Scottish Centre for Social Research
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A survey of 24 hour urinary sodium excretion in a representative sample of the Scottish population as a measure of salt intake

1. Introduction

This study was designed to provide data to establish the progress towards meeting the target to reduce salt intakes in Scotland to 6g/day. It builds on a previous study in Scotland which reported that the mean estimated salt intake for adults was 9.0g/day in 2006[i]. Since the 2006 survey a lot of effort has been made to educate the population about salt and health and to encourage a more informed choice through front-of pack labelling, alongside industry reductions in the salt content of many food products.

Epidemiological, clinical and animal-experimental evidence shows a direct relationship between dietary electrolyte consumption and blood pressure (BP). Furthermore, clinical trials show that a reduction in salt (NaCl) intake reduces BP levels in normotensive and hypertensive populations and prevents the development of hypertension.[ii]

In the UK, the Committee on Medical Aspects of Food Policy (COMA) panel on Dietary Reference Values (DRV)[iii] set the Reference Nutrient Intake (RNI) for men and women at 1.6g of sodium (or 4.2g of salt) per day. Following this, COMA's Cardiovascular Review Group recommended that salt intake by the adult population should be reduced from 9g to a daily average of 6g.[iv] This recommendation was accepted in a report on salt and health by the Scientific Advisory Committee on Nutrition (SACN) and the Scottish Executive's "Eating for Health: Diet Action Plan for Scotland" (SDAP) includes the dietary target to reduce the sodium intake of the Scottish population to 100mmol per day (equivalent to 6g of salt). More recently the Scottish Government's 2008 publication *Healthy Eating, Active Living: An action plan to improve diet, increase physical activity and tackle obesity (2008-2011)* reiterates the Scottish Government's commitment to the principles of the Diet Action Plan targets.

The intakes of sodium (Na) can be estimated by measuring urinary excretion, given that under normal circumstances this is the pathway for their elimination therefore electrolyte excretion rates reflect the diet of an individual. This study involved taking a 24-hour measurement from each respondent (a separate sub-sample of the Scottish Health Survey) to look at the dietary sodium intake in Scotland, with the aim of ascertaining the extent to which the Scottish dietary salt intake target is being met.

2. Aim of study

The aim of the study was to achieve a sample size of 800 adults, from which it was estimated that 640 useable 24-hour urine samples would be generated. The samples were to be obtained from a representative sample of the population of Scotland aged 19-64 years, covering all geographical areas including the Highlands and Islands (except those with small populations), and be representative of gender and the Scottish Index of Multiple Deprivation (SIMD)[v].

ScotCen submitted the application for MREC approval for the dietary sodium study in September 2008, and ethical approval for the study was granted by the REC for Wales (Ref. No. 08/MRE09/62).

3. Methodology

3.1 Recruitment

The sample of respondents came from the Scottish Health Survey (SHeS) 2009 household sample. This survey used the main SHeS household sample as a sampling frame to achieve an additional sample (separate from the main SHeS nurse interview) of over 800 adult respondents who provided the 24 hour urine samples. This removed the requirement for a new representative sample to be identified and was therefore a cost effective way of carrying out the study. Further details of the sampling method are given in Appendix A. Full details of the SHeS sampling and methodology can be found in the SHeS 2009 technical report[vi].

In summary, the sample for the 24-hour urinary sodium study was achieved as follows:

- the main nurse visit addresses for SHeS 2009 were flagged first, to ensure that the sodium study did not interfere with the main SHeS nurse interview.
- 2690 addresses from the remaining 2009 sample (which were still representative of Scotland as a whole) were then selected for a separate follow-up nurse visit as part of the 24-hour urinary sodium study.
- as the main SHeS sample is already stratified by HB area and by SIMD 2006, the sub-sample flagged for a sodium study follow-up visit was also stratified in this way.
- up to 2 respondents aged 19-64 years in each flagged household that completed a main SHeS interview in 2009 were invited to participate in the 24-hour urinary sodium study follow-up nurse visit. Where there were more than two eligible adults in a household, two individuals were selected at random.

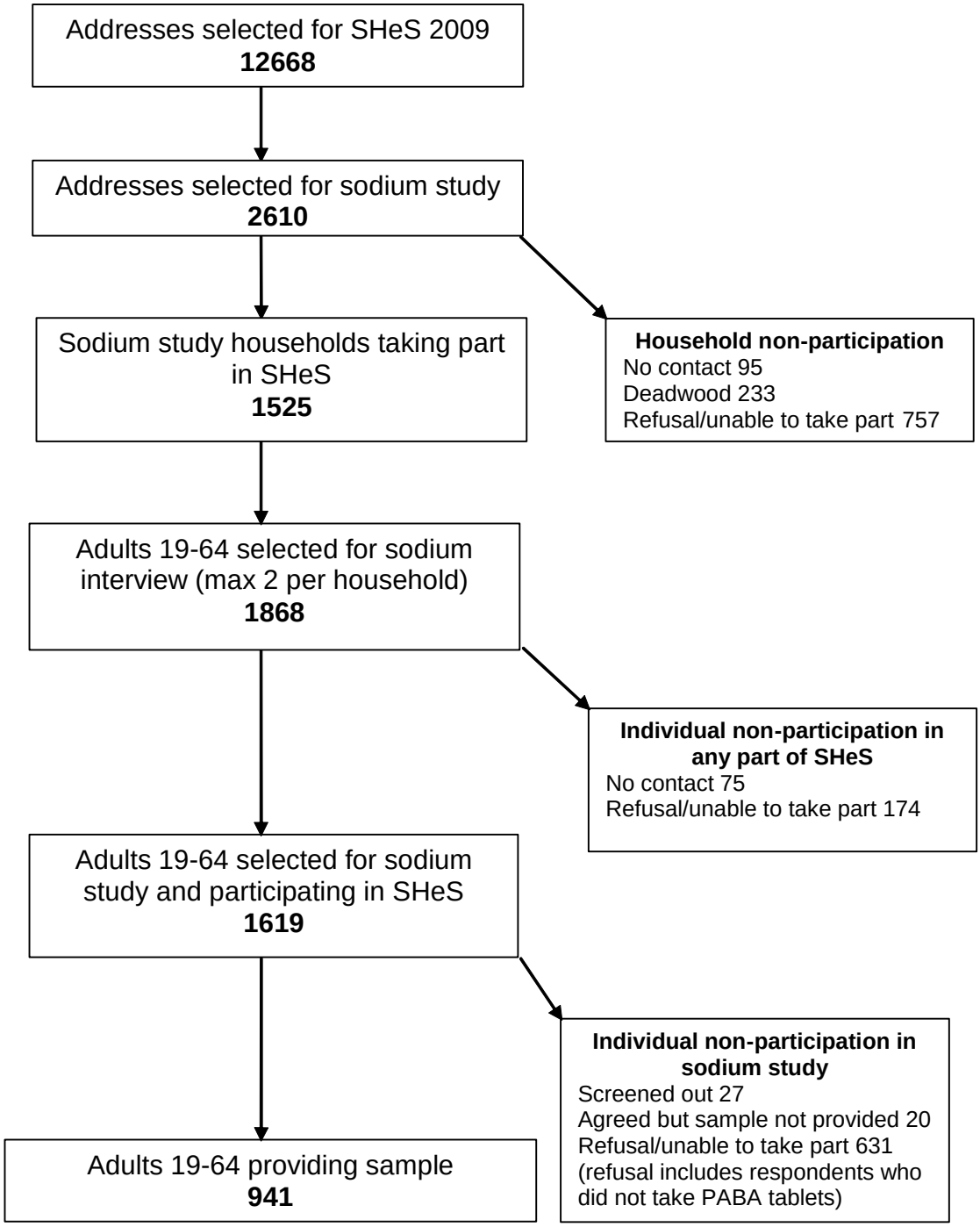
The interviewers asked the respondents if they were willing to take part in a nurse visit and were then given an information card with details about the urinary

sodium study and what it involved. The interviewer was able to write in an agreed appointment time for the nurse visit, if appropriate. An incentive of £20 was offered to respondents if they were able to provide a full sample and take the three PABA tablets.

At the initial nurse visit the nurses checked the eligibility of the selected adults. Respondents were excluded from the study if they were pregnant; or if they were allergic to hair dye, sunscreen or vitamins; or if they were taking sulphonamides. PABA interferes with the action of sulphonamide drugs, and those with allergies to hair dye, sunscreen or vitamins may be hyper-sensitive to it.

In total, 2,940 households were originally selected for the sodium study. However, as the monitoring of the study showed that more samples were being provided than had been assumed, a reduced sample size was issued for November and December 2009 and only 2,610 households were eventually issued. Data collection took place between January 2009 and February 2010.

Participant recruitment flow diagram



3.2 Urine collection

The study used very similar protocols and procedures that were used in the 2006 study. Trained nurses visited participating households. Twenty nurses attended a full Scottish Health Survey nurse briefing, about half a day of which covered the background and purpose of the 24-hour urinary sodium study, and the methodology. This comprised a teaching and practice session designed to familiarise nurses with the rationale for the study, the methodology and fieldwork procedures and included a demonstration of the equipment and despatch materials.

The nurses visited participating households at least twice. The first visit allowed the nurse to give information about the survey and procedures involved, to provide the necessary equipment and to book an appointment for the second visit in which the urine samples were collected. In a household with more than one eligible adult, if one of the adults was not present at the first visit, the nurse made a further appointment to personally brief each participating adult, since it was vital that all instructions were followed precisely.

Participants were instructed to pass urine into a 1 litre plastic jug, and then pour the sample into a large 5 litre collection container which contained the preservative, boric acid. Plastic bags were provided to carry the equipment (including a smaller 2 litre collection container) if respondents were not at home for some of the collection period. Three PABA tablets were provided, with the instruction that these should be taken at approximately even intervals throughout the 24-hour collection period, ideally with or after meals. Analysis of PABA excretion provides a measure of the completeness of the 24-hour sample. Nurses wrote the suggested times for taking the tablets on a diary left with respondents, and they were asked to record the time that they actually took them, as well as the start and finish times of their collection, any missed urine passes, and any medication taken during the collection. The full instructions given to the participants are outlined in Appendix B.

The second nurse visit was timed for Day 2 or 3 (therefore usually within one day) of the sample being collected. If there was a gap of several days between the nurse's first visit and the agreed time for the respondent to collect the urine samples, the nurse made a telephone reminder call the day before collection was due. If nurses visited an address and found that respondents are not available, they made up to three additional visits (after attempting to rearrange appointments) before abandoning the address.

At the second visit the nurse collected two aliquots from the 24 hour urine sample. The nurse also checked the completion diary, and labelled and packaged all samples for despatch to the laboratory. The nurse checked the diary to ensure that PABA tablets had been taken. Nurses were instructed to accept samples only if 3 PABA tablets had been taken. In most cases the second

visit was booked at a time when all participating adults were to be present, but as long as one eligible adult was present the nurse was able to complete the visit. If they discovered any queries that had to be resolved with an absent respondent, the nurse was normally able to resolve these with a telephone call.

3.3 Urine analysis

The two urine samples collected by the nurse from the 24 hour sample at the second nurse visit were labelled and despatched to the MRC Human Nutrition Research Laboratory in Cambridge, where the analyses of sodium and PABA were carried out.

3.4 Assessment of completeness of collection

Twenty-four-hour urine collection containing between 85% and 110% of the PABA marker analysed by the colourimetric method were considered complete. Urine samples with a PABA recovery under 70% were excluded as incomplete. Urine samples with over 110% of PABA recovery were considered high and they were re-analysed using the HPLC method. Unadjusted HPLC-analysed samples were included if the PABA recovery was between 78% and 110%. Urine samples with 70-84% PABA recovery (colourimetric method) and 75-77% (HPLC) were included after adjustments. The method used to compensate for incomplete 24 hour collections is described in Johannsson et al 1999, [vii] this referenced formula was last used in the 2004 HSE sodium survey[viii].

Corrected 24-hour Sodium= Sodium + 0.82*(93 - Percentage PABA recovery)

In recent UK sodium surveys including the 2006 Scottish Sodium Survey a different formula was used[i]:

Corrected 24-hour Sodium= Sodium*(93 / Percentage PABA recovery)

No reason for the change in the formula used could be found, and as there was no published reference for this formula the original correction formula taken from Johannsson et al 1999 has been used where corrections for incomplete urine collections were required. Data from the previous 2006 Scottish Sodium Survey have also been reanalysed using the referenced PABA correction formula taken from Johannsson et al 1999, to allow direct comparison with the current survey.

3.5 Statistical analysis

The aims of the 24-hour urine analysis were to estimate the mean 24-hour salt intake. As in the 2001 National Diet and Nutrition Survey, salt intake was calculated using the equation: 1 g salt=17.1 mmol of sodium.

The data were weighted to take account of different non-response rates by age group and gender as well as any difference in sampling. Weighting details are outlined in Appendix C.

Results are shown separately by sex and age group. The CSGLM test in SPSS was used to check for significant differences in mean salt intake by sex and by age group. The CSGLM test takes account of the complex sample design. Because of the small numbers involved it was not possible to test by sex within age group. The standard errors and confidence interval shown in the tables also take into account the complex sample design.

4. Results

4.1 Numbers of useable samples – PABA analysis

In total, 941 samples were collected from eligible participants. In addition, two samples were collected from respondents who were outwith the 19-64 age range (total= 943). Six samples were not received by the laboratory. Therefore 937 urine samples were processed by the laboratory (see Table 1). In analysis, 233 samples were discarded because they were assessed as being incomplete, PABA tablets had not been taken or the labelling of samples was incomplete or inconsistent. The two samples where the respondents were outwith the age range were also not used, leaving 702 useable samples (target c640).

In terms of age and sex, the participants included in the analysis were not significantly different from the participants excluded from the analysis. In total, urine samples from 23% of men (n=98) and 26% of women (n=135) were excluded from this analysis. Mean age for men was 46.0 in the included sample and 45.5 in the excluded sample. For women the mean age in the included sample was 45.4 years, and 44.6 years in the excluded sample.

Table 1: Survey response and number of useable samples

	Age group				
	19-24	25-34	35-49	50-64	Total[1]
Men	n	n	n	n	n
Selected[2]	41	112	283	260	696
Urine sample collected	15	63	175	167	420
Tested in lab	14	63	175	166	418
Valid sample	12	46	130	132	320
Women	n	n	n	n	n
Selected	71	162	356	334	923
Provided sample	31	75	209	206	521
Tested in lab	30	74	208	205	517
Valid sample	21	54	154	153	382

Table 2: Reasons why samples not used in analysis

	no. of samples
PABA recovery under 70%	136
HPLC under 75%	79
HPLC recovery over 110%	8
Problems with PABA tablets[3]	10
Outside 19-64 age range	2

4.2 PABA correction formula - comparison with the previous survey

The previous 2006 Scottish Sodium Survey data were reanalysed using the referenced PABA correction formula taken from Johannsson et al 1999, to allow direct comparison with the current survey. The effect of using the original formula on mean intakes of sodium overall was small, although differences in individual intakes where correction was required were more marked. Reanalysis of the 2006 data resulted in a 1.0% decrease in the estimate of the salt level for all participants (1.1% for men, 1.0% for women).

[1] This table does not include the 2 the respondents who were outwith the age range

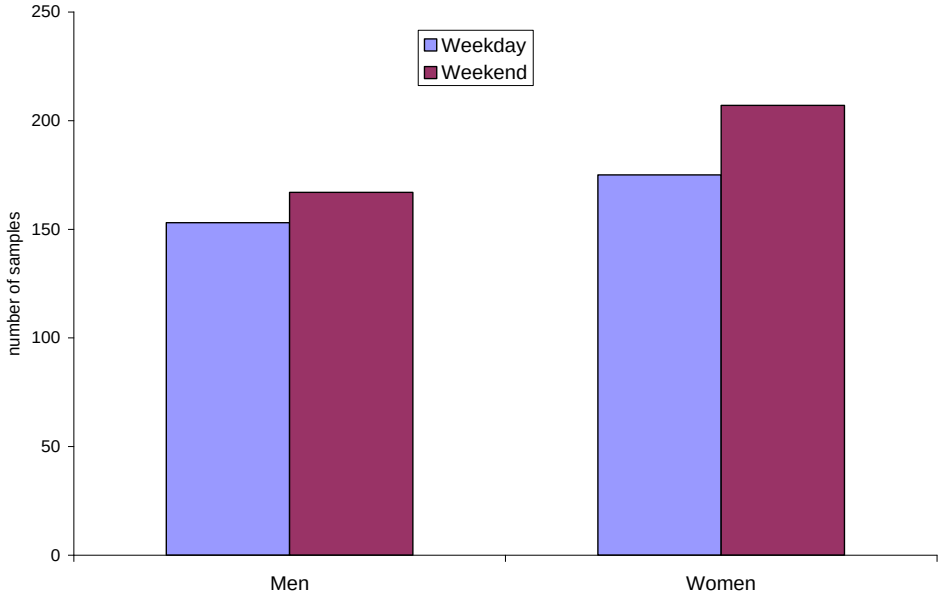
[2] These figures are the number of adults selected for the sodium study who took part in the main SHeS survey

[3] Results were excluded if all 3 tablets had not been taken or if there were discrepancies in the recorded times of taking tablets. 4 were excluded by the lab and further 6 were excluded before reporting

4.3 Urine collection dates

At the initial visit the nurses helped the respondents to choose a day on which to make the 24-hour urine collection. Nurses were instructed to try to get a range of collection days if possible. However, for participants who were at work it may have been inconvenient and therefore instructions to participants stated that "You may prefer to choose a day when you will be mostly at home or away for only a short time". Using the date of collection it was possible to ascertain which day of the week the 24 hour urine collection had taken place (although the final sample is collected during the morning of the following day). Figure 1 shows the distribution of collection days.

Figure 1: The distribution of collection days



Overall, 47% of samples were collected on a Monday to Friday, and 53% were collected at the weekend. Table 3 shows this broken down by age group and gender.

Table 3: Day of 24 hour urine collection by age of respondent

	Age group				
	19-24	25-34	35-49	50-64	Total
Men	n	n	n	n	n
Monday	0	2	13	9	24
Tuesday	3	4	10	19	36
Wednesday	3	3	9	14	29
Thursday	3	4	12	15	34
Friday	0	6	14	10	30
Saturday	1	4	26	20	51
Sunday	2	23	46	45	116
Total	12	46	130	132	320
Women	n	n	n	n	n
Monday	2	6	8	16	32
Tuesday	2	3	18	18	41
Wednesday	2	7	13	10	32
Thursday	2	6	23	20	51
Friday	0	3	6	10	19
Saturday	4	12	28	33	77
Sunday	9	17	58	46	130
Total	21	54	154	153	382

4.4 Final weighting

Table 4 below shows that the effect of the weighting is to increase the percentage of those in the younger age groups in order that they correspond to the Scottish population percentages.

Table 4: Age and sex of respondents by adult and final weights

Age by Sex	Respondents	Respondents Unweighted	Respondents Weighted by adult weights	Respondents Weighted by sodium weights	Population distribution
	n	%	%	%	%
Male 19-34	59	8.3	12.7	16.4	16.4
Male 35-44	79	11.2	12.8	11.2	11.2
Male 45-54	94	13.3	13.7	11.5	11.5
Male 55-64	92	13.0	12.3	9.9	9.9
Female 19-34	76	10.7	11.1	16.2	16.2
Female 35-44	111	15.7	13.8	12.2	12.2
Female 45-54	89	12.6	12.1	12.3	12.3
Female 55-64	108	15.3	11.5	10.4	10.4
Total[4]	708	100.0	100.0	100.0	100.0

[4] This total includes 6 cases that were subsequently excluded from analysis because of discrepancies in PABA tablet times/dates

4.5 Estimated salt intakes

Tables 5 and 6 provide means of estimated salt intake by sex and age and by collection day. Table 7 shows the percentage distribution of estimated salt intake (g/day). The mean salt intake was 8.8 g/day, with a mean of 10.0 g/day among men and 7.8 g/day among women (Table 5). Overall, 75% of the population had a daily intake higher than the recommended 6g/day (89% of men, 72% of women; see Table 7), compared with 85% of men and 65% of women exceeding the 6g/day of salt target in 2006.

Table 5: Mean estimated salt intake (g/day), by sex and age

2009

g/day	**Age group**				
	19-24	25-34	35-49	50-64	Total
Men					
Mean	9.3	10.1	9.7	10.6	10.0
Standard Deviation	2.0	3.1	3.6	5.5	4.1
Lower 2.5 centile	5.5	5.2	3.4	4.2	4.8
Top 2.5 centile	11.8	16.5	19.2	32.4	18.1
Median	10.0	9.4	9.1	9.5	9.4
complex se	0.6	0.5	0.4	0.8	0.3
95% CI	*(8.1-10.5)*	*(9.1-11.1)*	*(8.9-10.4)*	*(9.0-12.2)*	*(9.4-10.6)*
Women					
Mean	9.0	7.2	7.9	7.4	7.8
Standard Deviation	2.5	2.5	3.2	2.9	2.9
Lower 2.5 centile	4.5	2.8	3.1	2.4	2.9
Top 2.5 centile	13.9	11.7	16.4	14.6	14.2
Median	9.1	7.4	7.7	7.2	7.4
complex se	0.7	0.4	0.3	0.3	0.2
95% CI	*(7.7-10.3)*	*(6.3-8.0)*	*(7.4-8.5)*	*(6.9-8.0)*	*(7.4-8.1)*
All					
Mean	9.2	8.6	8.8	8.9	8.8
Standard Deviation	2.2	3.2	3.5	4.6	3.7
Lower 2.5 centile	4.5	3.0	3.3	3.4	3.4
Top 2.5 centile	13.9	14.9	17.0	17.8	17.0
Median	9.1	8.3	8.3	7.9	8.3
complex se	0.5	0.4	0.2	0.5	0.2
95% CI	*(8.2-10.1)*	*(7.9-9.4)*	*(8.3-9.3)*	*(8.0-9.8)*	*(8.5-9.2)*
Bases (weighted)					
Men	46	70	123	104	342
Women	44	71	126	121	361
Bases (unweighted)					
Men	12	46	130	132	320
Women	21	54	154	153	382

Table 6: Mean estimated salt (g/day), by sex and collection day

			2009
g/day	Mon-Fri	Sat-Sun	Total
Men			
Mean	9.9	10.1	10.0
Standard Deviation	4.6	3.4	4.1
Lower 2.5 centile	4.2	5.1	4.8
Top 2.5 centile	21.2	17.8	18.1
Median	9.0	9.7	9.4
complex s.e.	0.5	0.3	0.3
95% CI	*(8.9-11.0)*	*(9.5-10.7)*	*(9.4-10.6)*
Women			
Mean	7.5	8.0	7.8
Standard Deviation	2.7	3.1	2.9
Lower 2.5 centile	3.0	2.9	2.9
Top 2.5 centile	12.6	14.8	14.2
Median	7.4	7.4	7.4
complex s.e.	0.2	0.3	0.2
95% CI	*(7.0-7.9)*	*(7.5-8.6)*	*(7.4-8.1)*
All			
Mean	8.7	9.0	8.8
Standard Deviation	4.0	3.4	3.7
Lower 2.5 centile	3.4	3.3	3.4
Top 2.5 centile	17.1	16.5	17.0
Median	8.1	8.6	8.3
complex s.e.	0.3	0.2	0.2
95% CI	*(8.1-9.3)*	*(8.5-9.4)*	*(8.5-9.2)*
Bases (weighted)			
Men	*185*	*158*	*342*
Women	*172*	*188*	*361*
Bases (unweighted)			
Men	*153*	*167*	*320*
Women	*175*	*207*	*382*

Table 7: Percentage distribution of estimated salt intake (g/day), by sex and age

2009

g/day	**Age group**					
	19-24	**25-34**	**35-49**	**50-64**	**Total**	***Total 2006***
	%	%	%	%	%	%
Men						
3 or Less	0	0	0	1	0	*0*
6 or Less	12	7	12	14	11	*15*
9 or Less	48	40	49	43	45	*39*
12 or Less	100	67	74	70	75	*68*
15 or Less	100	96	94	87	93	*88*
18 or Less	100	100	97	95	97	*93*
Over 6g	*88*	*93*	*88*	*86*	*89*	*85*
Women						
3 or Less	0	4	2	3	3	*5*
6 or Less	5	36	29	31	28	*35*
9 or Less	49	77	67	77	70	*74*
12 or Less	84	98	91	94	93	*91*
15 or Less	100	100	97	98	98	*98*
18 or Less	100	100	99	100	100	*100*
Over 6g	*95*	*64*	*71*	*69*	*72*	*65*
All						
3 or Less	0	2	1	2	1	*2*
6 or Less	9	21	21	23	20	*24*
9 or Less	48	58	58	61	58	*56*
12 or Less	92	82	83	83	84	*79*
15 or Less	100	98	96	93	96	*92*
18 or Less	100	100	98	98	98	*96*
Over 6g	*91*	*79*	*79*	*77*	*80*	*76*
Bases (weighted)						
Men	*46*	*70*	*123*	*104*	*342*	*224*
Women	*44*	*71*	*126*	*121*	*361*	*206*
Bases (unweighted)						
Men	*12*	*46*	*130*	*132*	*320*	*195*
Women	*21*	*54*	*154*	*153*	*382*	*247*

Table 8: Mean estimated salt (g/day), by sex and collection month

	Month				2009
	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec	Total
Men					
Mean	9.6	9.6	10.4	10.6	10.0
Standard Deviation	3.1	3.6	3.6	5.5	4.1
Lower 2.5 centile	4.9	4.3	4.2	5.2	4.8
Top 2.5 centile	15.8	16.5	17.5	32.4	18.1
Median	9.2	9.4	10.1	9.1	9.4
complex se	0.4	0.4	0.4	1.0	0.3
95% CI	*(8.7-10.4)*	*(8.8-10.3)*	*(9.6-11.2)*	*(8.5-12.6)*	*(9.4-10.6)*
Women					
Mean	7.6	7.8	7.8	7.7	7.8
Standard Deviation	2.9	3.0	2.7	3.2	2.9
Lower 2.5 centile	3.3	2.4	3.1	2.8	2.9
Top 2.5 centile	14.6	14.6	13.3	13.9	14.2
Median	7.3	7.3	7.5	7.7	7.4
complex se	0.3	0.4	0.3	0.5	0.2
95% CI	*(7.0-8.3)*	*(7.1-8.5)*	*(7.2-8.4)*	*(6.7-8.8)*	*(7.4-8.1)*
All					
Mean	8.6	8.7	9.1	9.1	8.8
Standard Deviation	3.1	3.4	3.4	4.7	3.7
Lower 2.5 centile	3.4	3.0	3.2	3.5	3.4
Top 2.5 centile	15.2	16.2	17.1	20.7	17.0
Median	8.0	8.1	8.5	8.7	8.3
complex se	0.3	0.3	0.3	0.6	0.2
95% CI	*(7.9-9.2)*	*(8.1-9.2)*	*(8.5-9.6)*	*(8.0-10.3)*	*(8.5-9.2)*
Bases (weighted)					
Men	*82*	*98*	*74*	*88*	*342*
Women	*84*	*110*	*76*	*91*	*361*
Bases (unweighted)					
Men	*70*	*103*	*82*	*65*	*320*
Women	*86*	*125*	*97*	*74*	*382*

Table 9: Estimated salt intake (g/day), by sex, comparison with Scotland 2006 and UK 2008 studies**

	Men			Women			All 19-64		
g/day	Scotland		UK	Scotland		UK	Scotland		UK
	2006	2009	2008	2006	2009	2008	2006	2009	2008
Mean	10.5	10.0	9.7	7.5	7.8	7.7	9.0	8.8	8.6
Standard Error	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Standard Deviation	4.1	4.1	4.1	3.2	2.9	4.8	4.0	3.7	4.4
Lower 2.5 centile	4.3	4.8	3.2	2.0	2.9	3.0	3.1	3.4	3.0
Top 2.5 centile	19.2	18.1	16.6	15.0	14.2	14.8	18.9	17.0	15.8
Median	10.3	9.4	9.5	7.0	7.4	7.0	8.3	8.3	8.1
bases (unweighted)	*195*	*320*	*294*	*247*	*382*	*398*	*442*	*702*	*692*

** The UK 2008 study utilized a different formula for the adjustment of incomplete urine samples than the present Scottish analysis for 2006 and 2009. Any difference to the overall mean between the UK and Scottish data this has caused is likely to be no more than 2% based on re-analysis of the Scottish Data.

4.5 Spot urine samples

No spot urine samples were taken as part of this 24 hour sodium study. The Scottish Health Survey routinely collect spot urines as part of the core nurse visit. This method can be used to assess trends in population salt intake. However, the variation within individuals in samples taken at different times of the day means that a single spot sample is not enough to estimate the intake for an individual. Neither will the overall mean from a spot sample provide an accurate measure of intake for the population. The sodium concentrations in the spot urines tend to be lower than the levels found in the 24 hour urine samples.

Table 10: Estimated salt intake (g/day), by sex from spot urine samples, Scottish Health Survey

	Men			Women			All 19-64		
	g/day	s.e.	95% C.I.	g/day	s.e.	95% C.I.	g/day	s.e.	95% C.I.
2003	7.6	0.22	(7.1-8.0)	6.1	0.17	(5.8-6.4)	6.8	0.16	(6.5-7.1)
2008	6.9	0.19	(6.5-7.2)	5.7	0.14	(5.4-6.0)	6.4	0.15	(6.1-6.7)
2009	7.3	0.18	(6.9-7.6)	5.7	0.16	(5.4-6.1)	6.8	0.16	(6.5-7.1)
bases (unweighted)									
2003	*508*			*640*			*1148*		
2008	*474*			*567*			*1041*		
2009	*447*			*598*			*1045*		

Note: 2003, 2008 and 2009 figures are from the Scottish Health Survey. The 2009 figures are from respondents who were not included in the 24-hour sodium study.

Table 10 demonstrates that there appears to be no trends in salt levels in the spot samples when the results of four recent Scottish studies are compared, as is the case when the two recent Scottish 24 hour urine studies are compared

against each other. Salt levels are significantly higher in men than in women when the spot urine samples in 2003, 2008 and 2009 are compared.

5 Discussion

ScotCen achieved a higher number of samples in this urinary sodium study than had been anticipated. It is probable that this was due to the study being part of the main Scottish Health Survey interview; the previous 24 hour urinary sodium study in Scotland involved phoning those who had taken part in the Scottish Health Survey 2003 retrospectively. As a result, even after reducing the issued sample size in November and December 2009, 702 useable samples were obtained, comfortably exceeding the target of 640 useable samples. Previous studies have resulted in a low number of useable samples in the younger age groups; most notably the 19-24 age category. Although larger numbers of those aged 19-34 provided useable samples in this study, weighting still had to be applied in order that this age group was represented appropriately at the Scottish population level. The results of this and other surveys would suggest that it is always going to be challenging to involve younger adults in 24 hour urine studies.

Overall the mean intake of salt in the Scottish population was 8.8/day. However, salt intake was significantly lower among women; among men the intake was 10.0g/day compared with 7.8g/day among women. Among all participants, the mean salt intake did not appear to vary greatly by age and any differences were not statistically significant.

The previous Scottish 24 Hour urinary sodium study carried out in 2006 reported that the mean salt intake was 9.0g/day; only marginally higher than the mean salt intake reported here in the 2009 survey (8.8g/day). In men the mean daily salt intake was 10.5g/day in the previous study compared with 10.0g/day in this study; this difference is not statistically significant. Similarly, women's mean daily salt intake hardly changed when the results of the two studies are compared (7.5g/day in the previous study and 7.8g/day in the current study). It should also be noted that around 43% of the participants in the previous and current studies had a mean salt intake of over 9g/day. This suggests that a great deal of work still needs to be carried out if the dietary salt intake target of 6g per day is to be met.

Table 7 demonstrates that the mean salt intake was slightly higher at the weekend compared with the weekdays among both men and women, although this difference was not statistically significant. Among all participants, the mean estimated weekend salt consumption was 9.0g/day compared with 8.7g/day during the week. This may suggest that individuals are more likely to have a higher salt diet at the weekend, due to an increased consumption of higher salt foods. To the authors' knowledge, the mean estimated salt intake by day of the week has not been reported before. Of course, it is not an exact measurement of

a particular day of the week as the urine 24 hour sample starts with the second collection of the day, and is completed when the first urine is voided the following morning, but it still arguably a useful proxy measure. It should be noted that more samples were collected at the weekend than on weekdays. During this and previous studies, participants are encouraged to collect samples on weekdays and are provided with equipment to allow them to do this, but are also advised to collect samples at a time that is convenient to them. Given that the participants reflect the working age population it is not surprising that 53% of participants collected the bulk of their 24 hour urine samples over the course of a weekend. The timing of the sample collection across the week should be given more consideration in the design of future surveys.

This study also examined any possible seasonal effects on salt consumption. However, there did not appear to be a seasonal influence on salt intake among men and women. Table 8 shows that mean estimated salt intake was very consistent among women throughout the year. Among men mean salt intake appeared to increase slightly as the year progressed, although the confidence intervals are wide and the results are not statistically significant.

When the results of this Scottish study are compared with the most recent UK study it can be seen that the salt intake per day in Scotland was slightly higher (8.8g compared with 8.6g), but this difference was not statistically significant.

The results of this study suggest that a lot of work needs to be done if the dietary target of 6g salt/day is to be met in Scottish adults. Although spot urine tests are useful in monitoring dietary salt trends, further 24 hour urine studies will be required in order to give a more accurate understanding of salt intake among the Scottish population. This study achieved a large number of useable urine samples, which would indicate that it is best to carry out a 24 hour urine study as part of another national health study which involves nurse visits, such as the Scottish Health Survey.

APPENDIX A: SAMPLING

Sampling from Scottish Health Survey 2009

From 2008 the Scottish Health Survey (SHeS) adopted a continuous rolling program; the current contract covers four years of data collection (2008-2011). The survey now has a core and modular structure with a core set of questions going to the whole sample (7000 adults and 2500 children each year) and two additional modules of questions to a proportion of the adults in the sample. The nurse visit is only conducted with around one sixth of the sample (1100 adults each year).

Key points to note about the main SHeS 2008-2011 sample are as follows:

- the sample frame is the Post Office Address file (PAF) list of all residential addresses in Scotland, for all of Scotland excepting islands with small populations
- the sample frame is stratified by Health Board area and by Scottish Index of Multiple Deprivation (SIMD) 2006.
- the sampling intervals are designed to ensure that the sample as a whole is representative of SIMD 15% and individual Health Boards every 4 years (i.e. 4 years of sample together allows separate analysis at HB and SIMD15% level). This means that smaller HBs and the most deprived areas are over-sampled.
- in total, c.7,000 addresses are issued each year. Interviewers must try to achieve an interview with all adults aged 16 and over and up to 2 children (selected at random) from each household.
- of the 7,000 main addresses issued, about 2200 addresses are flagged at random for a nurse follow-up visit. This is the main nurse interview, conducted as part of the SHeS.

The sample for the 24-hour urinary sodium study was achieved as follows:

- the main nurse visit addresses for SHeS 2009 were flagged first, to ensure that the sodium study did not interfere with the main SHeS nurse interview.
- 2690 addresses from the remaining 2009 sample (which were still representative of Scotland as a whole) were then selected for a separate follow-up nurse visit as part of the 24-hour urinary sodium study.
- as the main SHeS sample is already stratified by HB area and by SIMD 2006, the sub-sample flagged for a sodium study follow-up visit was also stratified in this way.
- up to 2 respondents aged 19-64 years in each flagged household that completed a main SHeS interview in 2009 were invited to participate in the 24-hour urinary sodium study follow-up nurse visit. Where there were

more than two eligible adults in a household, two individuals were selected at random.

- assumptions about the required number of addresses which would be required to be flagged in the issued sample to yield 800 achieved samples took into account:
    - the number of addresses that were expected to be empty/vacant
    - the expected rate of participation in the main SHeS 2009 interview
    - the expected numbers of adults aged 16-18 or 65+, who were not eligible to participate in the sodium study (c23% of the main sample)
    - the need to restrict the sodium study to a maximum of 2 adults per household
    - the proportion of adults who participated in the main interview who would then agree in principle to the urinary sodium study nurse visit (estimated at 75% of those completing a main interview)
    - the proportion of those adults who agreed to take part from whom the nurse was then able to collect a sample (estimated at 70% of those initially agreeing to a nurse visit for the sodium study).
- ScotCen's assumptions on response rates were based on our experience of running the SHeS in 2008 and response rates to the 2006 urinary sodium study and other NatCen surveys involving a follow-up visit for urine collection.

APPENDIX B: RESPONDENT INSTRUCTIONS

Scottish Centre *for* Social Research

FOOD STANDARDS AGENCY SCOTLAND
Buidheann Inbhe-Bìdhe an Alba

A Study of Salt Levels in People's Diet
Instructions

Thank you for agreeing to take part in this study. Some information about this study and instructions for collecting urine samples are given here.

Introduction

Levels of salt in the diet can have an effect on health. It is possible to measure levels of salt in the diet by measuring salt levels in urine. Urine samples can be collected on the spot, e.g., during a visit by the nurse, or can be collected over a longer period of time.

Salt levels in urine vary due to salt in the diet, the amount a person has drunk and time of day. These variations can be reduced by taking a sample from urine collected over a 24-hour period.

Each person who takes part in this study will need to collect their urine over a 24 hour period. The urine samples will be only tested for salt levels. We will not test the sample for drugs or viruses.

24 hour sample Day 1 (from second urine pass) until Day 2 (first morning urine pass included in collection)

Equipment provided for the 24 hour collection

The nurse will give you the following equipment:

1. 1 litre plastic jug
2. A 5 litre and a 2 litre screw capped plastic bottle (the collection containers)
3. A funnel
3. Safety pin
4. 2 plastic bags for carrying the equipment
5. Blister pack of three PABA tablets.

NOTE: The 5-litre plastic bottle – the collection container - contains a boric acid preservative. This could cause skin or eye-irritations by contact or could cause stomach upset if swallowed. There is a warning label on the bottle but please be sure to keep it out of the reach of young children.

When to collect the 24 hour sample

The sample should be collected during the agreed 24-hour period. The nurse will help you to choose a day on which you would like to make the 24-hour urine collection. You may prefer to choose a day when you will be mostly at home or away for only a short time. If you are female, you will be asked not to make your collection during your period.

Please start your collection from the second morning pass and collect all daytime and night-time urine until the first morning pass the following day. During this time, use the safety pin provided to pin your underclothes to your outer garments or nightwear to remind you to collect your urine.

Collecting your urine for the 24 hour sample

Please follow these instructions during the 24-hour collection period.

1. Pass all urine directly into the **1 litre plastic jug**.
2. Pour urine from the beaker into the **5 litre collection container**
3. If you need to open your bowels, always remember to pass urine first **before** you pass a stool.

The PABA tablets

Three tablets are taken over the 24 hours. An information leaflet will be provided, along with a diary that tells you when to take these. It is important that you take these so that we can measure how complete the urine sample is.

What happens if you miss any collections?

If during the 24 hour collection a sample is missed for any reason, such as because of a bowel motion, we would like you to record this on the **24 hour urine study diary**.

The 24 hour urine study diary

The diary is used to record important information about the samples. The nurse will fill in some details including the agreed date and time for the 24-hour collection and when to take the PABA tablets. We need you to write down:

- date and time of any missed collections
- all medicines or vitamins you have taken during the 24 hours

If you have any questions about the 24-hour sample please speak to the nurse.

APPENDIX C WEIGHTING

The process was:

- start with the calibrated household weight already calculated for the main sample[5];
- generate a correction for whether the household was selected to be in the sodium sample;
- generate an additional correction for whether the household was issued in the sodium sample (this essentially weighted up households issued in November and December);
- generate an additional selection weight for whether the respondent was selected for the sodium study (this was equal to one if there were only one or two eligible adults in the household, and for larger households it was the number of eligible adults divided by two);
- combine the weights with the adult non-response weight (described in the main report);
- generate non-response weights for whether a responding adult gave a usable urine sample; and then
- post-stratify the combined weight to the population estimates and scale this to give the final weight, Na09wt. The population figures were taken from the 2008 mid-year household population estimates generated by General Register Office for Scotland (GROS).

[5] The main report describes two calibrated household weights. One including health board boosts (used for the adult sample), the other excluding health board boosts (used for the KAM and nurse samples). The weight used here excludes the health board boosts.

APPENDIX D MRC HNR LABORATORY QUALITY CONTROL PROCEDURES

The procedures are different for the manual colorimetric PABA, the HPLC PABA and the automated urinary electrolytes. They are all standard procedures for the type of assay used.

Colorimetric PABA (microplate assay)

A urine sample from a 24hr collection made by a volunteer who took 3 x 80 mg PABA and collected the urine reliably is included in every microplate (assay batch), treated in exactly the same way as the respondents' samples. This was frozen when fresh, as several hundred 1-batch aliquots, and one of these is thawed and used each day. The running mean and standard deviation of the PABA concentration obtained in this sample has been recorded in JMP, a laboratory QC program. Each result is compared with this mean and results are accepted if it lies between -2SD and +2 SD. The data are also examined for evidence of drift and for evidence of any change when new calibrators are prepared. Results are reported if these checks indicate that the assay is in control, and repeated if not.

HPLC PABA

The QC sample alluded to above is run with each batch of samples and the results examined for acceptability as above. In addition, because of the chromatographic quantitation, additional checks are possible which for technical reasons are not applicable to the colorimetric assay:

- An internal standard is used to ascertain that recovery is within acceptable limits and to correct for any minor discrepancies in extraction recovery.
- A solution of PAHA at known concentration is subjected to the hydrolysis procedure and included in the assay, to ensure that this part of the analysis has proceeded fully.

Urine electrolytes (Siemens Dimension analyser)

Internal commercially prepared quality control samples are run on the analyser to check for proper calibration and function before the samples are analysed, and included in every batch. The results are logged (mean, sd, %cv) and for each QC sample a check is made that the result obtained is within the manufacturer's specified range and also within our more stringent criteria.

We are members of NEQAS (National External Quality Assessment Scheme) - this scheme sends samples "blind" to all hospital and similar labs in the UK and compares results; therefore we have a regular accuracy check against hundreds of peer laboratories and against target concentrations. Our performance in this is good.

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