for people aged 65 years and over was 7.6g/day (8.7g/day for men and 6.7g/day for women) which is above the SACN recommended maximum of 6g/day.

Analysis for chapters 8, 9 and 10 was done for energy and macronutrients plus four micronutrients, selected on the basis of public health interest: iron, calcium, folate, vitamin C.

*Detailed age breakdown for young people and adults (chapter 8)*

Results for key foods and nutrients are presented for four age groups, subdivided by sex: 11 to 15 years, 16 to 24 years, 25 to 49 years and 50 to 64 years. These age sub-groups differ from the age/sex groups used elsewhere in the report and are referred to as “age sub-groups”.

- Mean daily intake for all age sub-groups was close to the DRV for total fat but exceeded the DRV for saturated fat. Mean intake of NMES exceeded the DRV in all age sub-groups, except females aged 50 to 64 years. Mean NMES intake was higher in the 11 to 15 years and 16 to 24 years sub-groups than in the older sub-groups.
- Mean intake of NSP increased by age across the age sub-groups but was below the DRV in all age sub-groups.
- For men and women aged 25 to 49 years and 50 to 64 years, mean intakes from food sources of vitamin C, folate, iron and calcium were close to or above the RNI, except iron for women aged 25 to 49 years. The mean iron intake in this group was 65% of the RNI; 29% of these women had iron intakes below the LRNI.
- For the 11 to 15 years and 16 to 24 years sub-groups, males had mean intake from food sources of vitamin C, folate, iron and calcium close to or above the RNI, while females had mean intake close to or above the RNI for vitamin C and folate but below the RNI for calcium and iron. Iron intake was below the LRNI for 44% of females aged 11 to 15

years and 40% of females aged 16 to 24 years. Calcium intake was below the LRNI for 18% of females aged 11 to 15 years and 16% of females aged 16 to 24 years.

- The number of portions of fruit and vegetables consumed per day increased with age from 2.9 for children aged 11 to 15 years to 4.7 for adults aged 50 to 64 years. The proportion of participants meeting the “5-a-day” recommendation also increased with age: 9% of those aged 11 to 15 years, 14% of those aged 16 to 24 years (18% of males and 10% of females), 29% of those aged 25 to 49 years and 38% of those aged 50 to 64 years (36% of males and 40% of females).

#### *Intake by equivalised income (chapter 9)*

Households were ranked by equivalised income, and grouped into five quintiles.<sup>26</sup> Statistical comparisons were undertaken for intakes of key foods and nutrients by quintiles of equivalised income within each age/sex group. Quintile 5 (the highest income) was used as the reference category.

- There were some differences observed in food consumption and energy and nutrient intakes by equivalised income quintile, particularly for fruit and vegetable consumption. Differences were clearest between the lowest and highest income quintile but were not seen in all age/sex groups. Where differences were seen they were generally in the direction of poorer diets in the lower income quintiles.
- Income differences in mean intake of energy and macronutrients were observed in women aged 19 to 64 years and to some extent in men aged 19 to 64 years. Total energy and protein intake in women aged 19 to 64 years was significantly lower in quintiles 1, 2 and 3 than in quintile 5. The lowest quintile in this age group also had a higher intake of carbohydrate and a lower intake of protein as a percentage of energy than did the highest quintile. However, protein intakes were above the RNI in all income quintiles. To some extent alcohol intake in men aged 19 to 64 years and women aged 19 to 64 years also increased through the quintiles.
- Men and women aged 19 to 64 years had a lower percentage of energy from saturated fat and a higher percentage energy from NMES in the lowest quintile compared with the highest although intakes exceeded recommended levels in almost all quintiles. NSP intakes were significantly lower in the lowest quintile groups compared with the highest

in all age/sex groups but intakes for adults were below the recommendation in all quintiles.

- Mean iron intake for girls aged 11 to 18 years and women aged 19 to 64 years was below 90% of the RNI in all income quintiles. In women, but not in girls, the lowest income quintile had a significantly lower mean intake than the highest quintile and a significantly higher proportion below the LRNI. For both men and women aged 19 to 64 years, mean intake of calcium increased from the lowest to highest quintile and a substantial proportion of girls aged 11 to 18 years in all income quintiles had calcium intakes below the LRNI. There were clear differences in intakes of both vitamin C and folate by income quintile with lower intakes in the lowest quintile. For vitamin C mean intake was above the RNI in all quintiles while for folate girls aged 11 to 18 years had a mean intake below the RNI in the lowest income quintile.
- Mean fruit and vegetable consumption expressed in grams and as “5-a-day” portions was significantly lower in all age/sex groups in income quintile 1 (lowest income) compared with quintile 5 (highest income). In most age/sex groups consumption in quintile 2 and 3 was also significantly lower than in quintile 5. No clear pattern in total meat or red meat consumption was observed, with the exception of children aged 1.5 to 3 years where mean consumption of total meat was higher in income quintile 1 and 2 than in quintile 5. Oily fish consumption, increased from the lowest to highest quintile for men and women aged 19 to 64 years.

*Years 3 and 4 combined (Y3&4) compared with Years 1 and 2 combined (Y1&2)*  
*(chapter 10)*

Statistical comparisons between Y3&4 and Y1&2 were carried out for key foods and nutrients. When interpreting the results it should be borne in mind that changes in nutrient intakes can reflect changes in food composition over time as well as changes in consumption. In some cases apparently marked differences between Y1&2 and Y3&4 are a result of step changes in the available data on nutrient composition.

- Mean reported total daily energy intake tended to be lower in all age/sex groups in Y3&4 compared with those in Y1&2 except for children aged 1.5-3 years. The differences were statistically significant in adults aged 19 to 64 years and children 11 to 18 years. Mean total fat intake was lower in Y3&4 in most age groups compared with Y1&2 whereas the differences for protein and total carbohydrate were smaller and less consistent.
- Mean intake of total fat as a percentage of energy was generally lower in Y3&4 compared with Y1&2 while intake of carbohydrate as a percentage of food energy tended to be higher in Y3&4 and there was no consistent difference for protein. Intakes of saturated and trans fatty acids as a percentage of food energy were also lower in Y3&4 but there was no consistent difference in intakes of NMEs as a percentage of food energy, nor in NSP intake.
- In all age/sex groups, mean daily iron intake was similar in Y3&4 and Y1&2. No clear pattern of differences was observed in mean calcium or vitamin C intake between Y3&4 and Y1&2 although a significantly higher proportion of girls aged 11 to 18 years and women aged 19 to 64 years had calcium intake below the LRNI in Y3&4 compared with Y1&2. Mean daily folate intake tended to be lower in Y3&4 compared with Y1&2 for most age groups, significantly so for children aged 1.5 to 3 years, boys aged 4 to 10 years and adults aged 19 to 64 years.
- No consistent differences between Y3&4 and Y1&2 were observed for total mean fruit and vegetable consumption (excluding fruit juice) in any age/sex group, except for boys aged 4 to 10 years in Y3&4 where mean consumption was significantly higher than in

Y1&2. The number of portions of fruit and vegetables consumed tended to be lower in boys aged 11 to 18 years and men aged 19 to 64 years in Y3&4 than in Y1&2, but this was not statistically significant.

- Mean intakes of total fish and oily fish were similar in all age/sex groups in Y3&4 compared with Y1&2.

*Years 1, 2, 3 and 4 combined of the RP compared with previous surveys (chapter 10)*

Comparisons between results from the RP and those from previous NDNS carried out between 1992 and 2000/01 should be interpreted with caution due to methodological differences between the RP and previous surveys (i.e. differences in duration of assessment period and methods of assessing portion size). Statistical comparisons have not been carried out for this reason.

- Mean reported total energy intake for children aged 4 to 18 years and adults aged 19 to 64 years was lower in the RP compared with previous surveys. For adults aged 65 years and over total energy intake was higher in the RP, while for children aged 1.5 to 3 years intake was similar between surveys.
- For all age/sex groups, mean daily intake of total fat both in grams and as a percentage of food energy was lower or similar in the RP compared with previous surveys. Mean intake of saturated fatty acids and *trans* fatty acids tended to be lower in the RP than in previous surveys, both in absolute terms and as a percentage of food energy for all age/sex groups. For example in adults aged 19 to 64 years intake of saturated fat as a percentage of food energy was 12.6% in the RP compared with 13.2% in the previous survey of this age group in 2000/01.
- Mean intake of NMES was lower in the RP than in previous surveys, both in absolute terms and as a percentage of food energy for all age/sex groups (except for women aged 65 years and over), particularly for younger children aged 1.5 to 3 years and 4 to 10 years where the proportion of food energy from NMES decreased from 18.7% to 11.9% and 17.1% to 14.7% respectively.

- Mean intake of NSP in children aged 1.5 to 3 years, 4 to 10 years and adults aged 65 years and over was higher in the RP than in previous surveys.
- For children aged 1.5 to 3 years and adults aged 65 years and over, mean intakes of iron, calcium, vitamin C and folate were higher in the RP than in previous surveys. For children aged 4 to 10 years, mean intake was similar for iron and folate and higher for calcium and vitamin C. In the 11 to 18 years age group, however, iron and folate intakes were lower in the RP than in the previous survey. For girls in the RP, mean iron intake remained below the RNI (57% compared with 60% in the previous survey) and mean folate intake was lower (93% of the RNI compared to 105% in the previous survey).
- For adults aged 19 to 64 years, mean intake was lower for iron, folate and calcium and similar for vitamin C in the RP compared with the previous survey.

Generally, there was little difference between surveys in terms of the proportion of individuals with intake below the LRNI for each micronutrient. There was a smaller proportion of individuals with iron intake below the LRNI for children aged 1.5 to 3 years in the RP (6% compared with 16% in the previous survey).

## **Methodological issues**

### *Misreporting of food consumption*

Dietary surveys are reliant on self-reported measures of food intake. Previous NDNS and the current RP are unique amongst large-scale population surveys in their inclusion of DLW as an objective biomarker to validate EI estimated from reported food consumption. There is evidence of mis-reporting of food consumption in this survey as in all dietary surveys. A sub-study comparing EI estimates from the four-day diary with total energy expenditure (TEE) measurements using the DLW technique found that reported EI in those aged 16 years and over was about 32% lower than TEE on average (see chapter 5 and appendix X for more detail). This should be borne in mind when interpreting the findings (see chapter 5).

### *Diet and nutritional status*

Results based on assessment of food and drink consumption over the four-day diary period provides information about dietary intake over a relatively short period. Analysis of blood samples generally provides an indication of the nutritional status of the population over a longer period. Nutritional status indices provide an assessment of availability of nutrients to the body (after absorption) for use in metabolic processes.

It is not possible to make direct comparisons between the dietary data and biochemical results presented in the report due to the elapsed time between the diary recording period and the collection of blood and urine (a gap of at least eight weeks in Year 2 onwards) and also because many of the biochemical indicators generally reflect longer term body stores of a nutrient rather than recent intake.

### *Days of the week*

Weekend days were oversampled in Year 1 and, while weekend days were under-sampled in Year 2 to redress this, there still remains a slightly higher proportion of weekend days in the Years 1 to 4 combined data.<sup>42</sup> As eating habits vary on different days of the week for some age groups, this could lead to a bias in the reporting of some foods and drinks.

### *Differences between the previous surveys and the RP*

There are a number of methodological differences between the previous cross-sectional surveys and the RP. The previous surveys of children aged 4 to 18 years<sup>7</sup> and adults aged 19 to 64 years<sup>8</sup> used a seven-day diary whereas the RP uses a four-day diary. The survey of children aged 1.5 to 4.5 years<sup>6</sup> used a four-day diary which over-sampled weekend days. Differences in number of days have little effect on comparisons of mean consumption of food groups or mean nutrient intakes between surveys but do affect comparisons for percentages consuming food groups and meeting dietary recommendations. Another key methodological difference is that all the previous surveys used a weighed diary method whereas the RP uses estimated portion sizes such as household measures and weights from labels.

For blood analytes, the RP collects blood samples following an overnight fast for all age groups (except those aged 1.5 to 3 years and diabetics not willing to fast who are asked to provide a non-fasting blood sample). Status data from fasting blood samples are considered to be more informative because some analytes are affected by recent food consumption. This is a change in methodology from the previous NDNS of adults aged 19 to 64 years carried out in 2000/01,<sup>8</sup> which collected non-fasting samples and means that comparisons with that survey cannot be made for nutrients affected by recent consumption. In addition, some of the analytical methods have changed since previous NDNS in 1997 and 2000/01 and the new analytical methods are not always comparable with those used in the previous surveys. Because of these methodological changes comparisons have not been made between the blood results in the report and those in previous NDNS surveys.

For urine analytes, some of the analytical methods have changed since previous NDNS surveys in 1997 and 2000/01 and the new analytical methods are not always comparable with those used in the previous surveys. In addition para-aminobenzoic acid (PABA)<sup>43</sup> was used to determine completeness of 24-hour urine collections in the RP but was not used in previous NDNS.

### **Future reports**

Reports of findings for Scotland, Northern Ireland and Wales will be published during 2014/15. These reports will include a comparison with findings for the UK as a whole.

Results for blood indices of folate status have been delayed due to analytical problems in the laboratory. Publication of these results is expected in 2015.

<sup>1</sup> Responsibility for nutrition policy in England and Wales transferred from FSA to Health Departments in 2010. Management of NDNS also transferred to the Department of Health in England at that time. From 1 April 2013, responsibility for the survey transferred to the Department of Health's Executive Agency, Public Health England (PHE).

<sup>2</sup> Additional recruitment in the devolved countries is funded by Government bodies in Scotland, Wales and Northern Ireland.

<sup>3</sup> For Years 6 onwards, the consortium comprises NatCen and MRC HNR.

<sup>4</sup> Ashwell M, Barlow S, Gibson S, Harris C (2006) National Diet and Nutrition Surveys: the British experience. *Public Health Nutrition* 9(4) 523-530.

<sup>5</sup> Department of Health Healthy Lives, Healthy People: Our Strategy for public health in England White Paper [http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH\\_121941](http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_121941) (accessed 22/04/2014).

<sup>6</sup> Gregory JR, Collins DL, Davies PSW, Hughes JM, Clarke PC. National Diet and Nutrition Survey: children aged 1 ½ to 4 ½ years. Volume 1: Report of the diet and nutrition survey London: HMSO, 1995.

Hinds K, Gregory JR. National Diet and Nutrition Survey: children aged 1½ to 4½ years. Volume 2: Report of dental survey. London: HMSO, 1995.

<sup>7</sup> 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. London: TSO, 2000.

Walker A, Gregory J, Bradnock G, Nunn J, & White D. National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 2: Report of the oral health survey. London: TSO, 2000.

<sup>8</sup> Henderson L, Gregory J, Swan G. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 1: Types and quantities of food consumed. London: TSO, 2002.

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. London: TSO, 2002.

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. London: TSO, 2003.

Rustin D, Hoare J, Henderson L, Gregory J, Bates CJ, Prentice A, Birch M. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 4: Nutritional status (anthropometry and blood analytes), blood pressure and physical activity. London: TSO, 2004.

Hoare J, Henderson L, Bates CJ, Prentice A, Birch M, Swan G, Farron M. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 5: Summary report. London: TSO, 2004.

<sup>9</sup> 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. London: TSO, 1998.

Steele JG, Sheiham A, Marcenes W, Walls AWG. National Diet and Nutrition Survey: people aged 65 years and over. Volume 2: Report of the oral health survey. London: TSO, 1998.

<sup>10</sup> As well as the individuals from the core UK sample, this report also includes individuals from the additional recruitment carried out in Scotland, Wales and Northern Ireland. All cases have been appropriately weighted to put them in their correct proportions to represent the UK population (See Appendix B in the main report for more detail of the weighting scheme).

<sup>11</sup> Bates B, Lennox A, Swan G (2010) National Diet and Nutrition Survey; Headline results from year 1 of the rolling programme (2008/09): <http://www.food.gov.uk/science/dietarysurveys/ndnsdocuments/ndns0809year1> (accessed 22/04/14).

Bates B, Lennox A, Bates C, Swan G (2011) National Diet and Nutrition Survey; Headline results from years 1 and 2 (combined) of the rolling programme (2008/09- 2009/10): [http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH\\_128166](http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH_128166) (accessed 22/04/14).

Bates B, Lennox A, Prentice A, Bates C, Swan G (2012) National Diet and Nutrition Survey; Headline results from years 1,2 and 3 (combined) of the rolling programme (2008/09- 2010/11): <https://www.gov.uk/government/publications/national-diet-and-nutrition-survey-headline-results-from-years-1-2-and-3-combined-of-the-rolling-programme-200809-201011> (accessed 22/04/14).

<sup>12</sup> The adequacy of vitamin or mineral intake can be expressed as the proportion of individuals with intakes below the LRNI. The LRNI for a vitamin or mineral is set at the level of intake considered likely to be sufficient to meet the needs of only 2.5% of the population.

<sup>13</sup> Basiotis PP, Welsh SO, Cronin FJ, Kelsay JL, Mertz W, (1987). Number of days of food intake records required to estimate individual and group nutrient intakes with defined confidence. *Journal of Nutrition*; 117(9):1638-41.

<sup>14</sup> In some core sample households (where up to one adult and one child could be selected), it was possible to end up with an adult participant only, either because the selected child was not able/did not wish to take part or because there was no resident child eligible for selection.

<sup>15</sup> Response rates for individual fieldwork years were as follows: 56% in Year 1, 57% in Year 2, 53% in Year 3 and 55% in Year 4. These response rates are different to those included in previous reports as they include cases from the country boost samples in Scotland, Wales and Northern Ireland whereas previous reports were based on core sample cases only.

<sup>16</sup> The majority of participants completed four days of the food and drink diary. Only 2% completed three days.

<sup>17</sup> All individuals visited by a nurse were asked if they were willing to provide a blood sample and, if aged four years and older (and fully out of nappies), a 24-hour urine sample.

<sup>18</sup> The report includes estimated salt intakes based on 24-hour urinary sodium excretion data from the analyses of 24-hour urine collections from participants aged 4-18 years and 65 years and over. Estimates for those aged 19 to 64 years have already been published. (Also see note 16 below).

<sup>19</sup> Non-response bias occurs if those who respond to the survey (or elements of the survey) differ from those who do not respond. Data were weighted to reduce such bias.

<sup>20</sup> Chapter 7 presents estimated salt intakes based on 24-hour urinary sodium excretion data from the sodium analyses of 24-hour urine collections from participants aged 4 to 18 years and 65 years and over in the NDNS RP. Estimated salt intakes based on 24-hour urinary sodium excretion for adults aged 19 to 64 years in England and, separately, in Scotland were published in 2012. These estimates were based on analysis of 24-hour urines collected over a shorter period in 2011 than the NDNS RP in order to provide a more precise estimate of salt intake in the population at a point in time. The estimate for England includes some urines collected as part of the NDNS RP, while the estimate for Scotland is based on 24-hour urines collected outside the RP. As these estimates (for adults aged 19 to 64 years) have already been published, the estimates based on four years of the RP are not included in this report. In addition results for those aged 19-64 years have been reported and published in 2016 in the 'National Diet and Nutrition Survey (NDNS): Assessment of Dietary Sodium Levels Among Adults (aged 19-64) in England, 2014'; [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/509399/Sodium\\_study\\_2014\\_England\\_Text\\_final.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/509399/Sodium_study_2014_England_Text_final.pdf). In the 'National Diet and Nutrition Survey (NDNS): Assessment of dietary sodium for adults (19 to 64 years) in Scotland, 2014 report';

[http://www.foodstandards.gov.scot/sites/default/files/Monitoring%20the%20Scottish%20Diet-%20Sodium%20Survey%202014%20SCOTLAND\\_FINAL%20PDF.pdf](http://www.foodstandards.gov.scot/sites/default/files/Monitoring%20the%20Scottish%20Diet-%20Sodium%20Survey%202014%20SCOTLAND_FINAL%20PDF.pdf).

and in the 'National Diet and Nutrition Survey: Assessment of dietary sodium - Adults (19 to 64 years) in Northern Ireland 2015'; <https://www.food.gov.uk/northern-ireland/nutrition/national-diet-and-nutrition-survey-assessment-of-dietary-sodium>.

<sup>21</sup> All composite dishes in the NDNS Nutrient Databank have been disaggregated into their constituent ingredients. This enables the fruit, vegetables, meat and fish in mixed dishes such as stews and pies to be included in consumption figures. The methodology for the disaggregation of composite dishes is provided in Appendix A.

<sup>22</sup> Department of Health 5 A DAY programme [online]  
<http://www.nhs.uk/Livewell/5ADAY/Pages/5ADAYhome.aspx> (accessed 22/04/14).

<sup>23</sup> Report on Health and Social Subjects, 41, *Dietary Reference Values (DRVs) for Food Energy and Nutrients for the UK*, Report of the Panel on DRVs of the Committee on Medical Aspects of Food Policy (COMA) 1991. The Stationery Office. London

<sup>24</sup> Scientific Advisory Committee on Nutrition. Dietary Recommendations for Energy:[Online] Available [http://www.sacn.gov.uk/pdfs/sacn\\_dietary\\_reference\\_values\\_for\\_energy.pdf](http://www.sacn.gov.uk/pdfs/sacn_dietary_reference_values_for_energy.pdf) (2011) (accessed 22/04/14).

<sup>25</sup> For some micronutrients, status can be assessed by directly measuring the level of the nutrient in blood, while for others it is assessed by a functional measure such as the activity of vitamin-dependent enzymes. For example, riboflavin status can be assessed by measuring the activity of the red cell enzyme glutathione reductase which is dependent on a co-factor derived from riboflavin. Threshold values, below or above which low status is indicated, have been set for some, though not all, micronutrients. A value indicating that the individual has low status for that micronutrient usually means that body stores or tissue levels are depleted and the individual is at greater risk of deficiency. This may reflect dietary inadequacy or health issues such as blood loss. However, a value indicating low status does not necessarily mean that the individual is clinically deficient, rather that they are at risk of becoming deficient.

<sup>26</sup> Equivalised household income is a measure of income that takes account of the differences in a household's size and composition and thus is made equivalent for all household sizes and compositions.

<sup>27</sup> Scientific Advisory Committee on Nutrition. Iron and Health. London: TSO, 2010. This recommendation applies to adults only. The recommendation is that adults with relatively high intakes of red and processed meat (of 90g or more per day) should consider reducing their intakes.

<sup>28</sup> Scientific Advisory Committee on Nutrition. Advice on fish consumption: benefits and risks. London: TSO, 2004

<sup>29</sup> Report on Health and Social Subjects 41 *Dietary Reference Values (DRVs) for Food Energy and Nutrients for the UK*, Report of the Panel on DRVs of the Committee on Medical Aspects of Food Policy (COMA) 1991. The Stationery Office. London.

<sup>30</sup> The RNI for a vitamin or mineral is the amount of the nutrient that is sufficient for about 97% of people in the group. If the average intake of the group is at the RNI, then the risk of deficiency in the group is judged to be very small. However, if the average intake is lower than the RNI then it is possible that some of the group will have an intake below their requirement.

<sup>31</sup> Department of Health. Report on Health and Social Subjects: 46. Nutritional Aspects of Cardiovascular Disease. HMSO (London, 1994).

<sup>32</sup> Scientific Advisory Committee on Nutrition (2003). Salt and Health. The Stationery Office.  
[http://www.sacn.gov.uk/pdfs/sacn\\_salt\\_final.pdf](http://www.sacn.gov.uk/pdfs/sacn_salt_final.pdf) (accessed 22/04/14)

<sup>33</sup> The Health Survey for England (HSE) is used to monitor “5-a-day”. HSE estimates of fruit and vegetable consumption are based on a recall of consumption over the previous 24 hours and are therefore different from NDNS RP estimates which are based on a four-day diary. NDNS RP estimates are higher than HSE estimates, at least in part because the NDNS RP is better able to capture the contribution from composite dishes containing fruit and vegetables.

<sup>34</sup> Weekly equivalent oily fish consumption has been calculated using unrounded data rather than the rounded figures in Table 5.3 and sex combined averages have been calculated using unrounded sex combined data in Table 5.3.

<sup>35</sup> For vitamin D, RNIs are only set for those aged up to four years and those aged 65 years and over.

<sup>36</sup> The British Cardiac Society, British Hyperlipidaemia Association, British Hypertension Society, endorsed by the British Diabetic Association, have issued guidance published in the article ‘Joint British recommendations on prevention of coronary heart disease in clinical practice’. *Heart*, 1998; 80: 1–29.

<sup>37</sup> Prospective Studies Collaboration (2007). Blood cholesterol and vascular mortality by age, sex, and blood pressure: a meta-analysis of individual data from 61 prospective studies with 55 000 vascular deaths. *Lancet*; 370: 1829–39.

<sup>38</sup> Riboflavin status was determined by measuring Erythrocyte Glutathione Reductase Activation Coefficient (EGRAC). EGRAC is a measure of red cell enzyme saturation with its cofactor flavin adenine dinucleotide (FAD) derived from riboflavin (vitamin B2).

<sup>39</sup> Scientific Advisory Committee on Nutrition: SACN/13/07. Setting an upper monitoring threshold for Erythrocyte Glutathione Reductase Activation Co-efficient (EGRAC) in reporting NDNS, Available: [http://www.sacn.gov.uk/pdfs/sacn1307\\_egrac\\_paper\\_june\\_2013.pdf](http://www.sacn.gov.uk/pdfs/sacn1307_egrac_paper_june_2013.pdf)

Minutes of 39<sup>th</sup> meeting 12<sup>th</sup> June 2013. Available: [http://webarchive.nationalarchives.gov.uk/20140507012718/http://www.sacn.gov.uk/pdfs/sacn13min01\\_draft\\_minutes\\_6\\_feb\\_13.pdf](http://webarchive.nationalarchives.gov.uk/20140507012718/http://www.sacn.gov.uk/pdfs/sacn13min01_draft_minutes_6_feb_13.pdf)

<sup>40</sup> Vitamin A can be obtained in two forms: as preformed vitamin A (retinol) and from some carotenoids that can be cleaved in the body to provide retinol.

<sup>41</sup> The SACN recommendation for maximum daily salt is no more than 3g/day for children aged 4 to 6 years, no more than 5g/day for children 7 to 10 years and no more than 6g/day for those aged 11 years and over.

<sup>42</sup> This may be explained by the survey design allowing some flexibility in the diary start day to help maintain response rates.

<sup>43</sup> To be representative of daily salt intake the 24-hour collection has to be complete; this can be assessed by orally administering para-aminobenzoic acid (PABA) and measuring its excretion in the 24-hour urine collection.

# 1 Background and purpose

*Original author: Beverley Bates*

*Updated by: Valdeep Gill & Rosie Sutton*

## 1.1 Introduction

The National Diet and Nutrition Survey (NDNS) is a survey of the food consumption, nutrient intakes and nutritional status of people aged 1.5 years and older living in private households. The survey is carried out in all four countries of the United Kingdom (UK) and is designed to be representative of the UK population. This report contains UK results covering the first four years of the rolling programme (RP) 2008/09 to 2011/12. The report provides information about the diet and nutrient intakes of participants and includes results from analysis of blood and urine samples.

Additional recruitment was undertaken in Scotland, Northern Ireland and Wales in order to achieve large enough samples in these countries to enable cross-country comparisons to be made.<sup>1</sup> These results will be reported separately in 2014/15.

The first four years of the NDNS RP (2008/09 to 2011/12) were commissioned by the UK Food Standards Agency (FSA) in 2006 with a contribution to funding from the Department of Health (DH) in England. The contract was extended in 2011 for a fifth year of fieldwork (2012/13). The contract for Years 6 to 9 of the NDNS RP (2013/14-2016/17) was awarded in late 2012. Results for years 5 onwards will be reported at a later date.

Responsibility for nutrition policy in England and in Wales transferred from FSA to Health Departments in 2010, but remains with FSA in Scotland and Northern Ireland. Management of the NDNS contract also transferred to DH at this time. From 1 April 2013, responsibility for the survey transferred to the Department's Executive Agency, Public Health England (PHE). The core UK survey is now jointly funded by PHE and FSA, with the additional recruitment in Scotland, Wales and Northern Ireland funded by Government bodies in those countries.

The NDNS RP is carried out by a consortium of three organisations: NatCen Social Research (NatCen), Medical Research Council Human Nutrition Research (MRC HNR), based in Cambridge and the Department of Epidemiology and Public Health at the Royal Free and

University College London Medical School (UCL). Fieldwork in Northern Ireland is carried out by the Northern Ireland Statistics and Research Agency (NISRA). Haematological and biochemical analyses of blood samples are carried out at MRC HNR and Addenbrooke's Hospital NHS Trust, Cambridge.

This report presents findings from the first four years combined of the NDNS RP, fieldwork for which was carried out between February 2008 and August 2012.<sup>2</sup> The four survey years have been combined to provide a larger sample size on which to base analyses. This first chapter provides an overview of the background and aims of the NDNS RP. This is followed by information about the research designs and methodologies and response (chapter 2), socio-demographic characteristics of the sample (chapter 3) and physical measurements and physical activity (chapter 4). Chapter 5 focuses on food consumption and nutrient intakes of participants and differences by age and sex and includes comparisons of intakes with government recommendations (Dietary Reference Values).<sup>3</sup> Chapter 6 provides results from analysis of blood samples for biochemical indices of nutritional status and chapter 7 provides results for sodium intake from 24-hour urine analyses. Chapters 8 to 10 present additional analyses for selected foods and nutrients. Chapter 8 presents a more detailed age breakdown. Chapter 9 presents a statistical comparison of intakes by equivalised household income and chapter 10 presents a statistical comparison of intakes between Years 1 and 2, and Years 3 and 4 of the RP. Chapter 10 also includes an informal comparison of current results with results from previous NDNS.

Results from the assessment of energy expenditure by doubly labelled water in a sub-sample of participants in Years 1 and 3 of the NDNS RP are presented in Appendix X with a summary in Chapter 5.

## 1.2 Background, aims and uses

Data from the NDNS are used for surveillance of the food consumption, nutrient intake and nutritional status of the general UK population. The NDNS is the major component of the evidence base to support work by DH in England, PHE and other Government bodies across the UK to facilitate the adoption of healthier eating in order to improve the diet and nutrition of the UK population and reduce diet-related disease. The NDNS also provides detailed data on

food consumption at the level of the individual which enables FSA to carry out food chemical exposure assessments which form an essential part of its food safety risk assessments.

In the past, the NDNS programme comprised a series of cross-sectional surveys, each covering a different age group: pre-school children (aged 1.5 to 4.5 years);<sup>4</sup> young people (aged 4 to 18 years);<sup>5</sup> adults (aged 19 to 64 years);<sup>6</sup> and older adults (aged 65 and over).<sup>7</sup> The programme was set up in 1992 following the 1986/87 Dietary and Nutritional Survey of British Adults,<sup>8</sup> the first survey of this type in Britain. The first survey of the NDNS programme was carried out in 1992/93, and a survey was carried out about every three years thereafter until the NDNS of adults aged 19 to 64 years, carried out in 2000/01. Each was conducted as a stand-alone survey. Following a review of the dietary survey programme in 2003, FSA's Board agreed in principle that future surveys should be carried out on a rolling basis in order to strengthen the ability to track changes in diet and nutrition over time. The new RP format of continuous fieldwork provides a more responsive framework for dietary surveys, giving a better ability to identify emerging policy issues, respond to changing data needs and identify and analyse trends. This will enable DH and PHE in England and other Government bodies across the UK to develop, implement and monitor effective policies to improve the nation's diet and nutritional status and will also support the FSA's risk assessment for food chemicals.

Prior to the launch of mainstage fieldwork in 2008, a comparison study of two different dietary assessment methods (randomly allocated to sampled addresses) was carried out in 2007. Over 1,100 adults and children took part with around half participating in interviewer-administered 24-hour dietary recalls (repeated on four non-consecutive days) and the others keeping a four-day estimated (unweighed) food diary on consecutive days. The NDNS Project Board considered the findings and decided that the four-day estimated diary (hereafter referred to as the "four-day food diary") should be used for the RP.<sup>9,10</sup>

The specific aims of the NDNS RP are to:

- provide quantitative data on the food and nutrient intakes, sources of nutrients and nutritional status of the UK population aged 1.5 years and above
- provide information on trends in food consumption, nutrient intake and nutritional status in different age groups

- describe the characteristics of individuals with intakes of specific nutrients above or below the national average
- produce a database of food consumption which will be used to calculate intakes of natural toxicants, contaminants, additives and other food chemicals
- measure blood and urine indices that provide evidence of nutritional status or dietary biomarkers, and to relate these to dietary, physiological and socio-demographic data
- provide height, weight and other anthropometric measurements and examine their relationship to socio-demographic, dietary, biochemical and health data
- monitor the diet of the population to establish the extent to which it is adequately nutritious and varied
- monitor the extent to which the diets of population sub-groups vary from expert recommendations
- assess total energy expenditure and physical activity levels and patterns in the study population
- provide information on oral health status in relation to diet and nutritional status

The RP will benefit a wide range of Government activities related to diet and health. It is key to monitoring progress on diet and nutrition objectives of UK Health Departments, for example those set out in the Healthy Lives, Healthy People White Paper in England.<sup>11</sup> It will also provide the detailed food consumption data essential to support risk assessments for food chemicals.

This report includes combined results from Year 1 of the NDNS RP (fieldwork carried out between February 2008 and June 2009), Year 2 (fieldwork carried out between April 2009 and August 2010), Year 3 (fieldwork carried out between April 2010 and August 2011) and Year 4 (fieldwork carried out between April 2011 and August 2012).<sup>12</sup> The results in this report supersede those presented in the earlier NDNS RP reports.<sup>13,14,15</sup>

---

<sup>1</sup> Boosted samples in Scotland and Northern Ireland were included from Year 1. A boosted sample in Wales was included from Year 2 (starting April 2009).

<sup>2</sup> Fieldwork for Year 1 began in April 2008 and was completed in June 2009. It was preceded by a short run-in period from February to March 2008 to test procedures. Data from the run-in are included in the results. Fieldwork for Year 2 ran from April 2009 to August 2010. Fieldwork for Year 3 ran from April 2010 to August 2011. Fieldwork

for Year 4 ran from April 2011 to August 2012. The fieldwork period was extended from Year 2 onwards to allow for a longer gap between the interviewer and nurse visits.

<sup>3</sup> Department of Health (1991). Dietary Reference Values for food Energy and Nutrients in the United Kingdom. (Report on Health and Social Subjects, No. 41). London: HMSO

<sup>4</sup> Gregory JR, Collins DL, Davies PSW, Hughes JM, Clarke PC. National Diet and Nutrition Survey: children aged 1 ½ to 4 ½ years. Volume 1: Report of the diet and nutrition survey London: HMSO, 1995.

Hinds K, Gregory JR. National Diet and Nutrition Survey: children aged 1½ to 4½ years. Volume 2: Report of dental survey. London: HMSO, 1995.

<sup>5</sup> 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. London: TSO, 2000.

Walker A, Gregory J, Bradnock G, Nunn J, & White D. National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 2: Report of the oral health survey. London: TSO, 2000.

<sup>6</sup> Henderson L, Gregory J, Swan G. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 1: Types and quantities of food consumed. London: TSO, 2002.

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. London: TSO, 2002.

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. London: TSO, 2003.

Rustin D, Hoare J, Henderson L, Gregory J, Bates CJ, Prentice A, Birch M, Swan G, Farron M. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 4: Nutritional status (anthropometry and blood analytes), blood pressure and physical activity. London: TSO, 2004

Hoare J, Henderson L, Bates CJ, Prentice A, Birch M, Swan G, Farron M. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 5: Summary report. London: TSO, 2004.

<sup>7</sup> 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. London: TSO, 1998.

Steele JG, Sheiham A, Marcenes W, Walls AWG. National Diet and Nutrition Survey: people aged 65 years and over. Volume 2: Report of the oral health survey. London: TSO, 1998.

<sup>8</sup> Gregory J, Foster K, Tyler H, Wiseman H. The Dietary and Nutritional Survey of British Adults. London: HMSO, 1990.

<sup>9</sup> Following considerable discussion of the dietary assessment method to use for the RP, it was decided to conduct a study to compare the two possible methods that might be adopted, a repeat 24-hour recall method and an estimated (unweighed) diary. The results of the comparison study showed equivalent response rates, comparable experiences for interviewers and participants, similar energy and nutrient intakes and similar extent of misreporting by the two dietary assessment methods compared. However, there were a number of considerations that leaned towards the estimated diary for the survey on an ongoing basis, not least continuity with past NDNS surveys and flexibility with a wide range of age groups.

<sup>10</sup> Stephen A, Teucher B, Bluck L, Cole D, Fitt E, Mander A, Woodward R, Wright A, Bates B, Roberts C, Mackenzie H, Deverill C, Mindell J. National Diet and Nutrition Survey Rolling Programme, Comparison Study, Part 1. A comparison of results by dietary assessment method: repeat 24-hour recall and four-day estimated (unweighed) diet diary. Unpublished. 2008.

<sup>11</sup> Department of Health Healthy Lives, Healthy People: our strategy for public health in England White paper: <https://www.gov.uk/government/publications/healthy-lives-healthy-people-our-strategy-for-public-health-in-england> (accessed 28/01/14).

<sup>12</sup> Fieldwork periods overlap as each fieldwork year continues for more than 12 months. This is due to the staggering of interviewer and nurse fieldwork (see chapter 2 for further detail).

<sup>13</sup> [www.food.gov.uk/multimedia/pdfs/publication/ndnsreport0809.pdf](http://www.food.gov.uk/multimedia/pdfs/publication/ndnsreport0809.pdf) (accessed 28/01/14).

<sup>14</sup> [http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH\\_128166](http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH_128166) (accessed 28/01/14).

<sup>15</sup> <https://www.gov.uk/government/publications/national-diet-and-nutrition-survey-headline-results-from-years-1-2-and-3-combined-of-the-rolling-programme-200809-201011> (accessed 28/01/14).

## 2 Methodology and response

*Original author: Sarah Pigott*

*Updated by: Gary Boodhna & Katharine Sadler*

### 2.1 Overview of methodology

This chapter provides an overview of Year 4 methodology. Information about methodology for Years 1 to 3 can be found in Chapter 2 of the previous reports.<sup>1,2,3</sup> There were very few methodological differences between Year 4 and previous years; the key changes introduced in Year 4 are provided in section 2.7.

In order to meet the aims of the survey (see Chapter 1, section 1.2) a sample of people representative of the UK population aged 1.5 years and over was required. This sample was drawn from the Postcode Address File (PAF),<sup>4</sup> a list of all the addresses in the UK. In order to improve cost effectiveness, the addresses were clustered into Primary Sampling Units (PSUs), small geographical areas, based on postcode sectors, randomly selected from across the UK. A list of addresses was randomly selected from each PSU.

Information describing the purpose of the survey was posted to all selected addresses. This was followed by a face-to-face visit by an interviewer to each address to recruit participants in the eligible age range(s). As in Years 1 to 3, the survey aimed to collect data from a UK representative core sample of 1,000 people per year, 500 adults (aged 19 years and over) and 500 children (aged 1.5 to 18 years). In order to achieve (as far as possible) equal numbers of adults and children in the sample, at some addresses only children were selected to take part (see section 2.2.2). Extra addresses were selected in Wales, Scotland and Northern Ireland to boost the sample size in these countries and enable comparisons to be made between the UK countries.

At each address, the interviewer enumerated the number of households and, in cases where there were two or more, randomly selected one for the NDNS RP. From each selected household the interviewer randomly selected up to one adult and one child to take part in the survey. These are known as *participants*.

The first stage of the survey comprised a face-to-face Computer Assisted Personal Interview (CAPI) with each participant (or in the case of a young child, their parent or guardian<sup>5</sup>), completion of a four-day food diary by the participant (outside the interviewer visits) and measurements of height and weight. The interviewer also collected information on shopping and food preparation practices and facilities in the household by additionally interviewing the *Main Food Provider* (MFP)<sup>6</sup> of the household where this was not a selected participant. The MFP was the person who was best placed to answer questions about food purchased and prepared for the participant(s). The interview also identified the *Household Reference Person* (HRP)<sup>7</sup> in each household and asked questions about housing tenure, as well as his or her employment, to determine the socio-economic classification of the household.<sup>8</sup>

Participants who took part in the CAPI interview and completed a food diary for at least three days were classified as '*fully productive*' and were invited to take part in the second stage of the survey. This involved a visit from a nurse to take further physical measurements, a blood sample and a 24-hour urine collection.

## 2.2 Sample design

### 2.2.1 Selecting addresses

The Year 4 sample was drawn from the PAF. A core UK sample of 3,240 addresses was selected from 120 PSUs. A further 2,754 addresses were selected from 102 "country boost" PSU's in Scotland, Wales and Northern Ireland. Twenty seven addresses were randomly selected in each PSU. At each address, the interviewer established the number of households and, in cases where there were two or more, selected one household at random.

### 2.2.2 Selecting participants

The 27 addresses were randomly allocated to one of two groups to determine whether an adult (aged 19 years or over) and a child (aged 1.5 to 18 years), or a child only, were selected for interview. In quarters 1 and 2, at 11 of the selected addresses the interviewer selected one adult and, where present, one child for inclusion in the survey ("basic" addresses). The remaining 16 addresses were for a "child boost" and the interviewer only carried out interviews in households with children. In quarters 3 and 4, this split was changed to 10 "basic" and 17 "child boost" addresses, with the aim of increasing the number of child participants in order to

ensure that the target of 500 children was met. In households containing more than one eligible person (adult and/or child), interviewers selected the participant(s) using a random selection procedure.

Further details on sampling can be found in Appendix B.

### 2.3 Ethics approval

Ethics approval for the study was obtained from the Oxfordshire A Research Ethics Committee. The letters of approval for the original submission and subsequent substantial amendments, together with approved documents, were sent to all Local Research Ethics Committees (LRECs) covering areas where fieldwork was being conducted. Research governance<sup>9</sup> approval was sought for all participating NHS laboratories and obtained where required by the Research and Development (R&D) Committee for each laboratory.

### 2.4 Fieldwork

Year 4 fieldwork was issued monthly to interviewers and nurses in the following quarters:

	<u>Interviewers (Stage 1)</u>	<u>Nurses (Stage 2)</u>
Quarter 1	April-June 2011	July-September 2011
Quarter 2	July-September 2011	October-December 2011
Quarter 3	October-December 2011	January-March 2012
Quarter 4	January-March 2012	April-June 2012

Stage 1 fieldwork commenced on the first weekday of the month, and interviewers were given six weeks in which to complete their assignment. Stage 2 fieldwork for a particular month started six weeks after the interviewer deadline (for example, interviewers completed April assignments by mid-May 2011 and nurse visits to these participants started in July 2011). Nurses had up to seven weeks to complete their work.

### 2.5 Overview of survey components and fieldwork procedures

There were two main stages to the survey:

Stage 1: Interviewer visit: Four-day food diary

	Detailed background interview
	Interview with MFP
	Height and weight measurements
	Smoking and drinking self-completion questionnaires
	Physical activity self-completion questionnaire or ActiGraph
Stage 2: Nurse visit:	Blood sample
	24-hour urine collection
	Physical measurements
	Blood pressure
	Collection of information about prescribed medicines

### 2.5.1 Stage 1: the interviewer visits

A letter and leaflet describing the purpose of the survey was sent to all sampled addresses before the fieldwork start date. A few days later, interviewers visited the addresses to determine whether the address was private, residential and occupied. They then carried out the selection process (see section 2.2) and, for children aged under 16 years, sought both the child's and their parent's (or guardian's) consent to interview.

Interviewers carried out three main visits to households who agreed to participate:

- **visit 1:** Four-day food diary explained to the participant and left with them to complete; interviewer-administered CAPI; height and weight measurements; self-completion booklets in which children and young people were asked to record their smoking and drinking habits. Participants aged 16 years and above were asked to fill in a self-completion questionnaire designed to collect information about physical activity (the Recent Physical Activity Questionnaire (RPAQ)).<sup>10</sup> Children aged 4 to 15 years were asked whether they would be willing to wear a physical activity monitor (an ActiGraph) for seven consecutive days (the monitor was explained and left with those who agreed to wear it)
- **visit 2:** The diary check up visit, where the interviewer reviewed the completion of the four-day food diary so far and filled in any missing information with the participant

- **visit 3:** Review and collection of four-day food diary, RPAQ self-completion and ActiGraph and further CAPI questionnaire administration

At the end of the third main interviewer visit, interviewers gave each participant completing at least three food diary recording days a token of appreciation (£30 in high street vouchers).<sup>11</sup> Interviewers then introduced the second stage of the survey, asking for permission for the nurse to visit.

Further details about information collected during the interviewer stage (and the fieldwork documents used) can be found in Appendices C to F.

#### **2.5.1.1 Computer Assisted Personal Interview (CAPI) programme**

CAPI interviewing involves the interviewer reading questions from a laptop screen and entering the participants' responses into designated fields. The CAPI questionnaire had three main elements: household composition/ structure interview, MFP interview and individual interview. The individual questionnaire, asked of each selected participant, had two parts: Part 1, which was asked at the first main interviewer visit; and Part 2, which was asked at the third main visit after the interviewer collected the food diary.

The content of the CAPI questionnaires is shown in Appendix D.

#### **2.5.1.2 Collection of dietary data: the four-day food diary**

Based on the day of the first individual CAPI interview, the interviewer's laptop program selected four consecutive days as the food diary recording period. Participants were provided with a diary and asked to keep a record of everything they ate and drank over these four days, both in and outside the home. Interviewers carried out a food diary check visit with participants on the second or third day of recording either in person or over the telephone, with the aim of collecting missing detail for foods recorded, improving recording for the remaining days and also providing encouragement to participants to continue recording. Interviewers then returned to collect the diary and check the remaining days no later than three days after the final day of recording.

As participants were not expected to weigh their food and drink, portion sizes were estimated using household measures (e.g. two thick slices of bread, four tablespoons of peas) or using weights from labels (e.g. 420g tin of baked beans, 330ml can of lemonade). Those aged 16 years and over were also able to describe their portion size using photographs of 10 frequently consumed foods reproduced in the diary. To improve the accuracy of recording of children's food portion sizes, three age-appropriate versions of a 'Young persons food photograph atlas' were used during the diary review process. The atlases presented a range of served and leftover portion sizes for 44 commonly consumed foods for which portion size estimation is difficult. Interviewers asked participants to select the appropriate portion sizes for all diary entries represented in the atlas.

A parent was asked to keep the food diary on behalf of participants aged 11 years and younger, with the child contributing information where possible and with help from other carers.

Appendix A provides full details of the dietary data collection and processing protocols.

### **2.5.1.3 Selection of food diary start day**

The study design for Year 4 aimed to give an even representation of diary days on all days of the week so the food diary could start on any day of the week and run for four consecutive days. The diary start day for each participant was assigned by the CAPI program but could be changed by the interviewer if the participant preferred a different day.

In Year 1, the recording period always started on a Thursday, Friday or Saturday and included both weekend days (Saturday and Sunday). This meant that weekend days were over-represented and Wednesdays were never represented. To redress the over-representation of weekend days and non-representation of Wednesdays in Year 1, the food diary recording period was changed from Year 2 onwards so that all days of the week would (as far as possible) be equally represented.

Further information about the distribution of days of the week can be found in Chapter 5, section 5.1.

#### **2.5.1.4 Collection of physical activity data**

The objective physical activity measurements were obtained through the use of a device called an accelerometer - the ActiGraph. This provides a measure of the frequency, intensity, and duration of physical activity and allows classification of activity levels as sedentary, light, moderate and vigorous.

In Year 1, all children aged 4 to 10 years were asked to wear an Actigraph. In Years 2 to 4, all children aged 4 to 15 years were asked to do so.

Children were asked to wear the ActiGraph on a belt above the right hip, during waking hours for seven consecutive full days. At the end of the first CAPI interview, interviewers obtained agreement for participation in this element of the study, provided the ActiGraphs and explained procedures. The protocols used for the placement are provided in Appendix G.

All children who wore an ActiGraph for seven consecutive days received a £10 high street voucher as a token of appreciation.<sup>11</sup>

Further information about the objective measurement of physical activity and the use of ActiGraphs can be found in Chapter 4, section 4.3.3.

#### **2.5.2 Stage 2: the nurse visit**

Stage 2 of the survey was carried out by a qualified nurse and took place within two to four months of the final interviewer visit. All individuals completing three or four food diary days were eligible for a nurse visit.

At the end of Stage 1, interviewers provided participants with information leaflets giving details of the nurse visit. Nurses could provide these again if necessary. The nurse asked questions about prescribed medications before taking, with agreement, a number of physical measurements.

### 2.5.2.1 Measurements taken by the nurse

A summary of the information collected during the nurse stage is provided below. Some of the information collected by nurses was limited to particular age groups.

<b>Measurement or procedure</b>	<b>Participant</b>
Details of prescribed medications	All ages
Blood pressure	Aged four years and over
Infant length measurement	Aged 18 to 23 months
Waist and hip circumferences	Aged 11 years and over
Demispan	Aged 65 years and over and those aged 16 to 64 years where height could not be measured
Mid Upper Arm Circumference (MUAC)	Aged 2 to 15 years
24-hour urine collection	Aged four years and over fully out of nappies
Non-fasting blood sample	Aged 1.5 to 3 years and diabetics not willing to fast
Fasting blood sample	Aged four years and over

The nurse fieldwork documents are provided in Appendices H and I. Measurement protocols are provided in Appendix L.

### 2.5.2.2 Blood sample

After providing the physical measurements, participants were asked whether they were willing to give a small blood sample by venepuncture after an overnight fast (those aged 1.5 to 3 years and diabetics not willing to fast were asked whether they were willing to provide a non-fasting blood sample). The nurse obtained written consent from the participants aged 16 years and over before the sample was taken. For children aged 1.5 to 15 years, written consent of a parent or guardian was required and nurses additionally obtained the assent of the child where possible. For those aged 10 years or younger, blood was taken by a paediatric phlebotomist who accompanied the nurse on the visit.<sup>12</sup> Nurses also sought written agreement to store part of the blood sample for additional analyses at a future date. Participants who provided a blood

sample were given £15 in high street vouchers as a token of appreciation for agreeing to this part of the study.

### **2.5.2.3 24-hour urine sampling**

Nurses also sought agreement from adult participants, and child participants aged four years and over who were fully out of nappies (and their parent or guardian), to provide a 24-hour urine collection. If participants agreed, they were asked to take three para-aminobenzoic acid (PABA) tablets evenly spaced throughout the waking hours of the day on which the 24-hour urine sample was collected, in order to assess the completeness of the urine collections.

Written consent was sought for the taking of PABA tablets, laboratory analysis of the 24-hour urine sample and storage of any remaining urine for future analyses. Participants who provided a 24-hour urine sample were given £10 in high street vouchers as a token of appreciation for taking part in this element of the study.

### **2.5.3 Feedback to participants and GPs**

Participants who completed three or four food diary recording days were asked whether they would like to be sent feedback on the analysis of their diary and how this compared to nutrient intake recommendations. The feedback also included general information on sources of healthy eating advice. Further information about the dietary feedback can be found in Appendix A and an example of the dietary feedback is provided in Appendix L.

Each participant was also given a 'Measurement Record Card' on which the interviewer and nurse recorded the person's height, weight, body mass index (BMI) (if aged 16 years and over), blood pressure (if aged four years and over) and other age-dependent anthropometric measurements: waist and hip circumferences (ages 11 years and over); mid upper arm circumference (MUAC) (aged two to 15 years); demispan measurement (aged 65 years and over) and infant length (aged 18 to 23 months). Participants who provided a blood sample were asked whether they wished to be sent results of the blood sample analyses most related to their health. Participants were asked if they wanted details of these analyses, their BMI and their blood pressure readings to be sent to their GP. If they did, written consent was obtained

from the individual (or from the parent/guardian in the case of a child). See Appendix L for an example of feedback to GPs.

## 2.6 Fieldwork quality control

### 2.6.1 Project specific training for interviewers and nurses

Fieldwork in England, Scotland and Wales was carried out by NatCen's panel of interviewers and nurses. In Northern Ireland, fieldwork was carried out by interviewers and nurses working for NISRA.

All interviewers and nurses working on the NDNS RP were briefed and trained before undertaking an assignment and were monitored during their assignment. Fieldworkers were also issued with comprehensive written instructions covering survey procedures and measurement protocols.

### 2.6.2 Training for interviewers

All new-to-NDNS RP interviewers (and those who had worked in Years 1 or 2 but not in Year 3) attended a two-day training course where they were fully briefed on the protocols and administration of the survey. Interviewers who had previously worked in Year 3 of the NDNS RP attended a one-day refresher briefing.

The full and refresher briefing sessions covered background and content, doorstep approach, questionnaire administration (including practice sessions), placement and collection of self-completions and ActiGraphs and the placement, checking and collection of the four-day food diaries. In Year 4, interviewers who had never been trained in measuring heights and weights were asked to attend an additional 'accreditation' day which focussed on how to take accurate measurements.

After the briefing, "early work" checks were carried out on the first two or three food diaries returned by each interviewer with timely feedback provided on any areas of concern. Before working on a second or subsequent assignment, all interviewers received feedback on the diaries from their previous assignment. Further, any interviewer who had more than three

months gap between assignments completed their own two-day diary which was reviewed and comments fed back.

### **2.6.3 Training for nurses**

Nurse briefings lasted one and a half days and covered equipment training, blood sampling and 24-hour urine sample training and questionnaire administration (including practice sessions). Nurses were also briefed on the demispan, MUAC and infant length measurement protocols (i.e. the physical measurements less regularly taken on other surveys). All other physical measurements were either regularly taken by nurses on the NDNS RP and other NatCen surveys or the newer nurses attended a general training session which covered these protocols.

Nurses who had a gap of three months or more between assignments and new-to-NDNS RP nurses completed three homework exercises which were marked and individual feedback given to each nurse.

## **2.7 Key methodological changes between Years 3 and 4**

A number of methodological changes were introduced in Year 4 of the NDNS RP. These are summarised below:

- the DLW sub-study took place in alternate fieldwork years (i.e. Years 1 and 3) and so was not included in Year 4
- the 'Young persons food photograph atlases' were introduced as a tool to improve the accuracy of portion sizes for participants aged under 16 years (see Appendix A for further information)

These methodological changes did not affect the way the rest of the data were collected, analysed or interpreted.

## **2.8 Response rates**

Response rates presented in this section are for Years 1 to 4 combined. For the first time, this report includes both core and country boost cases. Previous NDNS RP reports included core

sample cases only. Core cases are those which were selected for the main UK sample; country boost cases are those which were selected to increase the sample sizes in Wales, Scotland and Northern Ireland. See Appendix B for more information on sampling design.

### **2.8.1 Household level response**

Overall for Years 1 to 4 combined, of the 21,573 addresses (core and country boost) issued to interviewers, 46% were eligible for household selection and 54% were ineligible. Ineligible addresses include vacant or derelict properties and institutions. Addresses that were selected for the child boost and were screened out because they did not contain any children in the eligible age range were also included in the ineligible category. This explains the higher than average proportion of ineligible addresses.

Household selection was carried out at 91% of eligible addresses. The remaining 9% of addresses refused before the household selection could be carried out. 58% (5,730 / 9,858) of eligible households were productive – i.e. at least one selected participant completed three or four dietary recording days.

**(Table 2.1)**

### **2.8.2 Individual level response**

The overall response rate for fully productive individuals (i.e. those completing three or four dietary recording days) was 56% in Year 1, 57% in Year 2, 53% in Year 3 and 55% in Year 4, giving a sample size of 6,828 fully productive individuals.<sup>13</sup> Analyses in this report (including response rates for subsequent stages/components of the survey) are based on these 6,828 individuals.

Valid height and weight measurements were obtained for almost all fully productive participants (height 95%; weight 94%).

Seventy-five per cent of all fully productive participants were visited by a nurse.<sup>14</sup> Physical measurements including waist and hip circumference, MUAC and blood pressure were taken from almost all participants (adults and children) who had a nurse visit.

Fifty-one per cent of adults completing at least three diary days and 27% of children completing at least three diary days provided a blood sample. Younger children were less likely to give a blood sample than older children or adults: 9% of those aged 1.5 to 3 years and 21% of those aged 4 to 10 years provided a blood sample compared with 38% of those aged 11 to 18 years and 51% of those aged 19 years and over.

Fifty-nine per cent of participants aged four years and over<sup>15</sup> who completed at least three diary days went on to provide a 24-hour urine sample (60% of adults, 58% of children). Samples were assessed for completeness; a proportion were found to be incomplete and therefore not usable for the analysis (see Chapter 7).

In Year 1, all children aged 4 to 10 years were asked to wear an Actigraph. In Years 2 to 4, all children aged 4 to 15 years were asked to do so. Across all years interviewers placed an ActiGraph with 77% of participants aged 4 to 15 years. Usable ActiGraph data was collected from 52% of participants.

**(Table 2.2)**

## 2.9 Weighting the survey data

It is necessary to apply weighting factors to the data collected in the NDNS RP for two reasons: to remove any bias in the observed results which may be due to differences in the probability of households and individuals being selected to take part; and to attempt to reduce non-response bias.

The survey was designed so that no more than one adult and one child were selected from any one household to take part. This meant that adults living in households with one or more other adults, and children in households with one or more other child were less likely to be selected than were adults or children in single adult/child households.

In addition, the multi-stage design means there were a number of stages in the survey where it was possible for participants to drop out. If the people who refused to participate at a particular stage were systematically different from those who took part then the sample would be biased.

Weighting factors were used to correct for both these cases. There were two stages to the weighting scheme: the first was to generate a set of design weights to correct for the unequal selection probabilities; and the second was to create a set of weights to adjust for non-response. The final weights were a product of the selection weights and the non-response weights.

The sample design includes an adjustment for selecting more addresses in Scotland, Wales and Northern Ireland. All of the addresses in these countries, and therefore participants, are weighted down as a result. The applied weights puts the four countries into their correct population proportions so that, for example, the percentage of the NDNS RP sample in Scotland is the same as the percentage of the UK population that is in Scotland.

Full detail of the NDNS RP weighting scheme is provided in Appendix B.

---

<sup>1</sup> <http://www.food.gov.uk/multimedia/pdfs/publication/ndnsreport0809.pdf> (accessed 28/01/14).

<sup>2</sup> <https://www.gov.uk/government/publications/national-diet-and-nutrition-survey-headline-results-from-years-1-and-2-combined-of-the-rolling-programme-2008-9-2009-10> (accessed 28/01/14).

<sup>3</sup> <https://www.gov.uk/government/publications/national-diet-and-nutrition-survey-headline-results-from-years-1-2-and-3-combined-of-the-rolling-programme-200809-201011> (accessed 28/01/14).

<sup>4</sup> The sample was drawn from the 'small users' sub-file of the Postcode Address File (PAF), a computer list, prepared by the Post Office, of all the addresses (delivery points) which receive fewer than 25 articles of mail a day.

<sup>5</sup> A guardian is defined as a person with legal responsibility for the child.

<sup>6</sup> The Main Food Provider (MFP) is the person in the household with the main responsibility for shopping and preparing food. If these tasks were shared equally between two people, for example if one person did all the shopping and another person did all the cooking, then either resident could be classified as the MFP.

<sup>7</sup> The 'Household Reference Person' (HRP) was defined as the householder (a person in whose name the property is owned or rented) with the highest income. If there was more than one householder and they had equal income, then the eldest was selected as the HRP.

<sup>8</sup> Questions were asked to ascertain whether the HRP was in paid work at the time of the interview and, if not, whether they had ever had a paid job. If the HRP had ever worked, there were further questions about their current or most recent job in order to classify HRPs into the National Statistics Socio-economic Classification (NS-SEC) groupings.

<sup>9</sup> The Research Governance Framework is intended to define the broad principles of good research practice, and to ensure that health and social care research is conducted to high scientific and ethical standards.

<sup>10</sup> Based on the Recent Physical Activity Questionnaire developed by the MRC Epidemiology Unit, Cambridge.

<sup>11</sup> Children who had worn an ActiGraph were given a promissory note stating that their £10 token of appreciation would be sent from the office within four weeks of interview.

<sup>12</sup> Nurses qualified and experienced in paediatric phlebotomy took blood samples from children. Protocols and procedures are in line with official RCN guidelines. Ref: RCN (2013), An education and training competence framework for capillary blood sampling and venepuncture in children and young people, RCN London. ISBN 978-1-908782-56

<sup>13</sup> Of the 6,828 fully productive individuals, 6,700 (98%) completed four dietary days and 128 (2%) completed three days.

<sup>14</sup> The remainder of fully productive respondents either refused to progress to stage 2 or, in a small number of cases, could not be visited during the nurse fieldwork period.

<sup>15</sup> Participants also had to be fully out of nappies to be eligible for the 24-hour urine sampling element.

## 3 Socio-demographic characteristics of the NDNS RP sample

*Original authors: Sarah Pigott & Beverley Bates*

*Updated by: Laura Nass*

### 3.1 Introduction

This chapter describes the socio-demographic and health-related lifestyle characteristics of the NDNS RP sample for Years 1 to 4 combined, using data collected during the CAPI interviews and from self-completion questionnaires in the case of smoking and drinking analysis.

### 3.2 Sex

In the unweighted NDNS RP sample, 42% of adults (aged 19 years and over) were men and 58% were women, while for children (aged 1.5 to 18 years) 51% were boys and 49% were girls. The sample was weighted to reflect the distribution of males and females in the general population within the UK.<sup>1</sup>

**(Table 3.1)**

### 3.3 Age

The unweighted sample of adults included 78% aged 19 to 64 years and 22% aged 65 years and over. The unweighted sample of children included 18% aged 1.5 to 3 years, 38% aged 4 to 10 years and 44% aged 11 to 18 years. The sample was weighted to bring the proportions in line with the age profile of the UK general population.<sup>1</sup>

**(Tables 3.2 and 3.3)**

All text and tables in the remainder of this report use weighted data to present a representative sex and age profile of the UK population.

### 3.4 National Statistics Socio-economic Classification (NS-SEC), housing tenure, education and qualifications

Participants were assigned a socio-economic classification based on the employment of the Household Reference Person (HRP) for their household (see section 2.1 for HRP definition).

In terms of the HRP's current or most recent job, the proportion of participants' households<sup>2</sup> classified to the main NS-SEC occupational groupings reflected those reported in the General Lifestyle Survey (GLF 2010).<sup>3,4</sup>

Individuals were categorised according to the housing tenure of the HRP. Around two-thirds of participants (70% adults, 65% children) lived in owner-occupied accommodation and around one-fifth (15% of adults, 21% of children) lived in social housing. A further 15% of adults and 13% of children lived in privately rented accommodation. These proportions are in line with those found in the general Great Britain population.<sup>4</sup>

**(Table 3.4)**

Participants aged 16 years and over were asked the age at which they had left full-time education. Almost half (47%) reported that they had left school by the age of 16 years but the proportion having done so was much higher amongst older adults (74% of those aged 65 years and over had left school by the age of 16 years).

If participants had finished full-time education, they were asked the highest qualification (if any) they had achieved. Older adults aged 65 years and over were less likely than other adults to have a degree (10% compared with 25% of those aged 50 to 64 years, 28% of those aged 35 to 49 years and 29% of those aged 19 to 34 years). Conversely, the proportion of those having no qualifications increased with age: 3% of those aged 16 to 19 years had no qualifications compared with 49% of those aged 65 years and over.

**(Table 3.5)**

### 3.5 Vegetarian and vegan diets

Two per cent of both adults and children reported that they were vegetarian; and less than 1% of participants reported following a vegan diet.<sup>5</sup>

**(Table 3.6)**

### 3.6 Smoking

Of those aged 16 years and over, 24% of men and 19% of women reported that they were current smokers. These proportions are similar to those reported in the GLF 2010<sup>4</sup> (where 22%

of men and 21% of women were categorised as current smokers) and slightly lower for women than in Northern Ireland's Continuous Household Survey of 2009/10<sup>6</sup> (where 24% of both men and women reported being current smokers).

**(Table 3.7)**

Those who reported that they were current smokers were asked how many cigarettes they smoked on an average week and weekend day. Six per cent of men and 3% of women were classed as heavy smokers (i.e. they smoked 20 or more cigarettes per day). Again, these proportions are similar to those reported in the GLF 2010 (where 7% of men and 5% of women were classed as heavy smokers).<sup>4</sup>

**(Table 3.8)**

Information about experience of smoking was collected for children aged 8 to 15 years. A higher proportion of younger boys (aged 8 to 10 years) than girls of the same age had ever smoked a cigarette (4% of boys, 1% of girls). However, amongst older children, this difference had disappeared with a quarter of both girls and boys aged 13 to 15 years reporting having ever smoked a cigarette.

**(Table 3.9)**

## 3.7 Alcohol consumption

### 3.7.1 Drinking behaviour amongst adults aged 16 years and older

The recommended sensible drinking guidelines for all four UK countries are that men should not regularly drink more than three to four units of alcohol per day, and women should not regularly drink more than two to three units of alcohol per day. Men who regularly drink more than eight units a day (or 50 units a week) and women who regularly drink more than six units a day (or 35 units a week) are considered to be at particular risk of harm.<sup>7, 8</sup>

Alcohol consumption is reported in terms of units of alcohol; one unit of alcohol is 10ml by volume of pure alcohol. Daily consumption is calculated by recording the amounts drunk on the day in the past week when the participant drank most.

Most adults (70% of men, 58% of women) had drunk alcohol in the last week, including 24% of men and 15% of women who had drunk more than twice the recommended levels on one of these days.

**(Table 3.10)**

On average among those who drank in the last week, men consumed 8.1 units on the day they drank most in the last week, and women consumed 5.3 units.

**(Table 3.11)**

Alcohol consumption levels amongst NDNS RP adults are very similar to those reported in the GLF 2010.<sup>4</sup>

### **3.7.2 Drinking behaviour amongst children aged 8 to 15 years**

In 2009, the Department of Health published guidance from the Chief Medical Officer on the consumption of alcohol amongst children and young people.<sup>9</sup> It emphasises that an alcohol-free childhood is the healthiest option. The advice also recommends that parents should try to ensure that their children do not drink alcohol, at least up to the age of 15 years. Furthermore, it advises that young people aged 15 to 17 years should never exceed recommended adult daily limits and, on days when they drink, consumption should be below such levels. Guidance in Wales and Scotland is that not drinking alcohol at all is the best option for young people.<sup>10,11</sup>

The proportion of children who reported ever having had a proper alcoholic drink (not just a taste) increased with age, from 11% of boys and 7% of girls aged 8 to 10 years to 55% of boys and 53% of girls aged 13 to 15 years.<sup>12</sup> These proportions are broadly in line with Health Survey for England (HSE) 2009 results.<sup>13,14,15</sup>

**(Table 3.12)**

Three per cent of boys aged 13 to 15 years and 4% of girls of the same age reported usually drinking once a week or more.

**(Table 3.13)**

As discussed in the 'Smoking, drinking and drug use among young people in England in 2011' report,<sup>16</sup> attempting to accurately measure alcohol consumption among children can be

challenging. Recall of their drinking can be erroneous; a generally acknowledged problem for all surveys measuring alcohol consumption. Second, the majority of children's' drinking is in informal settings, and the quantities they drink are not necessarily standard measures. This should be borne in mind when interpreting the figures in Tables 3.12 and 3.13.

---

<sup>1</sup> Office for National Statistics. *2011 Population Estimates*.

For England and Wales:

<http://www.ons.gov.uk/ons/guide-method/census/2011/census-data/2011-census-user-guide/quality-and-methods/index.html>

For Scotland:

<http://www.gro-scotland.gov.uk/census/censushm2011/policy-and-methodology/index.html>

For Northern Ireland:

[http://www.nisra.gov.uk/Census/2011\\_results\\_population.html](http://www.nisra.gov.uk/Census/2011_results_population.html)

(accessed 03/07/13).

<sup>2</sup> Some households contained both an adult and a child participant. Such households and their HRP will be represented in both the adult and child figures.

<sup>3</sup> The General Lifestyle Survey (GLF) formerly known as the General Household Survey (GHS) is a multi-purpose continuous survey which collects information on a range of topics from people living in private households in Great Britain.

<sup>4</sup> Dunstan S General Lifestyle Survey 2010. Overview report, 2012 <http://www.ons.gov.uk/ons/rel/ghs/general-lifestyle-survey/2010/general-lifestyle-survey-overview-report-2010.pdf> (accessed 03/07/13)

<sup>5</sup> Self-reported assessment via question in the CAPI interview.

<sup>6</sup> [http://www.csu.nisra.gov.uk/Prevalence\\_of\\_cigarette\\_smoking\\_by\\_sex\\_Trend.xls](http://www.csu.nisra.gov.uk/Prevalence_of_cigarette_smoking_by_sex_Trend.xls) (accessed 03/07/13).

<sup>7</sup> <https://www.gov.uk/government/policies/reducing-harmful-drinking> (accessed 03/03/14).

Drinking at this level has been described in surveys, including the Health Survey for England, as 'binge drinking'. 'Binge drinking' is also used to define a pattern of drinking a large quantity of alcohol in a short period with the aim of getting drunk. In practice, this may involve considerably more than twice the recommended daily limits. To avoid confusion, the term 'binge drinking' is not used in this report.

<sup>8</sup> Adults (i.e. those aged 16 years or older) who drank bottled or canned beer, lager, stout or cider were asked in detail about what they drank, and this information was used to estimate the amount in pints (one pint is equivalent to 0.568 litres). Adults were also asked to quantify the amount of wine drunk in terms of large (250ml), standard (175ml) and small (125ml) glasses, and were also given the option of specifying the quantity of wine drunk in bottles or fractions of a bottle; a bottle was treated as the equivalent of six small (125ml) glasses. Adults who drank spirits were asked to quantify how much they drunk in single measures (25ml).

<sup>9</sup> Department of Health. Guidance on the consumption of alcohol by children and young people. A report by the Chief Medical Office. DH, London, 2009. [http://webarchive.nationalarchives.gov.uk/20130107105354/http://www.dh.gov.uk/prod\\_consum\\_dh/groups/dh\\_digitalassets/documents/digitalasset/dh\\_110256.pdf](http://webarchive.nationalarchives.gov.uk/20130107105354/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_110256.pdf) (accessed 03/07/13).

<sup>10</sup> Welsh Assembly Government. You, Your child and Alcohol.

<http://wales.gov.uk/docs/phhs/publications/100723cmoalcposen.pdf> (accessed 03/07/13).

<sup>11</sup> <http://www.drinksarter.org/sensible-drinking-and-you/alcohol-and-young-people> (accessed 03/07/2013).

<sup>12</sup> Children are likely to under-report their alcohol consumption (frequency and amount drunk) in home-based surveys because they may be worried about parents seeing their answers. This should be borne in mind when interpreting the findings presented in this section.

<sup>13</sup> Health Survey for England - 2009: Health and lifestyles.

<http://www.ic.nhs.uk/statistics-and-data-collections/health-and-lifestyles-related-surveys/health-survey-for-england/health-survey-for-england--2010-trend-tables>

(accessed 17/07/13).

<sup>14</sup> Note that results are not directly comparable with HSE (2009) as age groupings differ in the two surveys.

<sup>15</sup> Comparable data is not available for Scotland, Wales and Northern Ireland.

<sup>16</sup> Smoking, Drinking and Drug Use Among Young People in England - 2010.

<http://www.hscic.gov.uk/pubs/sdd10fullreport> (accessed 06/06/13).

## 4 Physical measurements and physical activity

*Original authors: Jenny Mindell & Vasant Hirani*

*Updated by: Shaun Scholes*

### 4.1 Physical measurements

#### 4.1.1 Introduction

Height and weight measurements, from which body mass index (BMI) was calculated, were taken during Stage 1 (the interviewer visit). Waist and hip circumference and blood pressure were measured during Stage 2 (the nurse visit). Comparisons are made, where possible, with data on physical measurements and from the most recent health surveys in England, Scotland and Wales.<sup>1,2,3,4</sup> Data presented are for Years 1 to 4 combined.

Detailed descriptions of the measurement protocols used in the NDNS Rolling Programme (RP) are available in Appendix I but a brief description is provided within each section below.

Measurements of mid upper arm circumference (MUAC) are not reported in this chapter but will be included in the archived data (see Appendix Q for more detail).

#### 4.1.2 Anthropometry

##### 4.1.2.1 Measurements

Height and weight were measured at the first interviewer visit, using a portable stadiometer, measuring to the nearest 0.1 cm (and if between two mm, rounded to the nearest even mm) and weighing scales, measuring to the nearest 0.1kg.  $BMI = \text{weight (kg)} / \text{height squared (m}^2\text{)}$  was calculated by the interviewer's CAPI programme. For participants whose height could not be measured, estimated height based on demispan<sup>5</sup> was used to calculate BMI.<sup>6</sup> For children aged 1.5 to 2 years, the interviewer measured length instead of height and this measurement was used in place of height when calculating BMI for these youngest children.<sup>7</sup> The nurse measured waist and hip circumferences in those aged 11 years and over using an insertion tape measure.<sup>8</sup>

### 4.1.3 Obesity

#### 4.1.3.1 Adults

Table 4.1a shows mean BMI and BMI status, in adults, by age group and sex (according to the World Health Organisation (WHO)<sup>9</sup> and National Institute for Health and Clinical Excellence (NICE) classification<sup>10</sup> as shown in Table 4A below):

**Table 4A: BMI classification**

<b><u>BMI (kg/m<sup>2</sup>)</u></b>	<b><u>Description</u></b>
Less than 18.5	Underweight
18.5 to less than 25	Normal
25 to less than 30	Overweight
30 or more	Obese
40 or more	Morbidly obese

An adult was classified as having abdominal obesity if their waist circumference was raised (greater than 102cm for men and greater than 88cm for women), or if their waist: hip ratio (WHR) was raised (greater than 0.95 for men and greater than 0.85 for women).<sup>11</sup>

There were no significant differences in mean BMI by age group or sex. However, a higher percentage of men (45%) than women (29%) were overweight, or were obese, including obese (71% in men and 58% in women).

Mean waist circumference and mean WHR were both significantly higher in men than in women in both age groups (19 to 64 years and aged 65 years and over).

In both sexes, mean waist circumference and mean WHR were both significantly higher<sup>12</sup> in the oldest age group (those aged 65 years and over). For example, mean WHR was 0.92 for men aged 19 to 64 years and 0.97 for men aged 65 years and over. For women, mean WHR was 0.82 for those aged 19 to 64 years and 0.86 for those aged 65 years and over.

The proportion of adults who had a raised waist circumference or raised WHR was significantly higher in older adults (aged 65 years and over) than in younger adults (aged 19 to 64 years). A higher percentage of women (46%) than men (37%) had a raised waist circumference, with the difference more marked in the 19 to 64 years group (43% in women, 33% in men). There were no significant differences between the sexes in the prevalence of raised WHR.

**(Table 4.1a)**

#### **4.1.3.2 Children**

New UK World Health Organisation (WHO) growth charts for children from birth to four years were introduced for all new births in England, Wales and Northern Ireland from May 2009 and in Scotland from January 2010.<sup>13</sup> These are based on WHO Growth Standards from data in infants who were exclusively or predominantly breastfed.<sup>14,15</sup>

Growth standards for the youngest children are based on breastfed babies, who tend to have a different pattern of growth compared with formula-fed infants, whereas growth standards for older children are based on the growth of UK children regardless of feeding (UK 1990 reference values). Differences between the youngest and oldest children should be viewed with caution due to the use of different growth standards.

For clinical purposes, the charts define overweight as above the 91<sup>st</sup> but on or below the 98<sup>th</sup> centile for BMI and obesity as above the 98<sup>th</sup> centile. However, this report uses the 85<sup>th</sup> and 95<sup>th</sup> centiles to define overweight and obesity, as is standard UK government practice for population monitoring.<sup>16</sup>

Similar proportions of boys and girls were overweight (14% and 15% respectively); overweight, including obese (31% and 33% respectively); and obese (17% and 19% respectively). BMI in children can be useful as an indicator of over- or under-nutrition, but must be interpreted carefully and compared with suitable age- and sex-specific thresholds for defining normal / abnormal categories.<sup>17</sup>

**(Table 4.1b)**

#### **4.1.4 Comparisons with other surveys<sup>4</sup>**

Comparisons of results for adults participating in the NDNS RP with adults measured recently in England and Scotland<sup>18</sup> showed that anthropometric measurements were broadly similar between the NDNS RP, Scottish Health Survey 2010/11 (SHeS 2010/11)<sup>1</sup> and the Health Survey for England 2011 (HSE 2011)<sup>2</sup> for both sexes.

Mean BMI in men was 27.6kg/m<sup>2</sup> in both the NDNS RP and SHeS 2010/11 and 27.2kg/m<sup>2</sup> in HSE 2011; mean BMI in women was 27.4kg/m<sup>2</sup>, 27.5kg/m<sup>2</sup> and 27.1kg/m<sup>2</sup> respectively in the three surveys. The proportion of overweight adults was also similar in the three surveys.

Among men it was 45% in the NDNS RP, 41.5% in SHeS 2010/11 and 41% in HSE 2011 and in women 29% in the NDNS RP compared with 32% in SHeS 2010/11 and 33% in HSE 2011.

Mean waist circumference was higher in men in the NDNS RP (98.3cm) than in HSE 2011 (97.1cm) and SHeS 2010/11 (96.3cm) but there were no differences among women in the three surveys. Raised waist circumference in men appeared more prevalent in the NDNS RP (37%) than in HSE 2011 (34%) or SHeS 2010/11 (32%). In women, raised waist circumference was higher in SHeS (49%) than in the NDNS RP and HSE 2011 (46% and 47% respectively). It should be noted that these comparisons were not formally tested for statistical significance.

In order to compare the NDNS RP estimates with the other surveys, this paragraph refers to children aged 2 to 15 years only; the estimates therefore differ from those shown for children aged 2 to 18 years in Table 4.1b. When comparing children's anthropometric results for the NDNS RP with the other surveys, analyses in the NDNS RP were not entirely comparable with HSE, SHeS<sup>19</sup> nor Welsh Health Survey (WHS)<sup>3</sup> due to the smaller age bands and different reference thresholds for obesity being used for children aged 2 to 3 years in the different surveys. The proportion of boys who were obese appeared to be lower in the NDNS RP (18%) than in WHS 2011 (21%) and SHeS 2011 (20%) but similar to HSE 2011 (17%). The proportion of girls who were obese appeared to be similar in the NDNS RP and WHS 2011 (18% in both surveys) but higher than in SHeS 2011 (14.5%) and HSE 2011 (16%). It should be noted that these comparisons were not formally tested.

## 4.2 Blood pressure

### 4.2.1 Measurement of blood pressure

Blood pressure was measured in a sitting position using an automated, validated machine, the Omron HEM907, after a five minute rest. Results presented in this chapter are based on the mean of the second and third readings, taken at one minute intervals, in participants with valid readings (i.e. three readings in people who had not eaten, drunk alcohol, smoked or exercised for at least 30 minutes prior to measurement). Full details of protocols are available in Appendix I.

Hypertension was defined as a systolic blood pressure of 140mmHg or above, and/or diastolic blood pressure of 90mmHg or above,<sup>20</sup> and/or taking medication specifically to reduce blood pressure.

#### **4.2.2 Results**

Table 4.2 shows mean systolic (SBP) and diastolic (DBP) blood pressure by age and sex, together with the proportion of participants whose blood pressure results indicated hypertension, and whether this was treated and/or controlled.

Mean SBP was significantly higher in men (130.2mmHg) than women (124.8mmHg) and significantly higher in adults aged 65 years and over than in adults aged 19 to 64 years. The difference with age was greater in women (137.4mmHg in those aged 65 years and over, 120.4mmHg in those aged 19 to 64 years) than in men (138.1mmHg and 128.1mmHg, respectively). Mean DBP, however, varied neither by age group nor sex.

The prevalence of hypertension was significantly greater in older adults than in younger adults. Among adults aged 19 to 64 years, 5% of men and 7% of women were on treatment for hypertension (i.e. controlled or uncontrolled hypertension),<sup>21</sup> compared with 36% of men and 33% of women aged 65 years and over. Untreated hypertension was twice as common in older adults (30% of men and 25% of women aged 65 years and over, compared with 17% of men and 11% of women aged 19 to 64 years).

**(Table 4.2)**

#### **4.2.3 Comparisons with other surveys**

Mean SBP and DBP levels in men in the NDNS RP were 130.2 and 74.7mmHg, whilst for men in HSE 2011 levels were 128.8 and 73.0mmHg, respectively. Among women, mean SBP and DBP levels in the NDNS RP were 124.8 and 73.4mmHg compared with 122.3 and 71.9mmHg for women in HSE 2011. Blood pressure was not measured in the WHS. Mean levels of SBP and DBP were not reported in SHeS 2010/11.

The proportion of participants in the NDNS RP with survey-defined hypertension (raised blood pressure and/or on medication for hypertension) was in line with the proportion in England in

HSE 2011 and in Scotland (SHeS) in 2010/11.<sup>1,2</sup> Thirty-two per cent of men in the NDNS RP, 31% of men in HSE 2011 and 33% of men in SHeS 2010/11 had survey-defined hypertension. In women, prevalence was 28% in both the NDNS RP and HSE 2011 but appeared lower than in SHeS 2010/11 (32%).

## 4.3 Physical activity

### 4.3.1 Introduction

Physical activity was assessed in different ways for children (aged 4 to 15 years) and adults (aged 16 years and over). Children's physical activity was measured using accelerometers (ActiGraphs) during Stage 1 (the interviewer visits). In Years 2 to 4, use of the ActiGraph was extended from children aged 4 to 10 years to also include children aged 11 to 15 years.

A self-completion questionnaire - the Recent Physical Activity Questionnaire; RPAQ (developed by the MRC Epidemiology Unit Cambridge)<sup>22</sup> was used to estimate physical activity in participants aged 16 years and over (deemed "adults" in this section) from Year 2 onwards. The RPAQ was designed to assess usual physical activity in the last month in four domains:

- home (watching television, using a computer, climbing stairs)
- work (type and amount of physical activity)
- commuting to work (by car, public transport, cycling, and/or walking)
- leisure activities (frequency of participation in 35 different activities (none to every day) and average time per episode)

The RPAQ was given to participants aged 16 years and over at the food diary pick-up visit. Participants completed the RPAQ while the interviewer was present.

Detailed descriptions of the assessment of adult and children's physical activity in the NDNS RP and the processing of data from the ActiGraph and RPAQ are available in Appendices G and V respectively, but a brief description is provided within each section below. Comparisons are made, where possible, with data on physical activity from the most recent relevant health surveys in England, Scotland and Wales.<sup>1,3,23</sup>

## 4.3.2 Physical activity in adults

### 4.3.2.1 Estimation of physical activity

Using the Physical Activity Compendium,<sup>24</sup> all activities covered by the RPAQ, including the type and amount of physical activity at work, were grouped into one of four categories representing the metabolic cost of each activity, expressed in metabolic equivalents (METs):

- sedentary (< 2 METs)
- light (2-3.5 METs)
- moderate (3.6-6 METs)
- vigorous (>6 METs)

For each participant, the number of hours per day (h/d) spent in each of the four categories was computed (see Appendix V). Time spent in each moderate or vigorous activity ( $\geq 3.6$  METs) was summed to provide the mean daily time (in h/d) spent in moderate or vigorous activities, the variable used to summarise adult physical activity levels in this report. As the physical activity data were skewed, the median rather than mean number of h/d spent in moderate or vigorous activity is presented as the summary measure of overall activity. The 5<sup>th</sup>, 10<sup>th</sup>, 25<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup> and 95<sup>th</sup> percentiles are also shown.

### 4.3.2.2 Results

Table 4.3 shows median number of h/d spent in moderate or vigorous physical activity by age and sex.

Median h/d spent in moderate or vigorous physical activities was higher in men (1.0h/d) than in women (0.5h/d). For both sexes, median time spent in moderate or vigorous activity were higher in adults aged 16 to 64 years than in those aged 65 years and over. However, because younger men were more active than younger women, the difference with age appeared greater in men (1.1h/d in those aged 16 to 64 years, 0.6h/d in those aged 65 years and over) than in women (0.5h/d and 0.3h/d, respectively). It should be noted that these comparisons were not formally tested.

**(Table 4.3)**

#### **4.3.2.3 Comparisons with other surveys**

There are methodological differences between the RPAQ and the physical activity questionnaire used in the HSE so this comparison should be interpreted with caution.

The median h/d spent in moderate or vigorous physical activities were similar in the NDNS RP to those found in HSE 2008.<sup>23,25</sup> The median h/d spent in moderate or vigorous activities were 1.0 and 0.5 in the NDNS RP in men and women, respectively. In HSE 2008, the average daily time spent in moderate or vigorous activity (in bouts of at least 10 minutes) was 1.2h/d in men and 0.8h/d in women.

### **4.3.3 Physical activity in children**

#### **4.3.3.1 Measurement of physical activity**

Objective measurements of physical activity were taken using the ActiGraph GMT1,<sup>26</sup> which recorded vertical movement, where the number of movements ('counts') increase with the intensity of activity. For any individual, the ActiGraph records different periods during the day spent at different levels of activity, i.e. differing levels of 'counts per minute' (cpm), while they are being sedentary or engaging in light, moderate, or vigorous activity.<sup>27</sup> For this report, the minimum wear time criterion for inclusion in analysis was set at 24 hours.<sup>28</sup> The average daily cpm for each participant was calculated as a weighted average based on the probability of wear/non-wear (for a minimum wear time of at least eight hours per day).

As the cpm data were skewed, the median rather than mean daily cpm is presented as the summary measure of overall activity.<sup>29</sup> The 5<sup>th</sup>, 10<sup>th</sup>, 25<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup> and 95<sup>th</sup> percentiles are also shown.

The results in Table 4.4 characterise the range of activity levels found in boys and girls in the two age groups.

#### **4.3.3.2 Results**

Table 4.4 shows the average daily volume of physical activity, expressed as median cpm. It shows, as has been found elsewhere, that boys are more active than girls, and that activity levels fall with age, particularly amongst girls. In both sexes, the median daily volume was

higher in those aged 4 to 10 years than 11 to 15 years. The median daily volume was higher in boys, with the gender difference increasing with age. The median cpm in those aged 4 to 10 years were 577cpm and 541cpm in boys and girls, respectively. Equivalent figures for those aged 11 to 15 years were 473cpm and 335cpm. In the younger children, the least active quartile had similar activity levels by sex. It should be noted that these comparisons were not formally tested.

**(Table 4.4)**

#### **4.3.3.3 Comparisons with other surveys**

The inclusion criteria for using accelerometer data and the way the data have been processed were both very different for the NDNS RP compared with HSE 2008 and other studies. These caveats must be borne in mind when making between-study comparisons.

A study of boys and girls aged 8 to 10 years in 2008/09 in Gateshead had mean daily levels of 688cpm and 612cpm, respectively.<sup>30</sup>

Similarly, boys and girls aged 11 to 12 years in the Avon Longitudinal Study of Parents and Children (ALSPAC) birth cohort had median daily levels of 645cpm (interquartile range (IQR) 528-773) and 529cpm (IQR 444-639) respectively.<sup>31,32</sup>

HSE 2008 results were presented as the average minutes of daily accelerometer wear in different categories of intensity of activity, with the data adjusted for average daily wear time, to allow comparisons between groups with different average wear times. Moderate to vigorous physical activities were defined in HSE 2008 as  $\geq 2802$  cpm. Using this cut-point, the average time spent doing any moderate to vigorous physical activities (MVPA) per day decreased with age for both sexes, from 124 minutes among boys and 101 minutes among girls aged 4 to 7 years, to 52 minutes among boys and 28 minutes among girls aged 12 to 15 years. Average minutes of MVPA were higher in all age groups for boys compared with girls.

---

<sup>1</sup> Rutherford L, Sharp C, Given L (eds). *The Scottish Health Survey 2011*. Edinburgh: Scottish Executive, 2012.

<sup>2</sup> Craig R, Mindell J (eds). *Health Survey for England 2011*. Leeds: The Health and Social Care Information Centre, 2012.

<sup>3</sup> Griffiths E, Roberts C (eds). *Welsh Health Survey 2011*. Welsh Assembly Government 2012. [On-line] <http://wales.gov.uk/docs/statistics/2012/120919healthsurvey2011en.pdf> (accessed 17/06/2013)

<sup>4</sup> Comparisons of the NDNS RP with health surveys in Northern Ireland could not be made, and for Wales could only be made for children due to the data not being comparable or available. The most recent Northern Ireland survey (carried out in 2010/11) did not include a measurement module. The Welsh Health Survey uses self-report, not measured weight and height for adults.

<sup>5</sup> Demispan is defined as the distance between the mid-point of the sternal notch and the finger roots with the arm outstretched laterally. Using BMI based on demispan equivalent height is recommended where no measured height is available, and has been suggested as a preferred measure of BMI in older people. (Hirani V, Mindell J. *A comparison of measured height and demispan equivalent height in the assessment of body mass index among people aged 65 years and over in England*. *Age Ageing*. 2008;37:311-7.)

<sup>6</sup> The demispan equivalent height was calculated using regression equations derived by Bassey: (Bassey EJ. *Demispan as a measure of skeletal size*. *Annals of Human Biology* 1986; 13: 499-502.) Females: Height (cm) = (1.35x demispan in cm) + 60.1. Males: Height in (cm) = (1.40x demispan in cm) + 57.8.

<sup>7</sup> These data are not shown but are included in the archived data.

<sup>8</sup> All fieldworkers were trained to carefully observe the standard measurement protocols. Each measurement was taken twice. Where the discrepancy between the measurements was at or above a given value (height  $\geq$  0.5cm, weight  $\geq$  0.2kg, waist and hip circumferences  $\geq$  3cm), a third measurement was taken. The mean of the two closest measurements was used. If only one measurement was available, it was excluded from the analysis.

<sup>9</sup> *World Health Organisation body mass index (BMI) classification*. [On-line] [www.who.int/bmi/index.jsp?introPage=intro\\_3.html](http://www.who.int/bmi/index.jsp?introPage=intro_3.html) (accessed 17/06/2013).

<sup>10</sup> National Institute of Health and Clinical Excellence. *Obesity: the prevention, identification, assessment and management of overweight and obesity in adults and children*. [On-line] [www.nice.org.uk/guidance/index.jsp?action=download&o=38295](http://www.nice.org.uk/guidance/index.jsp?action=download&o=38295). page 221 (accessed 17/06/2013).

<sup>11</sup> Molarius A, Seidell JC. *Selection of anthropometric indicators for classification of abdominal fatness – a critical review*. *Int J Obes* 1998; 22: 719-27.

<sup>12</sup> The term 'significant' refers to statistical significance (at the 5% level).

<sup>13</sup> SACN/RCPCH. *Application of WHO Growth standards in the UK*. London: TSO, 2007. [www.sacn.gov.uk/pdfs/sacn.rcpch\\_who\\_growth\\_standards\\_report\\_final.pdf](http://www.sacn.gov.uk/pdfs/sacn.rcpch_who_growth_standards_report_final.pdf) (accessed 17/06/2013)

<sup>14</sup> Royal College of Paediatrics and Child Health / World Health Organisation. *The UK WHO Growth Charts: Early Years*. London: RCPCH, 2009. [www.rcpch.ac.uk/Research/UK-WHO-Growth-Charts](http://www.rcpch.ac.uk/Research/UK-WHO-Growth-Charts) (accessed 17/06/2013).

<sup>15</sup> The new UK-WHO 0-4 years growth charts were introduced in the UK because they represent an international standard of growth for healthy infants and young children. Breastfed infants exhibit a healthier pattern of growth. The new charts were constructed using the WHO Growth Standards for infants aged two weeks to four years, which used data from healthy children from around the world with no known health or environmental constraints to growth. WHO found that infants worldwide have very similar patterns of linear growth, whatever their ethnic origin. The new charts provide a description of optimal growth, describing the ideal patterns of growth for all UK children, whatever their ethnic origin and however they are fed in infancy. The WHO data is combined with birth data for gestations 23 to 42 weeks from the UK1990 growth reference, as the WHO dataset did not include preterm infants. The UK1990 reference is still to be used for children aged four years and over.

<sup>16</sup> Cole T, Freeman JV, Preece MA. *Body mass index reference curves for the UK, 1990*. *Arch Dis Child* 1995; 73: 25-29.

<sup>17</sup> Scientific Advisory Committee on Nutrition and Royal College of Paediatrics and Child Health. *Consideration of issues around the use of BMI centile thresholds for defining underweight, overweight and obesity in children aged 2-18 years in the UK*. April 2012. Online at:

[http://www.sacn.gov.uk/reports\\_position\\_statements/position\\_statements/sacnrcpch\\_joint\\_statement\\_on\\_defining\\_child\\_underweight\\_overweight\\_and\\_obesity\\_in\\_the\\_uk\\_-\\_april\\_2012.html](http://www.sacn.gov.uk/reports_position_statements/position_statements/sacnrcpch_joint_statement_on_defining_child_underweight_overweight_and_obesity_in_the_uk_-_april_2012.html) (accessed 17/06/2013)

<sup>18</sup> The age at which a participant is defined as an adult is slightly different between the surveys: in the NDNS RP participants aged 19 years and over are classed as adults whereas for HSE and SHeS, those aged 16 years and over are defined as adults. In the results, 'younger' means from that minimum age up to 64 years.

<sup>19</sup> Rutherford L, Hinchliffe S, Sharp C (eds). *The Scottish Health Survey 2012*. Edinburgh: Scottish Executive, 2012. It should be noted that the SHeS excludes children whose BMI was more than 7 standard deviations above or below the norm for their age. The SHeS 2011 estimates shown are revised figures: originally, cases which were more than 3 standard deviations above or below the mean were excluded.

<sup>20</sup> Hypertension was defined as at or over 140/90mmHg in the following paper: Williams B, Poulter NR, Brown MJ et al. *Guidelines for management of hypertension: report of the fourth working party of the British Hypertension Society, 2004 –BHS IV*. *J Hum Hypertens*. 2004; 18:139-85. These thresholds were reiterated in the latest NICE guidelines, which also recommend ambulatory blood pressure monitoring to confirm a diagnosis of hypertension if the clinic measurement indicates blood pressure at or over the 140/90mmHg threshold. <http://publications.nice.org.uk/hypertension-cg127/key-priorities-for-implementation#diagnosing-hypertension> (accessed 17/06/2013). Within the constraints of the survey, blood pressure was measured three times, and the average of the second and third readings used for analysis.

<sup>21</sup> Participants who reported that they were taking medication prescribed for hypertension are classified as either controlled (if their blood pressure falls within the normal range) or uncontrolled (if it is raised).

<sup>22</sup> Besson H, Brage S, Jakes RW, Ekelund E, Wareham NJ. Estimating physical activity energy expenditure, sedentary time and physical activity intensity by self-report in adults. *Am J Clin Nutr*. 2010;91:106-114.

<sup>23</sup> Craig R, Mindell J, Hirani V (eds). *Health Survey for England 2008: Physical activity and fitness*. Leeds: NHS Information Centre, 2009.

<sup>24</sup> Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of Physical Activities: an update of activity codes and MET intensities. *Med Sci Sport Exer*. 2000;32(suppl):S498-S516.

<sup>25</sup> The HSE findings reported in this paragraph refer to Table 3.12 in the HSE 2008 report and so are restricted to those adults with a minimum of four days of valid accelerometry data.

<sup>26</sup> The ActiGraph model is a small and lightweight device around the size of a matchbox that is worn on the waist using a belt. A detailed description of the ActiGraph is available in Appendix G.

<sup>27</sup> A number of different authors have produced thresholds to distinguish these categories of activity intensity, based on counts per minute (cpm), by asking children to walk or run on a treadmill while wearing an accelerometer, then comparing the cpm data with the known speed of walking/running. However, these equations vary depending on the age of the study participants and other less-well characterised factors.

<sup>28</sup> Wear time is an integrated wear probability. It represents the area under the wear probability time-series for each participant and so represents an integral with respect to time. For this report we set the minimum wear time criterion for inclusion in analysis at 24 hours (i.e. at least 8 h/d on at least 3 days). However, the opportunity for accumulating wear time is somewhat age-dependent.

<sup>29</sup> It is possible to convert cpm (counts per minute) levels to METs (metabolic equivalents, as measure of the intensity of activity) and then to physical activity energy expenditure. A number of additional assumptions are required to derive these energy variables, so the decision was made to restrict this chapter to cpm data.

<sup>30</sup> Basterfield L, Adamson AJ, Frary JK, Parkinson KN, Pearce MS, Reilly JJ and for the Gateshead Millennium Study Core Team. 2011. Longitudinal study of physical activity and sedentary behavior in children. *Pediatrics*, 127, e24.

<sup>31</sup> Leary SD, Ness AR, Smith GD, Mattocks C, Deere K, Blair SN, Riddoch C. Physical Activity and Blood Pressure in Childhood. *Hypertension*. 2008;51:92-98.

<sup>32</sup> To put these values into context, the average cpm in the ALSPAC children for over a 5-minute period of each activity were: 2,954 cpm for slow walking (4.4 kph), 4,175 cpm for brisk walking (5.8 kph), and 7,667cpm for jogging (9.2 kph) (ref 30 above, Leary et al 2008).

## 5 Dietary intakes

*Original authors: Alison Lennox, Celia Prynne & Gillian Swan*

*Updated by: Caireen Roberts, Toni Steer, Sonja Nicholson, David Pell, Alison Lennox & Polly Page*

### 5.1 Introduction

The results presented in this chapter derive from Years 1 to 4 combined of the NDNS Rolling Programme (RP). Dietary data were collected between February 2008 and April 2012, with a UK sample of 6,828 individuals aged 1.5 years and over. The analysis in this report is based on both core cases from the UK sample and country boost cases from Scotland, Wales and Northern Ireland (see section 2.8). The country boost cases have been weighted down to reflect the population distribution in the UK (see Appendix B). The results supersede those reported for previous years of the NDNS RP.<sup>1,2,3</sup> No comparisons have been made between individual years of the survey because of the limited sample size in each year. However, comparisons have been made between Years 1 and 2 combined and Years 3 and 4 combined and these are presented in Chapter 10.

Results in this chapter are presented for both sexes combined for the age groups: 1.5 to 3 years, 4 to 10 years, 11 to 18 years, 19 to 64 years and 65 years and over. Results are also subdivided by sex for all age groups, except for children aged 1.5 to 3 years as intakes in this age group do not tend to vary by sex. Unless stated otherwise, all Dietary Reference Values (DRVs) discussed in Chapter 5 are those presented in the 1991 Committee on Medical Aspects of Food Policy (COMA) report on Dietary Reference Values for Food Energy and Nutrients for the United Kingdom.<sup>4</sup>

Results are based on dietary assessment using a four-day estimated food diary and represent a daily average of the days assessed.<sup>5</sup> In Year 1 the study design was to have each participant record both weekend days, in an effort to capture both weekday and weekend consumption for each person. It was thought that the oversampling of weekend days in Year 1 could have led to a bias in reported food consumption and nutrient intake, since it has been shown that there is day-to-day variation in intake of some foods and nutrients for specific age/sex groups. For example, men often consumed alcoholic beverages and takeaway foods more frequently on Fridays and Saturdays, whilst Sunday is often associated with higher consumption of meat and

vegetables in many groups (unpublished data). Hence the protocol was changed to one where all days of the week would (as far as possible) be equally represented. Year 2 was therefore designed to over-represent weekdays and under-represent weekend days to compensate for the over-representation of weekend days in Year 1 (see section 2.5.1.3). Years 3 and 4 were designed so that all days of the week were evenly represented. However, in the Years 1 to 4 combined data, there remains a slightly higher proportion of weekend days than weekdays (see Table 5A below). This may be explained by the survey design allowing some flexibility in the diary start day to help maintain response rates.

**Table 5A: Number of diary days by day of week (Years 1 to 4 combined)**

<b>Day of the week</b>	<b>Number of diary days</b>	<b>% of total days</b>
Monday	3,677	13.5
Tuesday	3,477	12.8
Wednesday	3,382	12.4
Thursday	3,879	14.3
Friday	4,234	15.6
Saturday	4,302	15.8
Sunday	4,232	15.6

Dietary surveys are reliant on self-reported measures of food intake. Misreporting of food consumption, generally underreporting, in self-reported dietary methods is a well-documented issue. The underreporting of energy intake (EI) is known to be an issue in past and current NDNS, as for all dietary surveys and studies.<sup>6,7</sup> This is an important consideration when interpreting the findings from this survey. Previous NDNS and the current RP are unique amongst large-scale population surveys in their inclusion of doubly labelled water (DLW)<sup>8</sup> as an objective biomarker to validate EI estimated from reported food consumption.

In the NDNS RP, estimates of EI from the four-day diary were compared with measurements of total energy expenditure (TEE) using the DLW technique in a sub-sample of survey participants. The results of this analysis indicated that reported EI in adults aged 16 to 64 years was on average 34% lower than TEE measured by the DLW technique, 12% lower in children aged 4 to 10 years, 26% lower in children aged 11 to 15 years, and 29% lower in adults aged 65 years and over. There are a number of factors that may contribute to this difference including: misreporting of actual consumption; the possibility that participants underreported or changed their usual intake during the diary period which was typically two to three weeks prior

to the DLW measurement; and, methodological considerations relating to dietary assessment method, food composition and portion assignment used in NDNS RP. It is not possible to extrapolate this estimate of underreporting to individual foods and nutrients because they may be affected differentially.

The energy and nutrient intakes presented in this report have not been adjusted to take account of underreporting.

Appendix X provides a summary of the DLW method, the results obtained and an illustration of a number of considerations relevant to the interpretation of the survey findings.

Results for key foods and nutrients in Years 1 to 4 are presented with a more detailed age breakdown for young people and adults in Chapter 8, and by equivalised income in Chapter 9. Comparisons between Years 1 and 2 and Years 3 and 4 of the RP, and observed differences between Years 1 to 4 of the RP and previous NDNS, are reported for key foods and nutrients in Chapter 10.

## 5.2 Foods consumed

Tables 5.1a-5.1c show mean consumption of standard NDNS food groups for the total survey population (i.e. including non-consumers, those who did not consume from a food group during the four-day diary recording period). Tables 5.2a-5.2c show mean consumption of standard NDNS food groups for consumers only and the percentage of consumers over four days. Mean consumption levels highlighted in the commentary below are for the total survey population including non-consumers of the food group. Details of the food groups can be found in Appendix R.

**(Tables 5.1a-5.2c)**

## 5.3 Cereals and cereal products

For all age groups, except those aged 65 years and over, 'white bread' and 'pasta, rice, pizza and other miscellaneous cereals' were the two most commonly consumed cereals and cereal products, eaten by more than 70% over the four-day recording period. Children aged 10 years and under consumed similar quantities of bread (all types combined) and 'pasta, rice, pizza and other miscellaneous cereals', as did adults aged 19 to 64 years. Children aged 11 to 18 years

consumed more 'pasta, rice, pizza and other miscellaneous cereals' than bread; while adults aged 65 years and over consumed more bread. 'Biscuits' were also consumed by more than 70% of those aged 10 years and under and those aged 65 year and over.

## **5.4 Milk and milk products**

For most age groups, 'semi-skimmed milk' had the highest mean consumption and was the most commonly consumed type of milk. The exception was those aged 1.5 to 3 years for whom 'whole milk' was the most commonly consumed milk. For all age groups, 'cheddar cheese' had the highest mean consumption compared with other types of cheese. Around two-thirds of participants in all age groups consumed cheese.

### **5.4.1 Fat spreads**

For all age groups, except those aged 65 years and over, 'reduced fat spread (not polyunsaturated)' was the most commonly consumed fat spread. For adults aged 65 years and over, 'butter' was the most commonly consumed.

### **5.4.2 Meat and meat products and dishes**

Consumption figures for 'meat and meat products' presented in Tables 5.1a-5.2c include non-meat components of composite and recipe dishes. 'Chicken, turkey and dishes' was the most commonly consumed type of meat for all age groups except those aged 65 years and over. For adults aged 65 years and over, the most commonly consumed type of meat was 'bacon and ham', with 60% having eaten this type of meat over the four-day recording period.

Results for disaggregated total meat consumption, excluding non-meat components of meat dishes and products, are presented in Table 5.3 and discussed in section 5.3.

### **5.4.3 Fish and fish dishes**

The highest per cent consumers of 'oily fish' over the four-day recording period were adults aged 65 years and over (38%), followed by adults aged 19 to 64 years (23%). For children, 8-12% consumed oily fish over the four-day recording period. 'White fish coated or fried including

fish fingers' was the most commonly consumed type of fish for children aged 10 years and under.

Results for disaggregated total fish consumption, excluding non-fish components of fish products and dishes are presented in Table 5.3 and discussed in section 5.3.

#### **5.4.4 Fruit and vegetables**

This section refers to fruit and vegetables consumed as discrete items, but excludes those consumed as part of composite dishes such as in meat and in fish dishes. Fruit and vegetable consumption including the contribution from composite dishes and as "5-a-day" portions are presented in Table 5.3 and discussed in section 5.3.

Children aged 1.5 to 3 years were the highest per cent consumers of 'fruit' over the four-day recording period (93%), followed by children aged 4 to 10 years (90%). Children aged 11 to 18 years were the lowest per cent consumers of 'fruit' (67%).

'Vegetables (not raw) including vegetable dishes' were consumed by 80% or more participants in all age groups. 'Salad and other raw vegetables' were less commonly consumed, particularly by children, about 50% of whom ate this type of food over the four-day recording period.

The highest percentage of consumers of 'chips, fried and roast potatoes and potato products' was in the 4 to 10 years age group (79%) and lowest in those aged 65 years and over (55%).

#### **5.4.5 Sugar, confectionery and snacks**

Mean consumption of 'sugar confectionery' and 'chocolate confectionery' combined was highest in the 11 to 18 years age group (19g per day) and the 4 to 10 years age group (18g per day). 'Chocolate confectionery' was consumed by 56-59% of children aged 4 to 18 years and 'sugar confectionery' by 49% of those aged 4 to 10 years and 35% of those aged 11 to 18 years. Mean consumption of 'sugar' and 'chocolate confectionery' combined was lowest in those aged 65 years and over (5g per day). However, the 65 years and over age group had the highest mean consumption of 'table sugar, preserves and sweet spreads' (14g per day).

#### 5.4.6 Beverages

Children aged 4 to 10 years were the highest per cent consumers of 'fruit juice' over the four-day recording period (62%) while adults aged 65 years and over were the lowest (37%). Highest mean consumption of 'soft drinks, not low calorie' was seen in children aged 11 to 18 years (261g per day); while highest mean consumption of 'soft drinks, low calorie' was seen in children aged 10 years and under (183g-185g per day). Children aged 10 years and under consumed more 'soft drinks, low calorie' than 'soft drinks, not low calorie'. Sixty-nine per cent of children aged 4 to 10 years and 78% of those aged 11 to 18 years consumed 'soft drinks, not low calorie' over the four-day recording period compared to 67% and 55% respectively who consumed 'soft drinks, low calorie'.

Adults aged 19 to 64 years had the highest mean consumption of total 'alcoholic beverages'. For 'wine', women aged 19 to 64 years had the highest mean consumption (67g per day) and were the highest per cent consumers of this type of alcoholic drink (40%). Men aged 19 to 64 years had the highest mean consumption of 'beer, lager, cider and perry' (337g per day) and were the highest per cent consumers of this type of alcoholic drink (52%). As noted in section 5.1, there remains a slightly higher proportion of weekend days than weekdays in the Years 1 to 4 combined data (see Table 5A) and this may have some effect on the results for consumption of alcoholic beverages.

#### 5.5 Vegetable, fruit, meat and fish consumption, including from composite dishes

This section reports consumption of vegetables, fruit, meat and fish, including the contribution from composite dishes (both homemade dishes and manufactured products), but excluding the other components of those dishes. All composite dishes in the NDNS Nutrient Databank have been disaggregated into their constituent ingredients so they can be reported separately. Details on the NDNS Nutrient Databank and the methodology for the disaggregation of composite dishes is provided in Appendix A. Mean consumption figures presented in Table 5.3 are for the total population (i.e. including non-consumers, those who did not consume from a food group during the four-day diary recording period).

As fruit and vegetable consumption figures in Table 5.3 are based on disaggregated data they give higher estimates of consumption than Tables 5.1a - 5.1c as the latter are based on fruit,

salad and cooked vegetables consumed and reported as discrete items, and exclude fruit and vegetables in mixed dishes which are reported according to the main component of the dish.

Mean total vegetable consumption based on disaggregated data was 72g per day for children aged 1.5 to 3 years, 97g per day for children aged 4 to 10 years and 112g per day for children aged 11 to 18 years. For adults, those aged 19 to 64 years consumed a mean of 183g per day and those aged 65 years and over consumed a mean of 186g per day. Mean total fruit consumption was 107-108g per day for children aged 10 years and under. Mean total fruit consumption for children aged 11 to 18 years was 60g per day, just over half that of the younger children; this was the case for both boys and girls. Adults aged 19 to 64 years consumed a mean of 100g of fruit per day and adults aged 65 years and over consumed a mean of 134g per day. Mean consumption of fruit juice was highest in children aged 4 to 18 years (104-111g per day) and lowest in those aged 65 years and over (56g per day).

The number of portions of fruit and vegetables consumed per day has been calculated from the disaggregated data in line with the “5-a-day” criteria, including up to one portion each of fruit juice and baked beans or pulses per day (see Appendix A). For children aged 11 to 18 years, mean consumption was 3.0 portions per day for boys and 2.7 portions per day for girls.<sup>9</sup> Adults aged 19 to 64 years consumed 4.1 portions per day, while adults aged 65 years and over consumed 4.6 portions per day. The proportion of participants meeting the “5-a-day” guideline was 9% of children aged 11 to 18 years, 30% of adults aged 19 to 64 years and 41% of adults aged 65 years and over.

Meat and fish consumption presented in Table 5.3 is based on disaggregated data. These figures give lower estimates of consumption than the figures presented in Tables 5.1a - 5.1c which include the non-meat and non-fish components of composite products and dishes. Total meat consumption based on disaggregated data was 109g per day for adults aged 19 to 64 years and 86g per day for adults aged 65 years and over. Consumption of red meat was 71g per day for adults aged 19 to 64 years and 63g per day for adults aged 65 years and over. The current recommendation is that, for adults, average intakes of red and processed meat should not exceed 70g per day.<sup>10</sup> Mean consumption of oily fish was well below the recommendation of at least one portion (140g) per week<sup>11</sup> in all age groups: for adults aged 19 to 64 years, mean consumption was equivalent to 53g per week and equivalent to 90g per week for adults aged 65 years and over.<sup>12</sup>

(Table 5.3, Appendix A)

## 5.6 Energy and macronutrient intake and percentage contribution of food groups to intake

This section presents daily intakes of energy and macronutrients estimated from the food consumption data, and the percentage contribution of the major food types to intake of each nutrient.

Mean daily intakes of energy and macronutrients are compared with the UK DRVs.<sup>1,13</sup> For total fat and saturated fatty acids and non-milk extrinsic sugars (NMES) the DRVs are the recommended maximum contribution these nutrients should make to the population average diet.<sup>14</sup> For total carbohydrate, *cis*-monounsaturated fatty acids and non-starch polysaccharide (NSP) the DRVs are recommended population averages. For protein, the Reference Nutrient Intakes (RNIs) are set at levels of intake considered likely to be sufficient to meet the requirements of 97.5% of the population. For total energy, the DRVs are defined as the Estimated Average Requirements (EARs), that is, the average of energy requirements for any population group and have been taken from the 2011 Scientific Advisory Committee on Nutrition (SACN) report on Dietary Reference Values for Energy.<sup>13</sup>

Analysis of the percentage contribution of the major food groups to energy and macronutrient intakes shown in Tables 5.5-5.12 uses the traditional NDNS food groups presented in section 5.2 and not the disaggregated food groups presented in section 5.3.

### 5.6.1 Energy

Mean daily intakes for total energy were 4.75 MJ (1126 kcal) for children aged 1.5 to 3 years, 6.46 MJ (1532 kcal) for children aged 4 to 10 years, 7.48 MJ (1776 kcal) for children aged 11 to 18 years, 8.88 MJ (2111 kcal) for men aged 19 to 64 years, 6.78 MJ (1613 kcal) for women aged 19 to 64 years, 8.14 MJ (1935 kcal) for men aged 65 years and over and 6.35 MJ (1510 kcal) for women aged 65 years and over. Mean daily intakes for total energy were close to or above the EAR in children aged 10 years and under but below the EAR in the other age groups (around 80% of the EAR in adults aged 19 years and over and around 70% in children aged 11 to 18 years).

'Cereals and cereal products' was the main source of energy for all age groups, contributing 31% to energy intake for children aged 1.5 to 3 years, 35-36% for children aged 4 to 18 years and 31% for adults aged 19 years and over. 'Milk and milk products' was the second largest contributor to energy intake for children aged 1.5 to 3 years (25%) while 'meat and meat products' was the second largest contributor to energy intake for children aged 11 to 18 years and adults aged 19 to 64 years (both 17%). Children aged 4 to 10 years and adults aged 65 years and over derived a similar proportion of energy from 'milk and milk products' and 'meat and meat products' (12-15%).

**(Tables 5.4 and 5.5)**

### **5.6.2 Protein**

Mean protein intakes were well above the RNI in all age/sex groups (table not included) and provided 14-15% of food energy for children and 17-18% for adults.

'Meat and meat products' was the largest contributor to protein intake for all age groups except children aged 1.5 to 3 years, with the contribution highest in children aged 11 to 18 years and adults aged 19 to 64 years (both 38%). 'Milk and milk products' was the major contributor to protein intake for children aged 1.5 to 3 years, providing 34% of intake. 'Cereal and cereal products' was the second largest contributor to protein intake for all age groups, providing 24% of protein intake for children aged 1.5 to 3 years, 27-28% for children aged 4 to 18 years and 22-23% for adults aged 19 years and over.

**(Tables 5.4 and 5.6)**

### **5.6.3 Carbohydrate**

The DRV for total carbohydrate is 50% of food energy as a population average. Mean total carbohydrate intakes ranged from 47.2% food energy (adults aged 65 years and over) to 52.1% (children aged 4 to 10 years).

'Cereals and cereal products' was the major contributor to carbohydrate intake, providing 42% for children aged 1.5 to 3 years, 45-46% for children aged 4 to 18 years, and 45% for all adults aged 19 years and over. 'Milk and milk products' contributed 16% to carbohydrate intake for children aged 1.5 to 3 years, but contributed much less for all other age groups (5-9%). For

children aged 4 to 10 years and adults aged 19 years and over, the 'vegetables and potatoes' group was the second largest contributor to carbohydrate intake providing 11% and 14% respectively. For children aged 11 to 18 years, 'non-alcoholic beverages' was the second largest contributor, providing 13% of carbohydrate intake, mainly from soft drinks.

**(Tables 5.4 and 5.7)**

#### **5.6.4 Non-milk extrinsic sugars**

The DRV for NMES is that the population average intake should provide no more than 11% of food energy intake. Mean intakes of NMES as a percentage of food energy exceeded the DRV in all age groups particularly in children aged 4 to 10 years (14.7%) and children aged 11 to 18 years (15.6%).

For children aged 10 years and under, the main sources of NMES were 'non-alcoholic beverages' (27-30%) and 'cereals and cereal products' (25-29%). For children aged 11 to 18 years, 'non-alcoholic beverages' was the largest contributor to NMES intake, providing 40%, mainly from soft drinks (30%). 'Fruit juice' contributed 10-14% to NMES intake in children across the age groups. 'Sugar, preserves and confectionery' contributed an additional 19-22% to intake for children.

For adults aged 19 to 64 years, the main sources of NMES were 'sugar, preserves and confectionery' (26%), 'non-alcoholic beverages' (25%) and 'cereals and cereal products' (21%). 'Alcoholic drinks' provided a further 10% of intake. 'Cereals and cereal products' was the main contributor to NMES intake for adults aged 65 years and over (29%) and 'sugar, preserves and confectionery' (26%).

**(Tables 5.4 and 5.8)**

#### **5.6.5 Non-starch polysaccharides**

Mean intakes of NSP were 8.2g per day for children aged 1.5 to 3 years and 11.1-11.8g per day for children aged 4 to 18 years. For adults aged 19 years and over, the DRV is set at a population average intake of 18g per day; mean intakes were well below this at 13.7-13.9g per day.

'Cereals and cereal products' was the main source of NSP for all age groups, contributing 41% for children aged 1.5 to 3 years, 42% for children aged 4 to 18 years, and 39% for adults aged 19 years and over. 'Vegetables and potatoes' were the second major contributor to NSP, showing an increasing contribution with age, from 24% in children aged 1.5 to 3 years to 32% for adults aged 65 years and over.

**(Tables 5.4 and 5.9)**

### **5.6.6 Total fat**

The DRV for total fat is that the population average intake should provide no more than 35% of food energy intake.<sup>14</sup> Mean percentage food energy from total fat met the recommendation in all age/sex groups, except for men aged 65 years and over, for whom total fat provided 36.0% food energy.

'Milk and milk products' was the major contributor to total fat intake for children aged 1.5 to 3 years, providing 34%, (15% from 'whole milk'). 'Milk and milk products' also provided 20% of total fat intake for children aged 4 to 10 years along with 24% from 'cereals and cereal products' and 19% from 'meat and meat products'. For the other age groups the main sources of total fat were 'meat and meat products', contributing 20-24% of total fat intake, and 'cereals and cereal products', contributing 19-23%. Adults aged 65 years and over derived 15% of their total fat intake from 'fat spreads' (7% from 'butter').

**(Tables 5.4 and 5.10)**

### **5.6.7 Saturated fatty acids**

The DRV for saturated fatty acids is that the population average intake should not exceed 11% of food energy intake.<sup>14</sup> Mean intakes of saturated fatty acids exceeded the DRV for all age groups at 13.2% for children aged 4 to 10 years, 12.5% for children aged 11 to 18 years, 12.6% for adults aged 19 to 64 years and 13.8% for adults aged 65 years and over.

'Milk and milk products' was the largest contributor to saturated fatty acids in children aged 1.5 to 3 years and children aged 4 to 10 years, providing 46% and 31% respectively. This food group was also among the main sources of saturated fatty acids for the other age groups, providing 22-25%. Other key sources were 'cereals and cereal products', contributing 18-25%

to intake across all age groups, and 'meat and meat products', contributing 13-17% for children aged 10 years and under, 23% for children aged 11 to 18 years and 20-24% for adults aged 19 years and over. 'Fat spreads' contributed 16% to saturated fatty acids intake for adults aged 65 years and over, mainly from 'butter' (10%).

**(Tables 5.4 and 5.11)**

### **5.6.8 *Trans* fatty acids**

The DRV for *trans* fatty acids is that the population average intake should provide no more than 2% of food energy. Mean *trans* fatty acid intakes were less than 2g per day for all age groups, representing 0.6-0.7% of food energy, thereby meeting the DRV. Intakes at the upper 2.5 percentile also met the DRV, providing 1.1-1.5% of food energy.

*Trans* fatty acids are derived from two sources in the diet: those that occur naturally in meat and dairy products of ruminant animals, and those produced artificially through food processing. The levels of *trans* fats from artificial sources have been reduced in recent years. This has resulted in a relative increase in the per cent contribution to intake of *trans* fats derived from natural sources.

'Milk and milk products' was the largest contributor to *trans* fatty acid intake in children aged 1.5 to 3 years (47%) and children aged 4 to 10 years (36%). In the other age groups, the largest contributors to *trans* fatty acid intake were 'milk and milk products' (27-29%) and 'meat and meat products' (23-26%). 'Cereals and cereal products' contributed 14-20% to *trans* fatty acid intake across the age groups.

**(Tables 5.4 and 5.12)**

### **5.6.9 Unsaturated fatty acids**

The DRV for *cis* monounsaturated fatty acids is 13% of food energy as a population average. Mean intakes of *cis*-monounsaturated fatty acids provided 11-13% of food energy for children and 12-13% for adults.

Mean intake of *cis* n-3 polyunsaturated fatty acids (PUFA), expressed as a percentage of food energy, increased with age from 0.7% for children aged 1.5 to 3 years to 1.1% for adults aged 65 years and over.

Mean intake of *cis* n-6 PUFA expressed as a percentage of food energy showed a similar trend with age, ranging from 3.9% for children aged 1.5 to 3 years to 4.8-5.1% for adults aged 19 years and over.

**(Table 5.4)**

## 5.7 Alcohol

This section reports on alcohol intake in grams per day and as a per cent of total energy, for both the total population (including non-consumers) and consumers only (those who reported consumption of alcoholic beverages in the four-day food diary and includes those who consumed dishes containing alcohol). In the Years 1 to 4 combined data, there is a slightly higher proportion of weekend days than weekdays and this should be taken into account when interpreting findings on alcohol intake as there is evidence that alcohol consumption is higher on weekend days than week days (see section 5.1 Table 5.A).

For adult consumers, alcohol provided on average 8.4% and 6.4% of energy intake for those aged 19 to 64 years and 65 years and over respectively. A higher proportion of adults aged 19 to 64 years (58%) consumed alcohol than did adults aged 65 years and over (51%); in both age groups, the proportion of male consumers was higher than female consumers. For male consumers, intakes at the upper 2.5 percentile provided 29.0% of energy intake from alcohol over the four-day recording period for those aged 19 to 64 years and 23.3% for those aged 65 years and over. For female consumers aged 19 to 64 years, alcohol intake at the upper 2.5 percentile provided 22.9% of energy intake.

Thirteen per cent of participants aged 11 to 18 years consumed alcohol in some form during the four-day recording period, and for them, alcohol provided on average 5.9% of energy intake for boys and 5.6% of energy intake for girls. At the upper 2.5 percentile, alcohol provided 26.7% of energy intake for male consumers and 31.9% of energy intake for female consumers.<sup>15</sup> Most of the consumers of alcoholic beverages in the 11 to 18 years age group were aged 15 to 18 years.

Questions about alcoholic beverage consumption were also asked in the CAPI interview and via self-completion for children and young adults. This is reported in Chapter 3, section 3.7 in terms of units of alcohol and related to recommended sensible drinking guidelines. The time period recalled in the CAPI/self-completions was the seven days before interview and so does not overlap with the diary recording period.

**(Table 5.13)**

## 5.8 Vitamins and minerals and percentage contribution of food groups to micronutrient intakes

Intakes of vitamins and minerals are reported in two ways: from foods only and from all sources, that is, including dietary supplements, as recorded in the four-day food diary. This section also reports on vitamin and mineral intakes from foods only for the group of individuals who recorded taking at least one dietary supplement (regardless of the type) during the four-day recording period compared with intakes for the group who did not record taking any dietary supplements during this period. The percentage of individuals taking supplements and the different types of dietary supplements taken is reported in section 5.7.

For those vitamins and minerals for which UK RNIs and Lower Reference Nutrient Intakes (LRNIs) have been published,<sup>1</sup> the proportions of participants with intakes below the LRNI is shown and mean daily intake for each age/sex group is compared with the RNI. The RNI for a vitamin or mineral is the amount of the nutrient that is sufficient for 97.5% of people in the group. If the average intake of the group is at the RNI, then the risk of deficiency in the group is judged to be very small. However, if the average intake is lower than the RNI then it is more likely that some of the group will have an intake below their requirement. The adequacy of vitamin or mineral intake can be expressed as the proportion of individuals with intakes below the LRNI. The LRNI for a vitamin or mineral is set at the level of intake considered likely to be sufficient to meet the needs of only 2.5% of the population. An intake below the LRNI is only considered a problem if sustained over a period of time. As diet is recorded for only four days in the NDNS RP, estimated intake values may not represent intakes over the longer term for micronutrients that are not widely distributed in foods such as vitamin A. It should also be noted that DRVs for some micronutrients such as magnesium, potassium, selenium and zinc are based on very limited data so caution should be used when assessing adequacy of intake using the LRNI. Published UK RNIs and LRNIs are shown in Tables 5.14 and 5.32.

Analysis of the percentage contribution of the major food groups to micronutrient intake, as shown in Tables 5.21-5.31 and Tables 5.39-5.47, uses the traditional NDNS food groups presented in section 5.2 and not the disaggregated food groups presented in section 5.3.

**(Table 5.14 and 5.32)**

## **5.8.1 Vitamins**

### **5.8.1.1 Vitamin A and retinol**

Vitamin A is found in two forms: as retinol in foods from animal sources and as carotenoids (mainly beta-carotene) in foods from plant sources. Some carotenoids can be converted to retinol in the body; 6mg of dietary beta-carotene is considered equivalent to 1mg of retinol. The total vitamin A content of the diet (from both animal and plant sources) is normally expressed as retinol equivalents (RE). Intakes are presented in this report for total vitamin A and pre-formed retinol. Intakes of carotenoids are not presented but will be included in the dataset deposited at the UK Data Archive.<sup>16</sup> Details can be found in Appendix W.

Mean daily intakes of vitamin A from food sources were close to or above the RNI for all age/sex groups. Thirteen per cent of children aged 11 to 18 years had intakes from food sources below the LRNI. The inclusion of dietary supplements had little effect on the per cent with intakes below the LRNI.

Vegetables were the major contributor to vitamin A intake for all age groups except children aged 1.5 to 3 years, providing 26-35% of intake. 'Milk and milk products' was the major contributor to vitamin A intake for children aged 1.5 to 3 years, providing 33% of intake. 'Fat spreads' contributed 12-14% to intakes across the age groups.

'Milk and milk products' was the largest contributor to retinol intake for all age groups, except those aged 65 years and over, with the contribution decreasing with age from 56% for children aged 1.5 to 3 years to 30% for adults aged 19 to 64 years. 'Fat spreads' was the second largest contributor and the contribution increased with age from 19% for children aged 1.5 to 3 years to 24% for adults aged 19 to 64 years. For those aged 65 years and over, the contribution from 'milk and milk products' and from 'fat spreads' was the same (28%). 'Cereals and cereal products' contributed 11-20% of retinol intake across the age groups. 'Liver and liver dishes'

contributed 8% of intake in people aged 65 years and over and 4% in adults aged 19 to 64 years.

(Table 5.15-5.17a and 5.21-5.22)

### 5.8.1.2 Thiamin

Mean daily intakes of thiamin from food sources were well above the RNI for all age/sex groups. Less than 0.5% of participants had intakes of thiamin from food sources below the LRNI.

The major source of thiamin for all age groups was 'cereals and cereal products', mainly bread (all types combined) and fortified breakfast cereals. The contribution from 'cereals and cereal products' decreased with age, providing 41-44% of intake for children and 33-35% for adults. For children aged 1.5 to 3 years, 'milk and milk products' was the second largest contributor to thiamin intake (18%) while 'meat and meat products' and 'vegetables and potatoes' were the second largest contributors for the other age groups, the contribution increasing with age.

(Table 5.15-5.17a and 5.23)

### 5.8.1.3 Riboflavin

Mean daily intakes of riboflavin from food sources were above the RNI for all age/sex groups. However, 15% of children aged 11 to 18 years (9% of boys, 21% of girls) and 8% of adults aged 19 to 64 years (5% of men, 12% of women) had intakes of riboflavin from food sources below the LRNI. The inclusion of dietary supplements had little effect on the percentages with intakes below the LRNI.

The major contributor to riboflavin intake was 'milk and milk products', providing 55% for children aged 1.5 to 3 years, 41% for children aged 4 to 10 years and 28-34% for children aged 11 to 18 years and adults aged 19 years and over. 'Cereals and cereal products' contributed 20-24% to riboflavin intake for those aged 1.5 to 3 years and adults aged 19 years and over and 30-31% for those aged 4 to 18 years, about half of which came from fortified breakfast cereals. 'Meat and meat products' contributed an additional 16-17% to riboflavin intake for adults and older children and less for younger children (6-10%).

(Table 5.15-5.17a and 5.24)

#### **5.8.1.4 Niacin equivalents**

Mean daily intakes of niacin equivalents from food sources were well above the RNI for all age/sex groups. Less than 0.5% of participants had intakes of niacin equivalents from food sources below the LRNI.

'Cereals and cereal products' was the largest contributor to intake of niacin for children aged 1.5 to 3 years and 4 to 10 years, providing 33% and 35% respectively. 'Meat and meat products' was the largest contributor for older children aged 11 to 18 years and adults aged 19 years and over, providing 32-37%.

**(Table 5.15-5.17a and 5.25)**

#### **5.8.1.5 Vitamin B<sub>6</sub>**

Mean daily intakes of vitamin B<sub>6</sub> from food sources were well above the RNI for all age/sex groups. Less than 0.5% of participants had intakes of vitamin B<sub>6</sub> from food sources below the LRNI.

The major contributors to vitamin B<sub>6</sub> were 'cereals and cereal products' for children (22-25%), 'meat and meat products' for adults aged 19 to 64 years (24%) and 'vegetables and potatoes' for adults aged 65 years and over (22%). 'Milk and milk products' also provided 22% of vitamin B<sub>6</sub> intake for children aged 1.5 to 3 years.

**(Table 5.15-5.17a and 5.26)**

#### **5.8.1.6 Vitamin B<sub>12</sub>**

Mean daily intakes of vitamin B<sub>12</sub> from food sources were well above the RNI for all age/sex groups. The proportion of individuals with intakes below the LRNI was 2% or less.

'Milk and milk products' was the largest contributor to vitamin B<sub>12</sub> intake for all age groups, with the contribution highest for children aged 1.5 to 3 years (63%) decreasing to 33-35% for adults aged 19 years and over. The second largest contributor was 'meat and meat products' with the contribution increasing with age from 14% for children aged 1.5 to 3 years to 27-29% for children aged 11 to 18 years and adults aged 19 years and over.

**(Table 5.15-5.17a and 5.27)**

#### **5.8.1.7 Folate**

Mean daily intakes of folate from food sources were close to or above the RNI for all age/sex groups. Eight per cent of girls aged 11 to 18 years had intakes from food sources below the LRNI. The inclusion of dietary supplements had little effect on the percentages with intakes below the LRNI.

'Cereals and cereal products' was the largest contributor to folate intake for children, providing 33-37%. Fortified breakfast cereals provided about half of this for children aged 10 years and under. For adults, 'vegetables and potatoes' and 'cereals and cereal products' each provided 26-28% of folate intakes. 'Milk and milk products' provided 19% of folate intake for children aged 1.5 to 3 years. 'Beer, lager, cider and perry' contributed 10% to folate intake for men aged 19 to 64 years.

**(Table 5.15-5.17a and 5.28)**

#### **5.8.1.8 Vitamin C**

Mean daily intakes of vitamin C from food sources were well above the RNI for all age/sex groups. The proportion of individuals with intakes below the LRNI was 1% or less.

The main source of vitamin C for children was 'non-alcoholic beverages', providing 32-39%, of which 14-19% came from 'fruit juice' and 18-20% from soft drinks. For adults, the main source was 'vegetables and potatoes', providing 37-41% of vitamin C intake. 'Vegetables and potatoes' also contributed 16-27% to vitamin C intake for children. 'Fruit' provided 26% of vitamin C intake for children aged 1.5 to 3 years and 22% for children aged 4 to 10 years decreasing to 12% for children aged 11 to 18 years. 'Fruit' contributed 19-24% to vitamin C intake for adults and 'non-alcoholic beverages' contributed 15-22%.

**(Table 5.15-5.17a and 5.29)**

#### **5.8.1.9 Vitamin D**

For vitamin D, RNIs are set only for those aged up to four years and those aged 65 years and over. Mean intakes from food sources were well below the RNI in both these age groups: 27% of the RNI for children aged 1.5 to 3 years and 33% for adults aged 65 years and over. Inclusion of intakes from dietary supplements brought the mean intake up to 32% of the RNI for

children aged 1.5 to 3 years and 51% for adults aged 65 years and over. There are no LRNI set for vitamin D.

'Meat and meat products' was the major contributor to vitamin D intake for all age groups, except children aged 1.5 to 3 years, providing 23-35% of intake. 'Milk and milk products' was the major contributor to vitamin D intake for children aged 1.5 to 3 years, providing 24%. 'Fat spreads', most of which have added vitamin D, contributed 19-21% to intakes across the age groups. 'Cereals and cereal products' provided 13-20% of intake across the age groups, from fortified breakfast cereals and from 'buns, cakes, pastries and fruit pies' (via fats and eggs used as ingredients).

The contribution from 'fish and fish dishes' was higher for adults (17-23%) compared to children (8-9%) and was mainly from 'oily fish', a rich source of vitamin D.

**(Table 5.15-5.16a and 5.30)**

#### **5.8.1.10 Vitamin E**

There are no RNI or LRNI set for vitamin E. However, intakes above 4mg per day for men and above 3mg per day for women are considered safe and adequate.<sup>1</sup> Mean intakes of vitamin E for men and women were well above these levels in both age groups. The main source of vitamin E for children was 'cereals and cereal products' providing 22-25% of intake. For adults, 'vegetables and potatoes' provided 20% of vitamin E intake with 'cereal and cereal products' providing 19%.

**(Table 5.15-5.15a and 5.31)**

#### **5.8.2 Vitamin intakes for supplement takers vs non-supplement takers<sup>17</sup>**

For most age/sex groups, supplement takers had similar or higher mean intakes of vitamins from food sources only compared to non-supplement takers. For example, women aged 19 to 64 years who took supplements during the four-day recording period had a mean vitamin C intake of 96.3mg from food compared to 76.1mg for those who did not take supplements (27% higher). The percentage of individuals with intakes below the LRNI from food sources only was the same or lower in the supplement takers compared to the non-supplement takers for all

age/sex groups. For example, 15% of non-supplement takers aged 11 to 18 years had intakes from food below the LRNI for riboflavin compared to 9% of supplement takers.

The percentage of individuals taking supplements and the different types of dietary supplements taken is reported in section 5.7.

**(Table 5.18-5.20)**

### **5.8.3 Minerals**

#### **5.8.3.1 Iron**

Mean daily intakes of iron from food sources were below the RNI for some age/sex groups, particularly girls aged 11 to 18 years where the mean intake reached only 57% of the RNI and women aged 19 to 64 years where the mean intake was 78% of the RNI. Dietary supplements made little difference to mean intakes for girls aged 11 to 18 years. For women aged 19 to 64 years, dietary supplements made a considerable difference to iron intakes bringing the mean intake of women in this group as a whole (including non-supplement takers) up from 78% to 91% of the RNI, although there was little change to the median intake, suggesting that those with higher intakes from food sources were taking these supplements.

Forty-six per cent of girls aged 11 to 18 years and 23% of women aged 19 to 64 years had iron intakes from food sources below the LRNI. Dietary supplements had little impact on these groups in terms of the proportions with intakes below the LRNI.

'Cereals and cereal products' was the largest contributor to iron intake for all age groups, with the contribution decreasing with age from 53-55% for children aged 10 years and under to 39% for adults aged 19 years and over. Within 'cereals and cereal products', bread and fortified breakfast cereals were the main sources of iron intake. The other major contributors to iron intake were 'meat and meat products' which provided 18-21% of intake for children aged 11 to 18 years and adults, and less for younger children, and 'vegetables and potatoes' which provided 17% of intake in adults and 12-14% in children.

**(Table 5.33-5.35a and 5.39)**

### 5.8.3.2 Calcium

Mean daily intakes of calcium from food sources were above the RNI for all age groups except those aged 11 to 18 years for whom intakes were 89% and 84% of the RNI for boys and girls respectively. Inclusion of intakes from dietary supplements made little difference to mean intakes as a percentage of the RNI.

Nineteen per cent of girls and 8% of boys aged 11 to 18 years had calcium intakes from food sources below the LRNI. Eight per cent of women aged 19 to 64 years also had intakes below the LRNI. The inclusion of supplements had no impact on these groups in terms of the proportions with intakes below the LRNI.

'Milk and milk products' was the largest contributor to calcium intake for all age groups, with the contribution highest for children aged 1.5 to 3 years (61%) and 35-45% for other age groups. Of 'milk and milk products', milk was the main source for children aged 1.5 to 3 years while milk and cheese were the main sources for the other age groups. The second largest contributor was 'cereals and cereal products' with the contribution highest for children aged 11 to 18 years (37%) and lowest for children aged 1.5 to 3 years (24%).

(Table 5.33-5.35a and 5.40)

### 5.8.3.3 Magnesium

Mean daily intakes of magnesium from food sources were below the RNI for children aged 11 to 18 years (72% of RNI), adults aged 19 to 64 years (89% of RNI) and adults aged 65 years and over (87% of RNI). Inclusion of intakes from dietary supplements made little difference to mean intakes as a percentage of the RNI.

Forty per cent of children aged 11 to 18 years (28% of boys, 53% of girls), 14% of adults aged 19 to 64 years and 13% of adults aged 65 and over (19% of men, 8% of women) had magnesium intakes from food sources below the LRNI. Dietary supplements had little impact on the proportion with intakes below the LRNI.

'Cereals and cereal products' was the largest contributor to magnesium intake for all age groups, providing 28-33%. 'Milk and milk products' contributed 27% to intake for children aged

1.5 to 3 years and less for the other age groups (10-17%). Across the age groups, 'vegetables and potatoes' contributed 12-16% and 'meat and meat products' 8-16% to magnesium intake.

(Table 5.33-5.35a and 5.41)

#### 5.8.3.4 Sodium

Mean daily sodium intakes presented in this chapter underestimate total sodium intake from the diet as they include only sodium from food and do not include additional salt added in cooking or at the table by survey participants. More complete estimates of total sodium intake from the diet are derived from urinary sodium excretion data and are presented in Chapter 7.

'Cereals and cereal products' was the largest contributor to sodium intake from food for all age groups, providing 31-37%, of which 16-19% came from bread. 'Meat and meat products' was the second largest contributor for all age groups, providing 19-28% of sodium intake from food. 'Milk and milk products' contributed 18% for children aged 1.5 to 3 years and 8-11% for the other age groups.

(Table 5.42)

#### 5.8.3.5 Potassium

Mean daily intakes of potassium from food sources were below the RNI for children aged 11 to 18 years (70% of RNI), adults aged 19 to 64 years (80% of RNI) and adults aged 65 years and over (81% of RNI). Inclusion of intakes from dietary supplements made little difference to mean intakes as a percentage of the RNI.

Twenty-five per cent of children aged 11 to 18 years (16% of boys, 33% of girls), 17% of adults aged 19 to 64 years (11% of men, 23% of women) and 14% of adults aged 65 years and over had potassium intakes from food sources below the LRNI. Dietary supplements had no impact on the proportions with intakes below the LRNI.

'Vegetables and potatoes' was the largest contributor to potassium intake for children aged 11 to 18 years and adults aged 19 years and over, providing 24-25%. 'Milk and milk products' was the major contributor to potassium intake for children aged 1.5 to 3 years, providing 31% of intake. For children aged 4 to 10 years, 'vegetables and potatoes', 'milk and milk products' and 'cereals and cereal products' provided similar proportions (18-21%) to potassium intake. 'Meat

and meat products' contributed 9% of intake for the youngest age group and 13-18% for other age groups.

**(Table 5.33-5.35a and 5.43)**

#### **5.8.3.6 Zinc**

Mean daily intakes of zinc from food sources were close to or above the RNI for all age groups except those aged 11 to 18 years (90% and 81% of the RNI for boys and girls respectively). Inclusion of intakes from dietary supplements made little difference to mean intakes as a percentage of the RNI.

Nine per cent of children aged 4 to 10 years (7% of boys, 11% of girls), 17% of children aged 11 to 18 years (12% of boys, 22% of girls) and 10% of men aged 65 and over had zinc intakes from food sources below the LRNI. Dietary supplements had little impact on the proportion with intakes below the LRNI.

'Meat and meat products' was the largest contributor to zinc intake for children aged 11 to 18 years and adults aged 19 years and over, providing 32-35%. 'Milk and milk products' was the major contributor to zinc intake for children aged 1.5 to 3 years, providing 36% of intake while 'cereals and cereals products' were the largest contributor for children aged 4 to 10 years (31%).

**(Table 5.33-5.35a and 5.44)**

#### **5.8.3.7 Copper**

Mean daily intakes of copper from food sources were below the RNI for women aged 19 to 64 years (86% of RNI) and women aged 65 years and over (90% of RNI). Inclusion of intakes from dietary supplements made little difference to mean intakes as a percentage of the RNI. There are no LRNI's set for copper.

'Cereals and cereal products' was the largest contributor to copper intake for all age groups, providing 31-43%. 'Vegetables and potatoes' contributed 11-15% and 'meat and meat products' 12-17% of copper intake.

**(Table 5.33-5.34a and 5.45)**

#### **5.8.3.8 Selenium**

Mean daily intakes of selenium from food sources were below the RNI for children aged 11 to 18 years (74% of RNI), adults aged 19 to 64 years (71% of RNI) and adults aged 65 years and over (69% of RNI). The inclusion of intakes from supplements brought the mean intake of adults aged 65 years and over as a whole (including non-supplement takers) up from 69% to 77% of the RNI, although there was little change to the median intake, suggesting that those with higher intakes from food sources were taking these supplements. Dietary supplements made a smaller difference to mean selenium intakes as a percentage of the RNI for the other age groups.

Thirty-three per cent of children aged 11 to 18 years (22% of boys, 46% of girls), 38% of adults aged 19 to 64 years (26% of men, 51% of women) and 42% of adults aged 65 years and over (30% of men, 52% of women) had selenium intakes from food sources below the LRNI. Dietary supplements had little impact on the proportion of this group with intakes below the LRNI.

The main source of selenium for children aged 10 years and under was 'cereals and cereal products', providing 30-35% of intake. 'Milk and milk products' and 'meat and meat products' provided 20% each for the 1.5 to 3 years age group and 11% and 26% respectively for the 4 to 10 years age group. For all adults aged 19 years and over, the main source of selenium was 'meat and meat products', providing 28-32% of intake. For children aged 11 to 18 years, 'meat and meat products' and 'cereals and cereal products' provided similar proportions (33-34%). 'Fish and fish dishes' contributed 17-22% to selenium intake for adults and less for children (11-13%).

**(Table 5.33-5.35a and 5.46)**

#### **5.8.3.9 Iodine**

Mean daily intakes of iodine from food sources were close to or above the RNI for all age groups except girls aged 11 to 18 years (81% of RNI). The inclusion of intakes from dietary supplements had little impact on mean intakes as a percentage of the RNI.

Twenty-two per cent of girls and 9% of boys aged 11 to 18 years had iodine intakes from food sources below the LRNI. Ten per cent of women aged 19 to 64 years had intakes below the

LRNI. Dietary supplements had no impact on the proportions with intakes below the LRNI for these groups.

'Milk and milk products' was the largest contributor to iodine intake for all age groups, with the contribution highest for children aged 1.5 to 3 years (64%) decreasing to 33% for adults aged 19 to 64 years. 'Cereals and cereal products' provided 10-17% of iodine intake across the age groups. Adults derived 11-15% of their intake from 'fish and fish dishes' and 5-10% from 'alcoholic beverages'.

(Table 5.33-5.35a and 5.47)

#### **5.8.4 Mineral intakes for supplement takers vs non-supplement takers<sup>17</sup>**

Supplement takers in all age/sex groups had higher mean intakes of all minerals from food sources compared to the non-supplement takers. The percentage of individuals with intakes from food sources below the LRNI was generally higher in the non-supplement takers. For example, the percentage of women aged 65 years and over with selenium intakes from food below the LRNI was almost a third higher in the non-supplement takers group (61%) than in the supplement takers group (41%).

The percentage of individuals taking supplements and the different types of dietary supplements taken is reported in section 5.7.

(Table 5.36-5.38)

### **5.9 Dietary supplements**

Information on consumption of dietary supplements was collected both in the four-day food diary and in the CAPI interview, which asks about consumption in the year before interview. Dietary supplements were defined for participants as products intended to provide additional nutrients or give health benefits and taken in liquid, powder, tablet or capsule form. In the CAPI, participants were asked to list any dietary supplements taken over the past year. In the diary, participants were asked to write down the details of the supplements they took on each diary recording day.

Twenty-two per cent of adults aged 19 to 64 years (17% of men, 27% of women) and 41% of adults aged 65 years and over (35% of men, 47% of women) had taken at least one supplement during the four-day diary recording period. For children, supplement use was most common among children aged 4 to 10 years with 16% taking at least one supplement during the four-day diary period.

In general, a higher proportion of participants reported in the CAPI having taken at least one supplement during the previous year than reported taking a supplement during the four-day diary period: 30% of adults aged 19 to 64 years and 42% of adults aged 65 years and over reported having taken supplements in the past year.<sup>18</sup> This may be because of infrequent, intermittent or seasonal use of supplements which may not have been captured in the diary period.

For most age groups, the two most common types of supplements were fish oils (including cod liver oil) and multivitamins with or without minerals. Twenty-four per cent of adults aged 65 years and over (25% of men, 24% of women) took cod liver oil and other fish oils during the four-day diary period.

**(Tables 5.48 and 5.49)**

## 5.10 Summary

The findings presented in this chapter show that fruit and vegetable consumption was generally below recommendations in all relevant age groups. Adults aged 65 years and over were most likely to meet the “5-a-day” guideline and to also meet the recommendation to limit red meat consumption. This age group also had the highest consumption of oily fish, although this still fell below the recommended one portion per week.

Recommendations for total fat were met or very close to being met for all age groups. Recommendations for *trans* fatty acids were met in all age groups. However intakes of saturated fatty acids were in excess of the recommended level for all age groups. NMES intakes also exceeded the recommended level although children aged 1.5 to 3 years and adults aged 65 years and over were close to meeting it.

There was also evidence of low intakes for vitamin A, riboflavin and most minerals for some age groups, although it is important to take into account that the recording period was four days and this may have been an insufficient period to capture intakes of micronutrients that are found in a limited number of foods.

In general, supplement takers had higher intakes of vitamins and minerals from food sources than those who did not take supplements during the four-day recording period.

The findings also indicate that some age groups are consistently not meeting dietary recommendations. Children aged 11 to 18 years in particular consumed the fewest portions of fruit and vegetables, had the highest percentage of food energy from NMEs and substantial proportions of this age group fell below the LRNI for some vitamins and most minerals.

---

<sup>1</sup> [www.food.gov.uk/multimedia/pdfs/publication/ndnsreport0809.pdf](http://www.food.gov.uk/multimedia/pdfs/publication/ndnsreport0809.pdf) (accessed 28/01/14).

<sup>2</sup> [http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH\\_128166](http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH_128166) (accessed 28/01/14).

<sup>3</sup> <https://www.gov.uk/government/publications/national-diet-and-nutrition-survey-headline-results-from-years-1-2-and-3-combined-of-the-rolling-programme-200809-201011> (accessed 28/01/14).

<sup>4</sup> Report on Health and Social Subjects 41 *Dietary Reference Values (DRVs) for Food Energy and Nutrients for the UK*, Report of the Panel on DRVs of the Committee on Medical Aspects of Food Policy (COMA) 1991. The Stationery Office. London

<sup>5</sup> Participants with dietary data for at least three days were included in the analyses (129 of the 6828 participants had three rather than four days of dietary data).

<sup>6</sup> Black, AE, Prentice, AM, Goldberg, GR, Jebb, SA, Bingham, SA, Livingstone, MB, Coward, WA, (1993). Measurements of total energy expenditure provide insights into the validity of dietary measurements of energy intake. *J Am Diet Assoc*, 93, 572-9.

<sup>7</sup> Livingstone, M. B., Black, A. E. (2003). Markers of the validity of reported energy intake. *J Nutr*, 133 Suppl 3, 895S-920S.

<sup>8</sup> The doubly labelled water technique (DLW) is widely agreed to be the most accurate way of assessing energy expenditure over one to two weeks. Participants in DLW studies drink a weighed amount of water labelled with known amounts of the stable isotopes of hydrogen (<sup>2</sup>H) and oxygen (<sup>18</sup>O<sub>2</sub>) based on their body weight. Loss of the

two isotopes from body water is assessed by measurement of the rate of decline in concentration of the isotope in samples of the subject's urine, collected during the study period, and measured by isotope ratio mass spectrometry. The difference between the elimination rates of the two isotopes reflects the rate at which CO<sub>2</sub> is produced from metabolism. Energy expenditure can then be estimated from the CO<sub>2</sub> production.

<sup>9</sup> "5-a-day" portions of fruit and vegetables were not calculated for children aged 10 years and younger as the 80g portion is only appropriate for older children and adults (see Appendix A).

<sup>10</sup> Scientific Advisory Committee on Nutrition. Iron and Health. London: TSO, 2010

<sup>11</sup> Scientific Advisory Committee on Nutrition. Advice on fish consumption: benefits and risks. London: TSO, 2004

<sup>12</sup> Weekly equivalent oily fish consumption has been calculated using unrounded data rather than the rounded figures in Table 5.3.

<sup>13</sup> Scientific Advisory Committee on Nutrition. Dietary Recommendations for Energy [http://www.sacn.gov.uk/pdfs/sacn\\_dietary\\_reference\\_values\\_for\\_energy.pdf](http://www.sacn.gov.uk/pdfs/sacn_dietary_reference_values_for_energy.pdf) (2011) (accessed 31/03/14).

<sup>14</sup> For total fat and saturated fatty acids, this recommendation applies to adults and children from the age of five years.

<sup>15</sup> Cell sizes for the upper 2.5 percentile for both boys and girls aged 11 to 18 years are small and this should be borne in mind when interpreting the data.

<sup>16</sup> <http://www.data-archive.ac.uk> (accessed 31/03/14).

<sup>17</sup> Separate descriptive statistics were carried out on two datasets – one containing all participants who had taken at least one dietary supplement (regardless of the type) during the four-day recording period (the supplement takers) and one containing all participants who had not taken any dietary supplement during the four-day recording period (the non-supplement takers).

<sup>18</sup> For women aged 65 years and over, 185 reported taking supplements during the recording period and 184 reported taking supplements in the previous year.

## 6 Blood analytes

*Original authors: Sonja Nicholson, Gerda Pot, Chris Bates & Ann Prentice*

*Updated by: Sonja Nicholson, Lorna Cox, Chris Bates, Ann Prentice & Polly Page*

### 6.1 Introduction

This chapter reports the results of the analysis of blood samples taken from participants aged 1.5 years and over during the nurse visit. Samples were collected between February 2008 and July 2012; Years 1 to 4 of the NDNS Rolling Programme (RP). In Year 1 there was a two week time lag between the start of the interviewer and nurse stages. From Year 2 onwards, the gap was extended, to an average of eight weeks, with the aim of increasing nurse stage response rates.

The results in Chapter 5 are based on assessment of food consumption over four days and indicate reported dietary intake over a short period. Analysis of blood samples provides an indication of the nutritional status of the population usually over a longer period; that is, the level of nutrients available to the body (after absorption) for use in metabolic processes. For some micronutrients, status can be assessed by directly measuring the concentration of the nutrient in blood, while for others it is assessed by a functional measure such as the degree of activation of vitamin-dependent enzymes.

An overview of the purpose, methodologies and other procedures associated with obtaining blood samples from participants, as well as the response rates achieved, are provided in Chapters 1 to 3. Examples of the letters sent to a participant and/or their GP containing results for clinically reportable analytes measured in their blood sample are presented in Appendix M. Analytes were given a priority order for analysis according to their clinical and public health importance (see Appendix N). Appendix O details the procedures for obtaining written consent from adult participants and the parent/legal guardian of child participants, including written child assent where appropriate, prior to blood sampling. Appendix J contains examples of consent forms used in the NDNS RP. Appendix O also provides information about obtaining and processing blood samples, the recruitment of field laboratories and the transport and storage of blood samples. Appendix P details the quality control data and methodology of blood analysis for each analyte described in this report. The nurse (stage two) participant information documents are provided in Appendix H. Appendix W lists the analytes included in this report

and details of other analytes which have been measured and will be included in the Years 1 to 4 dataset deposited at the UK Data Archive.<sup>1</sup>

### 6.1.1 Obtaining the blood sample

Blood samples were requested from all fully productive participants<sup>2</sup> aged 1.5 years and over who were visited by a nurse (5,109 individuals) and obtained where consent was provided. For children under 16 years of age, written parental consent was obtained, along with written assent from the child where the child was able to do so. Blood samples were collected by venepuncture by a qualified nurse or paediatric phlebotomist using a Sarstedt fixed or butterfly needle, depending on the blood taker's preference. The monovette tube system was used as it is a closed system, and allows the safe collection of blood in a participant's home. Children aged 1.5 to 15 years, where parental consent was obtained, were offered application of anaesthetic gel prior to venepuncture. In accordance with external ethical approval and participant consent, a maximum of 10.9mL of blood was taken from participants aged 1.5 to 6 years, 21.1mL from participants aged 7 to 15 years and 35.1mL for participants aged 16 years and over.

Blood was collected in between four and eight tubes, depending on the age group of the participant. Each tube contained anticoagulant/stabilising agent as appropriate for the analysis required.

The following monovette tubes were filled according to the age of the participant:

<u>Age group</u>	<u>Tubes</u>
1.5 to 6 years	1 x EDTA, 1 x lithium heparin, 1 x serum gel and 1 x serum
7 to 15 years	1 x EDTA, 1 x trace mineral controlled lithium heparin, 1 x lithium heparin, 1 x serum gel, 1 x serum and 1 x fluoride
16 years and over	2 x EDTA, 2 x trace mineral controlled lithium heparin, 1 x lithium heparin, 1 x serum gel, 1 x serum and 1 x fluoride

### **6.1.1.1 Blood Response**

Of those completing at least three diary days, 51% of adults and 27% of children provided a blood sample. Younger children were less likely to give a blood sample than older children or adults: 9% of those aged 1.5 to 3 years and 21% of those aged 4 to 10 years did so compared with 38% of those aged 11 to 18 years and 51% of those aged 19 years and over. The numbers in each age group vary slightly for each analyte because, when the quantity of blood collected was not sufficient, lower priority analytes may not have been assayed for some individuals. The primary reasons for not obtaining a sample, when consent had been given, were not being able to find a suitable vein or a vein collapsing during the procedure. Further details are provided in Chapter 2 and Appendix O.

Blood samples were obtained from a total of 2,671 fully productive participants. This report presents analytical results for up to 902 children aged 1.5 to 18 years and 1,769 adults aged 19 years and over.

### **6.1.2 Fasted blood samples**

Participants aged four years and over were asked to provide an overnight (minimum of eight hours) fasting blood sample. Children aged 1.5 to 3 years and diabetics (not willing or not able to fast) were invited to provide a non-fasting blood sample. Requirements for blood processing to commence within two hours of collection, and for procedure-standardisation, dictated that all samples had to be collected as early in the day as possible, and in all cases before midday.

### **6.1.3 Transport and storage of blood samples**

Following venepuncture, an EDTA and a serum gel monovette tube from each participant's sample set were sent by post, to the Immunology and Biochemistry Laboratory at Addenbrooke's Hospital in Cambridge (Addenbrooke's) for prompt analysis. The remaining blood monovette tubes from a participant's sample set were taken to a local field laboratory for immediate processing and storage below  $-40^{\circ}\text{C}$  (or at a maximum of  $-20^{\circ}\text{C}$  where  $-40^{\circ}\text{C}$  facilities were not available). At the end of each fieldwork period, samples were transported on dry ice to HNR where they were stored at  $-80^{\circ}\text{C}$  before analysis. Appendix O provides further details on the transport, tracking and storage of blood samples.

#### 6.1.4 Analysis of the blood samples

Blood analytes were assigned a priority order based on clinical and policy relevance. Where it was not possible to obtain the full volume of blood from a participant analytes were assayed in the order of priority detailed in Tables N.1, N.2 and N.3 (Appendix N). Therefore the base numbers in the tables may be smaller for the lower priority analytes in each monovette tube than for the higher priority ones.

The analytes presented in this chapter have been divided into the following main groups:

- haemoglobin and ferritin
- water-soluble vitamins
- fat-soluble vitamins and carotenoids
- blood lipids
- zinc and selenium

In addition to the blood analytes presented in Tables 6.1 to 6.5, a selected number of additional analytes are presented in Appendix Q. Data for all measured analytes reported in this chapter and Appendix Q will be included in the dataset submitted to the UK Data Archive.<sup>1</sup>

Serum and red cell folate were also measured but results have been delayed due to a problem with the laboratory analysis. Publication of these results, in a supplementary report, is expected in 2015.

Appendix P provides details on the quality control measures for all of the assays performed on blood samples in the NDNS RP. All the laboratories performing blood analyses for NDNS RP participate in external quality assessment schemes, where available.

Data for the blood analytes in Tables 6.1 to 6.5 have been weighted to account for differential non-response to providing a blood sample, in order to adjust for any bias arising from blood sampling refusals and/or failures. Details of the methodology used to weight the data are provided in Chapter 2 and Appendix B. Notional values were assigned to results below the limit of detection. These were calculated by dividing the analytical limit of detection by the square root of two. This method is consistent with that used in NHANES and has been described by

Hornung and Reed (1990).<sup>3</sup> Results are presented for the age groups 1.5 to 3 years, 4 to 10 years, 11 to 18 years, 19 to 64 years and 65 years and over and are split by sex, except data for the age group 1.5 to 3 years which are presented as sex combined only.

No comparisons are made with blood analytes data from previous NDNS surveys as some of the methods used are different from those used in previous NDNS.<sup>4,5,6,7</sup>

Where numbers accumulated during the four years are sufficient, the values at the upper and lower 2.5<sup>th</sup> percentiles have been provided in Tables 6.1 to 6.5 for each age/sex group included in this report. Cell sizes for children aged 1.5 to 3 years are small and this should be borne in mind when interpreting the results for this age group. Where accepted thresholds exist to indicate low status for a nutrient or an increased risk of poor function or ill health, the percentage of participants in that category has been provided in Tables 6.1 to 6.5.

## 6.2 Haemoglobin and ferritin

### 6.2.1 Haemoglobin concentration (*grams/litre, g/L*)

Haemoglobin is the iron-containing, oxygen-carrying molecule in red blood cells. Circulating levels of haemoglobin are indicative of the oxygen-carrying capacity of the blood and a low haemoglobin concentration (anaemia) when coupled with low serum ferritin can indicate iron deficiency. The haemoglobin concentration of women of childbearing age tends to be lower than in other population groups because of menstrual loss. The lower limits for haemoglobin below which anaemia is indicated are 110g/L for children aged 1.5 to 4 years and 115g/L, 120g/L for children aged 5 to 11 years and 12 to 14 years respectively and 130g/L and 120g/L for men and non-pregnant women aged 15 years and over respectively. These lower limits for haemoglobin have been set by the World Health Organization (WHO)<sup>8</sup> and are endorsed by the Scientific Advisory Committee for Nutrition (SACN).<sup>9</sup>

The mean haemoglobin concentration was above the relevant lower limit in each age/sex group.<sup>8,9</sup>

The mean haemoglobin concentration for children aged 1.5 to 3 years was 120g/L. For boys aged 4 to 10 years and 11 to 18 years the mean haemoglobin concentration was 130g/L and

144g/L, respectively. For girls aged 4 to 10 years and 11 to 18 years it was 128g/L and 131g/L respectively.

The mean haemoglobin concentration for men aged 19 to 64 years (149g/L) and 65 years and over (144g/L), and for women aged 19 to 64 years (132g/L) and 65 years and over (132g/L) was in each case also above the lower limits.<sup>8,9</sup>

The proportion of children with a haemoglobin concentration below the lower limits<sup>8,9</sup> was 12.9% for children aged 1.5 to 3 years, 3.1% for boys aged 4 to 10 years, 1.8% for boys aged 11 to 18 years, 5.7% for girls aged 4 to 10 years and 7.4% for girls aged 11 to 18 years.

The proportion of adults with a haemoglobin concentration below the lower limits<sup>8,9</sup> was 1.5% for men aged 19 to 64 years, 15.2% for men aged 65 years and over, 9.9% for women aged 19 to 64 years and 12.3% for women aged 65 years and over.

**(Table 6.1)**

### **6.2.2 Plasma ferritin (micrograms/litre, µg/L)**

Ferritin is an intracellular protein which stores iron. Plasma ferritin concentration gives an indication of the level of iron stores. However, plasma ferritin is an acute phase reactant that is raised in response to infection or inflammation. Therefore a plasma ferritin concentration should be interpreted with care as it can be raised by recent infections or inflammatory conditions, liver disease and other chronic disorders.<sup>9</sup>

The lower limit for plasma ferritin concentration, below which iron stores are considered to be depleted and the risk of iron-deficiency anaemia increased, is 12µg/L for children aged 1.5 years to 4 years and 15µg/L for children aged 5 to 14 years and for men and non-pregnant women aged 15 years and over.<sup>8,9</sup>

The mean ferritin concentration for each age/sex group was above the lower limit of the normal range for that group.<sup>8,9</sup>

The mean plasma ferritin concentration for children aged 1.5 to 3 years was 21µg/L. The mean plasma ferritin concentration for boys aged 4 to 10 years was 30µg/L and 44µg/L for boys aged

11 to 18 years. The mean plasma ferritin concentration for girls aged 4 to 10 years was 31µg/L and 30µg/L for girls aged 11 to 18 years.

The mean plasma ferritin concentration for men aged 19 to 64 years was 140µg/L and 154µg/L for men aged 65 years and over. The mean plasma ferritin concentration for women aged 19 to 64 years was 56µg/L and 116µg/L for women aged 65 years and over.

The proportion of children with a ferritin concentration below the lower limit of the normal range was 35.1% for children aged 1.5 to 3 years, 11.1% for boys aged 4 to 10 years, 8.2% for boys aged 11 to 18 years, 20.5% for girls aged 4 to 10 years and 27.5% for girls aged 11 to 18 years.

The proportion of adults with a ferritin concentration below the lower limit of the normal range was 2.2% for men aged 19 to 64 years, 6.4% for men aged 65 years and over, 15.5% for women aged 19 to 64 years and 5.8% for women aged 65 years and over.

(Table 6.1)

### **6.2.3 Combined index: Haemoglobin concentration (*grams/litre, g/L*) and plasma ferritin (*micrograms/litre, µg/L*)**

Assessment of an individual's iron status depends on the measurement, interpretation and synthesis of various markers of iron status. Determining adequate iron status is dependent on the measure of more than one marker.<sup>9</sup> The combination of haemoglobin and ferritin concentrations can be used as a measure of iron status and/or deficiency.

The proportion of children with a haemoglobin concentration and a plasma ferritin concentration below which iron deficiency is indicated was 5.2% for children aged 1.5 to 3 years, 1.1% for boys aged 4 to 10 years, 1.2% for girls aged 4 to 10 years and 4.9% for girls aged 11 to 18 years. There were no cases below the threshold for boys aged 11 to 18 years.

The proportion of adults with a haemoglobin concentration and plasma ferritin concentration below which iron deficiency is indicated was 0.3% for men aged 19 to 64 years, 1.5% for men aged 65 years and over, 4.7% for women aged 19 to 64 years and 3.1% for women aged 65 years and over.

(Table 6.1)

## 6.3 Water-soluble vitamins

### 6.3.1 Plasma vitamin C (micromoles/litre, $\mu\text{mol/L}$ )

Vitamin C is needed for the maintenance of healthy connective tissue in the body and can act as an antioxidant, protecting cells from the damage caused by oxidative free radicals. Clinical deficiency results in scurvy. Plasma vitamin C concentration reflects recent dietary intake of vitamin C; a value of less than  $11\mu\text{mol/L}$  indicates biochemical depletion.<sup>10</sup> The mean concentration for every age/sex group was above the level indicative of biochemical depletion for vitamin C.

The mean plasma vitamin C concentration for children aged 1.5 to 3 years was  $72.5\mu\text{mol/L}$ . The mean plasma vitamin C concentration for boys aged 4 to 10 years was  $74.3\mu\text{mol/L}$ ,  $54.3\mu\text{mol/L}$  for boys aged 11 to 18 years,  $67.9\mu\text{mol/L}$  for girls aged 4 to 10 years and  $56.7\mu\text{mol/L}$  for girls aged 11 to 18 years.

The mean plasma vitamin C concentration for men aged 19 to 64 years was  $48.9\mu\text{mol/L}$ ,  $41.7\mu\text{mol/L}$  for men aged 65 years and over,  $53.5\mu\text{mol/L}$  for women aged 19 to 64 years and  $52.3\mu\text{mol/L}$  for women aged 65 years and over.

The proportion of children who had a vitamin C concentration below the level indicative of biochemical depletion was 1.6% for boys aged 11 to 18 years and 1.1% for girls aged 11 to 18 years. There were no cases below the threshold for boys or girls aged 4 to 10 years.

The proportion of adults who had a vitamin C concentration below the level indicative of biochemical depletion<sup>10</sup> was 1.3% for men aged 19 to 64 years, 3.6% for men aged 65 years and over, 3.1% for women aged 19 to 64 years and 4.3% for women aged 65 years and over.

(Table 6.2)

### 6.3.2 Serum vitamin B<sub>12</sub> (picomoles/litre, $\text{pmol/L}$ )

Vitamin B<sub>12</sub> is a water-soluble vitamin with a key role in normal functioning of the brain and nervous system and in blood cell formation. Serum concentration of vitamin B<sub>12</sub> is the

commonly used measure of vitamin B<sub>12</sub> status. Vitamin B<sub>12</sub>, with folate, is required for methyl group transfer during protein metabolism, DNA synthesis and the methylation of DNA and various other substrates. The most common cause of vitamin B<sub>12</sub> deficiency is failure of the parietal cells of the stomach to secrete Intrinsic Factor (a protein cofactor), leading to impaired absorption and hence pernicious anaemia.<sup>11</sup> The lower threshold of the normal range for serum vitamin B<sub>12</sub> concentration for all ages is usually taken as 150pmol/L.<sup>12</sup>

The mean serum vitamin B<sub>12</sub> concentration for children aged 1.5 to 3 years was 505pmol/L. The mean serum vitamin B<sub>12</sub> concentration for boys aged 4 to 10 years was 428pmol/L, 289pmol/L for boys aged 11 to 18 years, 402pmol/L for girls aged 4 to 10 years and 284pmol/L for girls aged 11 to 18 years.

The mean serum vitamin B<sub>12</sub> concentration for men aged 19 to 64 years was 265pmol/L, 254pmol/L for men aged 65 years and over, 265pmol/L for women aged 19 to 64 years and 283pmol/L for women aged 65 years and over. Thus, the mean concentration for every age/sex group was above the lower threshold of the normal range of 150pmol/L.<sup>12</sup>

In the 11 to 18 years old age group 2.2% of boys and 4.3% of girls had a vitamin B<sub>12</sub> concentration below the lower threshold of the normal range (150pmol/L).<sup>12</sup> There were no cases below this threshold in children aged 1.5 to 10 years.

The proportion of adults who had a vitamin B<sub>12</sub> concentration below the lower threshold of the normal range of 150pmol/L<sup>12</sup> was 2.5% for men aged 19 to 64 years, 5.9% for men aged 65 years and over, 7.1% for women aged 19 to 64 years and 5.9% for women aged 65 years and over.

(Table 6.2)

### **6.3.3 Erythrocyte Transketolase Activation Coefficient (ETKAC) for thiamin status (ratio)**

Thiamin (vitamin B<sub>1</sub>) status is measured by ETKAC. Thiamin is required mainly during the metabolism of carbohydrate, fat and alcohol. Diets high in carbohydrate require higher intake of thiamin than diets high in fat.<sup>11</sup> As with most water-soluble vitamins, there is 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. ETKAC is a measure of the reactivation of the cofactor-depleted red cell enzyme transketolase *in vitro* by the cofactor, thiamin diphosphate. The higher the ETKAC, the lower the saturation *in vitro*, and hence the greater the degree of deficiency *in vivo*. This index is sensitive to the lower to moderate range of intakes of thiamin. For adults aged 19 to 64 years, values above 1.25 are indicative of biochemical thiamin deficiency.<sup>13</sup>

The mean ETKAC in children ranged from 1.07 for those 1.5 to 3 years to 1.12 for those aged 11 to 18 years. In adults mean values were 1.12 for those aged 19 to 64 years and 1.11 for those aged 65 years and over, with little difference between men and women.

No more than 1.5% of any age/sex group had ETKAC above 1.25, the threshold indicative of biochemical deficiency for adults.

(Table 6.2)

#### **6.3.4 Erythrocyte Glutathione Reductase Activation Coefficient (EGRAC) for riboflavin status (*ratio*)**

EGRAC is a measure of red cell enzyme saturation with its cofactor flavin adenine dinucleotide (FAD) derived from riboflavin (vitamin B<sub>2</sub>). Riboflavin is needed for the utilisation of energy from food and is a cofactor in the metabolism of other B vitamins. It may also be important for the metabolism of iron. The coefficient is expressed as the ratio of two activity measures of the enzyme glutathione reductase, with and without added FAD *in vitro*. The higher the EGRAC, the lower the saturation *in vitro*, and hence the greater the degree of deficiency *in vivo*. A coefficient between 1.0 and 1.3 has generally been considered to be normal.<sup>14</sup> The test is most sensitive at low levels of riboflavin intake. The EGRAC index is highly sensitive to small degrees of cofactor desaturation and raised values are indicative of low vitamin B<sub>2</sub> status. Although moderately raised values are not consistently associated with known functional abnormality, high values indicative of riboflavin deficiency may be associated with compromised iron metabolism.<sup>15</sup>

However recent research has indicated that the 1.30 threshold may be set too low, so giving an overestimate of the prevalence of functionally-significant low riboflavin status. It has been recommended that the EGRAC threshold should be raised to a level above 1.30 to better

recognise riboflavin inadequacy; this requires further consideration.<sup>15</sup> The values at the 75<sup>th</sup> and 90<sup>th</sup> percentiles for EGRAC have been provided in Table 6.2 as an additional means of monitoring changes in the population.

All age/sex groups had mean EGRAC greater than 1.30, the generally accepted upper threshold for normal riboflavin (vitamin B<sub>2</sub>) status.

The mean EGRAC in children aged 1.5 to 3 years was 1.31 whilst the mean EGRAC in boys aged 4 to 10 years was 1.43, 1.47 for boys aged 11 to 18 years, 1.41 for girls aged 4 to 10 years and 1.52 for girls aged 11 to 18 years.

The mean EGRAC was 1.40 for men aged 19 to 64 years, 1.35 for men aged 65 years and over, 1.43 for women aged 19 to 64 years and 1.32 for women aged 65 years and over.

The highest proportion of individuals with EGRAC above the 1.30 threshold indicating poorer B<sub>2</sub> status<sup>15</sup> was in boys and girls aged 11 to 18 years (78.2% and 87.8% respectively).

Approximately 72% of boys and girls aged 4 to 10 years and 42.1% of children aged 1.5 to 3 years had EGRAC above this threshold. The proportion of adults aged 65 years and over with EGRAC greater than 1.30 (45.5% of women; 50.0% of men) was lower than the proportion of adults aged 19 to 64 years with EGRAC above this threshold (68.4% and 70.3% respectively).

The values at the 75<sup>th</sup> percentile ranged from 1.35 for children aged 1.5 to 3 years to 1.64 for girls aged 11 to 18 years. The values at the 90<sup>th</sup> percentile ranged from 1.49 for children aged 1.5 to 3 years to 1.79 for girls aged 11 to 18 years.

(Table 6.2)

### **6.3.5 Plasma pyridoxal-5-phosphate (PLP) (nanomoles/litre, nmol/L)**

Vitamin B<sub>6</sub> comprises pyridoxal, pyridoxine, pyridoxamine and their 5'-phosphates, which are metabolically interconvertible. Pyridoxal-5-phosphate (PLP) is the primary biologically active form of vitamin B<sub>6</sub>, serving as a co-enzyme for a large number of enzymes which catalyse reactions of amino acids. These are important in the body's overall protein metabolism and B<sub>6</sub> requirements are therefore related to protein synthesis needs.<sup>11</sup> PLP may be decreased during

acute phase reaction;<sup>16</sup> therefore the interpretation of PLP concentration is more complicated in the presence of inflammation or infection.

PLP was not measured in previous NDNS<sup>4,5,6,7</sup> for which erythrocyte aspartate aminotransferase activation coefficient (EAATAC) was measured as an index of vitamin B<sub>6</sub> status.

There is currently no internationally recognised normal range for PLP concentration. Pyridoxic acid (PA), which is a less sensitive measure of vitamin B<sub>6</sub> status but also less affected by acute phase, was also measured; results for PA are presented in Appendix Q.

The mean PLP concentration for children aged 1.5 to 3 years was 65.8nmol/L. The mean PLP concentration for boys aged 4 to 10 years was 66.1nmol/L, 71.2nmol/L for boys aged 11 to 18 years, 70.2nmol/L for girls aged 4 to 10 years and 60.4nmol/L for girls aged 11 to 18 years.

The mean PLP concentration for men aged 19 to 64 years was 68.9nmol/L, 46.1nmol/L for men aged 65 years and over, 56.1nmol/L for women aged 19 to 64 years and 55.2nmol/L for women aged 65 years and over.

(Table 6.2)

## 6.4 Fat-soluble vitamins and carotenoids

### 6.4.1 Plasma retinol (vitamin A) (*micromoles/litre, µmol/L*)

Plasma retinol is related to long-term dietary intake of vitamin A. The plasma concentration is homeostatically controlled and there is little variation either within or between individuals.<sup>17</sup> For adults, concentrations below 0.35µmol/L are considered to reflect severe deficiency and concentrations between 0.35µmol/L and 0.70µmol/L to reflect mild deficiency.<sup>13</sup>

The mean plasma retinol concentration for children aged 1.5 to 3 years was 1.17µmol/L. The mean plasma retinol concentration for boys aged 4 to 10 years and 11 to 18 years was 1.37µmol/L and 1.67µmol/L respectively and 1.34µmol/L and 1.62µmol/L for girls aged 4 to 10 years and 11 to 18 years.

The mean plasma retinol concentration for men aged 19 to 64 years and 65 years and over and women aged 19 to 64 years and 65 years and over was 2.29 $\mu$ mol/L, 2.16 $\mu$ mol/L, 2.06 $\mu$ mol/L and 2.25 $\mu$ mol/L respectively. Thus, the mean concentration for all age/sex groups was above the limit of marginal status for retinol.

There were no cases of children who had a retinol concentration below the level associated with severe deficiency (0.35 $\mu$ mol/L) in an adult population.<sup>13</sup>

The proportion of adults who had a retinol concentration below the level associated with severe deficiency (0.35 $\mu$ mol/L)<sup>13</sup> was 0.3% for women aged 19 to 64 years, whilst there were no cases for men aged 19 years and over and women aged 65 years and over.

The proportion of children aged 4 to 10 years and 11 to 18 years who had a retinol concentration at a level associated with mild deficiency in an adult population (0.35-0.70 $\mu$ mol/L)<sup>13</sup> was 0.1% and 0.3% respectively, whilst there were no cases for children aged 1.5 to 3 years.

The proportion of men and women aged 19 to 64 years and 65 years and over who had a retinol concentration at a level associated with mild deficiency (0.35-0.70 $\mu$ mol/L)<sup>13</sup> was 0.3% and 0.5% respectively.

(Table 6.3)

#### **6.4.2 Plasma $\alpha$ - and $\beta$ -carotene and $\alpha$ - and $\beta$ -cryptoxanthin (*micromoles/litre, $\mu$ mol/L*)**

$\alpha$ - and  $\beta$ -carotene and  $\alpha$ - and  $\beta$ -cryptoxanthin are carotenoids with provitamin A activity and their plasma concentrations reflect short to medium term dietary intake. Plasma concentrations of these carotenoids may also be influenced by conversion to vitamin A, the conversion being dependent on vitamin A status and requirements. There are currently no established normal ranges for plasma  $\alpha$ - and  $\beta$ -carotene or  $\alpha$ - and  $\beta$ -cryptoxanthin concentrations.

Results for plasma concentrations of  $\alpha$ - and  $\beta$ -carotene and  $\alpha$ - and  $\beta$ -cryptoxanthin are shown in Table 6.3.

(Table 6.3)

#### **6.4.3 Plasma lycopene and plasma lutein and zeaxanthin (*micromoles/litre, $\mu\text{mol/L}$* )**

Lycopene, lutein and zeaxanthin are also carotenoids but do not have provitamin A activity. Plasma lutein and zeaxanthin concentrations may be useful markers of green vegetable intakes. There are currently no established normal ranges for the plasma concentrations of these carotenoids.

Results for plasma concentrations of lycopene, lutein and zeaxanthin are shown in Table 6.3.

**(Table 6.3)**

#### **6.4.4 Plasma 25-hydroxyvitamin D (*nanomoles/litre, nmol/L*)**

Plasma 25-hydroxyvitamin D (25-OHD) concentration is a measure of vitamin D status and reflects the availability of vitamin D in the body from both dietary and endogenous sources. Plasma 25-OHD is derived from synthesis in the skin of vitamin D<sub>3</sub> and its precursors during ultraviolet B irradiation from sunlight and from vitamin D<sub>2</sub> and D<sub>3</sub> and their precursors in the diet. Factors such as season of the year, time spent outdoors, habit of dress and consumption of foods and supplements containing vitamin D therefore influence 25-OHD. This metabolite has a long half-life in plasma and gives an indication of vitamin D availability over recent weeks. Vitamin D, after conversion to its active metabolite 1,25-dihydroxyvitamin D, facilitates calcium absorption from the intestine and is important for a range of other metabolic processes. In the UK 25nmol/L of 25-OHD has been used as the lower threshold for vitamin D adequacy below which there is an increased risk of rickets and osteomalacia.<sup>18,19</sup> A higher threshold has been adopted by some countries to indicate population vitamin D sufficiency; SACN convened a working group in 2011 to review the thresholds which is expected to report in 2014.

Blood collection within the NDNS RP is spread evenly across the year. The year-round averages are presented in Table 6.3.<sup>20</sup>

The mean 25-OHD concentration for children aged 1.5 to 3 years was 58.1nmol/L. The mean 25-OHD concentration for boys aged 4 to 10 years was 52.3nmol/L and 44.9nmol/L for boys aged 11 to 18 years. The mean 25-OHD concentration for girls aged 4 to 10 years was 48.0nmol/L and 41.1nmol/L for girls aged 11 to 18 years.

The mean 25-OHD concentration for men aged 19 to 64 years was 43.5nmol/L and 47.0nmol/L for men aged 65 years and over. The mean 25-OHD concentration for women aged 19 to 64 years was 47.3nmol/L and 42.5nmol/L for women aged 65 years and over.

The proportion of children who had a 25-OHD concentration below 25nmol/L was 7.5% for children aged 1.5 to 3 years, 12.3% of boys aged 4 to 10 years, 19.7% of boys aged 11 to 18 years, 15.6% of girls aged 4 to 10 years and 24.4% of girls aged 11 to 18 years.

The proportion of adults who had a 25-OHD concentration below 25nmol/L was 24.0% of men aged 19 to 64 years, 16.9% of men aged 65 years and over, 21.7% of women aged 19 to 64 years and 24.1% of women aged 65 years and over.

(Table 6.3)

#### **6.4.4.1 Seasonal variation in concentration of plasma 25-hydroxyvitamin D (nanomoles/litre, nmol/L)**

Vitamin D synthesised by the skin in the presence of sunlight is an important source and an individual's plasma concentration of 25-OHD is likely to be higher during the summer months. Plasma 25-OHD has not previously been split by season in the NDNS RP reports because of small sizes in each age/sex group. In this report, larger cell sizes for Years 1 to 4 combined have made it possible for 25-OHD concentration data to also be presented by season (Table 6.3.1).<sup>20</sup>

Table 6.3.1 illustrates the variation in plasma 25-OHD concentration for sex-combined age groups by season of venepuncture. As expected, the mean 25-OHD concentration was highest for those providing a blood sample during July to September for all age groups and was lowest for those providing a blood sample during January to March for all age groups.

Table 6.3.1 also shows the proportion of participants with a 25-OHD concentration below 25nmol/L. The lowest proportion of participants with a 25-OHD concentration below 25nmol/L was for those providing a blood sample during July to September for all age groups, with the exception of children aged 11 to 18 years for whom the lowest proportion was in April to June.

The highest proportion of participants in each age group with a 25-OHD concentration below 25nmol/L was for those providing a blood sample during January to March (ranging from 29.3% for adults aged 65 years and over up to 40.0% for children aged 11 to 18 years).

(Table 6.3.1)

#### 6.4.5 Plasma $\alpha$ -tocopherol (micromoles/litre, $\mu\text{mol/L}$ )

Vitamin E is a group of compounds called tocopherols. Alpha tocopherol is the predominant form of vitamin E in human tissues, and has the highest biological activity of the tocopherols. It acts as an antioxidant and is required to protect cells against oxidative damage by free radicals, for example oxidation of the lipids in the cell membranes. Plasma  $\alpha$ -tocopherol concentration can be used as a measure of vitamin E status.

Increased concentration of plasma lipids appear to cause tocopherols to partition out of cellular membranes, thus increasing plasma concentrations of tocopherols and resulting in a correlation between tocopherols and total lipid in the blood, particularly with the cholesterol fraction. For this reason plasma  $\alpha$ -tocopherol concentration can be usefully expressed as a ratio to plasma total cholesterol ( $\mu\text{mol}/\text{mmol}$ ), enabling comparisons to be made between groups with different plasma lipid concentrations.

For adults, a concentration of total plasma tocopherols below  $11.6\mu\text{mol/L}$ , of which approximately 93% would be  $\alpha$ -tocopherol, or a plasma tocopherol to cholesterol ratio of below  $2.25\mu\text{mol}/\text{mmol}$ , tends to cause red blood cells to haemolyse after exposure to oxidising agents *in vitro*; this is a functional test for biochemical vitamin E deficiency, although it is not necessarily indicative of a clinical deficiency of vitamin E. There is currently no established normal range for plasma  $\alpha$ -tocopherol concentration. The Committee on Medical Aspects of Food and Nutrition Policy (COMA) Panel on Dietary Reference Values considered a tocopherol to cholesterol ratio of  $2.25\mu\text{mol}/\text{mmol}$  to be the lowest satisfactory value for adults.<sup>11</sup>

The mean plasma  $\alpha$ -tocopherol concentration for children aged 1.5 to 3 years was  $22.8\mu\text{mol/L}$ . The mean plasma  $\alpha$ -tocopherol concentration for boys aged 4 to 10 years and 11 to 18 years was  $26.5\mu\text{mol/L}$  and  $23.6\mu\text{mol/L}$  respectively and  $28.3\mu\text{mol/L}$  and  $25.3\mu\text{mol/L}$  for girls aged 4 to 10 years and 11 to 18 years.

The mean plasma  $\alpha$ -tocopherol concentration for men aged 19 to 64 years and 65 years and over and women aged 19 to 64 years and 65 years and over was 32.5 $\mu$ mol/L, 29.8 $\mu$ mol/L, 32.0 $\mu$ mol/L and 35.9 $\mu$ mol/L respectively.

Alpha-tocopherol results expressed as  $\mu$ mol per mmol total cholesterol have also been provided in Table 6.3 for each age/sex group. The mean ratio of  $\alpha$ -tocopherol to total cholesterol was 5.74 $\mu$ mol/mmol for boys and girls aged 1.5 to 3 years, with 4.0% having a ratio of  $\alpha$ -tocopherol to total cholesterol less than the lowest satisfactory value in an adult population.<sup>11</sup> The mean ratio of  $\alpha$ -tocopherol to total cholesterol for boys aged 4 to 10 and 11 to 18 years and girls aged 4 to 10 years and 11 to 18 years was 6.22 $\mu$ mol/mmol, 5.92 $\mu$ mol/mmol, 6.72 $\mu$ mol/mmol and 6.23 $\mu$ mol/mmol respectively.

The proportion of children with a ratio of  $\alpha$ -tocopherol to total cholesterol below the lowest satisfactory value defined for an adult<sup>11</sup> was 0.9%, 2.5%, 2.7% and 0.7% of boys aged 4 to 10 years and 11 to 18 years and girls aged 4 to 10 years and 11 to 18 years respectively.

The mean ratio of  $\alpha$ -tocopherol to total cholesterol was 6.34 $\mu$ mol/mmol and 6.65 $\mu$ mol/mmol for men aged 19 to 64 years and 65 years and over, with 0.1% of men aged 19 to 64 years having a ratio of  $\alpha$ -tocopherol to total cholesterol lower than the lowest satisfactory value and no cases for men aged 65 years and over.

The mean ratio of  $\alpha$ -tocopherol to total cholesterol was 6.17 $\mu$ mol/mmol and 6.63 $\mu$ mol/mmol for women aged 19 to 64 years and 65 years and over. There were no adult women aged 19 years and over with ratios below the lowest satisfactory value.

(Table 6.3)

## 6.5 Blood lipids

### 6.5.1 Total cholesterol, high density lipoprotein (HDL) cholesterol and low density lipoprotein (LDL) cholesterol (*millimoles/litre, mmol/L*)

High circulating concentrations of serum total cholesterol and LDL cholesterol are among the predictors of coronary heart disease (CHD) and other vascular diseases in adults. They are

affected by age, genetic and environmental influences, including dietary factors, notably the amount of saturated fatty acids in the diet.<sup>21</sup> High concentrations of total cholesterol occur in some diseases, for example kidney, liver and thyroid disorders or in diabetes.

Cholesterol circulates in the body carried by a variety of lipoproteins. Cholesterol transported in 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 serum total cholesterol and LDL cholesterol. Cholesterol transported in high density lipoproteins (HDL cholesterol) is a smaller proportion of the total circulating cholesterol and is inversely related to the development of CHD. It is generally accepted that a serum total cholesterol concentration below 5.2mmol/L represents a level associated with minimal CHD risk, 5.2mmol/L to 6.4mmol/L mildly elevated, 6.5mmol/L to 7.8mmol/L moderately elevated and above 7.8mmol/L a severely elevated level.<sup>22</sup>

LDL cholesterol was not directly measured in the NDNS RP but it was calculated in samples taken after an overnight fast by subtraction of HDL cholesterol from serum total cholesterol and corrected for very low density lipoprotein (VLDL) cholesterol estimated from the serum triglyceride concentration using the Friedewald equation.<sup>23</sup> Serum triglyceride (triacylglycerol) concentrations are presented in Appendix Q of this report.

Table 6.4 shows the mean serum total, HDL and LDL cholesterol concentration for children and adults.

Approximately a third of adults aged 19 years and over had a serum total cholesterol between 5.2 and 6.4mmol/litre, indicating a marginally increased risk of cardiovascular disease.

In slightly more than 10% of adults aged 19 years and over, total serum cholesterol was between 6.4 and 7.8 mmol/litre indicating moderately elevated cardiovascular risk and in approximately 2% of adults it was above 7.8mmol/l indicating severe risk.

**(Table 6.4)**

## 6.6 Selenium and zinc

### 6.6.1 Plasma selenium (micromoles/litre, $\mu\text{mol/L}$ )

Selenium is an essential trace element. 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.<sup>24</sup> There is currently no established normal range for plasma selenium concentration.

Plasma selenium concentration was not measured for participants aged 1.5 to 6 years because the small volume of blood taken from these children precluded including these analyses (see section 6.1.1), therefore plasma selenium concentration is provided for children aged 7 to 10 years rather than for children aged 4 to 10 years.

Mean plasma selenium concentration was  $0.97\mu\text{mol/L}$  for boys aged 7 to 10 years,  $0.93\mu\text{mol/L}$  for boys aged 11 to 18 years,  $0.90\mu\text{mol/L}$  for girls aged 7 to 10 years and  $0.92\mu\text{mol/L}$  for girls aged 11 to 18 years.

Mean plasma selenium concentration was similar across all age/sex groups for adults with a mean concentration of  $1.08\mu\text{mol/L}$  for men aged 19 to 64 years,  $1.07\mu\text{mol/L}$  for men aged 65 years and over,  $1.06\mu\text{mol/L}$  for women aged 19 to 64 years and  $1.05\mu\text{mol/L}$  for women aged 65 years and over.

(Table 6.5)

### 6.6.2 Plasma zinc (micromoles/litre, $\mu\text{mol/L}$ )

Zinc is an essential trace element. It has a regulatory and catalytic role in numerous enzymes and also has a structural role in a number of enzymes and non-enzymatic proteins. Zinc also plays a role in major metabolic pathways which contribute to protein, carbohydrate, lipids, nucleic acids and energy metabolism.<sup>11</sup> There is currently no established normal range for plasma zinc concentration.

Plasma zinc concentration was not measured for participants aged 1.5 to 6 years because the small volume of blood taken from these children precluded including these analyses (see

section 6.1.1), therefore plasma zinc concentration is provided for children aged 7 to 10 years rather than for children aged 4 to 10 years.

Mean plasma zinc concentration was 15.15 $\mu$ mol/L for boys aged 7 to 10 years, 15.16 $\mu$ mol/L for boys aged 11 to 18 years, 14.34 $\mu$ mol/L for girls aged 7 to 10 years and 14.64 $\mu$ mol/L for girls aged 11 to 18 years.

Mean plasma zinc concentration was 14.91 $\mu$ mol/L for men aged 19 to 64 years, 14.32 $\mu$ mol/L in men aged 65 years and over, 14.17 $\mu$ mol/L for women aged 19 to 64 years and 13.73 $\mu$ mol/L for women aged 65 years and over respectively.

**(Table 6.5)**

## 6.7 Summary of the nutritional status of the UK population

Analysis of blood samples can provide an indication of the level of nutrients available to the body (after absorption) for use in metabolic processes.

There is evidence of iron-deficiency anaemia (as indicated by low haemoglobin levels) or low iron stores (plasma ferritin) in all age/sex groups in the population, with a higher preponderance in females. Almost 5% of girls aged 11 to 18 years and women aged 19 to 64 years had both concentrations below the threshold. There is evidence of low vitamin D status at the time of venepuncture in all reported age/sex groups, especially in the winter months; this has implications for bone health (increasing the risk of rickets and osteomalacia).

A substantial proportion of participants aged 1.5 years and over had riboflavin status values above the generally accepted upper threshold of normal status indicating biochemical depletion, particularly pronounced in children aged 11 to 18 years. However, there is uncertainty about the functional consequences of a raised EGRAC. From now on in addition to using this threshold, changes in the riboflavin status of the UK population will be monitored by reviewing the EGRAC values at the 75<sup>th</sup> and 90<sup>th</sup> percentiles in successive years.

There is little evidence of low status for other micronutrients where normal ranges or thresholds for low status have been set. Mean values for vitamin C, B<sub>12</sub>, thiamin, retinol and vitamin E fell within the normal range.

Approximately a third of adults had a serum total cholesterol concentration between 5.2 and 6.4mmol/L, indicating a marginally increased risk of cardiovascular disease, whilst slightly more than 10% of adults had a total serum cholesterol concentration between 6.4 and 7.8mmol/L indicating moderately elevated cardiovascular risk and in approximately 2% of adults it was above 7.8mmol/L indicating severe risk.

---

<sup>1</sup> <http://www.data-archive.ac.uk> (accessed 19/03/14).

<sup>2</sup> Participants are classed as “fully productive” if they have completed three or four days of the food and drink diary.

<sup>3</sup> Hornung, RW, Reed, LD. Applied Occupational and Environmental Hygiene, 1990, 5: 46-51.

<sup>4</sup> Rustin D, Hoare J, Henderson L, Gregory J, Bates CJ, Prentice A, Birch M. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 4: Nutritional status (anthropometry and blood analytes), blood pressure and physical activity. TSO (London, 2004). <http://multimedia.food.gov.uk/multimedia/pdfs/ndnsfour.pdf> (accessed 19/04/14).

<sup>5</sup> 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).

<sup>6</sup> 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). <http://www.esds.ac.uk/findingData/snDescription.asp?sn=4036> (accessed 19/04/14).

<sup>7</sup> Gregory JR, Collins DL, Davies PSW, Hughes JM, Clarke PC. National Diet and Nutrition Survey: children aged 1 ½ to 4 ½ years. Volume 1: Report of the diet and nutrition survey. HMSO (London, 1995).

<sup>8</sup> World Health Organization. Iron Deficiency Anaemia; Assessment, Prevention, and Control: A guide for programme managers. WHO (Geneva, 2001).

<sup>9</sup> Scientific Advisory Committee on Nutrition. *Iron and Health*. The Stationery Office (London, 2010).

<sup>10</sup> Sauberlich HE. Vitamin C status: methods and findings. Annals of the New York Academy of Sciences, 1971; 24: 444–454.

<sup>11</sup> Committee on Medical Aspects of Food Policy, *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom*, Department of Health Report on Health (1991).

<sup>12</sup> WHO. Conclusions of a WHO technical consultation on folate and vitamin B<sub>12</sub> deficiencies. Food and Nutrition Bulletin. 2008; 29. S238–S244.

<sup>13</sup> Bates CJ, Thurnham DI, Bingham SA, Margetts BM, Nelson M. Biochemical Markers of Nutrient Intake. In: Design Concepts in Nutritional Epidemiology. 2nd Edition. OUP (Oxford, 1997), pp 170–240.

- <sup>14</sup> Hill MH, Bradley A, Mustaq S, Williams EA, Powers HJ. Effects of methodological variation on assessment of riboflavin status using the erythrocyte glutathione reductase activation coefficient assay. *British Journal of Nutrition*, 2009; 102 (2): 273-8.
- <sup>15</sup> Powers HJ, Hill MH, Mushtaq S, Dainty JR, Majsak-Newman G, Williams EA. Correcting a marginal riboflavin deficiency improves hematologic status in young women in the United Kingdom (RIBOFEM). *American Journal of Clinical Nutrition*, 2011; 93(6):1274-84.
- <sup>16</sup> Friso S, Girelli D, Martinelli N, Olivieri O, Lotto V, Bozzini C, Pizzolo F, Faccini G, Beltrame F, Corrocher R. Low plasma vitamin B-6 concentrations and modulation of coronary artery disease risk. *American Journal of Clinical Nutrition*, 2004; 79 (6): 992-8.
- <sup>17</sup> Green MH, Green JB 'Dynamics and control of plasma retinol. In: *Vitamin A in Health and Disease*. Marcel Dekker Inc., (New York, 1994) Pp 119-133.
- <sup>18</sup> Department of Health Report on Health and Social Subjects, No. 49. Nutrition and bone health with particular reference to calcium and vitamin D. TSO (London, 1998).
- <sup>19</sup> Bates CJ, Carter GD, Mishra GD, O'Shea D, Jones J, Prentice A. In a population study, can parathyroid hormone aid the definition of adequate vitamin D status? A study of people aged 65 years and over from the British National Diet and Nutrition Survey. *Osteoporosis International*, 2003; 14: 152-9.
- <sup>20</sup> 25-hydroxyvitamin D was measured in plasma for Years 1-3 and for Year 4 samples taken during the first six issued fieldwork months (404-409). For samples taken during the last six issued fieldwork months of Year 4 (410-412), 25-hydroxyvitamin D was measured in serum. Concentrations of 25-hydroxyvitamin D have been shown to be the same in both plasma and serum.
- <sup>21</sup> Department of Health. Report on Health and Social Subjects: 46. Nutritional Aspects of Cardiovascular Disease. HMSO (London, 1994).
- <sup>22</sup> The British Cardiac Society, British Hyperlipidaemia Association, British Hypertension Society, endorsed by the British Diabetic Association, have issued guidance published in the article 'Joint British recommendations on prevention of coronary heart disease in clinical practice'. *Heart*, 1998; 80: 1–29.
- <sup>23</sup> Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clinical Chemistry* 1972;18: 499-502.
- <sup>24</sup> Rayman MP. The importance of selenium to human health. *Lancet*, 2000; 356: 233–41.

## 7 24-hour urine analyses: Sodium excretion and estimated salt intake

*Authors: Sonja Nicholson, Lorna Cox, Polly Page, Chris Bates & Ann Prentice*

### **Erratum note: Correction to data**

This chapter has been updated in 2017 since first publication (in May 2014). The results presented have been updated to take account of bias in the original sodium concentrations, which was detected and confirmed after original publication. This correction has resulted in slightly higher estimates of salt intake than originally published. However the overall conclusions are unchanged. Data will be made available in the UK Data Archive for urinary sodium concentration (mmol/L) and excretion (mmol/24hr) before and after application of the correction factor.

This correction is in line with the approach used in the 2014 urinary sodium surveys of adults<sup>1,2</sup> and brings the data in this report onto a comparable basis with the data from those surveys.

Published figures for estimated salt intake from previous sodium surveys<sup>3,4,5,6,7,8</sup> have also recently been revised to take account of analytical bias in the instruments used at the time of measuring sodium concentration in the samples for the respective surveys. These revisions facilitate comparisons between surveys over time.

Further details of the correction can be found in appendix U of this report and in the reports for the England and Scotland 2014 sodium surveys.<sup>1,2</sup>

### **7.1 Introduction**

This chapter presents estimated salt intakes based on 24-hour urinary sodium excretion data from participants aged 4 to 18 years and 65 years and over in Years 1 to 4 combined of the National Diet and Nutrition Survey Rolling Programme (NDNS RP). The RP data presented here add to previous publications on estimated salt intake in adults aged 19 to 64 years in UK countries.<sup>3,4,5,6,7,8</sup> Key results are highlighted in section 7.5 of this chapter.

Results for adults aged 19 to 64 years are not presented in this chapter nor in tables 7.1 to 7.4 because results for this age group, based on data collected separately and over a shorter time period in England and Scotland, were published in 2012 and 2011 respectively<sup>7,8</sup> and most recently in 2016.<sup>1,2,9</sup>

Data presented in this chapter provide an estimate of the progress of the population aged 4 to 18 years and 65 years and over towards meeting UK Health Department targets to reduce the average population salt intakes in the UK to no more than 3g/day for those aged 4 to 6 years, no more than 5g/day for those aged 7 to 10 years and no more than 6g/day for those aged 11 years and over.<sup>10,11</sup> The Reference Nutrient Intake (RNI)<sup>12</sup> for sodium set in 1991 by the Committee on Medical Aspects of Food and Nutrition Policy's (COMA) panel on Dietary Reference Values,<sup>13</sup> are presented in Table 7A for the different NDNS age groups. The table also shows the corresponding recommended maximum salt intake per day for adults, which was set by COMA<sup>10</sup> and endorsed by the Scientific Advisory Committee on Nutrition (SACN) in its report on Salt and Health (2003) and the recommended maximum intakes set by SACN (2003) for children.<sup>11</sup>

**Table 7A Reference Nutrient Intake for sodium and the corresponding recommended maximum salt intake per day for NDNS age groups**

NDNS age group	RNI <sup>12,13</sup> mmol sodium per day*	Recommended maximum salt intake <sup>10,11</sup> g per day**
4 to 6 years	30	3
7 to 10 years	50	5
11 to 18 years	70	6
19 to 64 years***	70	6
65 years and over	70	6

\*1g salt contains 17.1 mmol sodium.

\*\* These are the maximum daily dietary targets.

\*\*\* results for this age group have been previously published elsewhere.

Dietary salt intake can be assessed by measuring sodium excretion in urine. Salt is the predominant source of sodium in the UK diet and estimation of intake from excretion is more reliable than through dietary assessment as it is difficult to quantify discretionary salt used in

cooking and at the table. Estimates of sodium intake can be obtained by measuring urinary sodium excretion, assuming the body is in balance for sodium. Sodium is readily absorbed from the diet, its concentration in plasma is under tight homeostatic control and the excess is excreted rapidly in urine.

Sodium excretion in single (“spot”) urine samples is not a reliable indicator of salt intake because both the excretion of sodium and the excretion of water fluctuate greatly during the day according to what was eaten at the last meal and how much fluid an individual has drunk; hence the concentration of sodium in spot urine samples is very variable. A 24-hour urine collection is accepted as being the most reliable method for assessing population mean salt intake.<sup>11</sup> Therefore, as for the previous England and Scotland sodium surveys<sup>7,8</sup> and recently published sodium data for adults,<sup>1,2,9</sup> the 24-hour urine methodology was used for the NDNS RP, facilitated by the nurses during their visits to participants.

To be representative of daily salt intake the 24-hour urine collection has to be complete; this can be assessed by orally administering para-aminobenzoic acid (PABA) and measuring its excretion in the 24-hour urine collection.<sup>14</sup> Where participants were excluded from taking PABA<sup>15</sup> or were unwilling to do so, or where participants failed to take the required PABA dose, assessment of complete collections was reliant on information recorded by participants on the 24-hour urine record sheet (see appendix T).

Results for measurement of sodium excretion and estimated salt intake are provided in this chapter using only those 24-hour urine collections that were classified as complete.

Predetermined criteria were used to determine completeness (see section 7.4). Supporting information about the 24-hour urine collection and the results of other urine analyses are provided in other sections of the report as follows:

- data on excretion of potassium, nitrogen, urea and creatinine are described in appendix S
- an overview of the purpose, methodologies and other procedures associated with obtaining 24-hour urine collections from participants, as well as the response rates achieved, are provided in chapters 1 to 3
- appendix T details the procedures for obtaining written consent from adult participants and the parent/legal guardian of child participants, including child assent where appropriate, prior to the 24-hour urine collection

- appendix T also provides information about obtaining the 24-hour urine collection (including the administration of PABA), the processing of the urine aliquots, categorisation of collections as “complete” or “incomplete/unreliable” and representativeness of urine collections deemed to be complete and included in the data analysis
- appendix U details the quality control data and methodology of urine analysis for sodium along with details of the derivation of a method-specific factor to enhance accuracy of sodium results relative to a national consensus reference and to facilitate comparison with previous England and Scotland sodium surveys<sup>7,8</sup> and recently published data for adults.<sup>1,2,9</sup> Appendix U also includes quality control data and methodology for other urine analytes reported in appendix S
- appendix W details which analytes are reported for Years 1 to 4 combined, as well as providing details about those analytes that are not reported here but will be included in the dataset deposited at the UK Data Archive<sup>16</sup>

All urine excretion data were weighted to account for differential non-response in providing a 24-hour urine collection, in order to adjust for any bias arising from refusals to provide a 24-hour urine collection and also failure to provide a complete 24-hour urine collection; incomplete collections were excluded from the descriptive statistics.

## ***7.2 Urine collection and processing***

Eligible participants who agreed to the nurse visit were asked to provide a 24-hour urine collection for measurement of sodium excretion and other urinary analytes. Full details of the 24-hour urine collection protocol are given in appendix T.

The nurse visited the participant as soon as possible after the end of the collection period to process the urine. All urine from the 24-hour period was collected in a 5 litre bottle. The bottle containing the 24-hour urine collection was weighed twice by the nurse to determine urine volume and was thoroughly mixed prior to filling four monovette tubes with a representative aliquot of the urine. These were sent by post to HNR for storage at -20°C and later analysis of sodium, potassium, urea, creatinine and nitrogen (see appendix U); urine remaining after analysis was retained at -20°C, where consent had been given for storage and use in future research. Appendix T provides further details on urine processing and storage.

### **7.3 Results used in the data analysis**

For the age groups reported in this chapter (participants aged 4 to 18 years and 65 years and over) 2,038 24-hour urines (from 1,005 males and 1,033 females) were received at HNR and a total of 2,031 sodium results were obtained (from 1,003 males and 1,028 females). Of these 24-hour urines with a sodium result, 46.3% of collections (940) were classified as 'complete by standard criteria' and are included in the descriptive statistics in tables 7.1 to 7.4; 53.7% (1,091) were classified as 'incomplete or unreliable by standard criteria' and have been omitted from the descriptive statistics (see section 7.4.1 below for details about the 'standard criteria').

Sodium concentrations were converted to mmol/24hr based on the weight of the full collection in kg and assuming a specific gravity of 1.0kg/litre. Urinary sodium excretion data were adjusted using a method-specific factor (i.e. multiplied by 1.052) in order to correct for analytical bias and to enable comparison with results from recent and previous urinary sodium surveys of adults which have also been corrected.<sup>1,2,7,8,9</sup> Application of this factor has resulted in slightly higher estimates of salt intake compared with the previously published figures (for information on the derivation of this factor see appendix U).

In line with previous surveys, estimated salt intake was calculated from corrected 24-hour urinary sodium excretion using the equation:

17.1mmol of sodium excreted = 1 g of salt consumed.

This assumes that the dietary intake of sodium is equal to the urinary output, and that all sodium in the diet comes from salt.

### **7.4 Assessment of completeness of collection**

Sodium excretion in the urine approximates to 24-hour intake of sodium in the diet only if the 24-hour urine collection is complete. Full details of the procedures used to establish completeness and the criteria applied to categorise the collections are given in appendix T.

#### **7.4.1 Standard criteria for classifying complete collections**

24-hour urine collections were classified as 'complete' or 'incomplete/unreliable' by either of two criteria: 'complete by PABA' (where the participant has reported taking three PABA tablets and the amount of PABA recovered in the urine collection is consistent with completeness) or 'complete by claim' (where the participant has reported taking less than three PABA tablets and reported (i.e. claimed) collection of all urine passed during 23 to 25 hours), jointly referred to as 'standard criteria'. For participants aged 11 to 18 years and 65 years and over, only results of urine collections classified as complete by these criteria are included in the results data (tables 7.1 to 7.4).

#### **7.4.2 Alternative criterion for classifying complete collections from children**

##### **aged 4 to 10 years**

Children aged 4 to 10 years are more likely to have difficulty swallowing tablets than older participants so compliance with the PABA protocol is likely to be poorer in this age group, particularly at the younger end of the age range. Therefore, an alternative criterion was used for children to determine which collections could be regarded as 'complete', for collections not deemed complete by the PABA protocol. This alternative child criterion was when the collections were claimed to include all urine passed for 23 to 25 hours from the start time irrespective of PABA excretion. Results based on urine collections deemed complete by this alternative child (claim only) criterion are tabulated separately in tables 7.1 to 7.4.

Details regarding the number and representativeness of useable collections for the different age/sex groups are presented in appendix T and tables T.1-T.3.

### **7.5 Sodium excretion and estimated salt intake results**

Table 7.1 provides mean urinary sodium excretion by age/sex group expressed as mmol per 24 hours (mmol/24hr), table 7.2 shows the cumulative percentage distribution of urinary sodium excretion per 24 hours. Table 7.3 provides mean estimated salt intake by age/sex group expressed as gram per 24 hours (g/24hr). Table 7.4 shows the cumulative percentage distribution of urinary estimated salt intake per 24 hours. As explained above, these data have been revised to take into consideration the method specific factor (see appendix U).

For all age/sex groups, except for girls aged 7 to 10 years (complete by standard criteria only), estimated mean salt intake was higher than the recommended maximum intake for each age group.<sup>17</sup>

Males had higher mean urinary sodium excretion per 24 hours (and estimated salt intake) than their female counterparts in each age group. As expected, mean urinary sodium excretion (and estimated salt intake) was higher in the 65 years and over age group than in the 4 to 18 years age group and in children increased with age from 4 to 6 years to 11 to 18 years.

The mean urinary sodium excretion (using the standard criteria) for children aged 4 to 6 years was 66mmol/24hr and for children aged 7 to 10 years was 90mmol/24hr; 98mmol/24hr for boys and 82mmol/24hr for girls.

The mean estimated salt intake for children (complete by standard criteria) was 3.9g/day for those aged 4 to 6 years and 5.3g/day those aged 7 to 10 years, these mean intakes were 29% and 6% greater than the SACN recommendation of a population average of no more than 3g/day and 5g/day respectively.<sup>10,11</sup> For children aged 7 to 10 years; boys had a mean daily intake of 5.7g/day and girls had a mean daily intake 4.8g/day. The population distribution was heavily skewed towards higher values; the median estimated salt intake for children aged 4 to 6 years was 3.6g/day and for children aged 7 to 10 years was 4.8g/day (boys 5.2g/day, girls 4.6g/day).

Application of the alternative child criterion for completeness made little difference to the mean urinary sodium excretion or to mean estimated salt intake; the differences between the estimates from the two methods were equivalent to no more than 0.3g/day salt in any group.

The mean urinary sodium excretion for children aged 11 to 18 years was 127mmol/24hr for boys and 111mmol/24hr for girls.

The mean estimated salt intake for children aged 11 to 18 years was 7.0g/day, this was 16% greater than the SACN recommendation of a population average of no more than 6g/day.<sup>10,11</sup> Boys had a daily intake of 7.4g/day and girls had a mean daily intake 6.5g/day. The population

distribution for girls was heavily skewed towards higher values; the median estimated salt intake for girls aged 11 to 18 years was 6.2g/day.

Mean urinary sodium excretion was 149mmol/24hr for men aged 65 years and over and 115mmol/24hr for women aged 65 years and over.

The mean estimated salt intake for adults aged 65 years and over was 7.6g/day, this was 26% greater than the SACN recommendation of a population average of no more than 6g/day.<sup>10,11</sup> Men had a daily intake of 8.7g/day and women had a mean daily intake 6.7g/day. The population distribution was heavily skewed towards higher values; the median estimated salt intake for the adult population was 7.0g/day (men 8.0g/day, women 6.2g/day).

**(Tables 7.1 to 7.4)**

---

<sup>1</sup> National Diet and Nutrition Survey (NDNS): Assessment of dietary sodium for adults (19 to 64 years) in England, 2014 report; [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/509399/Sodium\\_study\\_2014\\_England\\_Text\\_final.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/509399/Sodium_study_2014_England_Text_final.pdf) Published 2016 (accessed 27/06/16).

<sup>2</sup> National Diet and Nutrition Survey (NDNS): Assessment of dietary sodium for adults (19 to 64 years) in Scotland, 2014 report; [http://www.foodstandards.gov.scot/sites/default/files/Monitoring%20the%20Scottish%20Diet-%20Sodium%20Survey%202014%20SCOTLAND\\_FINAL%20PDF.pdf](http://www.foodstandards.gov.scot/sites/default/files/Monitoring%20the%20Scottish%20Diet-%20Sodium%20Survey%202014%20SCOTLAND_FINAL%20PDF.pdf) Published 2016 (accessed 27/06/16).

<sup>3</sup> An assessment of dietary sodium levels among adults (aged 19-64) in the general population, based on analysis of sodium in 24 hour urine samples. Oct 2006  
<http://webarchive.nationalarchives.gov.uk/20101211052406/http://www.food.gov.uk/multimedia/pdfs/englandsodiumreport.pdf> (accessed 27/06/16).

<sup>4</sup> Joint Health Surveys Unit (NatCen and UCL). A survey of 24 hour and spot urinary sodium and potassium excretion in a representative sample of the Scottish population. Food Standards Agency Scotland, 2007: <http://tna.europarchive.org/20110116113217/http://www.food.gov.uk/multimedia/pdfs/scotlandsodiumreport.pdf> (accessed 27/06/16).

<sup>5</sup> An assessment of dietary sodium levels among adults (aged 19-64) in the general population in Wales based on analysis of dietary sodium in 24 hour urine samples. Feb 2007.  
<http://webarchive.nationalarchives.gov.uk/20101211052406/http://www.food.gov.uk/multimedia/pdfs/walessodiumreport.pdf> (accessed 27/06/16).

<sup>6</sup> An assessment of dietary sodium levels among adults (aged 19-64) in the UK general population in 2008, based on analysis of dietary sodium in 24 hour urine samples, June 2008;  
<http://tna.europarchive.org/20110116113217/http://www.food.gov.uk/multimedia/pdfs/08sodiumreport.pdf> (accessed 27/06/16).

<sup>7</sup> National Diet and Nutrition Survey - Assessment of dietary sodium in adults (aged 19 to 64 years) in England, 2011 report. [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/127916/Sodium-Survey-England-2011\\_Text\\_to-DH\\_FINAL1.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/127916/Sodium-Survey-England-2011_Text_to-DH_FINAL1.pdf) (accessed 27/06/16).

<sup>8</sup> A survey of 24 hour urinary sodium excretion in a representative sample of the Scottish population as a measure of salt intake. Published April 2011. <http://www.foodstandards.gov.scot/survey-24-hour-urinary-sodium-excretion-representative-sample-scottish-population-measure-salt> (accessed 27/06/16).

<sup>9</sup> National Diet and Nutrition Survey: Assessment of dietary sodium - Adults (19 to 64 years) in Northern Ireland 2015; <https://www.food.gov.uk/northern-ireland/nutritionni/national-diet-and-nutrition-survey-assessment-of-dietary-sodium> Published 2016 (accessed 06/10/16).

<sup>10</sup> Department of Health. Report on Health and Social Subjects: 46. Nutritional Aspects of Cardiovascular Disease. HMSO (London, 1994).

<sup>11</sup> Scientific Advisory Committee on Nutrition (2003). Salt and Health. The Stationery Office. [http://www.sacn.gov.uk/pdfs/sacn\\_salt\\_final.pdf](http://www.sacn.gov.uk/pdfs/sacn_salt_final.pdf) (accessed 27/06/16)

<sup>12</sup> The RNI for a vitamin or mineral is the amount of the nutrient that is considered to be sufficient for 97.5% of people in the group. If the average intake of the group is at the RNI, then the risk of deficiency in the group is judged to be very small. However, if the average intake is lower than the RNI then it is possible that some of the group will have an intake below their requirement.

<sup>13</sup> Report on Health and Social Subjects 41 *Dietary Reference Values (DRVs) for Food Energy and Nutrients for the UK*, Report of the Panel on DRVs of the Committee on Medical Aspects of Food Policy (COMA) 1991. The Stationery Office. London.

<sup>14</sup> Bingham S and Cummings J H. The use of 4-aminobenzoic acid as a marker to validate the completeness of 24h urine collections in man. *Clin Sci (Lond)* 1983; 64(6):629-35.

<sup>15</sup> Exclusions in the NDNS RP for participants taking PABA included those with conditions which could lead to a bad reaction to PABA (e.g. lactose intolerance; a previous allergic reaction to hair dye, sunscreen or a vitamin preparation) or who were taking sulphonamides were excluded from taking PABA.

<sup>16</sup> <http://www.data-archive.ac.uk> (accessed 06/10/16).

<sup>17</sup> The SACN recommendation for maximum daily salt is no more than 3g/day for children aged 4 to 6 years and no more than 5g/day for children 7 to 10 years. The recommended maximum salt intake per day for adults, which was set by COMA and endorsed by SACN for adults and set by SACN for children is no more than 6g/day for those aged 11 years and over.

## 8 Detailed age breakdowns for young people and adults for key nutrients and disaggregated foods

*Authors: Caireen Roberts, Toni Steer, Sonja Nicholson, David Pell, Polly Page & Alison Lennox*

### 8.1 Introduction

Dietary data for all participants in Years 1 to 4 combined of the NDNS Rolling Programme (RP) are presented in Chapter 5 across five standard age groups: 1.5 to 3 years, 4 to 10 years, 11 to 18 years, 19 to 64 years and 65 years and over. Within the standard age groups 11 to 18 years and 19 to 64 years, there are sub age groups of particular interest in terms of intakes of specific foods or nutrients (for example, young people aged 16 to 24 years in regard to alcohol), or who have specific requirements (such as folate for women of child bearing age). Results in this chapter are presented for four separate age groups: 11 to 15 years, 16 to 24 years, 25 to 49 years and 50 to 64 years. Results are also subdivided by sex for these age groups. Further details on the dietary data collection methods and interpretation can be found in Chapter 5, section 5.1.

For this chapter, nutrient intakes have been limited to key macronutrients and micronutrients of policy interest and are described from food sources only (not including supplements). Unless stated otherwise, all Dietary Reference Values (DRVs) discussed in this chapter are those presented in the 1991 COMA report on Dietary Reference Values for Food Energy and Nutrients for the United Kingdom.<sup>1</sup> Results for food consumption have been limited to fruit and vegetables and meat and fish after disaggregation (i.e. including the contribution from composite dishes containing these ingredients but excluding other components of these dishes),<sup>2</sup> and refer to mean values for the total survey population, including non-consumers.

### 8.2 Energy and macronutrient intake

This section presents key findings on the daily intakes of energy and macronutrients estimated from the food consumption data. Mean daily intakes of macronutrients are compared with the UK DRVs.<sup>1,3</sup>

- mean daily intakes of total and food energy were similar across the four age groups especially for females where there was less than 100 kcals difference in mean intakes between the age groups
- mean daily intakes of total fat met the DRV of contributing no more than 35% of food energy in all age/sex groups
- mean intakes of saturated fatty acids exceeded the DRV of providing no more than 11% of food energy in all age/sex groups. Mean intakes ranged from 12.3% for those aged 16 to 24 years to 13.0% for those aged 50 to 64 years
- mean *trans* fatty acid intakes were 0.6-0.7% of food energy in all age/sex groups, which met the DRV of providing no more than 2% of food energy
- mean intakes of non-milk extrinsic sugars (NMES) exceeded the DRV of providing no more than 11% of food energy in all age/sex groups, except females aged 50 to 64 years. Mean intakes were higher in the younger two age groups. For males, those aged 11 to 15 years had the highest mean intake of NMES as a per cent of food energy (15.8% of food energy) while for females, those aged 16 to 24 years had the highest mean intake (also 15.8% of food energy)
- mean intakes of non-starch polysaccharide (NSP) increased by age from 11.8g per day and 12.3g per day for those aged 11 to 15 years and 16 to 24 years respectively, to 13.6g per day and 14.4g per day for those aged 25 to 49 years and 50 to 64 years respectively. Mean intakes did not meet the DRV for adults which is set at a population average intake of 18g per day

**(Tables 8.1a-8.1c)**

### 8.3 Alcohol

This section reports on alcohol intake in grams per day and as a percentage of total energy for both the total sample (including non-consumers) and for consumers only. Consumers are those who reported consumption of alcoholic beverages in the four-day food diary.<sup>4</sup> In the Years 1 to

4 combined data, there is a slightly higher proportion of weekend days than weekdays and this should be taken into account when interpreting findings on alcohol intake (see Chapter 5, section 5.1, Table 5A).

On average over the four-day recording period, alcohol provided 9.1% of energy for male consumers aged 25 to 49 years and 9.4% of energy for male consumers aged 50 to 64 years. For female consumers over the four-day recording period, alcohol on average provided 7.8% of energy for those aged 25 to 49 years and 7.3% for those aged 50 to 64 years. Intakes at the upper 2.5 percentile provided 29.0-29.7% of energy for male consumers aged 25 to 49 years and 50 to 64 years and 22.2-23.6% for female consumers in these age groups in the four-day recording period. A slightly higher proportion of adults aged 50 to 64 years (64%) reported consumption of alcohol than did adults aged 25 to 49 years (58%). A higher proportion of men than women reported consuming alcohol in both age groups.

Forty per cent of participants aged 16 to 24 years reported consumption of alcohol during the four-day recording period, and for them, alcohol provided on average 6.9% of energy for male consumers and 8.3% for female consumers. Intakes at the upper 2.5 percentile provided 26.7% of energy for male consumers and 19.1% for female consumers in this age group.

Five per cent of participants aged 11 to 15 years reported consumption of alcohol during the four-day recording period.

**(Tables 8.2a-8.2c)**

## 8.4 Vitamins and minerals

This section presents daily intakes of selected vitamins and minerals, namely vitamin C, folate, iron and calcium, from foods only (excluding dietary supplements). Mean daily intakes of these vitamins and minerals are compared with the UK Reference Nutrient Intakes (RNIs)<sup>5</sup> and the proportions of participants with intakes below the Lower Reference Nutrient Intakes (LRNIs)<sup>6</sup> are shown. The RNIs and LRNIs for the vitamins and minerals presented are shown in Tables 5.14 and 5.32 (Chapter 5).

Overall, for men and women aged 25 to 64 years, mean intakes of the selected vitamins and minerals met the RNIs with the exception of iron for women aged 25 to 49 years (65% of the

RNI). Among the younger participants, females aged 11 to 15 years and 16 to 24 years had mean intakes below the RNI for calcium (86% and 90% of the RNI respectively) and iron (58% of the RNI for both age groups).

For males in all age groups, the proportion of intakes below the LRNI was low for all four micronutrients. Nine per cent of males aged 16 to 24 years had calcium intakes below the LRNI. For females, iron intakes were below the LRNI for 44% of those aged 11 to 15 years, 40% of those aged 16 to 24 years and 29% of those aged 25 to 49 years. Eighteen per cent of females aged 11 to 15 years and 16% of females aged 16 to 24 years had intakes of calcium below the LRNI. Nine per cent of females aged 16 to 24 years had intakes of folate below the LRNI.

**(Tables 8.3a-8.5c)**

## 8.5 Vegetable, fruit, meat and fish consumption, including from composite dishes

This section reports consumption of vegetables, fruit, meat and fish based on disaggregated data. This includes the contribution from composite dishes, but excludes the other components of those dishes.<sup>2</sup> The number of portions of fruit and vegetables consumed per day has also been calculated from the disaggregated data in line with the “5-a-day” criteria, including up to one portion each of fruit juice and baked beans or pulses per day (see Appendix A).

Based on disaggregated data, mean total vegetable consumption (not including potatoes) increased with age from 106g per day for those aged 11 to 15 years to 199g per day for those aged 50 to 64 years. Mean total fruit consumption (not including juice) also increased with age from 65g for those aged 11 to 15 years and 64g for those aged 16 to 24 years to 132g per day for those aged 50 to 64 years. The average number of portions consumed, calculated using the “5-a-day” criteria,<sup>7</sup> also increased with age from 2.9 portions per day for those aged 11 to 15 years to 4.7 portions per day for those aged 50 to 64 years. The proportion of participants meeting the “5-a-day” guideline was 9% of those aged 11 to 15 years, 14% of those aged 16 to 24 years (18% of males and 10% of females), 29% of those aged 25 to 49 years and 38% of those aged 50 to 64 years.

In males, mean consumption of red meat based on disaggregated data was lowest in the 11 to 15 years age group (69g per day), highest in the 16 to 24 years age group (92g per day) and

was 86g per day and 82g per day respectively for males aged 25 to 49 years and 50 to 64 years. The current recommendation is that, for adults, average intakes of red and processed meat should not exceed 70g per day.<sup>8</sup> Mean consumption increased by age in females from 45g per day for those aged 11 to 24 years to 62g per day for those aged 50 to 64 years.

Based on mean consumption in the four-day recording period, consumption of oily fish was well below the recommendation of at least one portion (140g) per week<sup>9</sup> in all age groups. Oily fish consumption was equivalent to 11g per week for those aged 11 to 15 years, 21g per week for those aged 16 to 24 years, 47g per week for those aged 25 to 49 years and 76g per week for those aged 50 to 64 years.<sup>10</sup>

**(Table 8.6a-8.6c)**

---

<sup>1</sup> Report on Health and Social Subjects 41 *Dietary Reference Values (DRVs) for Food Energy and Nutrients for the UK*, Report of the Panel on DRVs of the Committee on Medical Aspects of Food Policy (COMA) 1991. The Stationery Office. London

<sup>2</sup> All composite dishes in the NDNS Nutrient Databank have been disaggregated into their constituent ingredients. This enables the fruit, vegetables, meat and fish in mixed dishes such as stews and pies to be included in consumption figures. The methodology for the disaggregation of composite dishes is provided in Appendix A.

<sup>3</sup> For total fat, saturated and *trans* fatty acids and non-milk extrinsic sugars (NMES) the DRVs are the recommended maximum contribution these nutrients should make to the population average diet. For total carbohydrate, *cis*-monounsaturated fatty acids and non-starch polysaccharide (NSP) the DRVs are recommended population averages. For protein, the Reference Nutrient Intakes (RNIs) are set at levels of intake considered likely to be sufficient to meet the requirements of 97.5% of the population.

<sup>4</sup> Consumers also include those who consumed alcohol in recipes and other foods.

<sup>5</sup> The RNI for a vitamin or mineral is the amount of the nutrient that is sufficient for 97.5% of people in the group. If the average intake of the group is at the RNI, then the risk of deficiency in the group is judged to be very small. However, if the average intake is lower than the RNI then it is possible that some of the group will have an intake below their requirement.

<sup>6</sup> The adequacy of vitamin or mineral intake can be expressed as the proportion of individuals with intakes below the LRNI. The LRNI for a vitamin or mineral is set at the level of intake considered likely to be sufficient to meet the needs of only 2.5% of the population.

<sup>7</sup> <http://www.nhs.uk/Livewell/5ADAY/Pages/5ADAYhome.aspx> (accessed 28/01/14).

<sup>8</sup> Scientific Advisory Committee on Nutrition. *Iron and Health*. London: TSO, 2010

<sup>9</sup> Scientific Advisory Committee on Nutrition. *Advice on fish consumption: benefits and risks*. London: TSO, 2004

<sup>10</sup> Weekly equivalent oily fish consumption has been calculated using unrounded data rather than the rounded figures in Table 8.6c

## 9 Comparison of equivalised income quintiles for key nutrients and disaggregated foods

*Authors: Toni Steer, Caireen Roberts, Sonja Nicholson, David Pell, Polly Page & Alison Lennox*

### 9.1 Introduction

This chapter presents consumption of selected foods and intake of key nutrients in Years 1 to 4 combined of the NDNS Rolling Programme (RP) by equivalised household income.<sup>1</sup> Results are presented by standard age groups (1.5 to 3 years, 4 to 10 years, 11 to 18 years, 19 to 64 years and 65 years and over) subdivided into quintiles, with quintile 1 being the lowest equivalised household income group and quintile 5 the highest. Results are also shown for standard age groups subdivided by sex (except for those aged 1.5 to 3 years). Further details of the dietary data collection methods and interpretation are given in Chapter 5, section 5.1.

Nutrient intakes presented in this chapter have been limited to key macronutrients and micronutrients of policy interest and are described from food sources only (not including supplements). Unless stated otherwise, all Dietary Reference Values (DRVs) discussed in this chapter are those presented in the 1991 Committee on Medical Aspects of Food Policy (COMA) report on Dietary Reference Values for Food Energy and Nutrients for the United Kingdom.<sup>2</sup> Results for food consumption have been limited to fruit and vegetables and meat and fish after disaggregation (i.e. including the contribution from composite dishes containing these ingredients but excluding other components of these dishes),<sup>3</sup> and refer to mean values for the total population, including non-consumers.

Statistical analysis has been carried out for this chapter to compare quintiles of equivalised household income to the reference group only. The highest income group (quintile 5) has been used as the reference group (refer to Appendix Y for a more detailed explanation of the statistical analysis). All statistically significant differences between the reference group (quintile 5) and other quintiles are highlighted in the tables. This chapter presents a summary of reported intakes across quintiles, highlighting any patterns, for example where there is an increase or decrease across the quintiles. Not all statistically significant differences are

described, especially where there is no clear pattern by income quintile. No statistical analysis has been carried out on the 65 years and over group split by sex as the reference groups (quintile 5) for males and females in this age group have less than 50 individuals or for an individual quintile that has less than 50 cases. In some quintile groups, numbers are low (for example males and females aged 65 years and over); therefore caution should be exercised when interpreting findings. For ease of reading, the term 'equivalised household income quintile' has been abbreviated throughout the chapter to 'income quintile' or 'quintile'.

## 9.2 Energy and key macronutrient intake by equivalised household income

This section presents key findings on the daily intakes of energy and macronutrients estimated from the food consumption data. Mean daily intakes of macronutrients are compared with the respective UK DRVs.<sup>1,4</sup>

No clear pattern in mean daily intake of total or food energy was observed between income quintiles. The only exception was women aged 19 to 64 years for whom mean total energy intake was significantly lower in quintiles 1 (1576kcal), 2 (1578kcal) and 3 (1569kcal) compared with quintile 5 (1687kcal).

Overall, no clear pattern was observed for mean total fat intake between income quintiles, either when expressed as a percentage of food energy intake or in terms of absolute intake (grams per day). The only notable exception was women aged 19 to 64 years for whom mean fat intake expressed as a percentage of food energy intake and in absolute terms was significantly lower in quintiles 1 (34.0% and 59.2g) and quintile 3 (33.5% and 57.3g) compared with quintile 5 (36.0% and 64.2g).

No clear pattern was observed for mean saturated fat intake as a percentage of food energy or in terms of absolute intakes for boys and girls or men and women, although children aged 1.5 to 3 years and both men and women aged 19 to 64 years in the lowest quintile had significantly lower mean saturated fat intake as a percentage of food energy than those in the highest quintile. Mean saturated fat intakes in all quintiles were above the recommendation of no more than 11% of food energy intake.

There was no clear pattern in mean intakes of *trans* fatty acids as a percentage of food energy or in terms of absolute intakes. All age/sex groups in all income quintiles had mean intakes that met the recommendation of no more than 2% of food energy intake.

Mean protein intake in grams tended to be lower in quintile 1 than in quintile 5 in adults aged 19 to 64 years. For women mean protein intake increased from the lowest to highest quintile and was significantly lower in quintiles 1 (61.1g), 2 (62.5g) and 3 (64.4g) compared with quintile 5 (69.3g). Men aged 19 to 64 years had a mean protein intake in grams that was significantly lower in quintile 1 (79.2g) compared with quintile 5 (86.2g), however, there was no consistent pattern from highest to lowest quintile in this age/sex group. In boys aged 11 to 18 years, mean protein intake was significantly lower in quintiles 2 (71.4g) and 3 (71.8g) compared with quintile 5 (80.3g). There was no clear pattern in other age groups.

Mean protein intake expressed as a percentage of food energy was significantly lower in girls aged 4 to 10 years in quintile 1 (13.7%) compared with those in quintile 5 (14.8%) and lower for girls aged 11 to 18 years in quintile 1 (14.2%) compared with those in quintile 5 (15.4%). However, there was no consistent pattern from highest to lowest quintile in either child age group and no pattern was seen for boys. Women aged 19 to 64 years had a significantly lower protein intake expressed as a percentage of food energy intake in quintiles 1 (16.3%) and 2 (16.7%) compared with quintile 5 (17.8%). The pattern for men aged 19 to 64 years was similar but did not reach statistical significance.

Overall, no clear pattern was observed in mean intake of total carbohydrate either when expressed as a percentage of food energy intake or in terms of absolute intakes. The exception was women, and to a lesser extent, men, aged 19 to 64 years for whom a slight decrease in total carbohydrate, from the lowest to highest quintile, was observed when expressed as a percentage of food energy intake. In men aged 19 to 64 years, mean percentage of food energy from carbohydrate was significantly higher in quintile 1 (49.6%) compared with quintile 5 (47.2%). In women aged 19 to 64 years mean percentage of food energy from carbohydrate was significantly higher in quintiles 1 (49.8%), 2 (48.4%) and 3 (48.9%) compared with quintile 5 (46.2%).

Overall, mean intakes of NMES for adults, expressed both as a percentage of food energy intake and in grams, tended to be higher in the lowest income quintile compared with the highest, whereas in boys aged 4 to 18 years (but not girls), mean intakes tended to be lower in the lowest income quintile compared to the highest, although the differences were only significant for boys aged 4 to 10 years. For example in women aged 19 to 64 years, there was a consistent decrease in NMES intake from the lowest to the highest quintile, when expressed as a percentage of food energy intake, with quintiles 1 (13.1%) and 2 (12.1%) being significantly higher than quintile 5 (10.6%). For men aged 19 to 64 years NMES intake as a percentage of food energy intake and in absolute terms was significantly higher in quintile 1 (15.5% and 79.5g) compared with quintile 5 (12.4% and 66.0g). Conversely in boys aged 4 to 10 years mean percentage of food energy from NMES and intake in absolute terms was significantly lower in the lowest quintile (14.0% and 59.1g) compared with the highest quintile (16.1% and 69.0g).

For non-starch polysaccharides (NSP), mean intake tended to be lower in the lower quintiles than the highest quintile in all age/sex groups. These differences reached statistical significance in children aged 1.5 to 3 years, girls aged 4 to 18 years and adults aged 19 to 64 years. For example in women aged 19 to 64 years mean intake increased from the lowest to highest quintile and was significantly lower in quintiles 1 (11.8g), 2 (11.9g) and 3 (12.6g) compared with quintile 5 (13.7g). However, men and women in all income quintile groups had mean intakes which were below the population average recommendation of 18g per day.

**(Tables 9.1a – 9.1f)**

### 9.3 Alcohol intake by equivalised household income

This section reports on alcohol intakes in grams per day and as a percentage of total energy for both the total sample (including non-consumers) and for consumers only. Consumers are those who reported consumption of alcoholic beverages in the four-day food diary.<sup>5</sup> In the Years 1 to 4 combined data, there are a slightly higher proportion of weekend days than weekdays and this should be taken into account when interpreting findings on alcohol intake (see Chapter 5, section 5.1, Table 5A).

Population average alcohol intake in men aged 19 to 64 years expressed in grams was significantly lower in quintiles 1 (22.3g), 2 (9.7g) and 3 (17.1g) compared with quintile 5 (25.0g).

When expressed as a percentage of total energy intake alcohol was significantly lower in quintiles 2 (3.1%), 3 (5.6%) and 4 (5.7%) compared with quintile 5 (7.5%). Average alcohol intake in women aged 19 to 64 years both expressed in grams and percentage of total energy were significantly lower in quintiles 1 (6.0g, 2.5%), 2 (7.8g, 3.2%) and 3 (9.7g, 4.1%) compared with quintile 5 (14.3g, 5.6%) and showed a clear pattern of increasing intake through the quintiles. These observations were partly due to a higher percentage of alcohol consumers in the higher income quintiles. There were no clear income differences in other age/sex groups.

**(Tables 9.2a – 9.2c)**

#### 9.4 Vitamins and minerals by equivalised household income

This section presents daily intakes of selected vitamins and minerals, namely vitamin C, folate, iron and calcium, from foods only (excluding dietary supplements). Mean daily intakes of these vitamins and minerals are compared with the UK Reference Nutrient Intakes (RNIs)<sup>6</sup> and the proportions of participants with intakes below the Lower Reference Nutrient Intakes (LRNIs)<sup>7</sup> are shown. The RNIs and LRNIs for the vitamins and minerals presented are shown in Tables 5.14 and 5.32 (Chapter 5).

Mean iron intake in women aged 19 to 64 years increased from the lowest to the highest quintile. The mean intake was significantly lower in quintiles 1 (8.7mg), 2 (9.1mg) and 3 (9.5mg) compared with quintile 5 (10.4mg). No clear pattern was observed in other age/sex groups.

There were no significant differences by income quintiles in mean daily intakes of iron as a percentage of the RNI for boys and men, and all mean intakes were above 90% of the RNI. Girls aged 11 to 18 years and women aged 19 to 64 years in all income quintiles had a mean intake of iron below 90% of the RNI.

Children aged 1.5 to 3 years in quintiles 1 and 3 had a mean intake of iron below 90% of the RNI, however, there was no clear pattern or significant differences between quintiles in this group

A high proportion of girls aged 11 to 18 years and women aged 19 to 64 years in all income quintiles had iron intakes below the LRNI. In women aged 19 to 64 years there was a clear pattern across the quintiles, the proportion below the LRNI was significantly higher for quintiles

1 (39%), 2 (29%) and 3 (20%) compared with quintile 5 (12%). No clear pattern was seen for girls aged 11 to 18 years.

In adults aged 19 to 64 years there was a clear pattern for mean calcium intake to increase from quintile 1 to quintile 5. The mean intake in men in this age group was significantly lower in quintile 1 (768mg) compared with quintile 5 (940mg). Mean calcium intake in women aged 19 to 64 years also showed a pattern of increasing from the lowest to highest quintile, with mean intake in quintiles 1 (686mg), 2 (711mg) and 3 (709mg) being significantly lower than quintile 5 (767mg). This pattern was also seen in girls aged 4 to 18 years for whom intake in quintile 1 (686mg) was significantly lower compared with quintile 5 (748mg); however this pattern was not seen in other age/sex groups. Mean calcium intakes were above the RNI in all age/sex groups and income quintiles except boys and girls aged 11 to 18 years for whom mean intakes were below 90% of the RNI in most quintiles. A substantial proportion (15-21%) of girls aged 11 to 18 years in all income quintiles had calcium intakes below the LRNI. There was no pattern across the quintiles.

Mean vitamin C intake increased from the lowest income quintile to the highest in all age/sex groups. Mean vitamin C intake was greater than 100% of the RNI in all quintiles for all age/sex groups.

Mean folate intake tended to be lower in the lowest income quintile compared with the highest quintile for most age/sex groups. This difference was significant in boys aged 4 to 10 years in quintile 1 (191µg) and 2 (193µg) compared with those in quintile 5 (217µg), men aged 19 to 64 years in quintiles 1 (265µg) and 2 (263µg) compared with those in quintile 5 (304µg), girls aged 11 to 18 years in quintile 1 (176µg) compared with those in quintile 5 (198µg) and women aged 19 to 64 years in quintiles 1 (210µg) and 2 (218µg) compared with those in quintile 5 (242µg).

Mean folate intake was greater than 90% of the RNI in all age/sex groups and income quintiles with the exception of girls aged 11 to 18 years in quintile 1. In this group mean folate intake was 88% of the RNI and was significantly lower than quintile 5 (99% of the RNI).

**(Tables 9.3a – 9.5f)**

## 9.5 Vegetables, fruit, meat and fish consumption, including from composite dishes, by equivalised household income

This section reports consumption of vegetables, fruit, meat and fish based on disaggregated data. This includes the contribution from composite dishes, but excludes the other components of those dishes.<sup>2</sup> The number of portions of fruit and vegetables consumed per day has also been calculated from the disaggregated data in line with the “5-a-day” criteria, including up to one portion each of fruit juice and baked beans or pulses per day (see Appendix A).

Mean total fruit and vegetable consumption was significantly lower in income quintile 1 compared with quintile 5 in all age/sex groups, with the exception of adults aged 65 years and over. In addition, mean consumption of total fruit and vegetables was also significantly lower in quintile 2 compared to quintile 5 for children aged 1.5 to 3 years, boys aged 4 to 10 years, boys aged 11 to 18 years and women aged 19 to 64 years. In quintile 3, children aged 1.5 to 3 years, boys aged 11 to 18 years, men aged 19 to 64 years, girls aged 4 to 10 years and women aged 19 to 64 years also had significantly lower mean consumption of total fruit and vegetables compared to quintile 5. For quintile 4, the difference was significant for the 1.5 to 3 years age group only.

Mean consumption of “5-a-day” portions was significantly lower in quintiles 1, 2 and 3 compared to quintile 5 for boys aged 11 to 18 years, men aged 19 to 64 years and women aged 19 to 64 years. For girls aged 11 to 18 years, mean consumption of “5-a-day” portions was significantly lower in quintile 1 only, compared to quintile 5.

The percentage achieving 5 portions of fruit and vegetables per day was significantly lower in some age/sex groups in some quintiles compared with quintile 5: boys aged 11 to 18 years in quintiles 1 (3%) and 2 (5%) compared with those in quintile 5 (18%); men aged 19 to 64 years in quintiles 2 (26%) and quintile 3 (26%) compared with quintile 5 (39%) and women aged 19 to 64 years in quintiles 1 (23%) and 2 (23%) compared with those in quintile 5 (36%).

Mean total meat consumption, decreased in children aged 1.5 to 3 years from quintile 1 to quintile 5. The consumption was significantly higher in quintiles 1 (49g) and 2 (48g) compared with quintile 5 (32g). The same pattern was seen for red meat consumption in this age group though the differences did not reach statistical significance. No other clear patterns were

observed for the other age/sex groups.

Women aged 19 to 64 years in quintiles 1 (15g), 2 (16g) and 3 (20g) had significantly lower consumption of total fish compared with those in quintile 5 (28g). No other clear pattern was observed in the other age/sex groups.

Consumption of oily fish in adults aged 19 to 64 years and older adults aged 65 years and over tended to be lower in the lower income quintiles compared with the highest. In men aged 19 to 64 years, mean consumption of oily fish was significantly lower in quintile 1 (5g) compared with quintile 5 (9g). In women aged 19 to 64 years consumption was significantly lower in quintiles 1 (4g), 2 (5g) and 3 (8g) compared with quintile 5 (11g). Differences in the 65 years and over age group were not tested for statistical significance because of the low numbers in the reference quintile (quintile 5).

**(Tables 9.6a – 9.6f)**

## 9.6 Summary of main findings by equivalised household income

In summary, there were some differences observed in food consumption and energy and nutrient intakes by equivalised household income quintile, particularly for fruit and vegetable consumption. Differences were clearest between the lowest and highest income quintile but were not seen in all age/sex groups.

Income differences in mean intake of energy and macronutrients were observed in women aged 19 to 64 years and to some extent in men aged 19 to 64 years. Total energy and protein intake in women aged 19 to 64 years was significantly lower in quintiles 1, 2 and 3 than in quintile 5. The lowest quintile in this age group also had a higher intake of carbohydrate and a lower intake of protein as a percentage of energy than did the highest quintile. To some extent alcohol intake in men aged 19 to 64 years and women aged 19 to 64 years also increased through the quintiles.

Men and women aged 19 to 64 years had a lower percentage of energy from saturated fat and a higher percentage energy from NMES in the lowest quintile compared with the highest although intakes exceeded recommended levels in almost all quintiles. NSP intakes were

significantly lower in the lowest quintile groups compared with the highest in all age/sex groups but intakes for adults were below the recommendation in all quintiles.

Mean iron intake for girls aged 11 to 18 years and women aged 19 to 64 years was below 90% of the RNI in all income quintiles. In women, but not in girls, the lowest income quintile had a significantly lower mean intake than the highest quintile and a significantly higher proportion below the LRNI. For both men and women aged 19 to 64 years, mean intake of calcium increased from the lowest to highest quintile and a substantial proportion of girls aged 11 to 18 years in all income quintiles had calcium intakes below the LRNI. There were clear differences in intakes of both vitamin C and folate by income quintile with lower intakes in the lowest quintile. For vitamin C mean intake was above the RNI in all quintiles while for folate girls aged 11 to 18 years had a mean intake below the RNI in the lowest income quintile.

Mean fruit and vegetable consumption expressed in grams was significantly lower in children and adults aged 19 to 64 years in income quintile 1 compared with quintile 5. Mean fruit and vegetable consumption expressed as “5-a-day” portions was significantly lower in children aged 11 to 18 years and adults aged 19 to 64 years in income quintile 1 compared with quintile 5. No clear pattern in total meat or red meat consumption was observed, with the exception of children aged 1.5 to 3 years where mean consumption of total meat was significantly higher in income quintiles 1 and 2 than in quintile 5. Oily fish consumption increased from the lowest to highest quintile for men and women aged 19 to 64 years.

<sup>1</sup> Equivalisation is a standard methodology that adjusts household income to account for different demands on resources, by considering the household size and composition.

<sup>2</sup> Report on Health and Social Subjects 41 *Dietary Reference Values (DRVs) for Food Energy and Nutrients for the UK*, Report of the Panel on DRVs of the Committee on Medical Aspects of Food Policy (COMA) 1991. The Stationery Office. London

<sup>3</sup> All composite dishes in the NDNS Nutrient Databank have been disaggregated into their constituent ingredients. This enables the fruit, vegetables, meat and fish in mixed dishes such as stews and pies to be included in consumption figures. The methodology for the disaggregation of composite dishes is provided in Appendix A. Disaggregation has not been carried out for previous surveys.

<sup>4</sup> For total fat, saturated and *trans* fatty acids and non-milk extrinsic sugars (NMES) the DRVs are the recommended maximum contribution these nutrients should make to the population average diet. For total carbohydrate, *cis*-monounsaturated fatty acids and non-starch polysaccharide (NSP) the DRVs are recommended population averages. For protein, the Reference Nutrient Intakes (RNIs) are set at levels of intake considered likely to be sufficient to meet the requirements of 97.5% of the population.

<sup>5</sup> Consumers also include those who consumed alcohol in recipes and other foods.

<sup>6</sup> The RNI for a vitamin or mineral is the amount of the nutrient that is sufficient for 97.5% of people in the group. If the average intake of the group is at the RNI, then the risk of deficiency in the group is judged to be very small. However, if the average intake is lower than the RNI then it is possible that some of the group will have an intake below their requirement.

<sup>7</sup> The adequacy of vitamin or mineral intake can be expressed as the proportion of individuals with intakes below the LRNI. The LRNI for a vitamin or mineral is set at the level of intake considered likely to be sufficient to meet the needs of only 2.5% of the population.

# 10 Comparisons within the NDNS Rolling Programme (RP) and between the RP and previous NDNS surveys

*Authors: Toni Steer, Caireen Roberts, Sonja Nicholson, David Pell, Polly Page & Alison Lennox*

## 10.1 Introduction

This chapter presents comparisons within the RP (Years 1 and 2 combined (Y1&2) compared with Years 3 and 4 combined (Y3&4)) and between the current RP and previous NDNS.

Results are presented by standard age groups 1.5 to 3 years, 4 to 10 years, 11 to 18 years, 19 to 64 years and 65 years and over and are also subdivided by sex (except for children aged 1.5 to 3 years). Further details of the dietary data collection methods and interpretation are given in Chapter 5, section 5.1.

Nutrient intakes in this chapter have been limited to key macronutrients and micronutrients of policy interest and are described from food sources only (not including supplements). Unless stated otherwise, all Dietary Reference Values (DRVs) discussed in this chapter are those presented in the 1991 COMA report on Dietary Reference Values for Food Energy and Nutrients for the United Kingdom.<sup>1</sup> Results for food consumption are presented for comparisons within the RP only (i.e. Y1&2 compared with Y3&4) and have been limited to fruit and vegetables and meat and fish after disaggregation (i.e. including the contribution from composite dishes containing these ingredients but excluding other components of these dishes),<sup>2</sup> and refer to mean values for the total survey population, including non-consumers.

## 10.2 Comparison of NDNS RP Years 1 and 2 combined (Y1&2) with NDNS RP Years 3 and 4 combined (Y3&4)

### 10.2.1 Background

This section compares dietary data from Y1&2 and Y3&4 of the NDNS RP. When comparing the data from Y1&2 with Y3&4 there are some important considerations to note. Firstly, changes in nutrient intake over time can result from a change in patterns of food consumption or a change in the nutrient composition of a specific food or foods. The Department of Health's

Nutrient Databank<sup>3</sup> provides food composition data to support the estimation of nutrient intakes in the NDNS RP. Each survey year is analysed using a different version of the databank which is updated so that it best reflects the nutrient content of foods in that year. Updates aim to capture new food products to reflect foods available at the time of fieldwork data collection and to reflect reformulation of products (such as reductions in fat, sugar or salt content) and changes in fortification practices for vitamins and minerals, (see Appendix A). It is important to note that changes in the databank are partly driven by the availability of new analytical data. Such new data are produced only occasionally so a gradual change in the nutrient content of the food supply may appear as a step change in the nutrient databank and so in nutrient intakes. Therefore, observed changes in nutrient intake between Y1&2 and Y3&4 may be related to changes in nutrient composition reflected in the Nutrient Databank, rather than changes in actual nutrient intakes in the survey population over this period. A good example is *trans* fatty acids; new analytical data for *trans* fatty acids in processed foods<sup>4</sup> was generated in 2010 and incorporated into the Year 3 databank so there appears to be a sharp drop in *trans* fatty acid intake between Y1&2 and Y3&4, whereas the fall in the *trans* fatty acid content of processed foods actually occurred over a longer timescale.

Secondly, as detailed in Chapter 5, section 5.1, weekend days were oversampled in Year 1 and this has led to a slightly higher proportion of weekend days and slightly lower proportion of weekdays in Y1&2 compared with Y3&4 (see Table 10A below), even though weekend days were under sampled in Year 2. As already described in Chapter 5, eating habits vary on different days of the week for some age groups; hence the unequal distribution of days captured might impact on the comparisons presented in section 10.2. Alcohol consumption is likely to be particularly affected and therefore no comparison between Y1&2 and Y3&4 is made for alcohol.

**Table 10A: Number of diary days by day of week (Y1&2 compared with Y3&4)**

Day of the week	Y1&2		Y3&4	
	Number of diary days	% of total days	Number of diary days	% of total days
Monday	1,768	13.4%	1,909	13.7%
Tuesday	1,508	11.4%	1,969	14.1%
Wednesday	1,382	10.5%	2,000	14.3%
Thursday	1,855	14.0%	2,024	14.5%
Friday	2,162	16.4%	2,072	14.8%
Saturday	2,292	17.4%	2,010	14.4%
Sunday	2,246	17.0%	1,986	14.2%

The statistical analysis in this section has been carried out to compare Y1&2 with Y3&4. Results were tested at the 95% significance level. Statistically significant differences are highlighted in the tables. Some differences do not reach statistical significance due to small numbers in some groups. The following text focuses on statistically significant differences considered to be of public health interest rather than all of the statistically significant results.

### 10.2.2 Energy and macronutrient intake

This section presents key findings on the daily intakes of energy and macronutrients estimated from the food consumption data, comparing Y1&2 with Y3&4. Mean daily intakes of macronutrients are also compared with the UK DRVs.<sup>1,5</sup>

With the exception of children aged 1.5 to 3 years, mean total daily energy intakes tended to be lower in all age/sex groups in Y3&4 compared with those in Y1&2. The differences were significant for adults aged 19 to 64 years (1826 kcal per day in Y3&4 compared with 1896 kcal in Y1&2) and children aged 11 to 18 years (1735 kcal per day in Y3&4 compared with 1816 kcal in Y1&2).

Mean daily intakes of total fat for all age groups, except children aged 1.5 to 3 years, tended to be lower in Y3&4 compared with those in Y1&2. The differences were significant for men aged 19 to 64 years (75.3g compared with 80.1g per day), girls aged 4 to 10 years and 11 to 18 years and women aged 65 years and over (54.3g, 57.4g and 55.1g per day respectively compared with 57.8g, 62.3g and 60.1g per day respectively).

With the exception of children aged 1.5 to 3 years and boys aged 11 to 18 years, mean protein intakes tended to be slightly lower in Y3&4 compared with Y1&2. Mean protein intake in men aged 19 to 64 years was significantly lower in Y3&4 compared with Y1&2 (82.5g versus 87.7g per day).

Mean daily intakes of total carbohydrate tended to be similar between Y3&4 and Y1&2. Girls aged 11 to 18 years had a significantly lower mean intake of carbohydrate in Y3&4 compared with those in Y1&2 (204g versus 218g per day).

Expressed as a percentage of food energy, mean total fat intakes tended to be lower in Y3&4 compared with Y1&2. The differences were significant for boys aged 4 to 18 years (33.2% versus 33.9%), men aged 19 to 64 years (34.3% versus 35.2%), girls aged 4 to 10 years (32.9% versus 34.2%) and women aged 65 years and over (34.0% versus 35.6%). No clear pattern was observed between Y3&4 and Y1&2 for protein intake as a percentage of food energy, although girls aged 11 to 18 years in Y3&4 had a significantly higher mean protein intake as a percentage of food energy compared with those in Y1&2 (15.1% versus 14.4%). Carbohydrate as a percentage of food energy tended to be higher in Y3&4 compared with Y1&2 in most age groups and was significantly higher in men aged 19 to 64 years (48.5% versus 47.1%), girls aged 4 to 10 years (52.8% versus 51.4%) and women aged 65 years and over (48.4% versus 46.8%).

Mean daily saturated fat intakes for all age/sex groups, in line with total fat intakes, also tended to be lower in Y3&4 compared with those in Y1&2, with significant differences observed in boys aged 4 to 10 years (22.1g versus 24.0g), men aged 19 to 64 years (27.4g versus 29.4g), girls aged 11 to 18 years (20.9g versus 22.5g) and women 65 years and over (21.4g versus 24.3g). In line with total fat, mean saturated fat intakes as a percentage of food energy tended to be slightly lower in Y3&4 compared with Y1&2 and were significantly lower in boys aged 4 to 10 years (12.7% versus 13.4%) and women aged 65 years and over (13.2% versus 14.3%).

Mean *trans* fatty acid intakes as a percentage of energy intake were significantly lower in Y3&4 compared with those in Y1&2 in all age/sex groups. This is likely to be due to changes in the *trans* fatty acid composition data used to calculate intakes.<sup>6</sup> For example, in men aged 19 to 64 years in Y3&4, *trans* fatty acid intake contributed 0.5% to energy intake compared with 0.8% in Y1&2.

There were no significant differences in mean intakes of non-milk extrinsic sugars (NMES), either in absolute terms or as a percentage of energy in any of the age/sex groups. There was no consistent pattern of differences observed between Y3&4 and Y1&2 across the age groups.

Mean intakes of non-starch polysaccharides (NSP) were significantly higher in women aged 65 years and over in Y3&4 compared with Y1&2 (13.7g versus 12.5g). Mean intake of NSP for men aged 65 years and over was also slightly higher in Y3&4 compared with Y1&2 (15.2g versus 14.7g), although this did not reach statistical significance. In other age/sex groups intakes in Y3&4 were very similar to those in Y1&2.

(Tables 10.1a-10.1c)

### 10.2.3 Vitamins and minerals

This section presents daily intakes of selected vitamins and minerals, namely vitamin C, folate, iron and calcium, from foods only (excluding dietary supplements) for Y3&4 compared with Y1&2. Mean daily intakes of these vitamins and minerals are compared with the UK Reference Nutrient Intakes (RNIs)<sup>7</sup> and the proportions of participants with intakes below the Lower Reference Nutrient Intakes (LRNIs)<sup>8</sup> are shown. The RNIs and LRNIs for the vitamins and minerals presented are shown in Tables 5.14 and 5.32 (Chapter 5).

Mean daily iron intakes were similar in Y3&4 compared with Y1&2 in all age/sex groups. There was a higher proportion of girls aged 11 to 18 years with iron intakes below the LRNI in Y3&4 compared with Y1&2 (49% versus 43%) although this was not a significant difference.

No clear pattern of differences was observed in mean calcium intakes between Y3&4 and Y1&2. For girls aged 11 to 18 years and women aged 19 to 64 years, the proportion of participants with a daily calcium intake below the LRNI was significantly higher in Y3&4 compared with Y1&2 (23% and 10% versus 15% and 6% respectively).

Mean intakes of vitamin C were slightly lower in Y3&4 compared with Y1&2 for boys and girls aged 11 to 18 years, men and women aged 19 to 64 years and men aged 65 years and over although the differences did not reach statistical significance. Mean intakes were above the RNI

in both periods.

Mean daily folate intake was slightly lower in Y3&4 compared with Y1&2 for all age/sex groups except men aged 65 years and over and girls aged 4 to 10 years. This reached statistical significance for children aged 1.5 to 3 years, boys aged 4 to 10 years and adults aged 19 to 64 years (143µg, 194µg and 251µg versus 156µg, 209µg and 264µg respectively). For girls aged 11 to 18 years mean intake was 90% of the RNI in Y3&4 compared with 96% in Y1&2 and 9% of girls were below the LRNI in Y3&4 compared with 7% in Y1&2. For women aged 19 to 64 years, the proportion of participants with a folate intake below the LRNI was significantly higher in Y3&4 compared with Y1&2 (5% versus 3%).

(Tables 10.3a-10.5c)

### **10.2.5 Vegetables, fruit, meat and fish consumption, including from composite dishes.**

This section reports consumption of vegetables, fruit, meat and fish based on disaggregated data. This includes the contribution from composite dishes, but excludes the other components of those dishes.<sup>2</sup> The number of portions of fruit and vegetables consumed per day has also been calculated from the disaggregated data in line with the “5-a-day” criteria, including up to one portion each of fruit juice and baked beans or pulses per day (see Appendix A).

No consistent pattern of differences between Y3&4 and Y1&2 was observed for mean total fruit and vegetable consumption (excluding fruit juice). The only significant difference was for boys aged 4 to 10 years in Y3&4 where mean consumption was 207g and significantly higher compared with Y1&2 (192g).

The mean number of portions of fruit and vegetables consumed, based on the “5-a-day” criteria, tended to be slightly lower in boys aged 11 to 18 years and men aged 19 to 64 years in Y3&4 (2.8 and 3.9 portions respectively) compared with those in Y1&2 (3.1 and 4.3 portions respectively), although this did not reach statistical significance. No differences were seen for women or girls.

Mean consumption of total meat and red meat tended to be slightly lower in most age/sex groups in Y3&4 compared with Y1&2. Notably, in girls aged 4 to 10 years red meat consumption was significantly lower in Y3&4 compared with Y1&2 (35g versus 46g). However,

in children aged 1.5 to 3 years mean red meat consumption was significantly higher in Y3&4 (33g) compared with Y1&2 (27g).

Overall, mean total fish and oily fish consumption was similar in all age/sex groups in Y3&4 compared with Y1&2.

**(Tables 10.6a – 10.6c)**

## 10.3 Comparison with previous surveys for key nutrients

### 10.3.1 Background

This section compares dietary data from Years 1 to 4 combined of the RP (2008/09- 2011/12) with previous NDNS conducted between 1992 and 2000/01. Although all surveys in the NDNS series used a diary as the dietary assessment method, there were some methodological differences between the previous surveys and the RP.

The main difference is in the duration of the diary recording period. The NDNS survey of adults 19 to 64 years conducted in 2000/01<sup>9</sup> and the survey of young people aged 4 to 18 years conducted in 1997,<sup>10</sup> had seven days of assessment while the RP, the NDNS survey of children aged 1.5 to 4.5 years conducted in 1992<sup>11</sup> and the survey of people aged 65 years and over conducted in 1994/95<sup>12</sup> had four days. Dietary assessment over a four-day period may provide similar mean intakes for commonly consumed foods to assessment over a seven-day period, but the variation will be different. Moreover, estimates of the percentage of consumers for a food group and the proportions of individuals above or below specified cut-off values, such as LRNI for vitamins or minerals or DRV for saturated fat or NMES, will be affected by assessments of different durations. In order to enable comparisons of the current survey data with previous NDNS reports based on seven days duration, specifically the NDNS survey of adults 19 to 64 years and the NDNS of young people aged 4 to 18 years, results from these surveys have been recalculated based on four days of assessment. Further details of the background and methods used to derive the four-day values from the previous surveys are provided in Appendix K. Those previous surveys based on four days assessment, the NDNS survey of children aged 1.5 to 4.5 years and the NDNS survey of people aged 65 years needed no recalculating. Any comparisons between intakes in the RP and the previous NDNS survey of adults 19 to 64 years or the survey of young people aged 4 to 18 years should be made using the recalculated intakes and not the seven-day data from the published reports because

incorrect conclusions may be drawn if the original published data are used for comparisons, especially data on percent consumers and the proportions of individuals above or below cut-off values.

There is also a difference between the previous NDNS and the RP in the assessment of the quantities of food consumed. Previous surveys used a weighed diary methodology (participants were provided with digital scales to weigh each food item) whereas the RP uses estimated portion sizes.<sup>13</sup> The impact of this difference on survey estimates is not known but a study comparing dietary assessment methods suggests little effect on energy intakes overall.<sup>14</sup>

Due to the differences between the RP and previous NDNS in duration of dietary assessment and methods of assessing portion size, statistical comparisons have not been carried out. Therefore, unlike in section 10.1, differences highlighted in this section are observed only.

In order to compare equivalent age groups, children aged four years and over from the 1992 survey<sup>11</sup> are excluded from the comparison figures. Only adults aged 65 years and over living in private households (free-living) from the 1994/95 survey<sup>12</sup> are included in the comparison figures for this age group.

When comparing changes across different age groups it should be borne in mind that the previous surveys were carried out at different time points. As already mentioned, the NDNS survey of pre-school children aged 1.5 to 4.5 years was conducted in 1992,<sup>11</sup> the survey of people aged 65 years and over in 1994/95,<sup>12</sup> the survey of young people aged 4 to 18 years in 1997<sup>10</sup> and the NDNS survey of adults 19 to 64 years in 2000/01.<sup>9</sup> Therefore, some changes may appear to be larger simply due to the greater time elapsed since the previous survey. It should also be taken into account that observed changes in nutrient intake between the RP and previous surveys may be related to changes in nutrient composition over time as well as changes in actual food consumption (see section 10.2.1).

Tables comparing alcohol intakes in the RP and previous surveys are not presented in this chapter due to discrepancies in the alcohol intake data from the older surveys.<sup>15</sup>

### **10.3.2 Energy and macronutrient intake**

This section presents key findings on the mean daily intakes of energy and macronutrients estimated from the food consumption data, comparing the RP with previous NDNS. Mean daily intakes of macronutrients are also compared with the UK DRVs.<sup>1,5</sup>

Mean total energy intakes for children aged 4 to 18 years and adults aged 19 to 64 years were lower in the RP compared with previous surveys, particularly for boys aged 11 to 18 years (1972 kcal compared with 2131 kcal) and men aged 19 to 64 years (2111 kcal compared with 2308 kcal). For women aged 65 years and over total energy intake was higher in the current RP, while for children aged 1.5 to 3 years intake was similar in the two surveys. Mean daily intakes of total fat for children aged 4 to 18 years and men aged 19 to 64 years were lower in the RP compared with previous surveys while for children aged 1.5 to 3 years, women aged 19 to 64 years and adults aged 65 years and over, fat intakes were similar to the previous surveys. Mean daily intakes of protein were higher in the RP compared with previous surveys for all age groups except adults aged 19 to 64 years where intakes were similar. Mean intakes of carbohydrate in absolute terms were slightly lower in the RP than in previous surveys for all age/sex groups, with the exception of children aged 1.5 to 3 years and adults aged 65 years and over.

In terms of the contribution of macronutrients to food energy, fat intakes contributed a lower proportion of food energy in the RP compared with previous surveys for children aged 1.5 to 18 years. For adults aged 19 years and over, fat intakes as a percentage of food energy were similar to previous surveys except for women aged 65 years and over, where mean intake decreased from 36.8% to 34.9%. Mean protein intakes as a percentage of food energy, were higher in the current RP for all age groups although the difference for adults aged 19 to 64 years was smaller than for other age groups. The contribution of total carbohydrate intake to food energy was similar between surveys for all age groups; any differences were not consistent in direction.

For children aged 1.5 to 18 years, mean intake of saturated fatty acids was lower in the current RP than in previous surveys, both in absolute terms and as a percentage of food energy. For example, in children aged 4 to 10 years intake decreased from 14.7% of food energy in 1997 to 13.2% in the RP. Mean saturated fat intake as a percentage of food energy for people aged 65 years and over was also lower in the RP than in the previous survey in 1994/95 (13.8%

compared with 15.4% food energy). Mean intake for adults aged 19 to 64 years was also slightly lower than the previous survey of this age group in 2000/01.

Mean *trans* fatty acid intakes, both in absolute terms and as a percentage of food energy, were lower in the current RP than in previous surveys for all age/sex groups. This is due to changes in the *trans* fatty acid content of processed foods over time.<sup>4</sup>

Mean intakes of NMES were lower in the RP than in previous surveys, both in absolute terms and as a percentage of food energy for all age/sex groups, except for women aged 65 years and over. Decreases in intake were most marked for children aged 1.5 to 3 years where the proportion of food energy from NMES decreased from 18.7% in 1992/3 to 11.9% in the RP. The difference was also marked for children aged 4 to 10 years a decrease from 17.1% in 1997 to 14.7% in the RP. Smaller decreases were seen for older children and adults.

Mean intakes of NSP in children aged 1.5 to 3 years, 4 to 10 years and adults aged 65 years and over were higher in the current RP than in previous surveys.

**(Tables 10.7a-10.7c)**

### **10.3.3 Vitamins and minerals**

This section presents daily intakes of selected vitamins and minerals, namely vitamin C, folate, iron and calcium, from foods only (excluding dietary supplements), comparing the RP with previous NDNS. Mean daily intakes of these vitamins and minerals are compared with the UK RNIs<sup>7</sup> and the proportions of participants with intakes below the LRNI<sup>8</sup> are shown. The RNIs and LRNI for the vitamins and minerals presented are shown in Tables 5.14 and 5.32 (Chapter 5).

For children aged 1.5 to 3 years and adults aged 65 years and over, mean intakes for the selected vitamins and minerals were higher in the current RP than in previous NDNS surveys. For children aged 4 to 10 years, mean intakes were similar for iron and folate, and higher for calcium and vitamin C in the current RP compared with the previous survey. An opposite pattern was observed for children aged 11 to 18 years, notably mean intakes of iron and folate being lower in the current RP compared with the previous survey. For boys aged 11 to 18 years, mean intakes of iron fell from just above the RNI (103%) to just below (95%) between

1997 and the RP. For girls in the same age group, mean iron intakes remained below the RNI at 60% in 1997 and 57% in the current RP and mean folate intakes decreased over the same period from 105% of the RNI to 93%. For adults aged 19 to 64 years, mean intakes were lower for iron, folate and calcium and similar for vitamin C in the current RP compared with the previous survey. For women, iron intakes fell from 83% of the RNI in 2000/01 to 78% in the current RP.

Generally there was little change from the previous surveys in terms of the proportion of individuals below the LRNI, particularly where these proportions were low. Reductions were seen in the proportion of individuals below the LRNI for iron for children aged 1.5 to 3 years falling from 16% in 1992 to 6% in the current RP. There was no difference in the proportion of girls aged 11 to 18 years and women aged 19 to 64 years with iron intakes below the LRNI in previous surveys compared with the RP. The proportion of children aged 11 to 18 years with calcium intakes below the LRNI decreased from 13% for boys and 23% for girls in 1997 to 8% and 19% respectively in the current RP. There was a small increase from 5% to 8% in the proportion of girls aged 11 to 18 years with intakes of folate below the LRNI.

**(Tables 10.9a-10.11c)**

---

<sup>1</sup> Report on Health and Social Subjects 41 *Dietary Reference Values (DRVs) for Food Energy and Nutrients for the UK*, Report of the Panel on DRVs of the Committee on Medical Aspects of Food Policy (COMA) 1991. The Stationery Office. London

<sup>2</sup> All composite dishes in the NDNS Nutrient Databank have been disaggregated into their constituent ingredients. This enables the fruit, vegetables, meat and fish in mixed dishes such as stews and pies to be included in consumption figures. The methodology for the disaggregation of composite dishes is provided in Appendix A. Disaggregation has not been carried out for previous surveys.

<sup>3</sup> From 1 April 2013, responsibility for the NDNS including the Nutrient Databank, transferred to the Department's Executive Agency, Public Health England (PHE).

<sup>4</sup> Department of Health 2011 Nutrient analysis of a range of processed foods with particular reference to trans fatty acids. Available at: <https://www.gov.uk/government/publications/nutrient-analysis-of-processed-foods-including-trans-fats>.(accessed 10/02/14).

<sup>5</sup> For total fat, saturated and *trans* fatty acids and non-milk extrinsic sugars (NMES) the DRVs are the recommended maximum contribution these nutrients should make to the population average diet. For total carbohydrate, *cis*-monounsaturated fatty acids and non-starch polysaccharide (NSP) the DRVs are recommended population averages. For protein, the Reference Nutrient Intakes (RNIs) are set at levels of intake considered likely to be sufficient to meet the requirements of 97.5% of the population.

<sup>6</sup> The level of *trans* fats from artificial sources has been reduced in recent years through reformulation by manufacturers. Between years 2 and 3 of the RP a programme of updates to the Nutrient Databank included new analytical data for *trans* fats in commercially produced foods and takeaway items. This is likely to at least partly explain the differences seen when comparing *trans* fatty acid intakes within the current RP (Y1&2 versus Y3&4) and between the current RP and previous NDNS.

<sup>7</sup> The RNI for a vitamin or mineral is the amount of the nutrient that is sufficient for 97.5% of people in the group. If the average intake of the group is at the RNI, then the risk of deficiency in the group is judged to be very small. However, if the average intake is lower than the RNI then it is possible that some of the group will have an intake below their requirement.

<sup>8</sup> The adequacy of vitamin or mineral intake can be expressed as the proportion of individuals with intakes below the LRNI. The LRNI for a vitamin or mineral is set at the level of intake considered likely to be sufficient to meet the needs of only 2.5% of the population.

<sup>9</sup> Henderson L, Gregory J, Swan G. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 1: Types and quantities of food consumed. London: TSO, 2002.

<http://www.food.gov.uk/multimedia/pdfs/ndnsprintedreport.pdf> (Accessed 31/03/2014)

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. London: TSO, 2002.

<http://multimedia.food.gov.uk/multimedia/pdfs/ndnsv2.pdf> (Accessed 31/03/2014)

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. London: TSO, 2003.

<http://tna.europarchive.org/20110116113217/http://www.food.gov.uk/multimedia/pdfs/ndnsv3.pdf> (Accessed 31/03/2014)

Rustin D, Hoare J, Henderson L, Gregory J, Bates CJ, Prentice A, Birch M. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 4: Nutritional status (anthropometry and blood analytes), blood pressure and physical activity. London: TSO, 2004

<http://tna.europarchive.org/20110116113217/http://www.food.gov.uk/multimedia/pdfs/ndnsfour.pdf> (Accessed 31/03/2014)

Hoare J, Henderson L, Bates CJ, Prentice A, Birch M, Swan G, Farron M. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 5: Summary report. London: TSO, 2004

<http://multimedia.food.gov.uk/multimedia/pdfs/ndns5full.pdf> (Accessed 31/03/2014)

<sup>10</sup> 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. London: TSO, 2000. Walker A, Gregory J, Bradnock G, Nunn J, & White D. National Diet and Nutrition Survey: young people aged 4 to 18 years. Volume 2: Report of the oral health survey. London: TSO, 2000

<sup>11</sup> Gregory JR, Collins DL, Davies PSW, Hughes JM, Clarke PC. National Diet and Nutrition Survey: children aged 1 ½ to 4 ½ years. Volume 1: Report of the diet and nutrition survey London: HMSO, 1995.

<sup>12</sup> 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. London: TSO, 1998.

Steele JG, Sheiham A, Marcenes W, Walls AWG. National Diet and Nutrition Survey: people aged 65 years and over. Volume 2: Report of the oral health survey. London: TSO, 1998.

<http://www.esds.ac.uk/findingData/snDescription.asp?sn=4036> (accessed 28/03/14)

<sup>13</sup> Although it is worth noting that not all foods were weighed in the previous method, for example, food eaten out of the home.

<sup>14</sup> Bingham SA, Gill C, Welch A, *et al.* Comparison of dietary assessment methods in nutritional epidemiology: weighed records v. 24 h recalls, food-frequency questionnaires and estimated-diet records. *Br J Nutr* 1994;72: 619-43.

<sup>15</sup> This is due to discrepancies having been found in the number of alcohol consumers identified in previous NDNS surveys.