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Executive Summary

The National Diet and Nutrition Survey Rolling Programme (NDNS RP) is a continuous cross-sectional survey, 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. Each year a representative sample of around 1000 people (500 adults and 500 children) take part in the NDNS RP.

The NDNS RP comprises an interview, a 4-day estimated diet diary, physical measurements and a blood and urine sample. Results are used by government to monitor progress toward diet and nutrition objectives of UK Health Departments and to develop policy interventions. Fieldwork for the first 9 years of the NDNS RP was carried out between 2008/09 and 2016/17. Government bodies in Wales have funded additional recruitment (i.e. boosted sample) in 2009/10 to 2016/17 (Years 2 to 9) in order to achieve representative data for Wales and enable comparisons to be made with UK results.

The foods and nutrients and blood and urinary analytes presented in this report were selected for their nutritional and public health relevance in Wales. Results are analysed for five age groups: 1.5 to 3 years; 4 to 10 years; 11 to 18 years; 19 to 64 years and 65 years and over, split by sex in all except the youngest age group.

Food consumption, nutrient intakes and nutritional status compared with recommendations (Years 5 to 9; 2012/13-2016/17)

- Consumption of 5 A Day fruit and vegetable portions was below the recommendation in all age/sex groups. Average consumption of fruit and vegetables for children aged 11 to 18 years in Wales was 2.7 portions per day with 89% not meeting the 5 A Day recommendation. On average adults aged 19 to 64 years consumed 3.8 portions per day and adults aged 65 years and over consumed 3.9 portions per day. Three quarters of adults aged 19 to 64 years and two thirds of adults aged 65 years and over did not meet the 5 A Day recommendation.
- Average consumption of oily fish was well below the recommended 1 portion (140g) per week.
- Average daily consumption of red and processed meat for men aged 19 to 64 years and men aged 65 years and over exceeded the current maximum recommendation for adults.[1]

[1] The Department of Health has advised that people who eat a lot of red and processed meat a day (more than 90g cooked weight) cut down their intake to 70g. Meat in your diet.

- For all age/sex groups, average intakes of saturated fatty acids exceeded the current recommendation of no more than 11% of food energy.
- Average intakes of *trans* fatty acids met the recommendation of no more than 2% of food energy in all age/sex groups.
- Intakes of free sugars[2] exceeded the recommendation of no more than 5% of total energy from free sugars in all age/sex groups: Over 90% of children and 85% of adults did not meet the recommendation.
- For AOAC fibre,[3] over 90% of adults and children over 11 years, 89% of children aged 4 to 10 years and 84% of children aged 1.5 to 3 years were not meeting the recommendations.[4]
- Average intakes of vitamin D were well below the Reference Nutrient Intake (RNI)[5] 10µg/day in all age/sex groups. Average intakes of folate met the RNI in all age/sex groups except girls aged 11 to 18 years. Average intakes of vitamin A were also below the RNI in the 11 to 18 years age group and a substantial proportion of this age group had intakes below the Lower Reference Nutrient intake (LRNI[6]) for vitamin A and riboflavin.
- There was evidence of low intakes (below the LRNI) for magnesium, potassium, iodine, selenium and zinc, particularly in the 11 to 18 years age group and iron and calcium in girls in this age group.
- There was evidence of a high prevalence of low folate status, as determined by concentration of folates in red blood cells and in serum in all age groups indicating biochemical deficiency or increased risk of anaemia. Among women of childbearing age (16 to 49 years), 79% had red cell folate concentration below the optimal concentration for avoidance of folate-related foetal neural tube defects (748nmol/L).

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[2] The definition of free sugars as described by SACN includes all added sugars in any form; all sugars naturally present in fruit and vegetable juices, purees and pastes, and similar products in which the structure has been broken down; all sugars in drinks (except for dairy-based drinks) and lactose and galactose added as ingredients. Further details of the methodology for determining free sugars in the NDNS RP are provided in appendix AA.

[3] AOAC fibre is the term used to describe fibre measured by the American Association of Analytical Chemists (AOAC) methods. AOAC fibre includes resistant starch and lignin in the estimation of total fibre as well as NSP

[4] The Scientific Advisory Committee on Nutrition (SACN) AOAC fibre recommendations: 30g/day for adults; 25g/day for older children aged 11-16 years; 20g/day for the 5-11 years age group; 15g/day for the 2-5 years age group.

[5] 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.

[6] 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.

- There was evidence of low vitamin D status in all age groups.[7] Twenty-three percent of children aged 11 to 18 years, 19% of adults aged 19 to 64 years and 15% of adults aged 65 years and over had serum 25-OHD below 25nmol/L. Blood samples were collected throughout the year and so represent average summer and winter vitamin D status.
- The median concentration of iodine in spot urine samples for children aged 4 to 10 years and aged 11 to 18 years was above the threshold indicating adequate iodine status. The median concentration of iodine in spot urine samples for adults was slightly below the threshold.
- There was evidence of anaemia (low blood haemoglobin concentration and low plasma ferritin concentration) in older children and adults;[7] 6% of children aged 11 to 18 years and 5% of women aged 19 to 64 years.
- There was evidence of low vitamin B12 status (as determined by measurement of holotranscobalamin) in older children and adults,[7] particularly adults aged 65 years and over, of whom 13% were below the threshold indicating biochemical vitamin B12 deficiency.

Trends over time (Years 1 to 9; 2008/09-2016/17)

- Overall, trends over time in Wales were similar to those seen in the UK as a whole.
- There was little change in intake of fruit and vegetables over the 9-year period.
- There was little change in intake of oily fish over the 9-year period, except in the proportion of male consumers aged 65 years and over which increased by 30 percentage points.
- Intake of red and processed meat showed a downward trend over time.
- Over the 9 years, the proportion of the population consuming sugar sweetened soft drinks dropped by 38 and 42 percentage points respectively for those aged 4 to 10 years and aged 11 to 18 years. There was a significant decrease in intake over time among children aged 11 to 18 years who drank sugar sweetened soft drinks.
- As a percentage of total energy, free sugars intake dropped by 8.2 percentage points over the 9 years for boys aged 11 to 18 years compared with a 3.8 percentage point drop for this age group in the UK as a whole. There was no significant trend over time for other age/sex groups. Average intakes exceeded the recommendation of no more than 5% of total energy from free sugars in all age/sex groups over the 9 years.
- Over the 9 years total fat intake as a percentage of food energy dropped by 5.1 percentage points for men aged 65 years and over compared with a 1.1 percentage point drop in this age group in the UK as a whole. No trend over time was seen in total

[7] Results for blood analytes are not reported for children aged 1.5 to 3 years and aged 4 to 10 years because numbers are too small to be confident in estimates.

fat intake over the 9-year period for the other age/sex groups. As a percentage of food energy, saturated fatty acid intake increased over time for children aged 11 to 18 years while intake decreased over time for men aged 65 years and over. Average intakes in all age groups exceeded the current recommendation of no more than 11% of food energy over the 9-year period.

- Most age/sex groups showed a significant reduction in *trans* fatty acids intake as a percentage of food energy over time.[8]
- There was little change in AOAC fibre intake over time.
- There was a downward trend in intakes of most vitamins and minerals over the 9-year period for many age/sex groups.
- There was a downward trend over time in sodium intake[9] and this was significant in most age groups.
- In all age groups there was a decrease over the 9 years in folate status as determined by folate concentrations in red blood cells and in serum. While in the UK there was a decline in the folate status of women of childbearing age over the 9-year period, as shown by the proportion with red cell folate concentration below 748nmol/L; this was less clear in Wales.
- There was evidence of decreasing vitamin D status in children aged 11 to 18 years; a 32 percentage point increase over the 9-year period in children in this age group with 25-OHD concentration below 25nmol/L at the time of blood sampling. This was compared with a 12 percentage points increase in the same age group in the UK as a whole.

Equivalised household income[10] (Years 5 to 9; 2012/13-2016/17)

- There was evidence of greater intake of fruit and vegetables with increasing income in all age/sex groups and, for most age/sex groups, the increases in intake seen in Wales were greater than those seen in the UK as a whole. Higher percentages of consumers of fruit juice were also seen with increasing income in some age groups.
- Intakes of oily fish tended to increase with increasing income for adults.
- There was no consistent pattern across age/sex groups in total fat and saturated fatty acid intake as a percentage of energy with respect to income. As a percentage of food energy, *trans* fatty acids intake tended to increase with increasing income for most

[8] The levels of *trans* fats produced artificially through food processing have been reduced. NDNS relies on the availability of food composition data to support estimation of nutrient intakes. This decrease in intake may reflect changes in the composition of foods that took place some time ago, rather than changes in actual nutrient intakes in the survey population over the 9-year period.
[9] Sodium intake estimates are based on the sodium content of foods consumed. They do not fully take account of salt added during cooking and exclude salt added at the table by participants.
[10] Equivalisation is a standard methodology that adjusts household income to account for different demands on resources, by considering the household size and composition.

age/sex groups although the changes were small and only statistically significant for children aged 1.5 to 3 years.

- Free sugars intake as a percentage of total energy deceased significantly for adults aged 19 to 64 years with increasing income. For children there were small, non-significant increases in intake with increasing income.
- Intakes of AOAC fibre and most vitamins and minerals tended to increase with increasing income.
- Changes in sodium intake[11] with increasing income were small and not in a consistent direction.
- As for the UK as a whole, those with higher incomes tended to have better nutritional status, as indicated by concentrations of some biomarkers; this was not consistent in all age groups or for all nutrients.

[11] Sodium intake estimates are based on the sodium content of foods consumed. They do not fully take account of salt added during cooking and exclude salt added at the table by participants.

1 Chapter 1 Background and purpose

1.1 Background

The National Diet and Nutrition Survey Rolling Programme (NDNS RP) is a cross-sectional survey with a continuous programme of fieldwork, 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 core NDNS RP is jointly funded by Public Health England (PHE)[1] and the UK Food Standards Agency (FSA) with additional recruitment boosts funded as required by Government bodies in the devolved countries in order to achieve country-specific, representative dietary health data. Government bodies in Wales have funded additional recruitment in 2009/10 to 2016/17 (Years 2 to 9) in order to achieve representative data for Wales and to enable comparisons to be made with UK results.

Years 1 to 9 (2008/09-2016/17) of the NDNS RP was carried out by a consortium comprising NatCen Social Research (NatCen) and the Medical Research Council Elsie Widdowson Laboratory (MRC EWL).[2,3]

The NDNS provides the only source of nationally representative UK data on the types and quantities of foods consumed by individuals, from which estimates of nutrient intake for the population are derived.[i] Results are used by government to monitor progress toward diet and nutrition objectives of UK Health Departments and develop policy interventions, for example work to monitor progress towards a healthy, balanced diet as visually depicted in the Eatwell Guide.[ii] The NDNS is an important source of evidence underpinning the Scientific Advisory Committee on Nutrition's (SACN) work relating to national nutrition policy. The food consumption data are also used by the 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 designed to be representative of the UK population, each covering a different age group: pre-school children (aged 1.5 to 4.5 years);[iii] young people (aged 4 to 18 years);[iv] adults (aged 19 to 64 years)[v] and older adults (aged 65 years and over).[vi] Since 2008, the NDNS has run

[1] From 1 April 2013, responsibility for the NDNS contract transferred from the Department of Health in England to the Department of Health's Executive Agency, Public Health England (PHE).
[2] In 2016, following restructuring and refocusing of its research interests MRC Human Nutrition Research was renamed the MRC Elsie Widdowson Laboratory (MRC EWL). This took effect from 01 September 2016. At the end of December 2018, MRC EWL closed. For Years 11 to 14 (2018/19-2021/22), scientific leadership for NDNS transferred to NIHR Biomedical Research Centre's Diet, Anthropometry and Physical Activity Group and Nutritional Biomarker Laboratory in the MRC Epidemiology Unit at the University of Cambridge, which joined the consortium in Year 10 (2017/18).
[3] In Years 1 to 5 (2008/09-2012/13) the consortium also included the University College London Medical School (UCL).

continuously as a rolling programme (RP) covering adults and children aged 1.5 years and over. Methods used in the NDNS are kept under review to ensure they remain the best practical methods available.

1.2 Content of this report

This report includes the following analyses:

- Descriptive statistics on types and quantities of food consumed, nutrient intake and nutritional status for the Wales population for Years 5 to 9 (2012/13 to 2016/17).
- Trends over time in relation to food consumption, nutrient intakes and nutritional status in Wales for 9 years of the NDNS RP (2008/09-2016/17). In addition, these trends are compared with trends for equivalent food consumption, nutrient intakes and nutritional status in the UK as a whole.[4]
- Analysis of food consumption, nutrient intake and nutritional status by equivalised household income[5] for Years 5 to 9 (2012/13 to 2016/17). In addition, these trends are compared with trends for equivalent food consumption, nutrient intakes and nutritional status in the UK as a whole.[4]

Background information on the survey, including the sample and methodology is provided in chapter 2 and further details can be found in the appendices.[6]

The time trend and equivalised income[5]**Error! Bookmark not defined.** analyses in this report have been conducted on a number of key foods, nutrients, and blood and urinary analytes, selected for their nutritional and public health relevance to current dietary concerns in Wales and the UK. Plots (and tables) are provided in Excel and commentary is provided in chapters 2 to 8.

1.3 Interpreting the time trend and income analysis

In this report the time trend and equivalised income[7] analyses have been presented as plots in Excel. The following guidance is provided to aid interpretation of these plots. Appendix U provides a full explanation of the analytical approach.

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[4] Additional recruitment (country boost) was undertaken in Wales (Years 2 to 9) in order to achieve representative data for each country and to enable comparisons to be made with UK results. For the time trend analysis the Wales sample comprised core participants from Year 1 and core and boost participants from Years 2 to 9.
[5] Equivalisation is a standard methodology that adjusts household income to account for different demands on resources, by considering the household size and composition.
[6] Appendices A,B and L-AA describe in detail the methodology and protocols employed in the RP. Appendices C-J include the survey materials, including participant-facing documents.
[7] Equivalisation is a standard methodology that adjusts household income to account for different demands on resources, by considering the household size and composition.

- In each case the analysis has been summarised using the slope of the regression line along with the 95% confidence interval. Where there is a statistically significant trend (p<0.05) the quantification of the slope has been assigned an asterisk. The slope of the regression line represents the average change per year (trend analysis) or per £10,000 (income analysis).
- A comparison between the slope of the regression line for Wales and the slope of the regression line for UK has also been provided along with the 95% confidence interval. Where there is a statistically significant difference between the Wales and UK trends (p<0.05) the quantification of the difference of the slopes has been assigned a hat symbol.
- Where a data distribution was highly skewed it was analysed on a log scale. In these cases the geometric mean is the most appropriate average and changes are represented as ratios of geometric means (rather than differences of arithmetic means as they were for non-logged analyses). The average per year (trend analysis) or per £10,000 (income analysis) ratio of geometric means has been converted into a percent change per year or per £10,000.
- Information has been provided in appendix U of this report regarding how to calculate the average increase/reduction over the 9 years of the survey for the time trend analysis. The calculation method for variables analysed on the log scale is slightly different from that for variables that are analysed on the untransformed linear scale. Nine-year change values are presented in Excel tables U.1-U.4 and should be interpreted in conjunction with the time trend analysis Excel plots.
- Due to differences in the variation of the data points or sample size within each of the age/sex groups, there are instances for some foods/nutrients/blood analytes where larger slopes were not statistically significant whereas smaller slopes were statistically significant.
- For foods where there are a large number of non-consumers, percentage of consumers and intakes for consumers only are presented instead of population intakes. This is because the regression analysis of the population consumption is highly influenced by zero values which can be misleading.

1.4 Methodological changes during Years 1 to 9 of the NDNS RP

The data collection and analysis methods used in the first 9 years of the NDNS RP (2008/09-2016/17) were kept as consistent as possible over time. Dietary data is self-reported and was collected through a 4-day food and drink diary throughout the 9 years. Blood sampling, processing and analysis methods were generally unchanged, but, where changes were needed, crossover studies were carried out to ensure comparability of results over time was maintained. Details of the dietary data and blood and urine sample collection, processing and analyses along with any key methodological considerations/changes that occurred during Years 1 to 9 are provided in appendices A and Q respectively.

1.5 Methodological considerations

The misreporting of energy intake (EI) is known to be an issue for all dietary surveys and studies.[vii,viii] Previous NDNS and the current NDNS RP are unique amongst large-scale population surveys in their inclusion of doubly labelled water (DLW)[8] as an objective biomarker to validate EI estimated from reported food consumption. In the NDNS RP, estimates of EI from the 4-day diary were compared with measurements of total energy expenditure (TEE) using the DLW technique in 2 separate sub-samples of survey participants. The first sub-sample was taken from Year 1 (2008/09) and Year 3 (2010/11) and the second sub-sample from Year 6 (2013/14) and Year 7 (2014/15) for the UK as a whole. The results of analysis of the most recent DLW sub-study for the UK as a whole indicated that reported EI in children aged 4 to 10 years was on average 13% lower than TEE measured by the DLW technique, 31% lower in children aged 11 to 15 years, 33% lower in adults aged 16 to 64 years and 28% lower in adults aged 65 years and over. These results are consistent with findings from the DLW sub-sample taken from Years 1 and 3 which were reported in appendix X of the UK Years 1 to 4 report.[ix]

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

Appendix X provides a summary of the DLW method, the results of the UK analysis in Years 6 and 7 and an illustration of a number of considerations relevant to the interpretation of the survey findings. Appendix X of the UK Years 1 to 4 report[ix] provides the results of the UK analysis for the DLW sub-study carried out in Years 1 and 3.

1.6 Changes to UK dietary recommendations

Government advice on energy and nutrient intakes is based on recommendations from the Scientific Advisory Committee on Nutrition (SACN) (and its predecessor, the Committee on Medical Aspects of Food and Nutrition Policy (COMA)).[9] Since the start of the NDNS RP in 2008, government has revised its advice on:

- **Energy intakes**. Recommendations were revised upwards in all age groups but capped at 10.5MJ (2500kcal)/day for males and 8.4MJ (2000kcal)/day for females.[x]

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[8] 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 (^{2}H) and oxygen ($^{18}O_2$) based on their body weight. Loss of the 2 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 2 isotopes reflects the rate at which CO_2 is produced from metabolism. Energy expenditure can then be estimated from the CO_2 production.

[9] The Scientific Advisory Committee on Nutrition (SACN) was established in 2000 following the disbandment of COMA in March 2000.

- **Red and processed meat consumption**. The new recommendation is that adults with high intakes of red and processed meat (around 90g/day or more) should consider reducing their intakes towards the UK average of around 70g/day.[xi] A mean intake of 70g/day is used as the threshold for monitoring purposes.
- **Sugar intake**. SACN recommended that a definition of free sugars should be adopted in the UK replacing the term non-milk extrinsic sugars (NMES).[xii] The definitions of free sugars and NMES are broadly similar.[xiii] The new recommendation is that free sugars intake should not exceed 5% of total energy intake for adults and children over 2 years, effectively half of the previous recommendation for NMES.
- **Fibre intake**. The definition of dietary fibre has changed from non-starch polysaccharide (NSP) to AOAC fibre which includes starch and lignin in the estimation of total fibre as well as NSP.[xii] The new recommendation for AOAC fibre intake is 30g/day for adults, which represents an increase of 18g NSP per day (equivalent to 23-24g AOAC fibre).
- **Vitamin D intake**. The revised recommendation is 10µg/day for adults and children of all ages.[10,xiv] Government advice is that in the summer months, the majority of those over 5 years of age will get sufficient vitamin D from sunshine and by following a healthy balanced diet.

Revised advice has also been issued on consumption of fruit juice and smoothies in the context of the government 5 A Day recommendations.[xv] Before 2016 smoothies containing pureed fruit could count towards 5 A Day in addition to fruit juice. The recommendation since 2016 is that smoothies should be treated the same as fruit juice and 150ml of fruit juice or smoothies combined count as one of the 5 A Day; any additional fruit juice or smoothies does not count. The calculation of 5 A Day in NDNS was changed accordingly for Year 9.

1.7 Published NDNS RP reports

This report adds to the series of previous NDNS RP reports that have been published since Year 1 (2008/09). These include the Wales Years 2 to 5 combined report[xvi] and the Years 1 to 4 combined results reports for the UK,[ix] Scotland[xvii] and Northern Ireland,[xviii] and a series of paired years reports for the UK as a whole commencing from Year 5; i.e. Years 5 and 6 (2012/13-2013/14)[xix] and Years 7 and 8 (2014/15-2015/16).[xx] A supplementary folate report for Years 1 to 4 combined, including blood folate results for the UK as a whole and separately for Wales, Scotland and Northern Ireland, was published in 2017.[xxi] Reports of the latest data for the UK[xxii] as a whole and Northern Ireland[xxiii] were published in 2019. Both reports include an analysis of changes over time (Years 1 to 9 (2008/09-2016/17)) and by equivalised income (Years 5 to 9 (2012/13-2016/17)). The NDNS also includes a series of urinary sodium surveys for the assessment of population salt intake, with fieldwork in

[10] The Scientific Advisory Committee on Nutrition (SACN) vitamin D and health report published in 2016 recommended an RNI of 10µg/day for those aged 4 years and over and a safe intake of 10µg/day for those aged 1 to 4 years.

England in 2011[xxiv] and 2014,[xxiv] Scotland in 2014[xxv] and Northern Ireland in 2015.[xxvi] A urinary sodium survey for Wales was carried out in 2006.[xxvii]

Data for NDNS RP Years 1 to 9 are deposited at the UK Data Service.[xxviii]

2 Chapter 2 Characteristics and representativeness of the NDNS RP sample in Wales (Years 5 to 9 combined; 2012/13-2016/17)

2.1 Introduction

This chapter includes information about response rates for Years 5 to 9 (combined) in Wales.[11,xxix] The Wales sample was boosted in Years 5 to 9 (to a target of 100 adults and 100 children per year). Response rates for individual years are shown in the text. Commentary is also provided on the socio-demographic characteristics of the NDNS RP sample in Wales (split by age/sex); including representativeness to the Wales population shown via mid-year population estimates. Also shown are anthropometric measurements, using data collected during the interviewer and nurse visits. Information regarding weighting of the survey data is also discussed in this chapter. Detailed information about the sampling and weighting methodology is provided in appendix B.

2.2 Response rates

2.2.1 Household level response

Overall for Years 5 to 9 (combined), of the 3,560 addresses (core and country boost) in Wales issued to interviewers, 44% were eligible for household selection. Ineligible addresses included 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.

Household selection was carried out at 91% of eligible addresses. The individuals in the remaining 9% of addresses refused to participate before the household selection could be carried out.

(Table 2.1)

[11] Equivalent information for the earlier years is provided in the Years 2 to 5 (combined) report.

2.2.2 Individual level response

The overall response rate for fully productive individuals (i.e. those completing 3 or 4 diary recording days) in Wales was 58% in Year 5, 58% in Year 6, 49% in Year 7, 48% in Year 8 and 52% in Year 9, giving a sample size of 1,064 fully productive individuals. Of these, 1041 (98%) completed the diet diary for 4 days and 23 (2%) completed 3 days. Analyses in this chapter (including response rates for subsequent stages/components of the survey) are based on these 1,064 individuals.

In Years 6 to 9, participants aged 4 years and over[12] were asked to provide a spot urine sample; 77% of these fully productive participants provided a spot urine sample (80% of adults, 73% of children).

Seventy-five per cent of fully productive males and 74% of females (Years 5 to 9) were visited by a nurse.[13] Physical measurements including waist and hip circumference, mid-upper arm circumference (MUAC) and blood pressure were taken from almost all participants (adults and children) who had a nurse visit.

Fifty-seven per cent of fully productive adults and 28% of fully productive children provided a blood sample. Younger children were less likely to give a blood sample than older children: 15% of those aged 1.5 to 3 years and 21% of those aged 4 to 10 years provided a blood sample compared with 40% of those aged 11 to 18 years.

(Table 2.2)

2.3 Characteristics of the NDNS RP sample

2.3.1 Sex

In the overall unweighted NDNS RP sample in Wales, 36.4% of adults aged 19 years and over were men and 63.6% were women, while for children (aged 1.5 to 18 years) 52.3% were boys and 47.7% were girls.

The sample was weighted to reflect the distribution of males and females in the Wales population.[xxx] Once weighted, 48.6% of the adult sample were male and 51.4% were female; 51.2% of the child sample were boys and 48.8% were girls.

(Table 2.3)

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[12] Participants also had to be fully out of nappies to be eligible for the 24-hour urine sampling element.
[13] 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.

2.3.2 Age

In the overall unweighted NDNS RP sample in Wales, 53.5% were adults aged 19 and over and the remaining 46.5% were children and young people aged 1.5 to 18 years.

The sample was weighted to bring the age profile of the sample in line with the age profile of men and women in the Wales population.[xxx]**Error! Bookmark not defined.** Once weighted, 79.8% of the sample were adults and 20.2% were children and young people.

(Table 2.4)

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

2.3.3 Ethnicity

In terms of ethnicity, 94.9% of the overall sample in Wales (adults and children) were White British, 2.2% were Asian/Asian British, 1.1% Mixed/multiple, 1.3% Other and 0.5% Black/Black British. These numbers are broadly in line with official statistics published by the Welsh government.[xxxi]

(Table 2.5)

2.3.4 National Statistics Socio-Economic Classification (NS-SEC)[xxxii]

Participants were assigned a socio-economic classification based on the current or most recent job of the Household Reference Person (HRP) for their household.[14,15]

Amongst the adult sample in Wales, the HRP was most likely to be in lower managerial and professional occupations (21.1%), higher managerial and professional occupations (17.3%), semi-routine occupations or lower supervisory and technical occupations (13.1% respectively). A further 2.7% of the adult sample and 2.8% of the child sample were in a household where the HRP had never worked.

(Table 2.6)

[14] 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.
[15] 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.

2.4 Anthropometric measures

2.4.1 Introduction

A number of anthropometric measures provide contextual information on body weight and abdominal obesity. Detailed descriptions of the measurement protocols used in the NDNS RP are available in appendix L but a brief description is provided within each section below.

Height and weight measurements, from which body mass index (BMI) was calculated, were taken during Stage 1 (the interviewer visit). Height and weight were measured 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 = weight (kg) / height squared (m^2) was calculated by the interviewer's Computer Assisted Personal Interview (CAPI) programme. For participants whose height could not be measured, estimated height based on demispan[16,xxxiii] was used to calculate BMI.[17,xxxiv]

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.[18]

Waist and hip circumference[19] was measured for all participants aged 11 years and over who agreed during Stage 2 (the nurse visit). These measurements allow the calculation of waist:hip ratio, which provides an indication of abdominal obesity. Waist and hip circumferences were measured using an insertion tape measure.

2.4.2 Obesity in adults

BMI status has been categorised according to the classification used by the World Health Organization (WHO)[xxxv] and the National Institute for Health and Clinical Excellence (NICE),[xxxvi] as shown in table 2A below:

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[16] 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.
[17] The demispan equivalent height was calculated using regression equations derived by Bassey: Females: Height (cm) = (1.35x demispan in cm) + 60.1. Males: Height in (cm) = (1.40x demispan in cm) + 57.8.
[18] These data are not shown but are included in the archived data.
[19] 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 ≥ 0.5cm, weight ≥ 0.2kg, waist and hip circumferences ≥ 3cm), a third measurement was taken. The mean of the 2 closest measurements was used. If only 1 measurement was available, it was excluded from the analysis.

Table 2A: BMI classification BMI (kg/m2)	**Description**
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

Mean BMI was similar for men and women (28.0 and 27.8 respectively). However, men were more likely to be overweight than women (44.7% compared to 36.4%). In line with that, men aged 19 to 64 years were also more likely to be overweight (including obese) than women aged 19 to 64 years (73.0% compared to 62.8%). Likelihood of being overweight (including obese) increased with age, particularly for women: 62.8% of women aged 19 to 64 years were overweight (including obese) compared with 78.4% of women aged 65 years and over.

Table 2.7a shows mean BMI and BMI status, in adults, by age group and sex. 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).[xxxvii]

Mean waist circumference was higher in men than in women (100.2cm in men and 88.9cm in women). However, a greater proportion of women had a raised waist circumference than men (50.8% of women, compared to 43.4% of men).

Waist circumference increased with age. For both men and women, mean waist circumference and the proportion with a raised waist circumference was higher amongst older adults (aged 65 years and over) than those aged 19 to 64 years. For example, 46.4% of women aged 19-64 had a raised waist circumference, compared to 63.1% of women over the age of 65.

Mean waist:hip ratio was 0.9 amongst men and 0.8 amongst women. The proportion with a raised waist:hip ratio increased with age: 44.0% of men aged 19 to 64 years had a raised waist:hip ratio. This increased to 58.9% amongst men aged 65 years and over. Amongst women, 36.1% of those aged 19 to 64 years had a raised waist:hip ratio and that increased to 51.8% amongst women aged 65 years and over.

(Table 2.7a)

2.4.3 Obesity in children

New UK WHO growth charts for children from birth to 4 years were introduced for all new births in England, Wales and Northern Ireland from May 2009 and in Scotland from January 2010.[xxxviii] These are based on WHO Growth Standards from data in infants who were exclusively or predominantly breastfed.[20,xxxix]

Growth standards for the youngest children (aged under 4 years) 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 91st but on or below the 98th centile for BMI and obesity as above the 98th centile. However, this report uses the 85th and 95th centiles to define overweight and obesity, as is standard UK government practice for population monitoring.[xl]

Overall, a larger proportion of boys than girls were overweight (14.4% and 10.4% respectively) or obese (20.6% and 18.8% respectively).

There was no clear pattern of BMI among children by age.

(Table 2.7b)

[20] 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 2 weeks to 4 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 4 years and over.

3 Chapter 3 Food consumption and nutrient intakes (Years 5 to 9; 2012/13-2016/17)

3.1 Introduction

The results presented in this chapter derive from the Wales sample for Years 5 to 9 combined of the NDNS RP. Analysis is based both on Wales core cases from the UK sample and Wales boost cases providing an overall Wales sample of 1,064 individuals aged 1.5 years and over (see chapter 2, section 2.2.2).

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. The purpose of this chapter is to describe how the diets of different age groups in the Wales population compare with recommendations. Caution should be taken when interpreting results where the cell sizes are below 50.

3.2 Foods consumed

Consumption for standard NDNS food groups is presented in tables 3.1a-3.2c. In these tables, all ingredients in composite dishes (e.g. homemade dishes and manufactured products) are assigned to a food group based on the main components of the dish. Details of the NDNS food groups can be found in appendix R. No commentary is provided on these tables.

This section provides commentary on consumption of selected foods: fruit, vegetables, meat and fish, based on disaggregated data, presented in table 3.3. Consumption figures using disaggregated data include only the contribution of relevant ingredients from composite dishes (both homemade dishes and manufactured products) but exclude the other components of those dishes.[21] Consumption of sugar-sweetened soft drinks is also included in Table 3.3. Results are provided for the total Wales sample, including non-consumers.

- Mean daily total fruit and vegetable consumption based on disaggregated data was 185g for children aged 1.5 to 3 years, 186g for children aged 4 to 10 years and 168g for children aged 11 to 18 years. For adults, those aged 19 to 64 years consumed, on

[21] 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.

average, 267g per day and those aged 65 years and over consumed, on average, 283g per day. Mean daily consumption of fruit juice[22] was highest in boys aged 4 to 10 and 11 to 18 years (73g and 74g respectively) and lowest in women aged 65 years and over (21g).

- Consumption of 5 A Day portions was below the recommendation[xv] in all age/sex groups. Children aged 11 to 18 years consumed 2.7 portions per day on average and the proportion meeting 5 A Day was 11%. On average, adults aged 19 to 64 years and adults aged 65 years and over consumed 3.8 portions and 3.9 portions per day respectively. A quarter of those aged 19 to 64 years and a third of those aged 65 years and over met the 5 A Day recommendation.
- Mean daily consumption of red and processed meat for women aged 19 years and over (48g) met the current recommendation that adult average intakes should not exceed 70g per day. However, mean daily consumption for men aged 19 to 64 years and men aged 65 years and over exceeded the recommendation (81g and 79g respectively).[23,xli]
- Mean consumption of oily fish in all age groups was well below the recommended one portion (140g) per week. Mean consumption was highest in adults aged 65 years and over, equivalent to 89g per week.
- Among children, mean daily consumption of sugar sweetened soft drinks was 52g for children aged 1.5 to 3 years, 83g for children aged 4 to 10 years and 173g for children aged 11 to 18 years. Mean consumption in adults was 118g for those aged 19 to 64 years and 31g for those aged 65 years and over.

(Table 3.3)

3.3 Energy and macronutrient intake

Mean daily intakes of energy and key macronutrients are presented in table 3.5 and 3.14 and compared with the UK Dietary Reference Values (DRVs).[x,xii,xlii] DRVs for key macronutrients are shown in table 3.4. Where relevant, DRVs are referred to as ‘recommendations’ in the rest of this section. The recommendations for macronutrients generally indicate the maximum contribution the nutrient should make to energy intake at the population level or, in the case of AOAC fibre, represent the recommended population average intake.

The percentage contribution of food groups to energy and macronutrient intake are presented in tables 3.6-3.13 of the accompanying Excel tables to this report.

- Mean daily intakes for total energy were 4.72 MJ (1119 kcal) for children aged 1.5 to 3 years, 6.11 MJ (1449 kcal) for children aged 4 to 10 years, 7.36 MJ (1749 kcal) for children aged 11 to 18 years, 8.26 MJ (1965 kcal) for men aged 19 to 64 years, 6.55 MJ

[22] This includes the fruit juice component of smoothies but not smoothie fruit.
[23] The Department of Health has advised that people who eat a lot of red and processed meat a day (more than 90g cooked weight) should cut down to 70g.

(1556 kcal) for women aged 19 to 64 years and 6.83 MJ (1624 kcal) for adults aged 65 years and over.

- Mean intake of total fat met the recommendation (no more than 35% food energy) in all age/sex groups.
- Mean intake of saturated fatty acids exceeded the recommendation (no more than 11% of food energy) in all age/sex groups, providing 12.9% of food energy for children aged 4 to 10 years, 13.0% for children aged 11 to 18 years and 12.5% for adults aged 19 to 64 years and13.6% for adults aged 65 years and over.
- Mean intake of *trans* fatty acids provided 0.5-0.6% of food energy across the age/sex groups, and thus all groups met the recommendation (no more than 2% food energy).
- In all age groups, mean intake of free sugars[24] exceeded the recommendation of providing no more than 5% of total energy intake for those aged 2 years and over. In children, boys aged 4 to 10 years had the highest free sugars intake as a percentage of total energy (14.6% of total energy); whilst children aged 1.5 to 3 years had the lowest intake (12.8%).[25] In adults, mean intake of free sugars as a percentage of total energy intake was 11.5% and 10.2% respectively for adults aged 19 to 64 years and adults aged 65 years and over.
- The percentage meeting the recommendation of no more than 5% of daily total energy intake from free sugars was 8% for children aged 1.5 to 3 years, 2% of children aged 4 to 10 years and 6% of children aged 11 to 18 years. For both adults aged 19 to 64 years and adults aged 65 years and over, 15% met the recommendation.
  - In all age groups, the mean intake of AOAC fibre[26] was below the recommendations.[27] For children aged 1.5 to 3 years, 4 to 10 years and 11 to 18 years, mean daily intakes were 11.0g, 14.1g and 16.1g respectively. For adults aged 19 to 64 years and 65 years and over, mean daily intakes were 17.9g and 17.6g respectively.
  - The percentage of children meeting the AOAC fibre recommendation was 16% of those aged 1.5 to 3 years, 15% of boys and 8% of girls aged 4 to 10 years and 4% of those 11 to 18 years. For adults, 4% of those aged 19 to 64 years and 2% of those aged 65 years and over met the recommendation.

[24] The definition of free sugars as described by SACN includes all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and unsweetened fruit juices. Further details of the methodology for determining free sugars in the NDNS RP are provided in appendix AA.
[25] The recommendation that free sugars provides no more than 5% of daily total energy intake applies to those aged 2 years and over.
[26] AOAC fibre is the term used to describe fibre measured by the American Association of Analytical Chemists (AOAC) methods. AOAC fibre includes resistant starch and lignin in the estimation of total fibre as well as non-starch polysaccharides.
[27] SACN AOAC fibre recommendations: 30g/day for adults; 25g/day for older children aged 11-16 years; 20g/day for the 5-11 years age group; 15g/day for the 2-5 years age group

- During the 4-day recording period, 46% of adults aged 19 to 64 years and 55% of adults aged 65 years and over reported consuming alcohol. On average, adults aged 19 to 64 years and adults aged 65 years and over who consumed alcohol during the 4-day recording period obtained 8.8% and 7.5% respectively of total energy intake from alcohol.

(Table 3.5 and 3.14)

3.4 Vitamins and minerals

Mean intake is presented in tables 3.17 and 3.17a and compared with the Reference Nutrient Intake (RNI)[28] and an estimate is made of the proportion with intakes below the Lower Reference Nutrient Intake (LRNI).[29] Published UK RNIs and LRNIs[xlii,28,29] are shown in tables 3.15 and 3.16.

The percentage contribution of food groups to micronutrient intake are presented in tables 3.18-3.29 of the accompanying Excel tables to this report.

- Mean daily intakes of vitamin A from food sources were above the RNI for all age/sex groups with the exception of children aged 11 to 18 years (85% of the RNI). Sixteen percent of children aged 11 to 18 years and 11% of adults aged 19 to 64 years had intakes below the LRNI for vitamin A.
- Mean daily intakes of riboflavin from food sources were above the RNI for all age/sex groups. Twenty-five percent of girls aged 11 to 18 years had intakes below the LRNI for riboflavin, along with 11% of boys in the same age group, 12% of women aged 19 to 64 years and 11% of women aged 65 years and over.
- Mean daily intakes of folate from food sources were above the RNI for all age/sex groups with the exception of girls aged 11 to 18 years (87% of the RNI). Ten percent of girls aged 11 to 18 years had intakes from food sources below the LRNI and the inclusion of dietary supplements had no impact on this proportion. For women of childbearing age (16 to 49 years), mean daily intake of folate from food sources was just above the RNI with 7% of this group having an intake below the LRNI. Again, the inclusion of dietary supplements had little impact on the proportion with intakes below the LRNI.

[28] 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

[29] 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 4 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.

- For vitamin D, mean intakes from food sources were well below the RNI in all age/sex groups ranging from 16% of the RNI for children aged 1.5 to 3 years to 32% of the RNI for adults aged 65 years and over. There are no LRNIs set for vitamin D.

For children aged 1.5 to 3 years and 4 to 10 years, mean intakes for each of the minerals reported were close to or above the RNI with the exception of iron and zinc intake (85% of the RNI for iron for children 1.5 to 3 years and 84% of the RNI for zinc for children aged 4 to 10 years). Few children in these age groups had intakes below the LRNI, again with the exception of iron and zinc (12% of children aged 1.5 to 3 years had iron intakes below the LRNI and 12% of girls aged 4 to 10 years had zinc intakes below the LRNI). However, for children aged 11 to 18 years, mean intakes fell below the RNI for each of the minerals reported and a substantial proportion of children in this age group had intakes below the LRNI, including 56% of girls below the LRNI for iron.

For adults aged 19 to 64 years, mean intakes were below the RNI for potassium (79% of the RNI) and selenium (71% of the RNI). In addition, women aged 19 to 64 years had mean intakes below the RNI for iron (72% of the RNI) and magnesium (84% of the RNI) and a substantial proportion of women in this age group had intakes below the LRNI for many of the minerals reported. For adults aged 65 years and over, mean intakes were below the RNI for magnesium (85% of the RNI), potassium (79% of the RNI) and selenium (67% of the RNI); in this age group 47% had intakes below the LRNI for selenium.

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.

(Table 3.17 and 3.17a)

4 Chapter 4 Biochemical indices of nutritional status (Years 5 to 9; 2012/13-2016/17) and urinary iodine concentration (Years 6 to 9; 2013/14-2016/17)

4.1 Blood analytes

4.1.1 Introduction

This section reports on the analysis of blood samples taken from participants, providing an assessment of the availability of some key nutrients to the body (after absorption) for use in metabolic processes. 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. In addition, HDL-cholesterol:total-cholesterol ratios are compared with a clinical threshold to provide an indication of the proportion of the population at increased risk of cardiovascular disease.

Results for vitamin C, thiamin (ETKAC), retinol and vitamin E status, where there has previously been little evidence of low status, are not presented in this report. They are however, available as part of the archived NDNS RP Years 1 to 9 results dataset deposited in the UK Data Service.[xvi,30] A full list of analytes measured in the NDNS RP is given in appendix T.

Population statistics are only reported on where the cell contains data from at least 50 individuals. Cell sizes for children aged 1.5 to 3 years and aged 4 to 10 years are too small to report. For older children (aged 11 to 18 years) and adults, sexes are combined within an age group where necessary to bring the cell size to at least 50.

[30] Results for these analytes were presented in the Years 1 to 4 report and data for Years 5 and 6 are included in the dataset on the UK Data Service.

4.1.2 Haemoglobin and plasma ferritin

Haemoglobin is the iron-containing, oxygen-carrying molecule in red blood cells; ferritin is an iron storage protein. A low haemoglobin concentration (anaemia) when coupled with low plasma ferritin can indicate iron deficiency.

There is evidence of some anaemia (as indicated by low haemoglobin levels)[xliii] and of low iron stores (as indicated by low plasma ferritin)[xliii] in all age groups. The mean haemoglobin concentration for children aged 11 to 18 years was 136g/L; 8% of this age group were below the threshold for anaemia (120g/L for children up to 14 years and girls 15 to 18 years; 130g/L for boys aged 15 to 18 years). In adults aged 19 to 64 years the mean haemoglobin concentration was 140g/L and in adults aged 65 years and over it was 137g/L. The proportion of the population with haemoglobin concentration below the threshold (120g/L for non-pregnant women, 130g/L for men) was 7% of adults aged 19 to 64 years and 13% of adults aged 65 years and over.

The mean ferritin concentration for children aged 11 to 18 years was 33µg/L with 21% below the threshold of 15µg/L, indicating inadequate iron stores. The mean ferritin concentration for adults aged 19 to 64 years was 88µg/L (10% below the 15µg/L threshold) and for adults aged 65 years and over the mean concentration was 132µg/L with 4% below the 15µg/L threshold. Among children aged 11 to 18 years, 6% had both blood haemoglobin and plasma ferritin concentration below the relevant threshold, as did 5% of women aged 19 to 64 years. The percentage of men aged 19 to 64 years and adults aged 65 years and over with both parameters below the threshold was 2%.

(Table 4.1)

4.1.3 Water-soluble vitamins

4.1.3.1 Serum vitamin B12

Vitamin B_{12} is a water-soluble vitamin with a key role in normal functioning of the brain and nervous system and in blood cell formation. Chronic untreated vitamin B_{12} deficiency can cause macrocytic anaemia and is associated with lasting neurological damage.
Vitamin B_{12} status was assessed in terms of total vitamin B_{12} concentration in the serum and also that of holotranscobalamin (holoTC), the active form of vitamin B_{12} which is available for uptake into cells. The latter is a relatively new measure which is believed to be a better indicator of functional vitamin B_{12} deficiency and also changes faster than total vitamin B_{12} with altered dietary intake of vitamin B_{12}.[xliv]

There is evidence of low vitamin B_{12} status; 10% of adults 19 to 64 years and 5% of older adults aged 65 years and over had total serum vitamin B_{12} below 150pmol/L, the lower limit of the reference range.[xlv] The mean concentration for children aged 11 to 18 years was 291pmol/L, for adults aged 19 to 64 years was 244pmol/L and for adults aged 65 years and over it was 255pmol/L.

There is also evidence of low vitamin B_{12} status from low holotranscobalamin (holoTC) concentration, particularly in older adults. The mean holoTC concentration in children aged 11 to 18 years was 66pmol/L of whom 6% were below the threshold of 32pmol/L, indicating biochemical B_{12} deficiency.[31,xlvi] In adults aged 19 to 64 years the mean holoTC was 67pmol/L with 5% below 32pmol/L and in adults aged 65 years and over it was 64pmol/L with 13% below 32pmol/L.

(Table 4.1)

4.1.3.2 EGRAC for riboflavin status

Erythrocyte glutathione reductase activity coefficient (EGRAC) is a measure of red cell glutathione reductase saturation with its cofactor flavin adenine dinucleotide (FAD) derived from riboflavin (vitamin B_2). The higher the EGRAC, the lower the saturation *in vitro*, and hence the greater the degree of riboflavin deficiency *in vivo*. Traditionally EGRAC above 1.30 is interpreted as indicating biochemically suboptimal riboflavin status.

The mean EGRAC in children aged 11 to 18 years was 1.45, in adults aged 19 to 64 years it was 1.39 and in adults aged 65 years and over it was 1.33.

A substantial proportion of participants in all age/sex groups, ranging from 72% of children aged 11 to 18 years to 52% of older adults aged 65 years and over had raised EGRAC indicating biochemical riboflavin depletion.[xlvii] The 1.30 threshold is uncertain and therefore the 75th and 90th percentiles are also recorded for each age/sex group.

(Table 4.1)

4.1.3.3 Vitamin B6 Pyridoxal phosphate

Pyridoxal-5-phosphate (PLP) is the primary biologically active form of vitamin B_6, serving as a co-enzyme for a large number of enzymes which catalyse reactions of amino acids, and is therefore needed for protein synthesis. PLP may be decreased during acute phase reaction; therefore the interpretation of PLP concentration is more complicated in the presence of inflammation or infection.

There is currently no internationally recognised normal range for PLP concentration and no commentary on PLP results is provided in this report. Pyridoxic acid (PA), which is a less sensitive measure of vitamin B_6 status but also less affected by acute phase, was also measured; results for PA are presented in appendix Q. Descriptive statistics are presented for comparison between groups and over time in table 4.1.

(Table 4.1)

[31] Holotranscobalamin is a relatively recently established marker and thresholds indicating deficiency are under debate. 32pmol/L is suggested as a marker of biochemical holotranscobalamin deficiency, the concentration below which urinary methylmalonic acid is likely to be raised.

4.1.3.4 Folate

Folate is involved in single carbon transfer (methylation) reactions, including those necessary for the synthesis of purines, pyrimidines, glycine and methionine. It is needed for DNA synthesis and thus for the production and maintenance of new cells; this particularly affects situations of rapid cell turnover. Folate deficiency can lead to macrocytic anaemia. Serum folate concentration changes rapidly, reflecting recent intake of folates and folic acid; red blood cell folate reflects folate status at the time the RBC was synthesised and therefore indicates average status over approximately 2 months.

The population distributions of both red blood cell (RBC) folate and serum folate are heavily skewed, and therefore statistics such as arithmetic mean and standard deviations, which assume a normal distribution, cannot be used to describe the population robustly. For reporting purposes, geometric means have been calculated as a more valid indicator of the central value.[32] This parameter is presented in the accompanying Excel tables with the 2.5 and 97.5 percentiles which are more appropriate descriptive statistics of skewed data.[33]

Folate status is assessed with reference to thresholds indicating deficiency or insufficiency. The proportion of each age/sex group with folate concentrations below WHO clinical thresholds indicating folate deficiency[xlviii] are presented. For RBC folate this is 305nmol/L indicating deficiency, and for serum folate 13nmol/L indicating possible deficiency and 7nmol/L indicating clinical deficiency.

Population folate concentration distributions are included in the Excel tables so that data can be interpreted against these concentrations if a consensus regarding new biochemical thresholds for the UK should emerge in the future. For the UK population the threshold indicating biochemical folate insufficiency (increased risk of raised homocysteine) is estimated to lie between 450nmol/L and 550nmol/L for RBC folate and between 10nmol/L and 15nmol/L for serum folate.[xlix]

The NDNS assay-appropriate concentration in maternal RBCs above which the risk of neural tube defects (NTDs) is minimised is 748nmol/L.[l]

4.1.3.5 Red blood cell (RBC) folate

The geometric mean RBC folate concentration for children aged 11 to 18 years was 444nmol/L, for adults aged 19 to 64 years it was 518nmol/L and for adults aged 65 years and over it was 510nmol/L.

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[32] Geometric means are calculated using log transformed data and then back-transformed onto the original scale.

[33] In the NDNS RP supplementary report for blood folate results Years 1-4 (republished November 2017), arithmetic means are presented not geometric so direct comparisons cannot be made with this report.

RBC folate concentration below the WHO clinical threshold indicating risk of anaemia (305nmol/L) was found in 14% of children aged 11 to 18 years, 9% of adults aged 19 to 64 years and 11% of adults aged 65 years and over.

For women of childbearing age (16 to 49 years) the geometric mean RBC folate concentration was 506nmol/L, 9% had a RBC folate concentration below the clinical threshold indicating risk of anaemia (305nmol/L). The proportion of women of childbearing age who had a RBC folate concentration below the threshold indicating elevated risk of NTDs (748nmol/L) was 79%.

The proportion with RBC folate concentrations indicating increased risk of biochemical folate insufficiency, as defined by the estimated range within which the threshold lies (450 to 550nmol/L) was between 51% and 73% of children aged 11 to 18 years, 41% and 62% of women of childbearing age, 36% and 60% of adults aged 19 to 64 years, 36% and 52% of adults aged 65 years and over.

(Tables 4.1 and 4.1a)

4.1.3.6 Serum folate

The geometric mean serum folate concentration in children aged 11 to 18 years was 12.8nmol/L, in adults aged 19 to 64 years it was 14.0nmol/L and in adults aged 65 years and over it was 14.8nmol/L.

Serum folate concentration below the WHO clinical threshold indicating possible deficiency (13nmol/L) was found in 51% of children aged 11 to 18 years, 56% of men aged 19 to 64 years, 45% of women aged 19 to 64 years and 43% of adults aged 65 years and over. This includes 5% of children aged 11 to 18 years, 4% of men aged 19 to 64 years and 8% of women aged 19 to 64 years and 7% of adults aged 65 years and over who had a serum folate concentration below the WHO clinical threshold for folate deficiency (7nmol/L).

For women of childbearing age, the geometric mean serum folate concentration was 14.8nmol/L, 38% had a serum folate concentration below the clinical threshold indicating possible folate deficiency (13nmol/L). This includes 8% who had a serum folate concentration below the WHO clinical threshold for folate deficiency (7nmol/L).

The proportion of the population with serum folate concentration indicating increased risk of biochemical folate insufficiency, as defined by the estimated range within which the threshold lies (10-15nmol/L), was between 35% and 67% of children aged 11 to 18 years, 24% and 56% of women of childbearing age, 25% and 62% of adults aged 19 to 64 years, 31% and 53% of adults aged 65 years and over.

(Tables 4.1 and 4.1a)

4.1.4 Plasma/serum 25-hydroxyvitamin D (25-OHD)[34]

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. 25-OHD is derived from synthesis in the skin of vitamin D3 and its precursors during ultraviolet B irradiation from sunlight and from vitamin D2 and D3 and their precursors in the diet. There is evidence of low vitamin D status (vitamin D concentration below the threshold of 25nmol/L)[li] in all reported age/sex groups; this has implications for bone health, increasing the risk of rickets and osteomalacia.

The mean 25-OHD concentration in children aged 11 to 18 years was 43.5nmol/L, 47.0nmol/L in adults aged 19 to 64 years and 48.1nmol/L in adults aged 65 years and over. For children 11 to 18 years, 23% had levels below the 25nmol/L threshold. For adults, 19% of those aged 19 to 64 years and 15% of those aged 65 years and over had levels below the threshold. These data were collected throughout the year and so represent averages of summer and winter population 25-OHD status.

(Table 4.1)

4.1.5 Blood lipids

Cholesterol is a component of cell membranes and a precursor in steroid synthesis and is synthesised by all animal cells. Excess cholesterol in the blood indicates increased risk of cardiovascular disease.

The proportion of adults who had a total cholesterol concentration between 6.5 to 7.8mmol/L[lii] (indicating moderately elevated risk of cardiovascular disease) was 7% of men and 10% of women aged 19 to 64 years and 6% of adults aged 65 years and over. Total cholesterol concentrations greater than 7.8mmol/L[lii] (indicating high risk of cardiovascular disease) were limited to adult females; 2% of women aged 19 to 64 years and 4% of women aged 65 years and over.

The ratio of total cholesterol: HDL cholesterol indicates the proportion of the cholesterol bound to high-density lipoproteins which carry cholesterol back to the liver for metabolism or excretion. A lower ratio has been shown in adults to indicate a lower cardiovascular risk. The mean ratio of total to HDL cholesterol in children aged 11 to 18 years in Wales was 3.2, in adults aged 19 to 64 years it was 3.9 and in adults aged 65 years and over it was 3.7. Descriptive statistics for low-density lipoproteins (LDL) cholesterol (calculated from total cholesterol, HDL cholesterol and triglyceride concentrations using the Friedewald equation) are also presented for each age group. Higher concentrations of LDL cholesterol contribute

[34] The matrix in which 25-OHD was measured in changed from plasma to serum during the course of the NDNS RP, refer to appendix Q of this report for more details.

to higher levels of risk of cardiovascular disease and are interpreted by clinicians for individual patients alongside other risk factors.

(Table 4.1)

4.2 Urinary iodine

4.2.1 Introduction

- Lack of dietary iodine can lead to goitre (enlargement of the thyroid), hypothyroidism and impairment of mental function including retardation in infants and children. On a worldwide basis, iodine deficiency is the single most important preventable cause of brain damage.[liii] Indicators to assess and monitor the iodine status of a population have been defined by the World Health Organization (WHO 2007);[liii] these state that in children and adults, median urinary iodine concentrations of between 100µg/L and 199µg/L and fewer than 20% of the population below 50µg/L define a population which has no iodine deficiency.[35] These parameters assume collection of a single spot urine sample per individual and recommend that the median should be calculated from a sample size of 30 clusters, each including 30 individuals, (a total of 900 spot urine samples). The WHO guidelines suggest that the normal range for pregnant and lactating women should reflect their additional need and the risk that these needs may not be met if population levels are too low.[liii] Therefore, this group should have a median urinary iodine concentration of between 150µg/L and 249µg/L to reflect a population with no deficiency. It is important to note that a spot urine iodine concentration does not give any indication of the iodine status of the person who passed the urine because the iodine concentration depends on hydration status as well as iodine intake; each spot urine concentration is a contribution to the calculation of the population statistics which indicate overall iodine sufficiency or iodine deficiency of a population. This is in contrast to the other nutritional biomarkers discussed in this report, which indicate individual status with respect to that micronutrient.

- Collection of a spot urine sample was introduced in Year 6 (2013/14) of the NDNS RP for measurement of urinary iodine concentration. The median and other descriptive statistics for urinary iodine concentration are presented for males, females and sexes combined for the following age groups: children aged 4 to 10 years, children aged 11 to 18 years, adults aged 19 to 64 years, adults aged 65 years and over, and women of childbearing age (16 to 49 years). The following commentary is supported by accompanying Excel tables providing data for Years 6 to 9 (combined) (2013/14-2016/17). Spot urines were collected from a total of 100 children aged 4 to 10 years,

[35] Spot samples only allow for population level iodine concentration rather than individual iodine concentrations to be obtained.

131 children aged 11 to 18 years, 267 adults aged 19 to 64 years and from 98 adults aged 65 years and over. Spot urines were collected from 145 women of childbearing age). The limited number of participants in each age/sex group should be borne in mind when interpreting the Excel tables and the commentary in section 4.2.2.

4.2.2 Urinary iodine concentrations

- For children, urinary iodine concentrations met the WHO criteria for adequate iodine status in all age/sex groups (i.e. median urinary iodine concentration within 100-199µg/L and fewer than 20% of samples below 50µg/L).

- For adults, median urinary iodine concentration did not meet the WHO criterion of 100-199µg/L for adequate iodine status for any age/sex groups; spot urines from men aged 19 to 64 years and from adults aged 65 years and over met the criterion of less than 20% below 50 µg/L but those from women aged 19 to 64 years did not meet this criterion.

- In the NDNS RP, pregnant and lactating women are excluded from the survey. Results are presented for women of childbearing age in order to provide more information which may help to characterise the iodine status of this group.[36] The median urinary iodine for women of childbearing age (16 to 49 years) in Years 6 to 9 (combined) was 93µg/L with 28% of the spot urines below 50µg/L. These values did not meet either the WHO criterion for adequate intake for the general population, see above, or the criterion for iodine sufficiency in pregnant and lactating women (i.e. median urinary iodine concentration within 150-249µg/L).

(Tables 4.2 and 4.3a-b)

[36] Sampling of pregnant women can be difficult because the number of pregnant women present in household-based surveys may be small. Assessing the median value in women of reproductive age or among adolescent girls is more feasible in a population-based survey and may be helpful in interpreting the median population value.

5 Chapter 5 Time trend analysis (Years 1 to 9; 2008/09-2016/17) for selected foods and nutrients

5.1 Introduction

The results presented in this chapter derive from the Wales sample for Years 1 to 9 combined of the NDNS RP. Analysis is based both on Wales core cases from the UK sample and Wales boost cases providing an overall Wales sample of 1,774 individuals aged 1.5 years and over.[37]

This chapter presents time trend analyses for selected key foods and nutrients over the 9-year period 2008/09-2016/17 (fieldwork Years 1 to 9) of the NDNS RP. The foods and nutrients were selected for their nutritional and public health relevance to current dietary concerns.

The time trend analysis uses a linear regression model, which splits each survey year into quarters to more fully characterise the trends over time and to provide an estimate of the average per year change over the 9-year period. The slope of the regression line represents the average year-by-year change for Wales. This line is compared to the corresponding time trend for the UK in a plot in Excel. The plot also provides confidence intervals for the 2 slopes and their difference. Refer to chapter 1 (section 1.3) for a guide to interpretation of the time trend analysis plots. To calculate the 9-year change refer to appendix U which provides instructions on how to scale-up and explains that the calculations for variables that are analysed on the log scale are different from those for variables analysed on the linear scale. Nine-year change values for Wales are presented in tables U.1-U.4 and values for the difference between Wales and UK are presented in Excel tables U.1a-U.4a and should be interpreted in conjunction with the time trend analysis Excel plots.

Many of the trends identified by the analysis were small in magnitude and not all were statistically significant. The commentary in this chapter describes trends in key foods and nutrients in Wales taking account of statistical significance and whether the change is nutritionally meaningful. The text describes upward or downward trends and the overall size of any observed changes in intakes for Wales. The 95% confidence intervals for the size of

[37] Additional recruitment (country boost) was undertaken in Wales (Years 2 to 9) in order to achieve representative data for each country and to enable comparisons to be made with UK results. For the time trend analysis the Wales sample comprised core participants from Year 1 and core and boost participants from Years 2 to 9.

changes are set out in brackets in the text.[38] When the interval does not contain zero, this indicates a statistical difference at the 5% level. The text also describes trends for Wales which are different from those observed in the UK as a whole where these differences are statistically significant. Therefore unless stated otherwise, trends for Wales and the UK can be assumed to be similar.

The plots provide an indication of mean food and nutrient intakes across the 9-year period, however they are not intended to provide or describe the group mean values for each year. Group mean values are described for Years 5 to 9 (combined) in chapter 3. No commentary is provided in those cases where a regression line cannot be fitted. This occurred either when most of the data were zero, when there was a clear non-linear relationship or when the number of participants was less than 30. Furthermore, confidence in the regression estimates is diminished when the number of participants is close to 30 or when the number of participants within one of the early or late calendar years for an age/sex group is less than 3. In those cases, only limited commentary is provided.

Trends in arithmetic mean are reported as ‘change per year’ where the data were normally distributed and could be analysed without transformation. Where the data were skewed and needed to be log-transformed before analysis, the trends in geometric mean are reported as percentage change per year (see section 1.3 of chapter 1 for more detail).

5.2 Foods

5.2.1 Population intake

For total fruit and vegetable consumption, 5 A Day portions, total meat, and red and processed meat consumption, the proportion of non-consumers over the 4-day period was low. Therefore the trends in population intakes, including non-consumers, are presented.

Fruit and Vegetables. In Wales there was little change observed over the 9-year period for total fruit and vegetable intake in all age/sex groups and the changes were not in a consistent direction. There was an average yearly decrease in total fruit and vegetable intake of 5g/day for children aged 4 to 10 years and an average yearly increase of 4g/day for children aged 11 to 18 years and 5g/day for women aged 65 years and over, although none of these changes were significant.

5 A DAY. The number of 5 A Day portions consumed are presented for the age/sex groups for which there is a government recommendation[xv] that is for 11 to 18 years, 19 to 64 years and 65 years and over. Changes over the 9-year period were very small or close to zero for

[38] The 95% Confidence Intervals (CIs) presented in the plots relate to the magnitude and direction of change i.e. negative CIs for a downward trend. In the text, downward trends are expressed as a **decrease** and so the CIs quoted represent the magnitude of the decrease not the direction of change.

these age/sex groups for average number of 5 A Day portions consumed. However, there was a statistically significant 2 percentage point increase per year in the proportion of girls aged 11 to 18 years in Wales meeting the 5 A Day recommendation (CI 0, 3), equivalent to an increase of 16 percentage points over the 9 years. This change was significantly different from girls in this age group in the UK as a whole (who showed no clear trend). Changes in the other age/sex groups were smaller and not significant. As noted in chapter 3, all age/sex groups had a mean fruit and vegetable intake below the 5 A Day recommendation.

Total meat. Little change was observed in the intake of total meat in Wales over the 9-year period. The exception was girls aged 11 to 18 years where there was a significant average yearly decrease of 3g/day (CI 0, 6), and this was significantly different from this age group in the UK as a whole (who showed no trend).

Total red and processed meat. There was a downward trend over the 9-year period in intake of red and processed meat for all age/sex groups in Wales, with the exception of children aged 1.5 to 3 years, although the differences did not all reach statistical significance. The largest yearly reduction was seen in men aged 19 to 64 years (5g/day, CI: 1, 9), although as shown in chapter 3, men in this age group and men aged 65 years and over had a mean daily red and processed meat intake above the recommended 70g per day.[39,liv]

(Tables 5.1-5.5 and 5.8-5.9)

5.2.2 Percent consumers and intake by consumers only

For fruit juice, white meat, fish (and oily fish) and sugar sweetened soft drinks, trends are presented for percentage of consumers and intakes for consumers only. Trends for population intakes are not presented because the proportion of non-consumers over the 4 days was high or was high in some age/sex groups. Their inclusion could cause the regression analysis of population intakes to be misleading (see section 1.3).

Fruit juice. In Wales changes in the percentage consuming fruit juice[40] over the 4-day diary period were small and not in a consistent direction over the 9-year period. There was a significant average yearly reduction in fruit juice intake of 10g/day (CI 1, 18) for girls aged 11 to 18 years and 11g/day (CI 2, 20) for women aged 19 to 64 years (consumers only).

White meat. There was little change in most age/sex groups in terms of the percentage consuming white meat over the 9-year period and those changes observed were not in a consistent direction. There was a statistically significant 2 percentage point (CI 0, 4) increase per year in the percentage of consumers of white meat for children aged 1.5 to 3

[39] The Department of Health has advised that people who eat a lot of red and processed meat a day (more than 90g cooked weight) should cut down to 70g.
[40] This includes the fruit juice component of smoothies but not smoothie fruit.

years. For girls aged 11 to 18 years there was a downward trend over time in the percentage of consumers of white meat, whereas in the UK as a whole, there was a small non-significant upward trend in this group. Changes over time in white meat intake by consumers were very small or close to zero for most age/sex groups. In boys aged 11 to 18 years and men aged 19 to 64 years (consumers only) there was an average yearly increase in white meat intake of 3g/day (CI 0, 5) and 4g/day (CI 1, 6) respectively.

Fish. There was little change in most age/sex groups in terms of the percentage consuming fish over the 9-year period and those changes observed were not in a consistent direction. The exception was boys aged 11 to 18 years where there was a statistically significant 5 percentage point (CI 2, 7) increase per year in the percentage of consumers of fish. Changes over time in fish intake by consumers were very small or close to zero for all age/sex groups.

Oily fish. There was little change in most age/sex groups in terms of the percentage consuming oily fish over the 9-year period and those changes observed were not in a consistent direction. However there was a statistically significant 3 percentage point (CI 2, 5) increase per year in the percentage consuming oily fish in men aged 65 years and over. For consumers of oily fish, changes in intake were small over the 9 years.

Sugar sweetened soft drinks – children. For children aged 4 to 10 years and children 11 to 18 years in Wales there was an average reduction in the percentage consuming sugar sweetened soft drinks per year of 4 (CI 2, 6) and 5 percentage points (CI 3, 6) respectively. This is equivalent to a reduction of 38 and 42 percentage points respectively over the 9 years. Data for intake of sugar sweetened soft drinks (consumers only) were skewed and were log-transformed before analysis. The trends in geometric mean are reported as an average percentage change per year. Intakes of sugar sweetened soft drinks among children (consumers only) decreased over the 9-year period for children aged 4 to 10 years and 11 to 18 years although this was only significant for children aged 11 to 18 years (8% per year, CI: 3, 12).

Sugar sweetened soft drinks – adults. There was indication of a small (non-significant) downward trend in the percentage of adults consuming sugar sweetened soft drinks in Wales. There was a non-significant increase in the intake of sugar sweetened soft drinks by consumers over the 9-year period for adults aged 65 years and over, whereas there was a significant decrease in this age group in the UK as a whole.

(Tables 5.6-5.7 and 5.10-5.17)

5.3 Energy and macronutrients

To put the trends for energy and macronutrients over time into nutritional context, reference is made to population dietary intake in terms of Dietary Reference Values (DRVs).[x,xii,xlii] Where relevant, DRVs are presented in the individual plots and are referred to as 'recommendations' in the rest of this section. The recommendations for macronutrients generally indicate the maximum contribution the nutrient should make to energy intake at the population level or, in the case of AOAC fibre, represent the recommended population average intake.

Total energy. Changes in total energy intake across the age/sex groups in Wales over the 9-year period were small and not statistically significant. The same was seen for food energy intake (i.e. excluding energy from alcohol) for all age/sex groups.

Protein. Changes in protein intake were small and not in a consistent direction. For boys aged 11 to 18 years protein intake as a percentage of food energy increased by 0.2 percentage points per year (CI 0.0, 0.4).

Total fat. A significant average yearly reduction in total fat intake as a percentage of food energy of 0.6 percentage points was observed in men aged 65 years and over in Wales (CI 0.3, 0.9), equivalent to 5.1 percentage points over the 9 years. This was significantly larger than the decrease seen for this age group in the UK as a whole (0.1 percentage points per year). There was no consistent pattern in direction of change in total fat intake as a percentage of food energy across the other age/sex groups over time, and overall the changes were small and not statistically significant.

Saturated fatty acids. A significant average increase in saturated fatty acids intake as a percentage of food energy of 0.2 percentage points per year was seen in children aged 11 to 18 years in Wales (CI 0.1, 0.3). This was significantly different from this age group in the UK as a whole (who showed no trend). For men aged 65 years and over in Wales, a significant average yearly decrease in saturated fatty acids intake as a percentage of food energy of 0.3 percentage points was seen (CI 0.1, 0.5). This was significantly larger than the decrease seen for this age group in the UK as a whole (0.1 percentage points per year). Changes in saturated fatty acids intake as a percentage of food energy were very small or close to zero across the other age/sex groups. As indicated by the regression line, mean saturated fatty acids intake exceeded the recommendation of no more than 11% food energy in all age/sex groups over the 9-year period.

***Trans* fatty acids**. There was an average reduction per year in *trans* fatty acids intake as a percentage of food energy in all age/sex groups and in most groups this change was statistically significant.[41] The regression line indicates that all age/sex groups met the recommendation of no more than 2% food energy from *trans* fatty acids.

Carbohydrate. Changes in carbohydrate intake as a percentage of food energy were small and not in a consistent direction.

Free sugars.[42] A significant average decrease in free sugars intake as a percentage of food energy of 0.9 percentage points per year was seen in boys aged 11 to 18 years in Wales (CI 0.4, 1.4), equivalent to 8.2 percentage points over the 9 years. This was a significantly larger decrease than for this age group in the UK as a whole (0.4 percentage points per year). There was a yearly decrease in free sugars intake as a percentage of food energy of 0.4 percentage points for girls aged 11 to 18 years but this was not statistically significant. Changes in free sugars intake as a percentage of food energy were smaller across the other age/sex groups and not in a consistent direction. Mean free sugars intake exceeded the current recommendation of no more than 5% total energy in all age/sex groups, as indicated by the regression line.[43]

AOAC fibre.[44] Changes in AOAC fibre intake over the 9-year period were small or close to zero and not in a consistent direction. For children aged 11 to 18 years there was a non-significant upward trend over time in the AOAC fibre intake, whereas in the UK as a whole, there was a non-significant downward trend in this age group. Chapter 3 shows that mean AOAC fibre intake in all age/sex groups was below current recommendations.[45]

Alcohol. There was a downward trend over time in the percentage consuming alcohol for most age/sex groups from 11 years upwards, and this was statistically significant for adults

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[41] The downward trend in intake may reflect changes in the composition of foods rather than changes in actual nutrient intakes in the survey population over the 9-year period. The NDNS Nutrient Databank 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). It is important to note that changes in the databank are partly driven by the availability of new analytical data. New analytical data for *trans* fatty acids in processed foods was incorporated into the Nutrient Databank in Year 3 (2010/11) although the levels of *trans* fatty acids in these foods had already been reduced prior to this.

[42] The definition of free sugars as described by SACN includes all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and unsweetened fruit juices. Further details of the methodology for determining free sugars in the NDNS RP are provided in appendix AA

[43] The recommendation that free sugars provides no more than 5% of daily total energy intake applies to those aged 2 years and over.

[44] AOAC fibre is the term used to describe fibre measured by the American Association of Analytical Chemists (AOAC) methods. AOAC fibre includes resistant starch and lignin in the estimation of total fibre as well as non-starch polysaccharides.

[45] SACN AOAC fibre recommendations: 30g/day for adults; 25g/day for older children aged 11-16 years; 20g/day for the 5-11 years age group; 15g/day for the 2-5 years age group.

aged 19 to 64 years (3 percentage points, CI 1, 5). For those who consumed alcohol there was little change over time in alcohol intake as a percentage of total energy.

(Tables 5.18-5.28)

5.4 Micronutrients

To put trends in micronutrient intake over time into context, reference is made to population dietary intakes in terms of DRVs[xlii] and includes commentary on the Reference Nutrient Intake (RNI)[46] and an estimate of the proportion with intakes below the Lower Reference Nutrient Intake (LRNI).[47] All micronutrient intakes discussed in this report and associated Excel tables exclude contribution from supplements.

Vitamin A. The data for vitamin A intake were skewed and so were log-transformed before analysis. The trends in geometric mean are reported as an average percentage change per year. For girls aged 4 to 10 years and men aged 65 years and over in Wales there was a significant average yearly reduction of 5% (CI 2, 8) and 10% (CI 3, 17) respectively. For men aged 65 years and over this was significantly greater than the decrease seen in the same age group in the UK as a whole (4% per year). For most other age/sex groups there were small but non-significant decreases in vitamin A intake over the 9-year period. Chapter 3 shows that mean intake of vitamin A was above the RNI in all age/sex groups in Years 5-9 with the exception of children aged 11 to 18 years. There was a statistically significant 2 percentage point decrease per year in the proportion of boys aged 11 to 18 years (CI 0, 4) with vitamin A intake below the LRNI. This was significantly different from the UK as a whole (who showed a non-significant increase). For children aged 4 to 10 years there was a statistically significant 1 percentage point increase per year in the proportion with vitamin A intake below the LRNI (CI 1, 2).

Riboflavin. An average yearly reduction in riboflavin intake was seen in all age groups apart from those aged 19 to 64 years. For children aged 4 to 10 years this reduction was statistically significant (0.03 mg/day, CI: 0.00, 0.05). Chapter 3 shows that mean intake of riboflavin was above the RNI in all age/sex groups. There was a statistically significant 2 percentage point increase per year in the proportion of boys aged 11 to 18 years in Wales

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[46] 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.

[47] 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.

(CI 1, 3) with riboflavin intake below the LRNI. This was significantly different from this age group in the UK as a whole (who showed no trend).

Folate. A downward trend in folate intake over time was observed for all age/sex groups. This was statistically significant for boys and girls aged 4 to 10 years (8µg/day, CI: 1, 14 and 3µg/day, CI: 1, 5 respectively), children aged 11 to 18 years (6µg/day, CI 2, 11) and adults aged 19 to 64 years (5µg/day, CI 0, 11). There was also a 12µg/day decrease in folate intake per year for men aged 65 years and over but this was not statistically significant. Chapter 3 shows that mean intake of folate was above the RNI in all age/sex groups with the exception of girls aged 11 to 18 years. There was a statistically significant 1 percentage point increase per year in the proportion of women aged 19 to 64 years (CI 0, 2) with folate intake below the LRNI.

Vitamin D. The data for vitamin D intake were skewed and so were log-transformed before analysis. The trends in geometric mean are reported as an average percentage change per year. For most age/sex groups there was a downward trend in vitamin D intake over the 9-year period although the changes were small and generally did not reach statistical significance. Girls aged 11 to 18 years in Wales had a statistically significant average yearly reduction of 7% (CI 2, 11), significantly different from this age group in the UK as a whole (who showed a non-significant decrease). The regression line indicates that intakes of vitamin D were below the RNI in all age/sex groups.

Iron. An average yearly reduction in iron intake was seen in most age/sex groups, although this was generally not statistically significant. A significant yearly decrease of 0.3mg/day was seen in boys aged 4 to 10 years (CI 0.1, 0.5) and adults aged 65 years and over (CI 0.1, 0.4). For adults aged 65 years and over this was a significantly larger decrease than the same age group in the UK as a whole (who showed a significant decrease of 0.1mg/day). There was an increase in the proportion with iron intakes below the LRNI for girls aged 11 to 18 years and women aged 19 to 64 years although this was not statistically significant. As indicated by the regression line and as noted in chapter 3, some age/sex groups had mean intakes of iron below the RNI and substantial proportions with intakes below the LRNI, in particular girls aged 11 to 18 years and women aged 19 to 64 years

Calcium. The direction of the trend in calcium intake over time was inconsistent between age groups. A significant average yearly reduction in calcium intake of 25mg/day (CI 0, 51) and 18mg/day (CI 1, 34) was observed in children aged 1.5 to 3 years and boys aged 4 to 10 years respectively. Girls aged 11 to 18 years in Wales had an average yearly increase in calcium intake of 17mg/day (CI 1, 34), significantly different from the UK as a whole (who showed a non-significant decrease). The regression line indicates that mean intake of calcium was above the RNI in all age groups with the exception of children aged 11 to 18 years. There was a statistically significant 1 percentage point increase per year in the proportion of boys aged 11 to 18 years (CI 0, 2) with calcium intakes below the LRNI.

Sodium. An average yearly reduction in sodium intake was seen in all age/sex groups and this was mostly statistically significant. For children this decrease ranged from 26-45mg/day. For adults, the smallest significant decrease was seen in women aged 19 to 64 years 33mg/day, CI 5, 61) with the largest in men aged 19 to 64 years (77mg/day, CI 35, 119). These sodium intake estimates are based on the sodium content of foods consumed. They do not fully take account of salt added during cooking and exclude salt added at the table by participants.[48]

Iodine. A downward trend in iodine intake over time was observed for most age/sex groups although the changes were small and not statistically significant in most groups. Boys aged 4 to 10 years had a significant average yearly reduction in iodine intake of 4µg/day (CI 0, 9). There were no clear or statistically significant trends in the proportions with iodine intake below the LRNI across the age/sex groups. Chapter 3 shows that there was evidence of low intakes of iodine for children aged 11 to 18 years.

Magnesium. Changes over time in magnesium intake were small and inconsistent in direction between age groups. Boys aged 4 to 10 years had a significant average yearly reduction in magnesium intake of 5mg/day (CI 0, 10). There was no significant trend in the proportion with magnesium intake below the LRNI across the age/sex groups. Chapter 3 shows that mean intake of magnesium was below the RNI for older children and adults.

Potassium. Changes over time in potassium intake were inconsistent in size and direction between age groups. An average yearly reduction in potassium intake was seen in children aged 1.5 to 3 years and children aged 4 to 10 years, although these were not statistically significant. The regression line indicates that mean potassium intakes were below the RNI for children aged 11 to 18 years, adults aged 19 to 64 years and adults aged 65 years and over. There was no significant trend in the proportion with potassium intake below the LRNI across these age groups.

Selenium. In children aged 4 to 10 years a significant average yearly reduction in selenium intake of 1µg/day (CI 0, 1) was observed while boys aged 11 to 18 years had a significant average yearly increase of 1µg/day (CI 0, 2). For boys aged 11 to 18 years in Wales, this increase was significantly different from the UK as a whole (who showed no trend). No trend was seen for selenium intakes in adults. There was a statistically significant 3 percentage point decrease per year in the proportion of boys aged 11 to 18 years (CI 0, 6) with selenium intakes below the LRNI. The regression line indicates that mean selenium intake was below the RNI for children aged 11 to 18 years, adults aged 19 to 64 years and adults aged 65 years and over.

[48] A nominal 0.01g of salt is added to homemade recipes where salt has been specified by the participant as an ingredient.

Zinc. Trends in zinc intake over time in Wales were inconsistent in direction between age groups and did not reach statistical significance. Chapter 3 shows that mean intake of zinc was below the RNI for children aged 4 to 10 and 11 to 18 years.

(Tables 5.29-5.50)

6 Chapter 6 Equivalised income (Years 5-9; 2012/13-2016/17) for selected foods and nutrients

6.1 Introduction

The results presented in this chapter derive from the Wales sample for Years 5 to 9 combined of the NDNS RP. Wales core cases from the UK sample and Wales boost cases, provide an overall Wales sample of 1,064 individuals aged 1.5 years and over (see chapter 2, section 2.2). The 905 individuals who provided income data are included in this analysis.

This chapter presents key findings for food consumption and nutrient intakes by equivalised household income[49] for selected key foods and nutrients for Years 5 to 9 (2012/13-2016/17) combined. The foods and nutrients were selected for their nutritional and public health relevance to current dietary concerns in Wales and the UK as a whole.

For the equivalised income analysis the average change in each outcome per £10,000 increase in equivalised household income was estimated (via the slope) from a linear regression model. This line is compared to the corresponding income trend for the UK in a plot in Excel. The plot also provides confidence intervals for the two slopes and their difference. Refer to chapter 1 (section 1.3) for a guide to interpretation of the income analysis plots.

Many of the trends identified by the analysis were small in magnitude and some were not statistically significant. The commentary in this chapter describes trends in key foods and nutrients in Wales taking account of statistical significance and whether the change is nutritionally meaningful. The text describes upward or downward trends and the overall size of any observed changes in intakes for Wales. The 95% confidence intervals for the size of changes are set out in brackets in the text.[50] When the interval does not contain zero, this indicates a statistical difference at the 5% level. The text also describes trends for Wales which are different from those observed in the UK as a whole, where these differences are statistically significant. Therefore unless stated otherwise, trends for Wales and the UK can be assumed to be similar.

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[49] Equivalisation is a standard methodology that adjusts household income to account for different demands on resources, by considering the household size and composition.

[50] The 95% Confidence Intervals (CIs) presented in the plots relate to the magnitude and direction of change i.e. negative CIs for a downward trend. In the text, downward trends are expressed as a **decrease** and so the CIs quoted represent the magnitude of the decrease not the direction of change.

The text in this report does not describe the group mean values for each income decile.[51] No commentary is provided in those cases where a regression line cannot be fitted. This occurred either when most of the data were zero, when there was a clear non-linear relationship or when the number of participants was less than 30. Furthermore, confidence in the regression estimates is diminished when the number of participants is close to 30. In those cases, only limited commentary is provided.

Trends in arithmetic mean are reported as 'change per £10,000' where the data were normally distributed and could be analysed without transformation. Where the data were skewed and needed to be log-transformed before analysis, the trends in geometric mean are reported as 'percentage change per £10,000' (see chapter 1, section 1.3 for more detail).

6.2 Note regarding distribution of equivalised income data

There is evidence that the equivalised income[52] data are positively skewed but a log transformation of these data resulted in a negative skew. Therefore no transformation was applied to the income data prior to the regression analysis, but the influence of high income responses was investigated to ensure the regression slope was not unduly affected by them.

6.3 Foods

6.3.1 Population intake

For total fruit and vegetable consumption, 5 A Day fruit and vegetable portions, total meat, and red and processed meat consumption, the proportion of non-consumers over the 4-day period was low. Therefore, the trends in population intakes, including non-consumers, are presented.

Fruit and Vegetables. There was an increase in total fruit and vegetable intake with increasing equivalised income for all age/sex groups, and this was statistically significant in all groups except girls aged 4 to 10 years and women aged 65 years and over. The largest increase was seen in men aged 65 years and over who consumed, on average, 51g/day (CI 20, 81) more fruit and vegetables for every £10,000 increase in equivalised income. This was significantly different from men of the same age in the UK as a whole (who showed a non-significant increase of 3g/day for every £10,000 increase in equivalised income). Boys aged 4 to 10 years had an increase of 36g/day (CI 29, 43), significantly different from boys

[51] Income deciles were created where participants were subset into 10 equally sized groups based on their equivalised income.
[52] Equivalisation is a standard methodology that adjusts household income to account for different demands on resources, by considering the household size and composition.

of the same age in the UK as a whole (who showed a significant increase of 15g/day for every £10,000 increase in equivalised income).

5 A DAY. The number of 5 A Day portions consumed are presented for the age groups for which there is a government recommendation[xv] that is for 11 to 18 years, 19 to 64 years and 65 years and over. With increasing equivalised income, the number of 5 A Day portions consumed increased significantly for all age/sex groups, except women aged 65 years and over. The largest increase was seen in men aged 65 years and over with 0.6 portions (approximately 48g of fruit and vegetables) (CI 0.2, 1.0) for every £10,000 increase in equivalised income. This was significantly different from men of the same age in the UK as a whole (who showed no trend). For the age/sex groups where it was possible to estimate trends, the proportion meeting the 5 A Day recommendation rose significantly with increasing equivalised income for women aged 19 to 64 years (5 percentage points, CI 3, 8) and men aged 65 years and over (9 percentage points, CI 0, 18).

Total meat. For men aged 19 to 64 years intake of total meat increased by 8g/day (CI 1, 14) for every £10,000 increase in equivalised income. This was significantly greater than the increase seen in men of this age in the UK as a whole (who showed a non-significant increase). However, for girls aged 4 to 10 years and 11 to 18 years there were significant decreases in intake with increasing equivalised income (4g/day, CI: 0, 8 and 6g/day, CI: 2, 11), significantly different from these age groups in the UK as a whole. In all the other age groups changes with respect to equivalised income were smaller and/or not significant.

Total red and processed meat. For girls aged 11 to 18 years intake of red and processed meat decreased, on average, by 3g/day (CI 0, 7) for every £10,000 increase in equivalised income. In most other child age/sex groups intake decreased with increasing equivalised income but changes were small and/or not significant. For adults, intake of red and processed meat tended to increase with increasing equivalised income although changes were not statistically significant.

(Tables 6.1-6.5 and 6.8-6.9)

6.3.2 Percentage of consumers and intake by consumers only

For fruit juice, white meat, fish (and oily fish) and sugar sweetened soft drinks, trends are presented for percentage of consumers and intakes for consumers only. Trends for population intakes are not presented because the proportion of non-consumers over the 4 days was high in some age/sex groups. Their inclusion can cause the regression analysis of population intakes to be misleading (see chapter 1, section 1.3).

Fruit juice. For all age/sex groups, where it was possible to estimate income trends, there was an upward trend in the percentage consuming fruit juice[53] with increasing equivalised

[53] This includes the fruit juice component of smoothies but not smoothie fruit.

income while for boys aged 11 to 18 years and men aged 19 to 64 years there was a reduction in the quantities of fruit juice drunk by consumers. For boys aged 11 to 18 years, there was a significant increase in the percentage consuming fruit juice (7 percentage points, CI 4, 11) for every £10,000 increase but a significant decrease in the intake among consumers (20g/day, CI 5, 35). In both cases, the changes with increasing equivalised income were significantly greater than seen in boys in this age group in the UK as a whole (who showed a 3 percentage point increase in consumers and a non-significant increase in intake for those who consumed fruit juice). For adults aged 65 years and over there was a significant increase in the percentage consuming fruit juice (6 percentage points, CI 0, 11) for every £10,000 increase but little change in intake among consumers.

White meat. There was no consistent pattern across the age/sex groups with respect to equivalised income in terms of the percentage consuming total white meat or the intake for consumers and the changes were small.

Total fish. For almost all age/sex groups, where it was possible to estimate income trends, there was an upward trend in the percentage consuming fish with increasing equivalised income. This was statistically significant for children aged 1.5 to 3 years who had an increase of 4 percentage points (CI 1, 7) for every £10,000 increase in equivalised income. In some age groups, intake of total fish (consumers only) showed an increase with increasing equivalised income but the changes were small

Oily fish. In adults, where it was possible to estimate income trends, there was an increase in the percentage consuming oily fish with increasing equivalised income. This was statistically significant in men 19 to 64 years and men aged 65 years and over with an increase of 4 percentage points (CI 2, 6) and 9 percentage points (CI 0, 17) for every £10,000 increase in equivalised income respectively.

Sugar sweetened soft drinks. There was a non-significant increase in the percentage consuming sugar sweetened soft drinks with increasing equivalised income for children aged 4 to 10 years, whereas there was a significant decrease in this age group in the UK as a whole. For adults aged 65 years and over there was also a non-significant increase in the percentage consuming sugar sweetened soft drinks with increasing equivalised income. Small downward trends in the percentage consuming sugar sweetened soft drinks with increasing equivalised income were seen in children aged 11 to 18 years and adults aged 19 to 64 years although these were not statistically significant. For children aged 11 to 18 years (consumers only) there was a significant decrease in intake of sugar sweetened soft drinks with increasing income (7% CI: 0, 13) and a smaller, non-significant decrease in children aged 4 to 10 years.

(Tables 6.6-6.7 and 6.10-6.17)

6.4 Energy and macronutrients

To put the trends for energy and macronutrients over time into nutritional context, reference is made to population dietary intake in terms of Dietary Reference Values (DRVs).[x,xii,xlii] Where relevant, DRVs are presented in the individual plots and are referred to as 'recommendations' in the rest of this section. The recommendations for macronutrients generally indicate the maximum contribution the nutrient should make to energy intake at the population level or, in the case of AOAC fibre, represent the recommended population average intake.

Total energy. For children, total energy intake increased with increasing equivalised income for children aged 4 to 10 years and boys aged 11 to 18 years and this was statistically significant for children aged 4 to 10 years: 0.13MJ/day (31kcal) (CI 0.03, 0.24) for every £10,000 increase in equivalised income. For adults, total energy intake increased with increasing equivalised income for men and this was significant for men aged 19 to 64 years where total energy intake increased, on average, by 0.26MJ/day (62kcal) (CI 0.10, 0.41) for every £10,000 increase in equivalised income. This was significantly greater than the increase seen in this age/sex group in the UK as a whole (0.09MJ/day). The same pattern was mostly observed for food energy intake (i.e. excluding energy from alcohol).

Protein. For men aged 19 to 64 years, protein intake as a percentage of food energy increased significantly by 0.6 percentage points (CI 0.2, 1.1) for every £10,000 increase in equivalised income. This was a significantly greater increase than for men in the UK as a whole (who showed a significant increase of 0.2 percentage points).

Total fat. Income differences in total fat intake were inconsistent in direction between age groups. For girls aged 11 to 18 years total fat intake as a percentage of food energy decreased, on average, by 0.8 percentage points (CI 0.2, 1.3) for every £10,000 increase in equivalised income. This was significantly different from girls in the UK as a whole (who showed a non-significant increase with increasing income). The regression line indicates that girls in this age group in higher income groups were more likely to meet the recommendation of no more than 35% of food energy. Girls aged 4 to 10 years, men aged 19 to 64 years and men aged 65 years and over showed an increase in total fat intake as a percentage of food energy with increasing equivalised income but these changes were not statistically significant. For the other age/sex groups changes in total fat intake as a percentage of food energy were small or close to zero.

Saturated fatty acids. Mean saturated fatty acids intake exceeded the recommendation of no more than 11% food energy across the range of equivalised income for all age/sex groups, as indicated by the regression line. There was no consistent pattern across the age/sex groups with respect to equivalised income in terms of saturated fatty acids intake as a percentage of food energy. For men aged 65 years and over, saturated fatty acids intake as a percentage of food energy increased, on average, by 0.7 percentage points (CI 0.0, 1.4) for every £10,000 increase in equivalised income.

***Trans* fatty acids**. Mean *trans* fatty acids intake as a percentage of food energy was well within the recommendation of no more than 2% food energy across the range of equivalised income for all age/sex groups, as indicated by the regression line. For every £10,000 increase in equivalised income, *trans* fatty acids intake as a percentage of food energy increased, on average, for most age/sex groups, although the changes were small and only statistically significant for children aged 1.5 to 3 years (0.03 percentage points CI: 0.01, 0.05).

Carbohydrate. For girls aged 11 to 18 years, carbohydrate intake as a percentage of food energy increased, on average, by 0.7 percentage points (CI 0.1, 1.4) for every £10,000 increase in equivalised income. This was significantly different from girls in the UK as a whole (who showed a non-significant decrease with increasing income). For all other age groups carbohydrate intake as a percentage of food energy decreased with increasing equivalised income although the changes were small and not always statistically significant. For men aged 19 to 64 years, carbohydrate intake as a percentage of food energy decreased, on average, by 0.9 percentage points (CI 0.4, 1.4) for every £10,000 increase in equivalised income. This was a significantly larger reduction than in men in the UK as a whole (who showed a significant decrease of 0.5 percentage points with increasing income).

Free sugars.[54] Mean free sugars intake exceeded the recommendation of no more than 5% total energy across the range of equivalised income for all age/sex groups, as indicated by the regression line. Adults aged 19 to 64 years showed a significant average decrease in free sugar intake as a percentage of total energy of 0.5 percentage points (CI 0.3, 0.8) for every £10,000 increase in equivalised income. This was a significantly larger reduction than for adults in the UK as a whole (who showed a significant decrease of 0.3 percentage points with increasing income). For children there were no significant trends but the data suggested a small upward trend in most age/sex groups.

AOAC fibre.[55] Mean intake of AOAC fibre showed an increase with increasing equivalised income in all age/sex groups, although this was not always statistically significant. The largest increase was seen in children aged 4 to 10 years with 0.9g/day (CI 0.6, 1.2) for every £10,000 increase in equivalised income. This was a significantly larger increase than for this age group in the UK as a whole (who showed a significant increase of 0.5g/day with every £10,000 increase in equivalised income).

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[54] The definition of free sugars as described by SACN includes all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and unsweetened fruit juices. Further details of the methodology for determining free sugars in the NDNS RP are provided in appendix AA

[55] AOAC fibre is the term used to describe fibre measured by the American Association of Analytical Chemists (AOAC) methods. AOAC fibre includes resistant starch and lignin in the estimation of total fibre as well as non-starch polysaccharides.

Alcohol. For women aged 19 to 64 years there was a statistically significant increase in the percentage consuming alcohol of 4 percentage points (CI 1, 8) for every £10,000 increase in equivalised income. For the other age/sex groups from 11 years upwards, where it was possible to estimate trends, the data suggested a small upward trend in the percentage consuming alcohol.

(Tables 6.18-6.28)

6.5 Micronutrients

For micronutrients, analysis has been carried out for intake and the proportion with intakes below the LRNI.[56] All micronutrient intakes discussed in this report and associated Excel tables exclude contribution from supplements. Reference is made to population intake compared with the RNI.[57] However, for the proportion with intakes below the LRNI there are very few age/sex groups where a regression line can be fitted (either due to most of the data being zero or there being a clear non-linear relationship). Therefore, no commentary is provided on this analysis in this section. For those age/sex groups where a regression line cannot be fitted, plots showing proportions per income decile are presented to aid the readers interpretation of the relationship. The relationship between the proportion with intakes below LRNI[58] and equivalised income can be investigated further using the archived datasets.

Vitamin A. Data for vitamin A intakes were skewed and so needed to be log-transformed before analysis. The trends in geometric mean are reported as an average percentage change per £10,000 increase. For children aged 1.5 to 3 years and 4 to 10 years in Wales, there was a statistically significant increase in vitamin A intake of 9% (CI 4, 14) and 10% (CI 6, 15) respectively for every £10,000 increase in equivalised income. For older children and adults increases in vitamin A intake with increasing income were generally smaller and/or

[56] 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 4 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

[57] 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

[58] 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.

not statistically significant. The regression line indicates that for children aged 1.5 to 3 years and 4 to 10 years and for adults aged 19 to 64 years, those in higher income groups were more likely to have vitamin A intakes that met the RNI.

Riboflavin. Intake of riboflavin increased with increasing equivalised income for most age/sex groups. For every £10,000 increase in equivalised income, riboflavin intake increased significantly for men aged 19 to 64 years by 0.08mg/day (CI 0.03, 0.13). This was significantly greater than the increase seen in men in this age group for the UK as a whole (who showed a non-significant increase). There were also statistically significant increases for children aged 1.5 to 3 years (0.07mg/day CI: 0.00, 0.14) and men aged 65 years and over (0.13mg/day CI: 0.01, 0.25).

Folate. For all age/sex groups folate intake increased, on average, with increasing equivalised income, although this was not always statistically significant. For every £10,000 increase in equivalised income, intake increased by 12µg/day (CI 7, 17) in men aged 19 to 64 years. This increase was significantly greater than that seen in men aged 19 to 64 years in the UK as a whole (a significant increase of 6µg/day for every £10,000 increase in equivalised income). There were also statistically significant increases for children aged 1.5 to 3 years (5µg/day CI: 0, 9) and girls aged 4 to 10 years (9µg/day CI: 3, 16).

Vitamin D. Data for vitamin D intakes were skewed and needed to be log-transformed before analysis. The trends in geometric mean are reported as an average percentage change per £10,000 increase. The regression line indicates that vitamin D intakes were below the RNI across the range of equivalised income for all age groups. For every £10,000 increase in equivalised income, vitamin D intake increased significantly in girls aged 4 to 10 years by 10µg/day (CI 2, 19). This was significantly different from girls aged 4 to 10 years in the UK as a whole (who showed no trend). There were also statistically significant increases in children aged 1.5 to 3 years (11µg/day CI: 2, 21) and boys aged 11 to 18 years (9µg/day CI: 3, 17). Most other age groups had small non-significant increases.

Iron. With the exception of children aged 1.5 to 3 years and women aged 65 years and over, intake of iron increased with increasing equivalised income for all age/sex groups, although this was not always statistically significant. For every £10,000 increase in equivalised income, iron intake increased significantly by 0.2mg/day (CI 0.0, 0.4) for children aged 4 to 10 years, 0.4mg/day (CI 0.1, 0.7) for boys aged 11 to 18 years and 0.4mg/day (CI 0.3, 0.6) for adults aged 19 to 64 years. For adults aged 19 to 64 years, this was significantly greater than the increase seen in this age group for the UK as a whole (who showed a significant increase of 0.2mg/day for every £10,000 increase in equivalised income).

Calcium. In most age/sex groups, calcium intake increased with increasing equivalised income, although this was not always statistically significant. The largest increase was in men aged 65 years and over, with an increase in calcium intake of 95mg/day (CI 18, 171) for every £10,000 increase in equivalised income. The regression line indicates that men of this age in higher income groups in Wales are more likely to have calcium intakes that meet the RNI. For children aged 1.5 to 3 years in Wales, calcium intake increased by 37mg/day (CI 7, 67) for every £10,000 increase in equivalised income which was significantly greater than the change in the same age group in the UK as a whole (a non-significant increase of 4mg/day).

Sodium. Trends in sodium intake with income in Wales were inconsistent in direction between age groups and did not reach statistical significance. For adults aged 19 to 64 years and men aged 65 years and over, sodium intake increased with increasing equivalised income, although this was not statistically significant. For all other age/sex groups, sodium intake decreased with increasing income, although again, this was not statistically significant. These sodium intake estimates are based on the sodium content of foods consumed. They do not fully take account of salt added during cooking and exclude salt added at the table by participants.[59]

Iodine. For most age/sex groups, intake of iodine increased with increasing equivalised income, although this was not statistically significant in all groups. For children aged 1.5 to 3 years and men aged 65 years and over, iodine intake increased by 12µg/day (CI 1, 22) and 21µg/day (CI 5, 37) respectively for every £10,000 increase in equivalised income. For children aged 1.5 to 3 years, this increase was significantly larger than the UK as a whole (who showed a non-significant increase for every £10,000 increase in equivalised income).

Magnesium. For all age/sex groups, with the exception of women aged 65 years and over, magnesium intake increased with increasing equivalised income, and this was statistically significant for most groups. The largest significant increase was in men aged 19 to 64 years (15mg/day, CI: 10, 19) and this was significantly greater than the increase seen in this age group for the UK as a whole (who showed a significant increase of 5mg/day for every £10,000 increase in equivalised income).

Potassium. For all age/sex groups, potassium intake increased with increasing equivalised income, and this was statistically significant for most groups. The largest increase was seen in men aged 65 years and over (197mg/day, CI: 21, 373). For children aged 4 to 10 years and men aged 19 to 64 years, potassium intake increased by 96mg/day (CI 56, 135) and 121mg/day (CI 59, 184) respectively for every £10,000 increase in equivalised income. In both these groups this increase was significantly greater than the increase seen in the same age group in the UK as a whole (39mg/day and 56mg/day respectively for every £10,000 increase in equivalised income).

Selenium. There were small increases in selenium intake with respect to equivalised income in most age/sex groups. However these were generally not significant.

[59] A nominal 0.01g of salt is added to homemade recipes where salt has been specified by the participant as an ingredient.

Zinc. For all age/sex groups, with the exception of women aged 65 years and over, intake of zinc increased with increasing equivalised income, although this was not statistically significant in all groups. The largest increase was seen in men; 0.5mg/day for every £10,000 increase in equivalised income for those aged 19 to 64 years and 65 years and over (CI 0.3, 0.7 and 0.2, 0.9 respectively).

(Tables 6.29-6.50)

7 Chapter 7 Time trend analysis (Years 1-9; 2008/09- 2016/17) for selected blood analytes

7.1 Introduction

This chapter presents time trend analyses for selected measures of nutritional status over the 9-year period 2008/09-2016/17 (fieldwork Years 1 to 9) of the NDNS RP. The blood analytes were selected for their nutritional and public health relevance to current dietary concerns in the UK. Their nutritional significance is outlined in chapter 4 of this report.

The time trend analysis involves a linear regression model, which splits each survey year into quarters to more fully characterise the trends over time and provide an estimate of the average per year change over the 9-year period. The slope of the regression line represents the average year-by-year change. This line is compared to the corresponding time trend for the UK in a plot in Excel. The plot also provides confidence intervals for the 2 slopes and their difference. Refer to chapter 1 (section 1.3) for a guide to interpretation of the time trend analysis plots. To calculate the 9-year change refer to appendix U, which provides instructions on how to scale-up and explains that the calculations for variables that are analysed on the log scale are different from those for variables analysed on the linear scale. Nine-year change values for Wales are presented in Excel tables U.1-U.4 and for the difference between Wales and UK in Excel tables U.1a-U.4a and should be interpreted in conjunction with the time trend analysis Excel plots. Where a threshold has been established below (or above) which there is an indication of inadequate micronutrient status, trends over time are also reported, where appropriate, for the percentage below or above the threshold indicating suboptimal status.

Because of the achieved sample size in Wales, commentary is in most cases limited to sex-combined age groups although plots are also included for males and females separately.

Many of the trends identified by the analysis were small in magnitude and some were not statistically significant. The commentary in this chapter describes trends in key nutritional biomarkers in Wales taking account of statistical significance and whether the change is physiologically meaningful. The text describes upward or downward trends and the overall size of any observed changes in nutritional status. The 95% confidence intervals for the size of changes are set out in brackets in the text.[60] When the interval does not contain zero, this

[60] The 95% Confidence Intervals (CIs) presented in the plots relate to the magnitude and direction of change i.e. negative CIs for a downward trend. In the text, downward trends are expressed as a **decrease** and so the CIs quoted represent the magnitude of the decrease not the direction of change.

indicates a statistical difference at the 5% level. The text also describes differences between trends observed in Wales and in the UK as a whole.

The plots provide an indication of mean concentration for a key biomarker across the 9 years, however they are not intended to provide or describe the group mean values for each year. Group mean values are described for Years 5 to 9 (combined) in chapter 4. No commentary is provided in those cases where a regression line cannot be fitted. This occurred either when most of the data were zero, when there was a clear non-linear relationship or when the number of participants was less than 30. Furthermore, confidence in the regression estimates is diminished when the number of participants is close to 30 or when the number of participants within one of the early or late calendar years for an age/sex group is less than 3. In those cases, only limited commentary is provided.

Trends in arithmetic mean are quoted as 'change per year' where the data were normally distributed and could be analysed without transformation. Where the data were skewed and needed to be log-transformed before analysis, the trends in geometric mean are reported as 'percentage change per year' (see section 1.3 of chapter 1 for more detail).

7.2 Iron status markers - Haemoglobin and plasma ferritin concentrations

There was little observed change during Years 1 to 9 (2008/09 to 2016/17) in average haemoglobin concentration in any of the age groups in Wales or in the UK as a whole. A significant increase in average ferritin concentration was seen in children aged 4 to 10 in Wales (6% per year, CI 1, 12). A non-significant decrease was observed in adults 19 to 64 years (4% per year, CI 0, 8) while no trend was observed in the UK as a whole.

(Tables 7.1 – 7.5)

7.3 Measures of folate status - Red blood cell (RBC) and serum folate

7.3.1 RBC folate

In Wales the geometric mean RBC folate concentration decreased by around 3% to 5% per year in every sex-combined age group 4 years of age and over. This decrease was statistically significant in all age groups except adults aged 65 years and over and a similar decrease was observed in the UK as a whole. There were insufficient samples from children aged 1.5 to 3 years to plot a regression line. In women of childbearing age (16 to 49 years) the decrease in geometric mean RBC folate concentration was 2% per year (CI -2, 6) which was not statistically significant, unlike the 5% (CI 3, 6) per year decrease in the UK as a whole.

The percentage below the clinical threshold for RBC folate concentration indicating folate deficiency (305nmol/L) increased on average by 1 to 2 percentage points per year in the age groups in which the trend could be estimated; this is similar to the UK as a whole, though in Wales this trend was only statistically significant in children aged 11 to 18 years. In contrast to the UK as a whole, no increase over time was observed in Wales in the percentage of women of childbearing age (16 to 49 years) with a RBC folate concentration below 748nmol/L, the concentration in maternal red blood cells above which the risk of folate-sensitive NTDs is minimised.

(Tables 7.6 – 7.10)

7.3.2 Serum folate

In Wales the geometric mean serum folate concentration decreased over the 9-year period (2008/09 to 2016/17) by approximately 3% per year in all age groups; this was statistically significant in children aged 4 to 10 years and in adults aged 19 to 64 years. The decreases observed in Wales were similar to those in the UK as a whole.

Trends over time in the percentage with serum folate concentration below 7nmol/L, indicating folate deficiency, could only be estimated in children aged 11 to 18 years (a non-significant 1 percentage point increase, CI -1, 2). When data were examined in relation to the threshold of 13nmol/L indicating possible folate deficiency, year-by-year increases over time in the percentage of those with a serum folate concentration lower than this threshold were seen in all standard sex-combined age groups. The largest statistically significant increases, 4 percentage points per year, were seen in boys aged 11 to 18 years (CI 0, 9) and in men aged 19 to 64 years (CI 0, 8). No increase over time was observed in the percentage of women of childbearing age (16 to 49 years) with serum folate concentration below 13nmol/L indicating possible folate deficiency; this was in contrast to the 3 percentage point increase per year seen in the UK as a whole.

(Tables 7.11 – 7.16)

7.4 EGRAC for riboflavin status

Downward trends over time in EGRAC and in the percentage with EGRAC greater than 1.30 (both trends indicating improving riboflavin status) were seen in children in Wales aged 4 to 10 years but not in other age-groups, whereas in the UK as a whole this trend was also seen in adults. This threshold is uncertain and therefore the 75th and 90th percentiles are also recorded for each age group; although a regression line could not be fitted to these percentiles, there was no evidence of any trends in these over the 9 years.

(Tables 7.17 – 7.20)

7.5 Serum vitamin B12

HoloTC was only measured during Years 6 to 9 and so no time trends are presented for this analyte.

No statistically significant trends in vitamin B_{12} concentration over time were seen in Wales whereas in the UK as a whole there was a statistically significant 1% increase per year (CI 0, 2) in children aged 11 to 18 years.

(Tables 7.21 – 7.22)

7.6 Plasma vitamin C[61]

In Wales, no significant changes were seen in mean vitamin C concentration over time. The mean concentration in every age/sex group is well above the threshold and the % below the threshold was too low for any conclusions to be drawn about its change over the 9 years.

(Tables 7.23 – 7.24)

7.7 Plasma/serum 25-hydroxyvitamin D (25-OHD) concentration[62]

In most sex-combined age groups there was little change in mean 25-OHD concentration in Wales over the 9-year period 2008/09 to 2016/17. There was a statistically significant 2nmol/L decrease per year (CI 1, 4) in mean 25-OHD concentration for men aged 19 to 64 years while there was a 2nmol/L increase per year (CI 1, 3) for women in the same age group. In Wales the percentage of children aged 11 to 18 years with 25-OHD concentration below 25nmol/L increased by 4 percentage points year-on-year (CI 2, 5), a total of 32 percentage points over the 9 years whereas in the UK as a whole the equivalent figure was 1 percentage point (12 percentage points over 9 years); changes over time in the percentage of participants in the other age groups with a 25-OHD concentration below this threshold were minimal. Seasonal changes in population 25-OHD concentration for the UK as a whole are discussed in chapter 7 of the UK Years 1 to 9 report.[lv] Changes with seasonality do not affect the calculation of the time trend because individual data are used rather than annual averages and the NDNS RP covers the entire calendar equally.

(Tables 7.25 – 7.26)

7.8 Serum total cholesterol:HDL cholesterol ratio

In Wales no changes in total cholesterol:HDL cholesterol ratio over the 9-year period were seen in any of the age groups.

(Table 7.27)

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[61] Vitamin C (ascorbic acid) is an antioxidant present mainly in fruits and vegetables. Its functions in the body include promotion of healing and maintenance of healthy skin, blood vessels, bones and cartilage. It is a water-soluble vitamin which is not stored in the body. Very low vitamin C levels can result in scurvy.
[62] The matrix in which 25-OHD was measured in changed from plasma to serum during the course of the NDNS RP, refer to appendix Q of this report for more details.

8 Chapter 8 Equivalised income (Years 5-9; 2012/13-2016/17) for selected blood and urinary analytes

8.1 Introduction

This chapter presents key findings for selected measures of nutritional status by equivalised household income[63] for selected key blood and urinary analytes for Years 5 to 9 (2012/13-2016/17) combined. The analytes were selected for their nutritional and public health relevance to current dietary concerns in Wales and the UK as a whole. Their nutritional significance is outlined in chapter 4.

For the equivalised income analysis the average change in each outcome per £10,000 increase in equivalised household income was estimated (via the slope) from a linear regression model. This line is compared to the corresponding income trend for the UK in a plot in Excel. The plot also provides confidence intervals for the two slopes and their difference. Refer to chapter 1 (section 1.3) for a guide to interpretation of the income analysis plots. This is the first time that blood and urine analytes have been analysed by equivalised income in the NDNS RP.

Many of the trends identified by the analysis were small in magnitude and some were not statistically significant. The commentary in this chapter describes trends in key nutritional biomarkers in Wales taking account of statistical significance and whether the change is physiologically meaningful. The text describes upward or downward trends and the overall size of any observed changes in nutritional status. The 95% confidence intervals for the size of changes are set out in brackets in the text.[64] When the interval does not contain zero, this indicates a statistical difference at the 5% level. Commentary also describes where trends in Wales are different to those in the UK as a whole.

The text in this report does not provide or describe the group mean values for each income decile. No commentary is provided in those cases where a regression line cannot be fitted. This occurred either when most of the data were zero, when there was a clear non-linear relationship or when the number of participants was less than 30. Furthermore, confidence

[63] Equivalisation is a standard methodology that adjusts household income to account for different demands on resources, by considering the household size and composition.
[64] The 95% Confidence Intervals (CIs) presented in the plots relate to the magnitude and direction of change i.e. negative CIs for a downward trend. In the text, downward trends are expressed as a **decrease** and so the CIs quoted represent the magnitude of the decrease not the direction of change.

in the regression estimates is diminished when the number of participants is close to 30. In those cases, only limited commentary is provided.

Trends in arithmetic mean are reported as 'change per £10,000' where the data were normally distributed and could be analysed without transformation. Where the data were skewed and needed to be log-transformed before analysis, the trends in geometric mean are reported as 'percentage change per £10,000' (see chapter 1, section 1.3 for more detail).

8.2 Note regarding distribution of equivalised income data

There is evidence that the equivalised income[65] data are positively skewed but a log transformation of these data resulted in a negative skew. Therefore no transformation was applied to the income data prior to the regression analysis, but the influence of high income responses was investigated to ensure the regression slope was not unduly affected by them.

8.3 Iron status markers - Haemoglobin and plasma ferritin concentrations

In Wales there was no statistically significant trend with respect to income in haemoglobin concentration or the percentage below the lower threshold for any of the age groups, although a non-significant increase in haemoglobin concentration with increasing equivalised income was observed in adults aged 65 years and over. There was a steeper increase in ferritin with increasing equivalised income in adults aged 65 years and over in Wales (24% per additional £10,000, CI 9, 41) than in the UK as a whole (increase 9% per £10,000, CI 2, 17). The increase in ferritin with increasing equivalised income seen in the UK for adults aged 19 to 64 years and for children aged 11 to 18 years was not seen in Wales

(Tables 8.1 – 8.5)

8.4 Measures of folate status - RBC and serum folate

8.4.1 RBC folate

RBC folate concentration increased with increasing equivalised income in all age groups over 4 years of age; not all increases were statistically significant. In women of childbearing age (16 to 49 years) the increase per £10,000 increase was 9% (CI 4, 14) which was greater than the 4% increase seen in UK women of childbearing age as a whole.

[65] Equivalisation is a standard methodology that adjusts household income to account for different demands on resources, by considering the household size and composition.

It was not possible to estimate any trend in percentage with RBC folate below the clinical threshold with respect to equivalised income for any age/sex group, nor the proportion of women of childbearing age with RBC concentration optimal for avoidance of folate sensitive NTDs. This was because there was no consistent pattern in the proportions per income decile. Many of the data points were “zero”, and for those population subgroups where data points were not zero there was no linear relationship.

(Tables 8.6 – 8.10)

8.4.2 Serum folate

In Wales, as in the UK as a whole, serum folate concentration showed an increase with respect to increasing equivalised income for all age groups, although not all increases were statistically significant. The increase per £10,000 increase in women of childbearing age (16 to 49 years) in Wales was 11% (CI 6,16) which is greater than for women of childbearing age in the UK as a whole whose increase per £10,000 increase was 5% (CI 2, 8).

There were no trends with respect to equivalised income in percentage of any age/sex group with a serum folate concentration below the clinical threshold indicating folate deficiency (7nmol/L). Where it was possible to estimate trends with respect to equivalised income, decreases (some not statistically significant because of wide confidence limits) in the percentage of those with a serum folate concentration below 13nmol/L indicating possible risk of folate deficiency were seen in all age groups. In women of childbearing age (16 to 49 years) the decrease per £10,000 increase was 7 percentage points (CI 5, 8) which was significantly greater than that in the UK as a whole (2 percentage points CI (0, 5)).

(Tables 8.11 – 8.16)

8.5 EGRAC for riboflavin status

Small downward trends in average EGRAC (indicating improving riboflavin status) and in percentage above the currently-accepted inadequacy threshold of 1.30 with higher equivalised income were observed in all age groups aged 4 years and over. Not all the trends were statistically significant.

(Tables 8.17 – 8.18)

8.6 Measures of serum vitamin B12 status

8.6.1 Serum vitamin B_{12}

In Wales the greatest increases in vitamin B_{12} concentration with respect to increasing equivalised income were seen in adults 19 to 64 years (3% per £10,000; CI 1, 6); in the UK as a whole the greatest increase was seen in older adults (4% per £10,000 increase; CI 1, 6 but in Wales no change was seen in the B12 status of this age group with increasing income).

(Tables 8.19 – 8.20)

8.6.2 Serum Holotranscobalamin (holoTC)[66]

In Wales, a non-significant decrease of 2pmol/L (CI -2, 6) was observed in holoTC concentration with respect to increasing equivalised income in older adults aged 65 years and over. This was in contrast to a significant increase seen in older adults in the UK as a whole (2pmol/L per £10,000; CI 0, 5). No significant changes were seen in other age groups.

(Table 8.21 – 8.23)

8.7 Plasma vitamin C

In Wales, vitamin C concentration increased with respect to increasing equivalised income in children aged 4 to 10 years and in adults, but not in children aged 11 to 18 years. The increase was statistically significant in children aged 4 to 10 years (3µmol/L; CI 0, 5) and in adults aged 19 to 64 years (4µmol/L; CI 2, 5).

(Tables 8.24)

8.8 Plasma/serum 25-hydroxyvitamin D (25-OHD)

Increases in 25-OHD with respect to increasing equivalised income were observed in children aged 11 to 18 years and in adults, but not in children aged 4 to 10 years. The increase was statistically significant in adults aged 19 to 64 years where the increase per £10,000 was 3nmol/L (CI 1, 5).

It was not possible to estimate any trends in the percentage of those with a 25-OHD concentration below 25nmol/L with respect to equivalised income, because there was there was no linear relationship.

(Tables 8.25 – 8.26)

8.9 Serum total cholesterol:HDL cholesterol ratio

Total cholesterol:HDL cholesterol ratio decreased slightly with respect to increasing equivalised income in children and in adults aged 19 to 64 years, but not in those aged 65 years and over. A lower ratio indicates a lower risk of cardiovascular disease.

(Table 8.28)

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[66] Measurement of serum Holotranscobalamin commenced in Year 6 therefore the dataset is smaller than for other analytes.

8.10 Urinary analyte

8.10.1 Urinary iodine concentration (spot urine)

Spot urinary iodine concentrations do not represent the iodine status of individuals, but the median of a large number of spot urine concentrations indicates the iodine sufficiency or otherwise of a population. Any spot urine concentration depends on many factors, including hydration status of the participant at the time the urine was passed as well as recent iodine intake.

No statistically significant trends in spot urinary iodine concentration with equivalised income were observed for any age group.

(Table 8.29)

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