National Diet and Nutrition Survey:
Assessment of dietary sodium

Adults (19 to 64 years) in Northern Ireland, 2015

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About Food Standards Agency in Northern Ireland

Food Standards Agency in Northern Ireland (FSA in NI) is responsible for devolved matters relating to food safety, standards, nutrition and dietary health in Northern Ireland and has responsibility for monitoring the diet of the population in Northern Ireland.

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Notes to text and tables

1 The data used in the report have been weighted. The weighting is described in appendix A of this report. Unweighted sample sizes (as well as weighted sample sizes – where appropriate) are shown at the foot of each table.

2 This survey requires weights to adjust for differences in sample selection and response. The weights adjust for:
- differential selection probabilities of addresses, households and individuals
- non-response to the visit
- non-response to providing a 24-hour urine sample

3 The data in chapter 4 and appendix C were analysed with the complex survey package R (version 3.1.3)

4 The following conventions have been used in tables:

-	no observations (zero value)
0	non-zero values of less than 0.5% and thus rounded to zero
[ ]	unless stated otherwise data and bases for a variable with a cell size between 30-49 are presented in square brackets. For cell sizes below 30, bases have been presented in square brackets, but data has not been presented.

5 Because of rounding, row or column percentages may not add exactly to 100%.

6 A percentage may be quoted in the text for a single category that aggregates two or more of the percentages shown in a table. The percentage for the single category may, because of rounding, differ by one percentage point from the sum of the percentages in the table.

7 Values for means (arithmetic and geometric), medians, percentiles and standard deviations and standard errors are shown to an appropriate number of decimal places. For reasons of space, standard error may sometimes be abbreviated to SE and standard deviation to SD.

8 'Missing values' occur for several reasons, including refusal or inability to answer a particular question and cases where the question is not applicable to the participant. In general, missing values have been omitted from all tables and analyses.

9 The age/sex group to whom each table refers is stated at the upper left corner of the table.

10 The term ‘significant’ refers to statistical significance (at the 5% level) and is not intended to imply substantive importance.

Contents

Executive summary

There is an established relationship between salt intake and risk of high blood pressure.[1] High blood pressure (hypertension) is a risk factor for cardiovascular disease (CVD) and scientific evidence shows that a high salt intake can contribute to the development of elevated blood pressure.

The Scientific Advisory Committee on Nutrition (SACN)[2,3] recommend a target reduction in the average salt intake of the population to no more than 6 grams per day. This figure has been adopted by the UK Government as the recommended maximum salt intake for adults and children aged 11 years and over.

Considerable effort has been made over recent years to raise public awareness of salt intake and health to enable individuals to make informed choices through information (including front-of pack nutrition labelling) and education. In parallel action has also focused on reformulation of manufactured foods, because around 75% of the salt we consume comes from manufactured foods.[4] Voluntary salt (sodium) targets for 85 food categories were first set by the Food Standards Agency (FSA) in 2006.[5] These targets were revised in 2009 and 2011 to take account of food industry achievements in salt reduction. The current targets, which have been agreed across the UK, were set for achievement in 2017.[6]

Estimated salt intake of adults aged 19 to 64 years in Northern Ireland was assessed from the sodium excretion in complete 24-hour urine collections from 609 participants, selected to be representative of this section of the population. Urine samples were collected over seven months (February to August) in 2015, following on from similar surveys in England[7] and Scotland[8] in 2014. Estimated salt intake was calculated using the equation 17.1 mmol of sodium = 1g of salt and assumes all sodium was derived from salt. The data were validated as representing intake over 24-hours by checking completeness of the urine collections by the para-aminobenzoic acid (PABA) method.

This report presents results for an assessment of salt intake in Northern Ireland and a comparison of these results with equivalent results for the England and Scotland 2014 sodium surveys.[7,8] Sodium excretion and estimated salt intake are provided as the arithmetic mean. However, because of the skewed nature of the data, the geometric mean was used for the comparison with the England and Scotland 2014 sodium surveys.[7,8]

Key findings

- In 2015 the mean estimated salt intake for adults aged 19 to 64 years in Northern Ireland was 8.6g/day (on average 43% higher than the recommended maximum); 10.0g/day for men and 7.1g/day for women.

- There was no statistically significant difference between the mean salt intake for all adults combined in the Northern Ireland 2015 sodium survey and the England 2014 sodium survey.[7] However, mean salt intake was significantly higher in Northern Ireland than in the Scotland 2014 sodium survey[8] for all adults combined.

- Mean salt intake was significantly higher for men in Northern Ireland compared with men in England and Scotland. There were no statistically significant differences for women.

1 Introduction

This survey provides data to establish Northern Ireland's current position compared to the Government recommendation to reduce the average population salt intake to no more than 6g per day (g/day) for adults, which is based on advice from the Scientific Advisory Committee on Nutrition (SACN) in 2003.[2] This survey builds on the series of previous urinary sodium excretion surveys reporting salt intake in the general adult population (19 to 64 years) in the United Kingdom (UK) countries.[7,8,9,10,11,12,13,14]

Dietary salt intake can be assessed by measuring sodium excretion in urine. Salt is the predominant source of sodium in the UK diet and estimation of intake from excretion is more reliable than through dietary assessment because it is difficult to quantify discretionary salt used in cooking and at the table. A 24-hour urine collection method validated by the para-aminobenzoic acid (PABA) method (see chapter 2, section 2.5), was used for this survey, and is consistent with previous sodium studies. This method is accepted as being the most reliable and practical method for assessing salt intake in the population. The concentration of sodium in urine fluctuates according to what was eaten at the last meal and how much fluid an individual has drunk, making assessments based on a 24-hour collection more accurate than a spot sample.

The aim of the survey was to obtain 550 complete 24-hour urine collections representative of the population aged 19 to 64 years living in Northern Ireland.

1.1 Background

There is an established relationship between salt intake and risk of high blood pressure (BP).[1] High blood pressure (hypertension) is a risk factor for cardiovascular disease (CVD) and scientific evidence shows that a high salt intake can contribute to the development of elevated blood pressure.[2,15] CVD is a major cause of morbidity and mortality in the UK and worldwide. The British Heart Foundation (BHF) in 2015 estimated that CVD causes 155,000 deaths in the UK and costs the UK economy £15 billion annually.[16,17] Dietary modification is a major component in the preventative strategy to reduce the risk of CVD.

Since the early 1990s the UK Government has recommended a reduction in salt intake in the interest of public health. In 1994, the Committee on Medical Aspects of Food and Nutrition Policy's (COMA) cardiovascular review group recommended that population average salt intake should be gradually reduced from 9g/day to 6g/day or less for adults.[18] In 2003, SACN published its Report on Salt and Health which endorsed COMA's recommendation of a maximum of 6g/day. The report noted that a reduction in the salt content of processed foods was necessary to achieve the recommendation.[2]

Considerable effort has been made over recent years to raise public awareness of salt intake and health to enable individuals to make informed choices through information (including front-of-pack nutrition labelling) and education. Action has also focused on reformulation of manufactured foods, because around 75% of salt consumption is derived from manufactured foods.[4] To support this aim, voluntary salt (sodium) targets for 85 food categories were first published by the Food Standards Agency (FSA) in 2006. These targets were revised in 2009 and 2011 to take account of food industry achievements in salt reduction. The current targets, which have been agreed across the UK, were set in 2014 for achievement in 2017. These targets outline salt reductions for 76 food categories that contribute the most to the population's salt intake.[6] Major retailers, manufacturers and eating out businesses are now working towards these targets.[19] To increase consumer awareness of the salt content of foods, many businesses are using front of pack nutrition labelling alongside pre-existing back of pack nutrition declaration, to make the salt content of food clearer to consumers.

Advice to consumers over recent years has been to 'check the label' and choose products which are lower in salt. Previous UK targeted salt reduction campaigns by the FSA aimed to inform the UK population about health risks associated with high salt intake. In June 2013, the UK Government including FSA in Northern Ireland (FSA in NI) launched a revised front-of-pack nutrition labelling scheme, designed to make healthy choices easier for consumers and raise awareness of high levels of fat, saturated fat, sugars and salt within food products. The universal system uses colour coding and percentage reference intakes of nutrients to inform customers.[20] These campaigns have advised individuals to reduce their salt intake to no more than 6g/day (less for children).

Prior to this survey (carried out in 2015), a total of 170 complete urine collections from adults aged 19 to 64 years in Northern Ireland were obtained from the NDNS RP between 2008/09 and 2011/12.[21] These results have not been included in this report but will be made available on the UK Data Archive.

1.2 Aims of this survey

The aims of the survey were to:

- obtain, over a seven-month period (February to August 2015), 550 complete 24-hour urine collections, representing the population of Northern Ireland aged 19 to 64 years.
- statistically compare estimated salt intake in Northern Ireland with estimates from the England and Scotland 2014 sodium surveys.[7,8]

Ethical approval for the survey was granted by the Cambridge South NRES Committee (Ref. No. 13/EE/0016).

The survey was carried out by NatCen Social Research (NatCen) and MRC Human Nutrition Research (HNR) and was funded by the FSA in NI, Department of Health and *safe*food. Fieldwork visits were carried out by fieldworkers from Ulster University.

2 Methodology

2.1 Sample design

The aim was to obtain, over a seven-month period (February to August 2015), 550 complete 24-hour urine collections, representing the population of Northern Ireland aged 19 to 64 years.

The Postcode Address File was used to sample postcodes that were representative of the population. Forty-five postcode sectors were selected and stratified by district council, index of multiple deprivation and population density. Within these postcode sectors, a random sample of telephone numbers was drawn using Random Digit Dialling (RDD). The sample was issued in six batches.[22,23]

Participants were recruited by NatCen's Telephone Unit (TU) interviewers, using the same sampling methodology as for the England and Scotland 2014 sodium surveys.[7,8] Within each household a maximum of two people aged 19 to 64 years were eligible to take part in the survey. Where there were more than two eligible adults in a household, two were randomly selected. Those living in institutions and females who were pregnant or breastfeeding were not eligible to take part in the survey.

2.2 Participant recruitment

NatCen's TU interviewers attempted to make contact with the households of the generated telephone numbers and when successful, followed a Computer Assisted Telephone Interviewing (CATI) script to introduce the survey, check the eligibility of household members and attempt to recruit up to two participants per household. The TU interviewer also asked about household income (including earnings, pension and benefits), occupational status and housing tenure. The TU interviewer then sought agreement for a fieldworker from Ulster University to contact the selected participant(s) in order to provide more information about taking part in the survey.[24]

The fieldworker made initial contact with the participant(s) via telephone, after which they sent a letter confirming details of the appointment date and time to the participant(s). The fieldworker then visited participating households twice: the first visit to explain the collection protocol and provide the participant(s) with the collection equipment and the second visit to take a sub-sample of the urine collection. Each participant who provided a urine sample was given a £15 gift card as a token of appreciation for their participation in the survey.

2.3 Urine collection protocol

After obtaining written consent (see appendix A), the fieldworker instructed participants in the 24-hour urine protocol. They were asked to collect all urine during a 24-hour period starting from, and including, the second morning urine pass of the 24-hour collection day, and ending with the first urine passed the following morning. The fieldworker randomly allocated a day of collection for the participant(s). Fieldworkers discussed the allocation of the collection day with each participant, explaining that diet often differs between weekdays and weekends and emphasising the importance of the representativeness of the survey across the whole week. However, in order to maximise response participants were allowed to collect their sample on the day of their choice. Women were instructed to collect their urine on non-period days.

Participants were provided with the necessary equipment to do the 24-hour collection and were asked to take one PABA tablet at three evenly spaced intervals throughout the day of the collection. Participants were still eligible to take part if they were willing to carry out the 24-hour urine collection but did not want to, or could not, take PABA.

During the collection period participants were required to record the time they took the PABA tablets, the start and finish times of their urine collection, any missed urine passes, and any medication or supplements taken during the collection period.

The fieldworker revisited participants on the day or the day after the 24-hour urine collection was completed. This ensured that the urine did not deteriorate before reaching HNR for analysis. At this second visit the fieldworker weighed the urine collection using Salter Breknell ElectroSamson digital handheld scales and collected two sub-samples from the total 24-hour urine collection and disposed of the remaining urine and equipment.

The fieldworker then packaged and posted the samples and paperwork to the laboratory at HNR (further details about the collection protocol are provided in appendix A).

2.4 Urinary sodium measurement and analytical laboratory procedures

Measurement of urinary sodium was carried out at HNR using an ion selective electrode on the Siemens Dimension® Xpand clinical chemistry system with the QuikLYTE® module. 24-hour excretion was determined by multiplying urinary concentration by 24-hour volume. The 24-hour volume was determined from the tared weight of the filled 24-hour urine container, recorded by the fieldworker. Twenty-four hour urinary sodium excretion for each individual was then multiplied by the method-specific factor for this survey of 1.03 to enhance accuracy and facilitate comparisons with results from other surveys (see appendix B, section B.2.1 and the reports for the England and Scotland 2014 sodium surveys[7,8]). Urinary potassium and creatinine were measured simultaneously with sodium and results will be included in the dataset deposited at the UK Data Archive. Details of the analytical procedures are given in appendix B.

2.5 Assessment of completeness of collection

Completeness of 24-hour urine collections was assessed using the PABA recovery method,[25] with modifications as described in appendix B (section B.2.2). Where participants reported taking the three 80mg PABA tablets at appropriate intervals, 24-hour urine collections were considered to be complete if they contained between 70% and 104% of the PABA, i.e. 168 to 250 mg[26] (further details are provided in appendix B).

Urine collections with a PABA recovery under 70% were considered incomplete, whilst those with a PABA recovery greater than 104% were considered unfeasibly high and therefore unreliable. Complete collections (those with a PABA recovery of between 70% and 104% of the PABA) were included in the results, whilst collections deemed incomplete or unreliable were excluded.

Individuals who elected not to take PABA but recorded they had completed a 24-hour urine collection were also included. Such individuals who recorded start and finish times within one hour of a 24-hour collection period (i.e. recorded urine collected between 23 to 25 hours) were deemed to have a complete 24-hour collection. In addition, participants were included who elected to take PABA but reported that they did not take all three PABA tablets, yet still recorded they had completed a 24-hour urine collection.

Urinary PABA excretion was measured by high performance liquid chromatography (HPLC).

Further detail of the analytical methodology used in this survey can be found in appendix B.

2.6 Considerations for data interpretation

The following should be borne in mind when interpreting the data:

- statistical analyses were based on each participant's sodium excretion during a single 24-hour period and assumed that the 24-hour collections defined as "useable" contained all urine passed during the collection period

- as with other sodium surveys, the estimated salt intake distributions show a very wide scatter (approximately five-fold difference between the lower and upper 2.5 percentiles)

- a single 24-hour urine collection does not represent a typical sodium excretion for an individual participant. Salt excretion varies day to day depending not only on intake but also on hormonal and other physiological influences. Each urine collection contributing to a survey provides a data point; taken together they describe the population distribution

- as in other previous urinary sodium excretion surveys in the UK, the number of people in the youngest age group (19 to 34 years) providing 24-hour urine collections in this survey was low, highlighting the challenges in involving younger adults in 24-hour urine studies. This may also have been influenced by the household/participant selection method which included only households with landline telephones

3 Response & Weighting

Information about response, the useability of the 24-hour urines collected (and urine collection days) is presented below.

3.1 Random Digit Dialling and response

Of 14,816 telephone numbers attempted by NatCen's TU interviewers, 81% (11,996) were useable. Of these, 12% (1,456) were households that had at least one eligible adult aged 19 to 64 years who agreed to the telephone interview (16% were ineligible, 51% refused the telephone interview and 21% were unproductive for another reason).

In total 929 households, containing 1,412 individuals, were issued to the fieldworkers.

(Tables 1 and 2)

Of the 1,412 individuals issued to fieldworkers, 58% (812) were visited by a fieldworker and 54% (767) provided a 24-hour urine collection.

These response rates contrasted to those obtained in the England and Scotland 2014 sodium surveys.[7,8] In England[7] 92% of individuals issued to fieldworkers were visited by a fieldworker and 86% provided a 24-hour urine collection and in Scotland[8] 94% of individuals were visited by a fieldworker and 88% provided a 24-hour urine collection This is likely to be related to differences in the type and experience of the fieldworkers used in each study (see appendix A for more details).[27]

(Table 2)

3.2 Number of useable urine collections

In total, 767 urines were collected. Of these, two urine collections were from participants for whom the urine volume information was missing from the collection sheet and so it was not possible to calculate 24-hour urinary sodium excretion.

Therefore 765 urine collections, from 341 men and 424 women, were processed by the HNR laboratory. Of these, 80% (609/765) were classified as 'complete' and 20% (156/765) were classified as 'incomplete or unreliable'. The percentage of complete collections provided in Northern Ireland was higher than the percentage of complete collections provided in the 2014 sodium surveys in England[7] (70%) and Scotland[8] (78%).

The majority (130) of the 'incomplete or unreliable' samples were excluded from the dataset on the basis of PABA excretion being outside the range of 70-104% (where three PABA tablets had been taken). A further 26 were excluded on the basis of the participant's record (where three PABA tablets were not taken), and therefore these urine collections were not analysed. The percentage of 'incomplete or unreliable' urine collections provided in Northern Ireland (20% (156/765)) was lower than the percentage of 'incomplete or unreliable' urine collections excluded from the 2014 sodium surveys in England[7] (30%) and Scotland[8] (22%).

(Table 3)

Of the urine collections included in the final analysis, 44% (270/609) were from men and 56% (339/609) were from women. These were the same percentage of collections included in the final analysis in Scotland;[8] 44% from men and 56% from women and similar to those in England;[7] 43% from men and 57% from women.

(Table 3)

From all of the urine collections provided by men 79% (270/341) were classified as complete and 21% (71/341) were classified as 'incomplete or unreliable'. From all of the urine collections provided by women 80% (339/424) were classified as complete and 20% (85/424) were classified as 'incomplete or unreliable'. The proportion of complete collections provided by men and by women in Northern Ireland was similar to that in Scotland but higher than that in England. The mean age for men in the included sample was 47.9 years and 43.9 years in the excluded sample. For women the mean age of those in the included sample was 48.4 years and 47.7 years in the excluded sample. The mean age of the population sample obtained for Northern Ireland was slightly lower than the mean age of the population sample obtained for the England 2014 and Scotland 2014 sodium surveys.[7,8]

(Tables 3 and 5)

3.3 Urine collection days

Start days for 24-hour urine collections were randomly allocated in order to spread sampling throughout the week and avoid over-representation of weekend days when diet may be different from weekdays. Fieldworkers encouraged participants to follow this allocation but in order to maximise response they were allowed to choose a different start day.

Overall, 54% (326/609) of urines were collected from Monday to Friday, and 46% (283/609) were collected at the weekend, so samples collected at the weekend were over-represented in the dataset, as in other sodium surveys. These proportions were similar to those in the England and Scotland 2014 sodium surveys.[7,8]

(Table 4)

3.4 Weighting

The data were weighted to minimise any bias in the results which may be due to differences in the probability of households and individuals being selected to take part; and to reduce non-response bias[28] (see appendix A for details of the weighting strategy).

4 Results

4.1 Estimated salt intake

The aim of the 24-hour urine collection analysis was to estimate the mean and population distribution of estimated salt intake (g/day) in Northern Ireland among adults aged 19 to 64 years. In line with the England and Scotland 2014 sodium surveys[7,8] and previous urinary sodium surveys[9,10,11,12,13,14] estimated salt intake was calculated using the equation:

17.1 mmol of sodium = 1 g of salt

This assumes that dietary intake of sodium is equal to the 24-hour sodium output in urine, and that all sodium in the diet comes from salt. Prior to applying this equation, the urinary sodium excretion data were adjusted using the method-specific factor for this survey in order to improve accuracy and to facilitate comparisons with other surveys over time. For information on derivation of the correction factor see appendix B, section B.2.1 and the reports for the England and Scotland 2014 sodium surveys[7,8].

Table 6 provides mean urinary sodium excretion by sex/age group expressed as mmol/24hr and table 7 shows the cumulative percentage distribution of urinary sodium excretion. Table 8 provides mean estimated salt intake by sex/age group expressed as g/day and table 9 shows the cumulative percentage distribution of estimated salt intake.

Mean urinary sodium excretion for adults was 147mmol/24hr; 172mmol/24hr for men and 122mmol/24hr for women.

(Table 6)

The mean[29] estimated salt intake for adults aged 19 to 64 years was 8.6g/day, which is 43% greater than the SACN recommendation of a population average of no more than 6g/day.[2] Men had a mean[29] daily intake of 10.0g/day, and women had a mean[29] daily intake of 7.1g/day. As in the past, there was a wide distribution in estimated salt intake; some urine collections contained a large amount of salt. This makes the median a more robust description of the overall population status. The median estimated salt intake for the adult population was 8.0g/day (33% higher than the SACN recommended maximum); 9.5g/day for men, 6.7g/day for women).

(Table 8)

There was a wide distribution of estimated salt intakes. Overall, 71% of the estimates were higher than the population maximum recommended limit of 6g/day.[30]

(Table 9)

4.2 Comparison of estimated salt intake in Northern Ireland 2015 sodium survey and in the England and Scotland 2014 sodium surveys[7,8] for adults aged 19 to 64 years

Tables A, 11 and 12 show descriptive statistics of estimated salt intake (g/day) in sodium surveys in Northern Ireland 2015 and in the England and Scotland 2014 sodium surveys.[7,8]

Estimated salt intake in the current Northern Ireland survey (2015) was compared with that for the England and Scotland 2014 sodium surveys.[7,8,29] Due to the skewed nature of salt intake data, log-transformation of the data and geometric means[31] were used in the statistical comparison of mean estimated salt intake between Northern Ireland (2015) and England (2014)[7] and between Northern Ireland (2015) and Scotland (2014).[8]

Tables A, 11 and 12 show that mean estimated salt intake for adults aged 19 to 64 years was greater than the population target maximum of 6g/day in all three countries. There was no significant difference between the geometric mean estimated salt intake in Northern Ireland (7.7g/day) and the geometric mean estimated salt intake in England[7] (7.2g/day) for all adults (p=0.07). However, the geometric mean estimated salt intake in Northern Ireland (7.7g/day) was significantly higher (p=0.02) than the geometric mean estimated salt intake in Scotland[8] (7.1g/day).[32]

Looking at the mean estimated salt intake for males and females separately, tables A, 11 and 12 show that there were statistically significant differences between the geometric mean estimated salt intake for men in Northern Ireland (9.3g/day) and that for men in England[7] (8.5g/day) and Scotland[8] (8.0g/day) (p=0.03 and p=0.0001 respectively). There were no significant differences between the geometric mean estimated salt intake for women in Northern Ireland and that for the women in England[7] or Scotland[8] (p=0.3 and p=0.8 respectively).

(Tables A, 11 and 12)

Table A: Estimated salt intake (g/day) in Northern Ireland (2015), England (2014)[7] and Scotland (2014)[8] by sex and age group[a]

Estimated salt intake (g/day)[a,b]	Survey		
	Northern Ireland 2015	**England 2014**	**Scotland 2014**
Men			
Arithmetic mean[c]	10.0	9.1	8.6
Geometric mean[d]	9.3	8.5*	8.0**
Median	9.5	8.6	7.8
SD	4.02	3.71	3.54
SE of the arithmetic mean	0.24	0.33	0.28
SE of the geometric mean	0.23	0.29	0.24
Upper 2.5 percentile	17.9	19.2	16.5
Lower 2.5 percentile	3.4	3.9	3.5
Women			
Arithmetic mean[c]	7.1	6.8	6.9
Geometric mean[d]	6.5	6.2	6.4
Median	6.7	6.2	6.5
SD	3.61	3.01	2.73
SE of the arithmetic mean	0.25	0.24	0.24
SE of the geometric mean	0.19	0.20	0.24
Upper 2.5 percentile	14.3	12.9	13.6
Lower 2.5 percentile	2.3	2.9	2.6
All			
Arithmetic mean[c]	8.6	8.0	7.8
Geometric mean[d]	7.7	7.2	7.1*
Median	8.0	7.6	7.3
SD	4.08	3.58	3.27
SE of the arithmetic mean	0.16	0.25	0.21
SE of the geometric mean	0.15	0.20	0.21
Upper 2.5 percentile	17.3	17.0	15.9
Lower 2.5 percentile	3.0	3.2	2.8
Percentage difference of sample mean from population recommendation[e,f,g]	43	33	29
Bases (weighted)			
Men	*286*	*340*	*322*
Women	*298*	*327*	*336*
All	*584*	*667*	*657*
Bases (unweighted)			
Men	*270*	*298*	*294*
Women	*339*	*391*	*369*
All	*609*	*689*	*663*

* p<0.05 and ** p<0.01 denotes a statistical difference between estimated salt intake for adults aged 19 to 64 years in North ern Ireland and England and between Northern Ireland and Scotland.

[a] For reporting purposes, arithmetic means have been provided. Due to the skewed nature of the data, geometric means have been calculated (by transforming the data on a natural logarithmic scale) and used for statistical analyses to evaluate relat ive changes in the data (e.g. between years or groups) and minimise bias from the skewed data.

[b] Estimated using the equation 17.1mmol of sodium = 1g of salt.

[c] The arithmetic mean is calculated from non-transformed data (on the original measurement scale).

[d] The geometric mean is calculated from log-transformed data (on the natural logarithmic scale). It is the arithmetic mean of the log-transformed data. To transform back to the original scale, calculate $e^{x=mean}$

[e] Scientific Advisory Committee on Nutrition (2003). Salt and Health. The Stationery Office. http://www.sacn.gov.uk/pdfs/sacn_salt_final.pdf (The recommendation is for no more than 6g of salt per day).
[r] The percentage difference has been calculated using the arithmetic mean.
[g] Where a percentage is positive this indicates that the sample mean exceeds the recommended maximum intake of salt for that age group and where a percentage is negative this indicates that the sample mean is meeting the population recommendation and is that per cent below the recommended maximum intake of salt for that age group. The percentage difference of the sample mean from the population recommendation has not been presented separately for men and women as it is a population mean.

Appendix A: Methodology

A.1 Sample design

The aim was to obtain, over a seven-month period (February to August 2015), 550 complete 24-hour urine collections representing the population of Northern Ireland aged 19 to 64 years.

The Postcode Address File (PAF) was used to sample postcodes that were representative of the Northern Ireland population. Forty-five postcode sectors were selected across Northern Ireland with probability proportional to number of addresses in them. Postcode sectors were then stratified by district council,[33] Index of Multiple Deprivation and population density.

Within the 45 postcode sectors a random sample of telephone numbers was drawn using Random Digit Dialling (RDD). RDD is a method where a representative sample of landline telephone numbers is generated at random from a frame of all possible telephone numbers.[34] Mobile numbers were not included because they are UK wide and cannot be pinned to specific geographic areas.

The RDD sample covered all eligible telephone area codes located in the 45 selected postcode sectors. The database lists the first seven digits of all telephone numbers, including ex-directory numbers, which have been allocated to telephone companies for land lines (e.g. 01234 56XXXX). For each selected area code, the last four digits were randomly generated.

As well as including ex-directory numbers, RDD samples include disconnected numbers but as many non-working numbers as possible were removed before the sample was drawn.

The sample was intended to be issued in five batches. However, as there was some difficulty in recruiting sufficient participants to achieve the required 550 useable urine samples, a sixth batch was issued. This was made up of 3,021 telephone numbers from the same postcode sectors as used for batch 5.

In addition to this, a 'supplementary sample' was also issued alongside batch 6, made up of 36 individuals from earlier batches who had agreed to be contacted by a fieldworker but whose incomplete contact details meant they were not issued in their original batch. These participant contact details were cleaned and issued to fieldworkers.

A.2 Participant selection

The participants were recruited by NatCen's Telephone Unit (TU) interviewers. Within each household a maximum of two people aged 19 to 64 years were eligible to take part in the survey. Where there were more than two eligible adults in a household, two were randomly selected. Females who were pregnant or breastfeeding were not eligible to take part.

Previous sodium studies in UK countries had lower response rates in men so samples were skewed towards women. To increase the number of male participants in this survey men were given a higher chance of being selected and the results were weighted in order to make them representative of the adult population of Northern Ireland. Selection weights were applied to account for the selection of more than one participant within the household and calibration weights were applied to weight the data according to population estimates (age and sex).

A.3 Participant recruitment

Participants were recruited by NatCen's TU interviewers. Prior to starting work on the survey, TU interviewers attended a half-day training session which covered the background and purpose of the survey and their role in recruiting individuals to the survey. Interviewers were also given detailed written project instructions covering the aims of the survey, methodology and fieldwork procedures.

The survey was referred to in the field as the "Diet and Health Study 2015" to minimise risk of participants changing their diets. Telephone interviewers (and fieldworkers) were briefed to not mention salt but instead to say that we were interested in measuring nutrients such as sodium and potassium in the diet.

Telephone numbers were issued to the TU in six batches. The TU interviewers attempted to make contact with the households of the generated telephone numbers and when successful, followed a Computer Assisted Telephone Interviewing (CATI) script to introduce the survey, check the eligibility of household members, and to ask demographic questions. Within each household, up to two adults, aged between 19 and 64 years, were eligible to take part in the survey. If there were three or more eligible adults, two were selected at random within the CATI programme. The TU interviewer then sought agreement for a fieldworker to contact the selected participant(s) in order to arrange a home visit for collection of the 24-hour urine sample(s).

Each household that agreed to take part received a letter thanking them for their agreement to take part in the survey and informing them that the fieldworker would be in touch shortly to arrange a visit. They were also sent a leaflet outlining the survey in more detail.

The details of those agreeing to be visited were passed on to the assigned fieldworker, who then provided further explanation about the survey and arranged a home visit appointment at a time convenient to the participant(s).

A.4 Fieldworker training

All fieldworkers were recruited by Ulster University specifically for this study and were post-graduate students with a background in health and nutrition. This was a different approach from the England and Scotland 2014 sodium surveys[7,8] which used nurses employed by NatCen, the majority of whom had worked on a range of studies and were therefore experienced in contacting and recruiting participants. All fieldworkers attended a briefing before starting work on the survey. The briefing covered all elements of the survey including aims, background and methodology, fieldwork procedures and a practical demonstration of the equipment used to collect urine and the despatch procedures.

To ensure that all fieldworkers followed the standard protocol they were accredited for the weighing and sub-sampling of the urine collection. Fieldworkers were also given detailed written project instructions covering the aims and objectives of the survey, and their performance in the use of the spring balance to measure accurately the mass of the filled urine container was assessed.

A.5 Fieldworker contact and first visit

The fieldworker made initial contact with the participant(s) via telephone (and in a few cases by email), after which they sent a letter confirming details of the appointment date and time to the participant(s). The fieldwork then visited participating households at least twice.

The purpose of the first visit was to:

- encourage the participant(s) to take part and answer any questions they may have had
- check eligibility
- provide the participant(s) with detailed leaflets about para-amino-benzoic acid (PABA) and the urine collection instructions (see appendix D)
- obtain written consent and deliver the equipment
- randomly allocate a date for when the participant(s) would carry out the 24-hour urine collection
- provide labelled Urine Collection Sheet
- book an appointment for the second visit (usually the day, or the day after, the 24-hour urine collection finished). The fieldworker completed an appointment card for the participant(s) to serve as a reminder of when the fieldworker would return to pick up the urine sample(s)

A.6 Urine collection protocol

After obtaining written consent (see appendix D), the fieldworker instructed participants in the 24-hour urine protocol. They were asked to collect all urine during a 24-hour period starting from the second morning urine pass of the 24-hour collection day, and ending with the first urine passed the following morning. The fieldworker randomly allocated a day of collection for the participant(s).

Participants often preferred to do their collection on a weekend day but in order to give an even representation across the week, fieldworkers would ask participants to collect on a Monday to Friday if a weekday was the day allocated, explaining that their diet often differs between weekdays and weekends.

Women were instructed to collect their urine on non-period days.

To do the 24-hour collection, participants were provided with the following equipment:

- five litre capacity screw cap (or jerry can) container to serve as the collection container for urine
- two litre capacity screw cap container for collections made away from the home This was also used as an overflow container should the participant fill the five litre jerry can
- one litre plastic jug, kept inside a re-sealable plastic bag when not used
- funnel kept inside a re-sealable plastic bag when not used
- plastic carrier bags for transporting the equipment away from home
- an aide-memoire safety pin for the participant to pin the under- and outer-garments together during the period of the collection to remind that the specimen of urine about to be passed should be collected
- three PABA tablets to be taken to verify completeness of the 24-hour collection
- coloured stickers to distinguish equipment between two participants in the same household

Participants were instructed to pass urine into the one litre plastic jug, and then pour the sample into the five litre collection container using the funnel provided. Plastic bags were provided for participants to carry the equipment (including a smaller two litre collection container) if they were not at home for some of the collection period.

Participants were asked to take one PABA tablet on three occasions spaced evenly throughout the day of the collection.

Participants were still eligible to take part if they were willing to carry out the 24-hour urine collection but did not want to (or could not) take PABA (see chapter 2, section 2.5).

Before leaving the household the fieldworker recorded the participant details, the agreed start date of the 24-hour collection and whether the participant had consented to take PABA tablets on a Urine Collection Sheet (see appendix D). This sheet was then completed by the participant during the collection period. They were required to record the time they took the PABA tablets, the start and finish times of their urine collection, any missed urine passes, and any medication or supplements taken during the collection period.

A.7 Second fieldworker visit

Visit 2 took place on the day or the day after the 24-hour urine collection was completed. The fieldworker collected two sub-samples from the 24-hour urine sample and disposed of the remaining urine and equipment. To do this the fieldworker was supplied with the following equipment:

- Salter Brecknell ElectroSamson digital hand held scales for weighing the urine collection container (set on kg)
- two x 10ml Sarstedt Urine syringe and two extension tubes for urine monovettes for aliquoting urine
- disposable gloves, apron, disposable work mat for handling the urine
- jiffy bag and packaging material for despatching the samples
- participant-specific pre-printed labels for the filled monovettes

The container with the 24-hour collection was weighed twice by the fieldworker and the weight recorded on the despatch sheet. The fieldworker then thoroughly mixed the urine by repeated inversion of the container before carrying out the sub-sampling procedure, subsequent to which, the fieldworker discarded the remainder of the 24-hour collection and labelled the samples. The fieldworker also checked that the Urine Collection Sheet was complete (asking the participant for any missing information), paying particular notice to the start and end time, report of any missed collections or missed PABA tablets and any medications/supplements taken during the collection period.

The fieldworker then packaged and posted the samples, Urine Collection Sheet, PABA blister pack and despatch paperwork to the laboratory at HNR.

A.8 Weighting

There were two stages to the weighting. The first step was to generate a set of weights to correct for unequal selection probabilities of individuals within households. The second stage was to make an adjustment for different levels of non-response and to ensure that the sample was representative of the Northern Ireland population with regards to age and sex.

A.8.1 Selection weights

A set of selection weights were generated to adjust the sample for selection of individuals within eligible households. Selection probabilities varied depending on the household type, In households with one or two eligible members (adults aged 19 to 64 years) all were selected. In households with three or more eligible members, only two were selected. Males were given a higher chance of being selected as previous studies had shown that men, especially young men, had lower response rates. At the selection stage a factor of 1.56 was applied to all men as it was estimated that this would increase young males in the responding sample by around 30%. Then two household members were selected at random with probability proportional to this factor.

Selection weights are equal to the inverse of the selection probabilities:

- the selection weights for sample members in households with up to two eligible household members are equal to 1.00, since all eligible individuals were selected
- the selection probabilities for sample members in households with more than two eligible household members are equal to: 2.00 x (weighting factor / total weighting factor), where the weighting factor is 1.56 if the individual was male and 1.00 if the individual was female, and the total weighting factor is the sum of the weighting factors of all eligible household members.

The selection weights are then equal to the inverse of this selection probability.

A.8.2 Calibration of the selection weights

The selection weights were then adjusted to create a final set of weights for analysis. All individuals who provided a useable sample were given an analysis weight. The analysis weights were generated using calibration methods. The aim was to reduce bias resulting from sampling error and differential non-response by sex and age. An iterative procedure was used to adjust the selection weights until the distribution of the weighted sample matched that of the population by age and sex.

Population information about individuals aged 19 to 64 years and living in Northern Ireland was taken from the 2014 mid-year population estimates.[35] The distributions of the population and weighted and unweighted samples are shown in table 10.

(Table 10)

Appendix B Urine analytical methods and quality control procedures

B.1 Introduction

This appendix describes the methods used to measure urinary analytes for the Northern Ireland urinary sodium survey 2015 and provides details of the quality control (QC) procedures for these assays. The quality of the laboratory analyses is assured by rigorous instrument maintenance, staff training, adherence to standard operating procedures, membership of external quality assurance schemes and good laboratory practice. The QC and assessment practices used at HNR are all standard procedures for the type of assay used and HNR is ISO certified (BS EN ISO 9001:2008).

B.2 Analysis of urine samples

B.2.1 Sodium and potassium

Urinary sodium and potassium were measured using ion-specific electrodes (ISEs). The sodium and potassium methods on the Siemens Dimension® Xpand clinical chemistry system with the QuikLYTE® module are *in vitro* diagnostic tests intended for the quantitative measurement of sodium and potassium in urine, which use indirect sample sensing with the QuikLYTE® Integrated Multi-sensor Technology (IMT) to develop an electrical potential proportional to the activity of each specific ion in the sample. Each urine sample is diluted automatically and then transferred automatically to the sensor, where Na^+ and K^+ ions establish equilibrium with the electrode surface. A potential is generated proportional to the logarithm of the analyte activity in the sample. The electrical potential generated by a sample is compared with the electrical potential generated by a standard solution, and the concentration of the desired ions is calculated.

Sampling, dilution, reagent delivery, mixing, processing, calculation and printing of results are automatically performed by the Siemens Dimension® system. Samples are identified with bar codes; the instrument automatically uploads barcode and concentration information to a results spreadsheet, thus eliminating transcription errors. The assay range is for sodium is 5-300mmol/L and for potassium 1-300mmol/L.

The Siemens Dimension® method for sodium measurement shows good consistency but gives results which are lower than those given by other analytical methods in the external quality assessment scheme (NEQAS).

In order to provide accurate analytical measurements, the Siemens Dimension® performance was monitored closely during analysis for this survey and the England and Scotland 2014 sodium surveys.[7,8] Crossover studies were performed in the HNR laboratories, comparing sodium concentrations in NDNS RP urines as measured using the Siemens Dimension® with those obtained using a Roche Cobas C111 which gives results consistent with the consensus All Laboratory Trimmed Mean (ALTM) established by the UK National External Quality Assessment Scheme (UK NEQAS).[36] The ALTM is regarded as the best indication available of the accurate concentration. The crossover studies showed that urinary sodium measured in native NDNS RP samples using the Siemens Dimension® at the time of this survey was approximately 3% lower than when measured on the Roche Cobas C111. Therefore, a method-specific factor of 1.03 was applicable to the Siemens Dimension® results for urinary sodium excretion in this survey in order to improve accuracy and to facilitate comparison with other surveys. In this report, the comparison of Northern Ireland data with that from the England and Scotland 2014 sodium surveys[7,8] has been made using sodium data after applying the relevant method-specific factor for each survey. Data for the Northern Ireland 2015 and the England and Scotland 2014 sodium surveys[7,8] will be made available in the UK Data Archive for urinary sodium concentration (mmol/L) and excretion (mmol/24-hour) with and without application of the factor.

B.2.1.1 Quality controls (QC) for sodium and potassium

B.2.1.1.1 Internal QC

Internal commercially-prepared QC samples (Biorad Liquichek, Level 1 and Level 2) were run on the analyser to check for correct calibration and function before the samples were analysed, and included in every batch to determine between-assay precision. Once a bottle was opened, the remaining volume was aliquoted into smaller tubes and frozen at -20°C and then brought to room temperature and mixed thoroughly before use. The batch was accepted provided that the QC result obtained was within the manufacturer's specified range and also within the more stringent range determined within the laboratory.

Internal QC results for the assays in which the reported results were obtained are tabulated in table B.1.

Table B.1 Internal QC for sodium and potassium

	Internal QCs for sodium		Internal QCs for potassium	
	Level 1	Level 2	Level 1	Level 2
mean (mmol/L)	80.0	170	30.3	69.1
SD	0.95	2.91	0.29	0.94
% coefficient of variation	1.19	1.71	0.95	1.36
n	43	42	44	43

B.2.1.1.2 External quality assessment (QA)

HNR is a member of UK NEQAS for urinary sodium and potassium. This scheme sends samples to all hospital and many other analytical laboratories in the UK for analysis and compares results, to improve harmonisation of results between laboratories. NEQAS samples are urine or artificial matrices spiked to simulate the range of concentrations found in human urine. The target concentration against which the accuracy of results from individual laboratories is assessed is the All Laboratory Trimmed Mean (ALTM).

The urines for this survey were assayed over a short period which did not coincide with a NEQAS distribution. Stored NEQAS controls from thirteen previous cycles were assayed alongside survey samples, the results plotted against the ALTM target and the results compared by least-squares linear regression.

Table B.2 shows the bias with respect to ALTM as calculated from the regression equation; original results are in the first column and results multiplied by the factor of 1.03 are in the second column; the latter are comparable with the reported results from survey participants.

Table B.2 NEQAS results for urinary sodium and potassium; stored NEQAS samples assayed alongside survey samples

	sodium	sodium*1.03	potassium
Regression equation	$[Na]_{Siemens\ Dimension®}=[Na]_{Target} * 0.9798$	$[Na]_{corrected\ Siemens\ Dimension®}=[Na]_{Target} * 1.009$	$[K]_{Siemens\ Dimension®}=[K]_{Target} * 0.9657$
Bias derived from regression equation	-2.0%	+1.0%	-4.3%
Correlation coefficient (r^2)	0.997	0.997	0.998
n	39	39	39

B.2.2 Measurement of urinary para-aminobenzoic acid (PABA) by high performance liquid chromatography (HPLC)

PABA metabolites in urine are hydrolysed under alkaline conditions, the solution is then neutralised and the resultant PABA concentration determined by HPLC. The HPLC method is a reverse-phase method using an internal standard to compensate for volume losses during hydrolysis. The PABA HPLC method used at HNR is based upon that previously used at the MRC Dunn Nutrition Unit which in turn was based upon the method described by Jakobsen *et al*. (1997);[26] it was then modified at HNR to replace the acetonitrile in the mobile phase with methanol because of the unavailability of acetonitrile.

A recent methodological study (unpublished data) conducted at HNR using 50 adult volunteers showed that for the current analytical HPLC method, the reference range for PABA excretion indicating a complete 24-hour urine collection), allowing for both biological and analytical variation, was 70 to 104% of the 240mg dose, (mean -2 SD to mean +2 SD). PABA excretion below this range indicates an incomplete 24-hour collection. PABA excretion above this range could indicate either inadequate mixing of the urine before sampling or inaccurate recording of the volume, and therefore an incorrect 24-hour sodium excretion result, or ingestion of PABA in supplements which precludes assessment of completeness of urine collections by this method. Such urines were excluded from the dataset.

24-hour PABA excretion is calculated by multiplying concentration by 24-hour volume; this is then expressed as the percentage of the 240mg PABA dose recovered in the 24-hour collection ("PABA recovery") for comparison with the reference range above.

B.2.2.1 QC for PABA HPLC assay

B.2.2.1.1 Internal QC

A sample of urine containing PABA is analysed with each batch of samples in order to determine inter-assay variation. Assay results for each run are accepted if the QC results fall within limits defined within the laboratory, otherwise the batch is re-assayed.

Completeness of hydrolysis is monitored by including a sample containing PAHA (*para*-aminohippuric acid) with each batch. This is hydrolysed to PABA which is then quantitated by HPLC. 2mM PAHA theoretically yields 2mM PABA (i.e. 275mg/L). Quantitative hydrolysis of the PAHA indicates quantitative hydrolysis of urines prepared at the same time.

Internal QC results for the assays in which the reported results were obtained are tabulated in table B.3.

Table B.3 Quality control (QC) for PABA assay

	QC1 (target 75.4)	QC2 (target 30.3)	PAHA (target 263)
Mean (mg/L)	75.1	29.9	263
SD (mg/L)	3.98	2.30	8.11
% coefficient of variation	5.30	7.71	3.08
n	46	46	48

B.2.2.1.2 External QA

There is no external QA scheme for PABA.

B.2.3 Creatinine

The creatinine method, performed on the Siemens Dimension® Xpand,is an enzymatic method using creatininase, creatinase and sarcosine oxidase, generating hydrogen peroxide. Colour development is achieved with peroxidase and 4-aminophenazone which react to generate a coloured compound in proportion to the concentration of creatinine in the urine sample assayed. This enzymatic method is less subject to interference than the kinetic Jaffe reaction used in previous surveys. Sample dilutions (x20) and result export are performed automatically by the analytical instrument. Creatinine is stable in urine without preservative.

Creatinine excretion is affected by muscle mass and recent meat consumption and therefore varies considerably from person to person.

B.2.3.1 QC for Creatinine

B.2.3.1.1 Internal QC

The creatinine assay on the Siemens Dimension® Xpand is controlled with Lyphochek QC 1 and 2 produced by Bio-Rad Laboratories, included in every batch to determine between-batch precision. Once a bottle is opened, the remaining volume is aliquoted into smaller tubes and frozen at -20°C. QC material is brought to room temperature and mixed thoroughly before use. The batch is accepted if the QC results fall within limits defined by the manufacturer and also within the more stringent range defined by the HNR laboratory.

Internal QC results for the assays in which the reported results were obtained are tabulated in table B.4.

Table B.4 Internal QC for creatinine

	Internal QCs for urinary creatinine	
	Level 1	Level 2
mean (mmol/L)	5.03	10.5
SD	0.08	0.14
% coefficient of variation	1.65	1.36
n	43	42

B.2.3.1.2 External QA

HNR subscribes to NEQAS for urinary creatinine; this scheme sends samples to all hospital and many other analytical laboratories in the UK for analysis and compares results, to improve harmonization of results between laboratories. NEQAS samples are urine or artificial matrices spiked to simulate the range of concentrations found in human urine. The ALTM is the target concentration against which the accuracy of results from individual laboratories is assessed.

Table B.5 summarises the results obtained using the HNR Siemens Dimension® assay relative to the ALTM derived from the results of all participating laboratories, using previous NEQAS samples assayed alongside the study samples (see section B.2.1.1.2).

Table B.5 NEQAS results for urinary creatinine; stored NEQAS samples assayed alongside survey urines

	creatinine
Regression equation vs ALTM	$[creatinine]_{Siemens\ Dimension®} = [creatinine]_{Target} * 0.9951$
Bias derived from regression equation	-0.5%
Correlation coefficient (r2)	0.998
n	38

Appendix C Distribution of estimated salt intake

The distribution of estimated salt intake data included in the statistical comparisons between Northern Ireland 2015 and England 2014[7] and Northern Ireland 2015 and Scotland 2014[8] are presented as boxplots by survey and histograms (both original and logarithmic (natural log) scales) for men, women and sex-combined data. These plots incorporate the sampling weights used to reflect the distribution of the target population of the surveys.[37,38]

Figure C.1A: Boxplots of estimated salt intake of adults aged 19 to 64 years in Northern Ireland (2015), England (2014)[7] and Scotland (2014)[8] - showing median, first and third quartiles, and very high or very low observations[37]

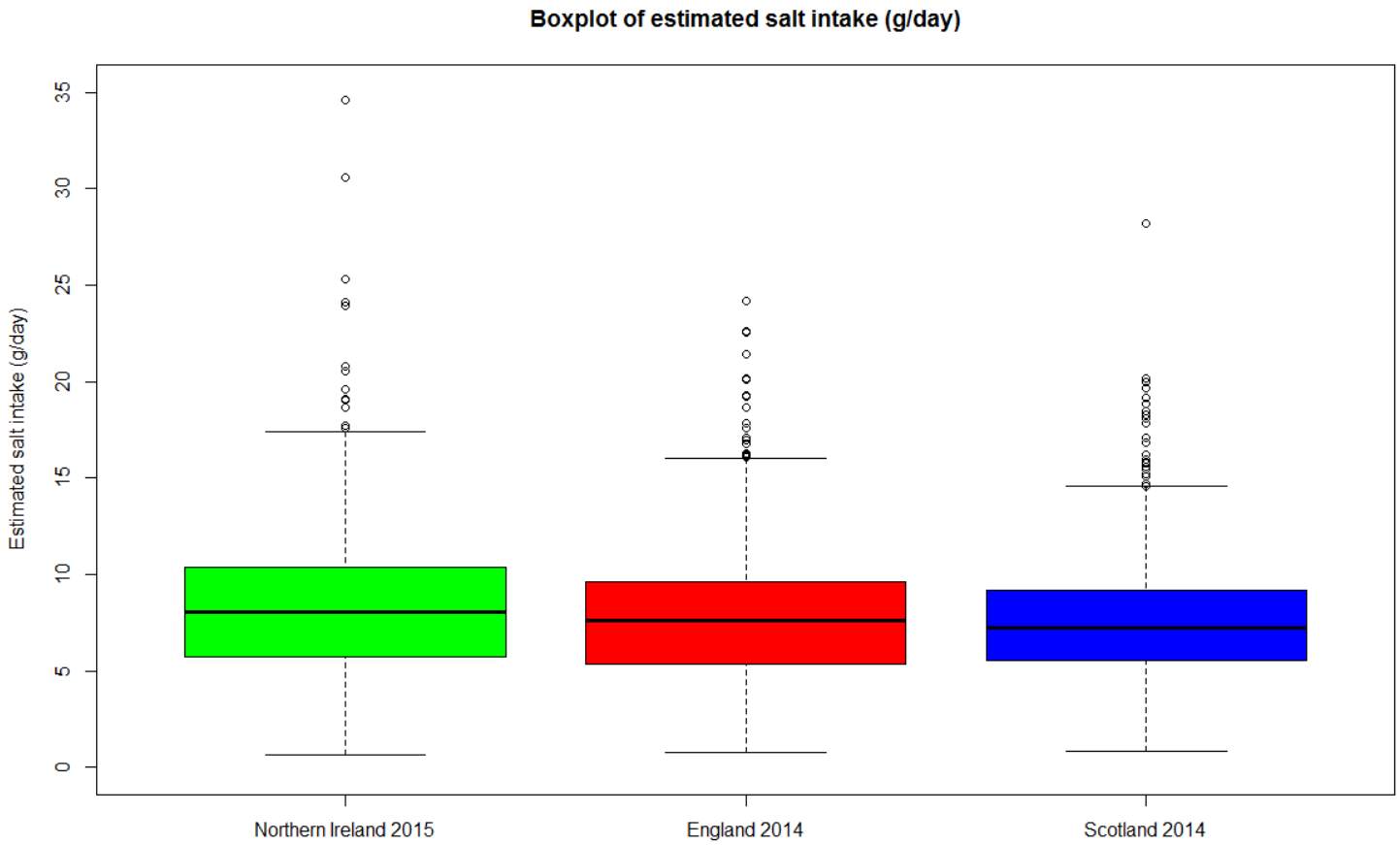


Figure C.1B: Boxplots of estimated salt intake (on natural log scale) of adults aged 19 to 64 years in Northern Ireland (2015), England (2014)[7] and Scotland (2014)[8] - showing median, first and third quartiles, and very high or very low observations[37]

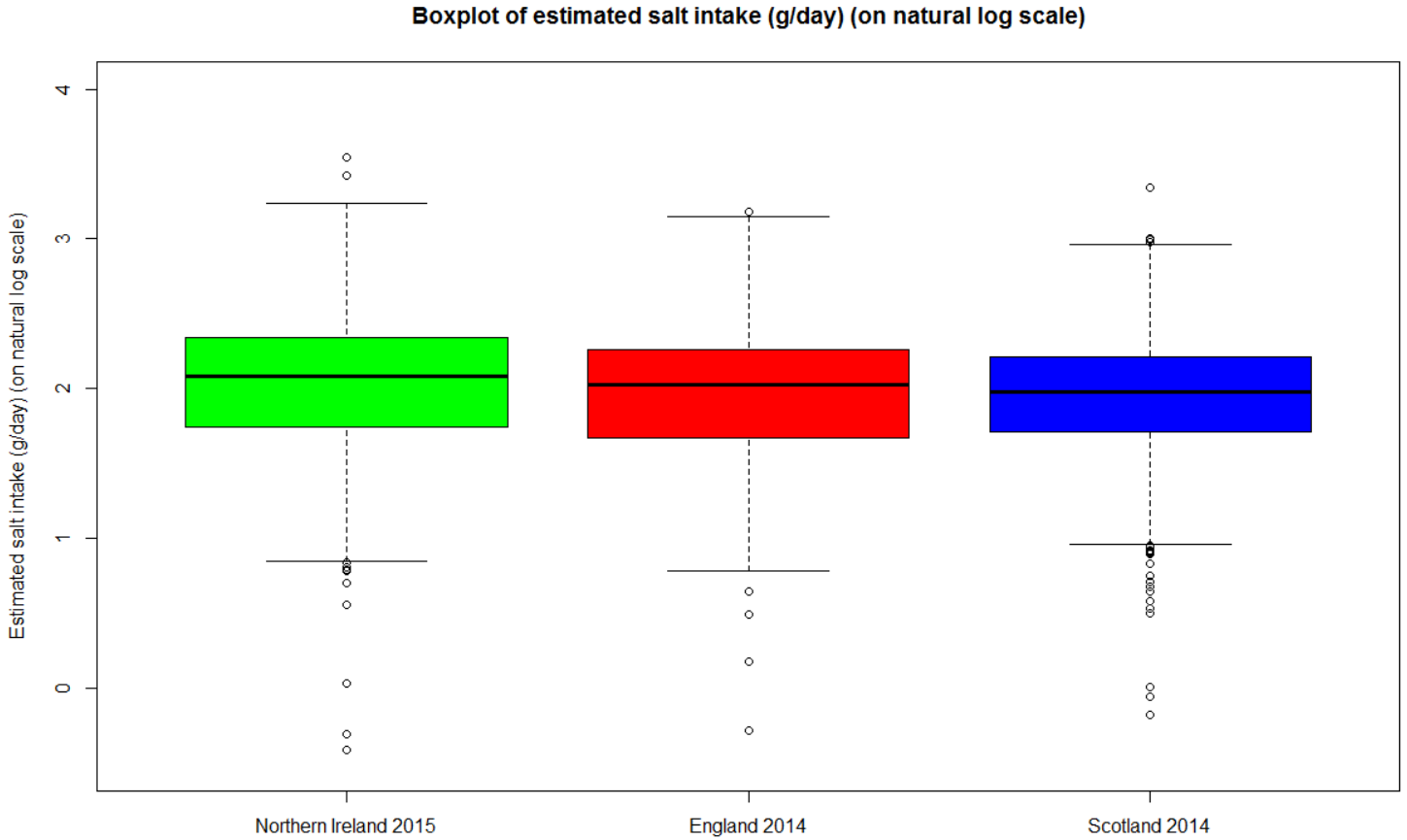


Figure C.2A: Boxplots of estimated salt intake of adults aged 19 to 64 years in Northern Ireland (2015), England (2014)[7] and Scotland (2014)[8] by sex and survey year - showing median, first and third quartiles, and very high or very low observations[37]

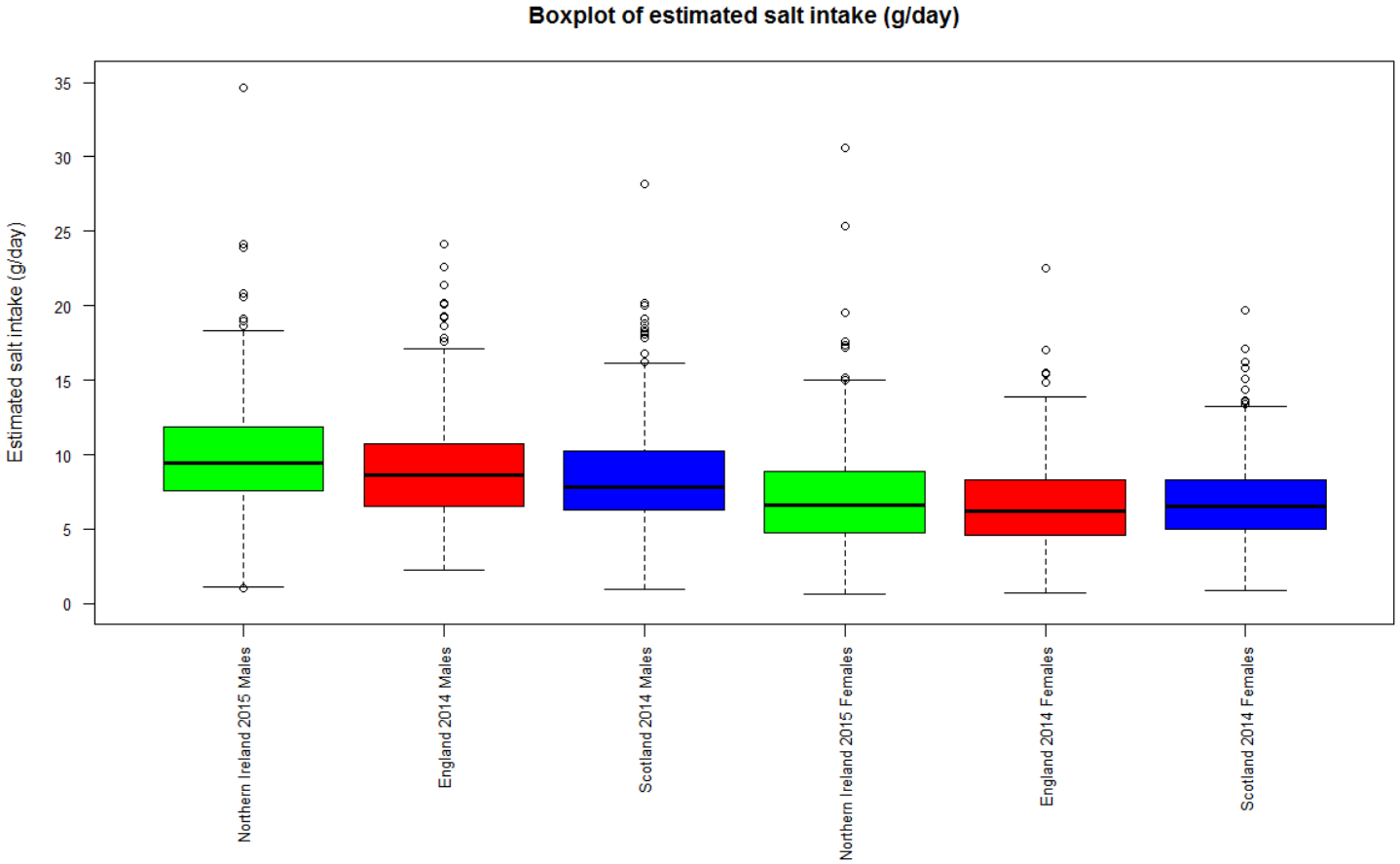


Figure C.2B: Boxplots of estimated salt intake (on natural log scale) of adults aged 19 to 64 years in Northern Ireland (2015), England (2014)[7] and Scotland (2014)[8] by sex and survey year - showing median, first and third quartiles, and very high or very low observations[37]

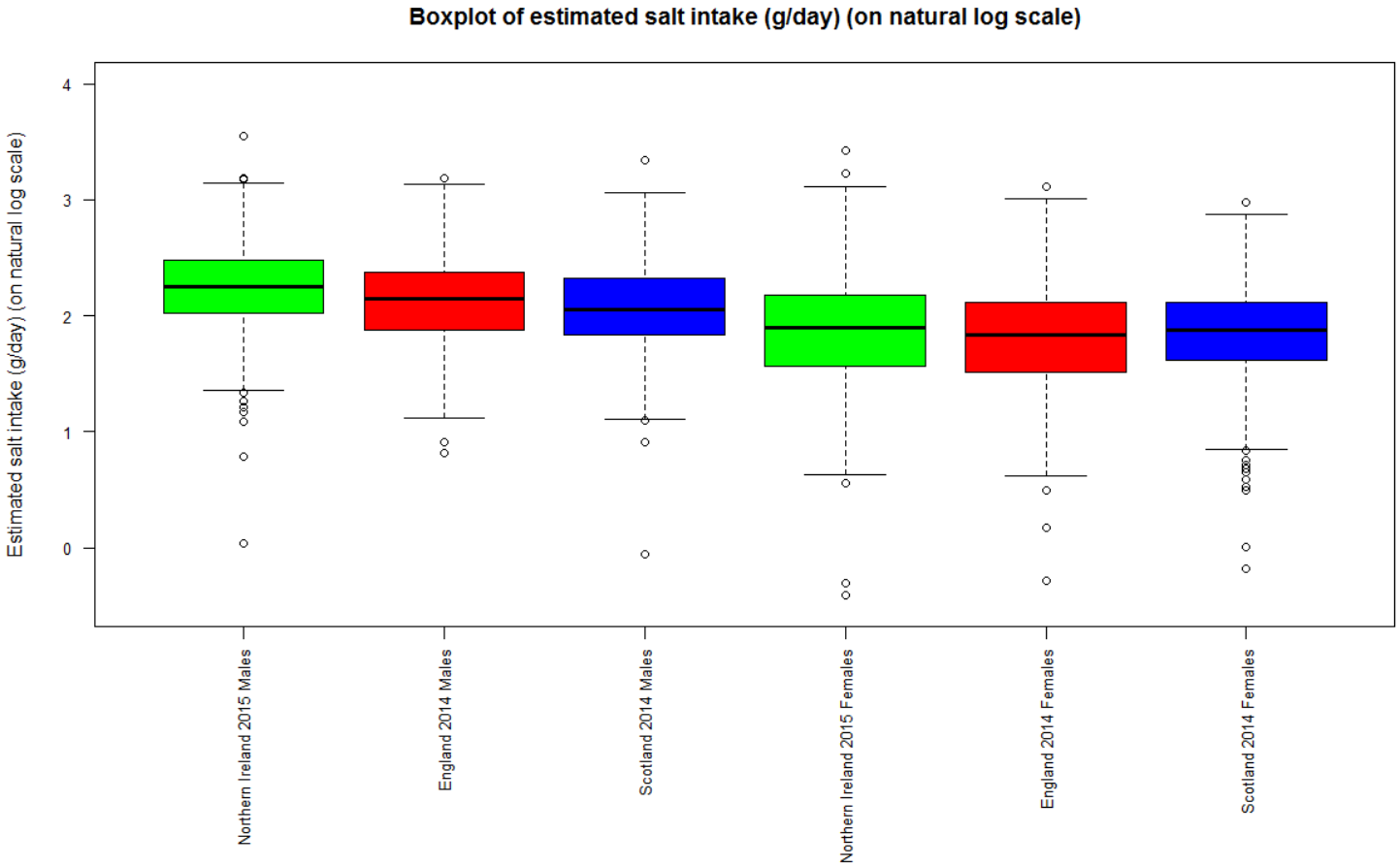
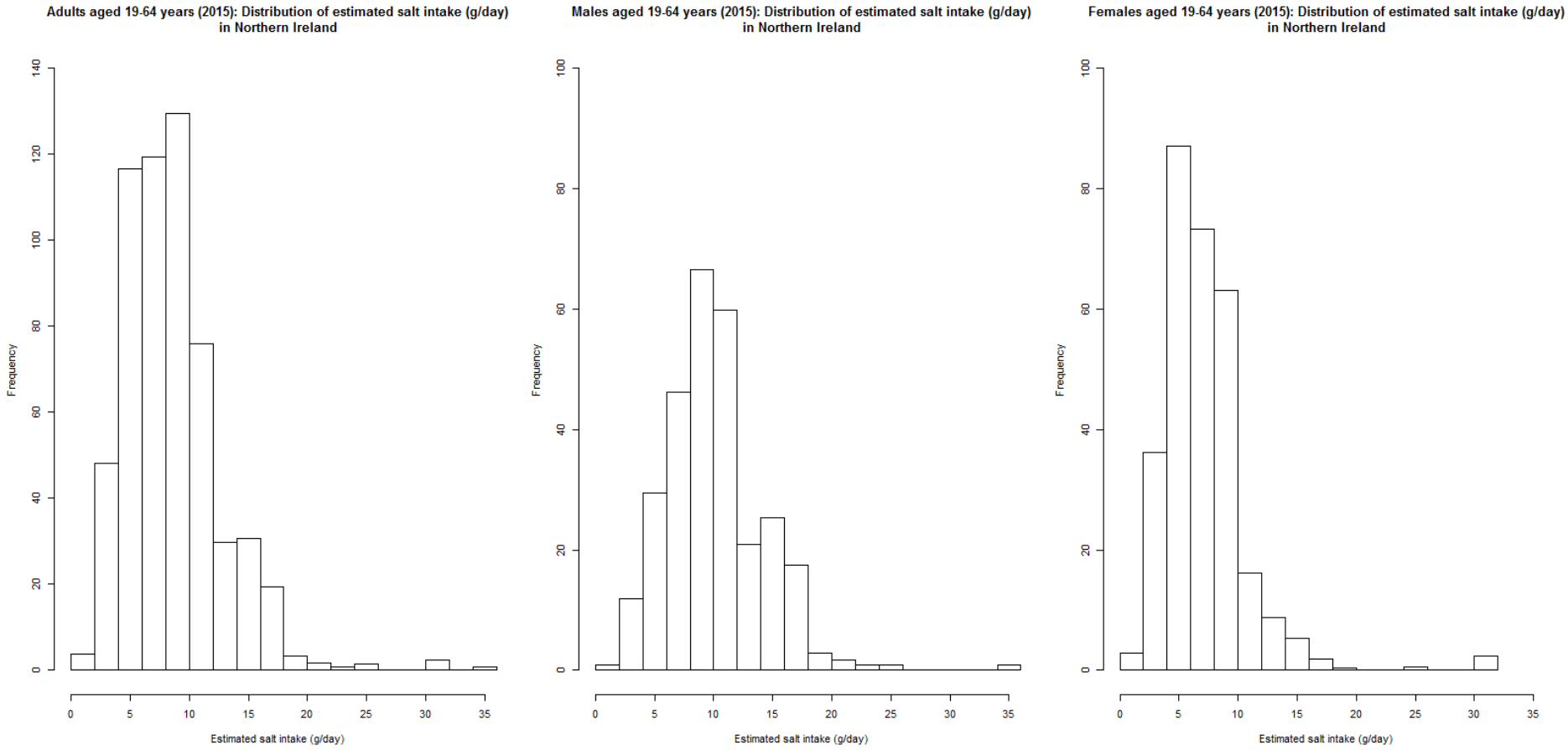
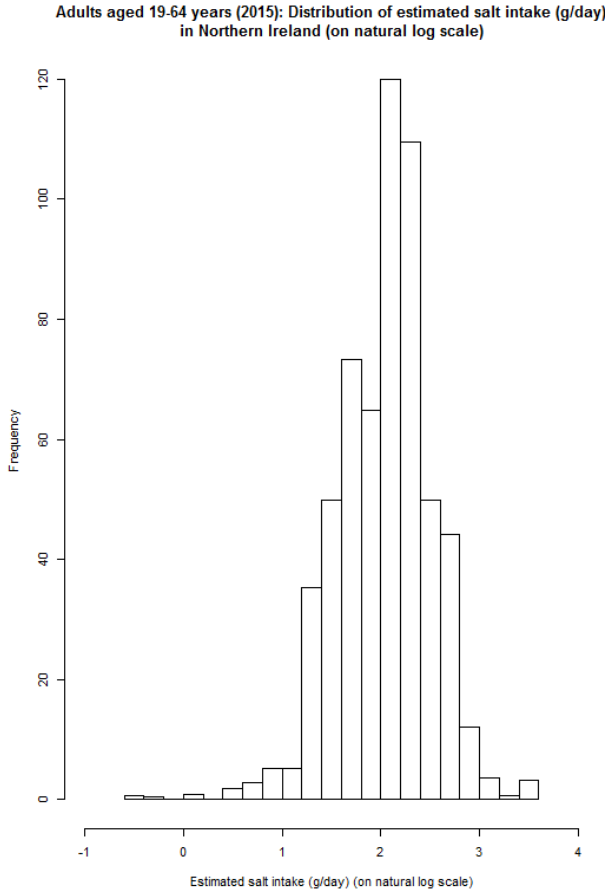


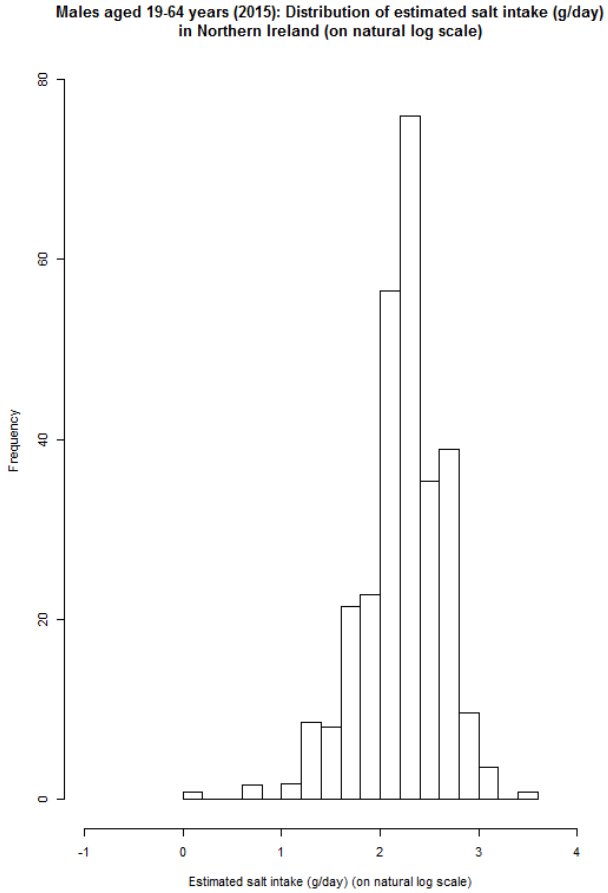
Figure C.3: Histograms of estimated salt intake of adults aged 19 to 64 years in Northern Ireland combined and split by sex (2015)[38]

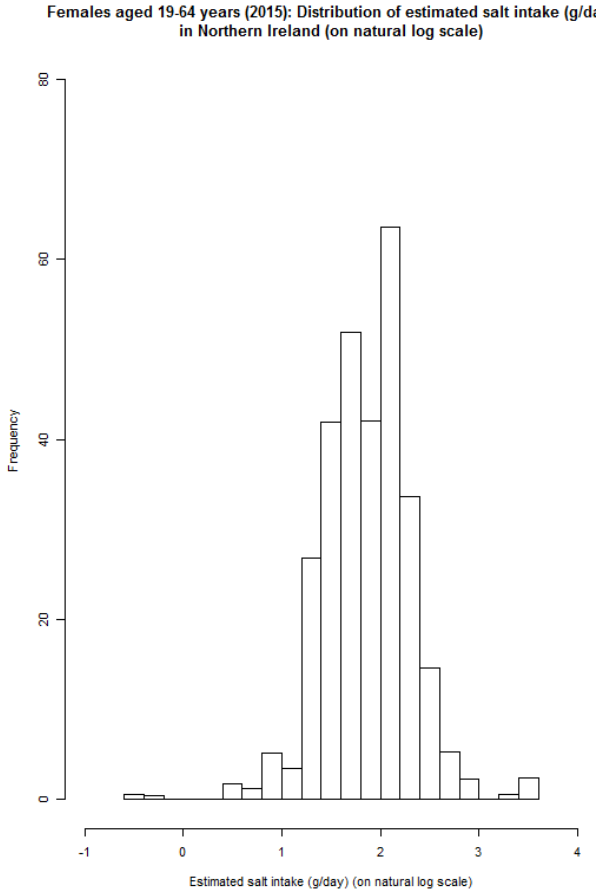


The asymmetrical histograms above demonstrate that the data are not normally distributed. They are plotted below as log-transformed data which produce a more symmetrical normal distribution.

Figure C.4: Histograms of estimated salt intake (on natural log scale) of adults aged 19 to 64 years in Northern Ireland combined and split by sex (2015)[38]







Appendix D Field documents

See separate document

[1] Bibbins-Domingo, K., Chertow, G. M., Coxson, P.G., Moran, A., Lightwood, J.M., Pletcher, M. J., and Goldman, L. (2010) *Projected Effect of Dietary Salt Reductions on Future Cardiovascular Disease*. The New England Journal of Medicine. 362:590-599.

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[3] The recommendation is no more than 5g/day of salt intake for females and no more than 7g/ day of salt intake for males.

[4] http://www.sciencedirect.com/science/article/pii/S0140673687901279 (accessed 08/03/16).

[5] http://webarchive.nationalarchives.gov.uk/20080910120337/food.gov.uk/healthiereating/salt/ (accessed 08/03/16).

[6] https://www.food.gov.uk/northern-ireland/nutritionni/salt-ni/salt_targets (accessed 13/07/16).

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[17] British Heart Foundation (2015) BHF Headline Statistics. British Heart Foundation. http://www.bhf.org.uk/research/statistics.aspx (accessed 13/06/16).

[18] Department of Health (1994). Nutritional Aspects of Cardiovascular Disease. Report on Health and Social Subjects 46. London: The Stationery Office.

[19] https://responsibilitydeal.dh.gov.uk/salt-reduction-onwards-and-downwards (accessed 16/02/16).

[20]Food Standards Agency Northern Ireland (2013) *Front of Pack Nutrition Labelling.* Available at: http://www.food.gov.uk/northern-ireland/nutritionni/fop-ni (accessed: 02/11/15).

[21] Food Standards Agency in Northern Ireland, (2015) *National Diet and Nutrition Survey Rolling Programme (NDNS RP) Results from Years 1-4 (combined) for Northern Ireland (2008/09-2011/12.* Available at: http://www.food.gov.uk/sites/default/files/ndns-ni-full-report.pdf (accessed: 02/11/15).

[22] The sample was intended to be issued in 5 waves but in order to increase numbers an additional wave was issued. Batch 6 of the survey was issued using the same postcode sectors as for batch 5 of the sample.

[23] An additional 'supplementary sample' that was made up of participants from waves 2 to 4 who agreed to be contacted by a fieldworker, but had incomplete contact details and were therefore cleaned out of the original sample was also issued to fieldworkers. Please refer to appendix A, section A.1 of this report for further information on the additional wave and supplementary sample.

[24] At this point the participant was only agreeing to be contacted by a fieldworker. Formal consent to take part in the survey was obtained by the fieldworker.

[25] Bingham S and Cummings J H. The use of 4-aminobenzoic acid as a marker to validate the completeness of 24h urine collections in man. Clin Sci (Lond) 1983; 64(6):629-35.

[26] Jakobsen J, Ovesen L, Fagt S, et al. Para-aminobenzoic acid used as a marker for completeness of 24-hour urine: Assessment of control limits for a specific HPLC method. Eur J Clin Nutr 1997; 5: 514.

[27] The fieldworkers in the England and Scotland 2014 sodium surveys were NatCen nurses and were experienced in recruiting participants.

[28] Non-response bias occurs if those who respond to the survey (or elements of the survey) differ from those who do not respond. Data were weighted to reduce such bias.

[29] For reporting purposes, arithmetic means have been provided. Due to the skewed nature of the data, geometric means have been calculated (by transforming the data on a natural logarithmic scale) and used for statistical analyses to evaluate relative changes in the data (e.g. between years or groups) and minimize bias from the skewed data.

[30] NHS choices website: Salt: the facts http://www.nhs.uk/Livewell/Goodfood/Pages/salt.aspx (accessed 20/10/15).

[31] The geometric mean is calculated from log-transformed data whereas the arithmetic mean is calculated from non-transformed data.

[32] Due to the low salt intake observed in the males 19 to 34 years age/sex group and the small number of participants in this group in Scotland in 2014, the statistical analysis of the differences between the geometric means in Northern Ireland (2015) and Scotland (2014) for adults and for males only was performed both excluding this group and including this group. In both instances of either excluding or including the males aged 19 to 34 years from 2014, the difference was statistically significant. This difference is indicative of the lower salt intake observed in adults in Scotland (2014) than in Northern Ireland and suggests that the subset of males aged 19 to 34 years pulls the estimated salt intake down further.

[33] The equivalent region variable was Government Office Region (GOR) in the England 2014 survey; no regional stratifier was used in the Scotland 2014 survey.

[34] As the sampling frame excluded households without landlines, there was an element of non-coverage bias (as those without a landline had zero chance of being included).

[35] Estimates of the usual resident population in the United Kingdom and its constituent countries. http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/latest (accessed 06/04/16).

[36] The consensus is the All Laboratory Trimmed Mean (ALTM).

[37] Each box in the boxplots of figures C.1A-C.2B represent the first quartile (bottom of the box; 25th percentile), the median (middle of the box; 50th percentile) and the third quartile (top of the box; 75th percentile). The whiskers (bottom and top) help the identification of very high or very low observations. These are demarcated by the maximum and minimum observations or by 1.5 interquartile ranges beyond the end of the box, whichever are closer to the box.

[38] The histograms in figures C.3-C.4 illustrate the skewed distribution of salt intake in its original (or raw) form, and subsequent less skewed distributional form after a natural log-transformation of the data.