

**Joint Health Surveys Unit  
February 2007**

## **An assessment of dietary sodium levels among adults (aged 19-64) in the general population in Wales, based on analysis of dietary sodium in 24 hour urine samples**

### **Introduction**

The FSA has a target in its strategic plan to reduce average salt intakes across the population from 9.5g to 6g per day by 2010, with an interim target of a 10% reduction in 2005/06. This study was designed to collect 24-hour urine samples for sodium analysis to provide a 'snapshot' of overall sodium intakes in Wales. This report presents the final results of the study.

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.<sup>1</sup>

In the UK, the Committee on Medical Aspects of Food Policy (COMA) panel on Dietary Reference Values (DRV)<sup>2</sup> advised that sodium (Na) intakes should be kept below 3.2g (or 8.4g of salt) per day and 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 should be gradually reduced further to a daily average of 6g.<sup>3</sup> The Chief Medical Officer of England endorsed this recommendation,<sup>4</sup> which was also accepted in a recent report on salt and health by the Scientific Advisory Committee on Nutrition<sup>5</sup>. In general, diets of western communities contain amounts of sodium which are far in excess of any physiological need and many times the recommended daily sodium requirement. Earlier UK surveys have estimated an intake of 10g of salt/day in men (range 4-18g) and 7.7g of salt/day (range 3-14g) in women.<sup>6</sup> It is now thought that with increasing consumption of processed food, salt intake may be higher and this is supported by the 2000-01 National Diet and Nutrition Survey where the salt intake estimates were 11 g/day in men and 8.1 g/day in women.<sup>7</sup>

The intakes of sodium (Na) and potassium (K) can be estimated by measuring urinary excretion, given that under normal circumstances this is the pathway for their elimination. As electrolyte excretion rates reflect the diet of an individual, unless the diet is very stable over time, variation in Na and K excretion from spot samples taken at different times of day within the same individual can be large, often larger than the variation among a group of

individuals in westernised populations. Therefore a 24-hour measurement has been taken for this study.

## **Methodology**

### ***Sample design, recruitment and response***

The aim was for the study to collect 24-hour urine samples from 550 respondents, representative of the population aged 19-64 living in Wales. It was expected that this would yield samples sufficiently complete for analysis from around 80%, i.e. around 440 individuals.

For a comparable study in England, respondents were selected from those who had taken part in the Health Survey for England (HSE) 2005. There is no comparable sample of the general population in Wales available for follow up, and therefore a different sampling approach was adopted. A random sample of 30 postcode sectors was selected initially, and within these a random sample of telephone numbers was drawn using random digit dialling. When eligible households were identified, a short telephone interview was conducted and the household was asked to take part in the 24-hour urine collection study, and an appointment for a nurse visit was made. Within each household, no more than two adults, aged between 19 and 64, were eligible to take part in the study, and if there were three or more eligible adults two were selected at random. Respondents were offered an incentive of £15 per person on successful completion of the study.

Random digit dialling was used for this study to ensure a random sample of the population including households that were ex-directory as well as those with listed telephone numbers. Random digit dialling is a method where a representative sample of telephone numbers is generated at random from a frame of all possible telephone numbers. Many of the numbers generated are non-working numbers (some of which, at the time of the project, could be identified and removed from the sample). Others are non-residential.

NatCen was provided with a RDD sample of telephone numbers from within the 30 postcode sectors selected to provide some clustering. This sample covered all eligible telephone area codes located in these 30 points. The Ofcom database lists the first seven digits of all telephone numbers that have been allocated to telephone companies for land lines (e.g. 01222 78XXXX). For each selected area code, the last four digits were randomly generated.

In total, 5,400 telephone numbers were generated (after removing non-working numbers). A reserve sample of the same size was also generated in case the required number of completed urine samples was not obtained from the initial sample. In fact numbers of productive outcomes were lower than average in some of the sampling points, and some reserve sample was released towards the end of fieldwork to ensure adequate coverage across all points. 1080 numbers from the reserve sample, spread across 6 areas, were issued, but only a minority of these were needed to achieve the required sample size.

### Response from sample from Random Digit Dialling

	<i>First issued sample</i>			<i>Reserve sample</i>		
	Number	%		Number	%	
<b>Total issued</b>	<b>5,400</b>	<b>100%</b>		<b>1,080</b>	<b>100%</b>	
Telephone number unusable, out of service, disconnected, non-residential	967	18%		184	17%	
No contact/ Incomplete contact ( <i>reserve sample only</i> )	1031	19%		328	30%	
<b>Total usable</b>	<b>3402</b>	<b>63%</b>		<b>568</b>	<b>53%</b>	
Not eligible: no-one in household aged 19-64, out of area	856	16%		178	16%	
<b>Eligible</b>	<b>2546</b>	<b>47%</b>	100%	<b>390</b>	<b>36%</b>	<b>100%</b>
Refused, not available etc	2071		81%	339		87%
<b>Agreed at telephone interview</b>	<b>475</b>		<b>19%</b>	<b>51</b>		<b>13%</b>

Overall, 553 adults (209 men, 344 women) aged 19-64 completed the study and provided a 24-hour sample. Data collection took place between May and November 2006. The basic characteristics of the recruited sample are presented in the table below.

<i>Basic characteristics of recruited sample</i>			
	<i>N</i>	<i>Mean Age</i>	<i>SD</i>
<b>Men</b>	209	45.9	11.7
<b>Women</b>	344	46.8	11.7

During lab analyses it was not possible to provide results for 36 samples, and further edit checks revealed that two individuals outside the eligible age range had been included. The analysis in this report was therefore based on samples from 515 individuals.

#### *Nurse training*

Nurses attended a half-day briefing covering the background and purpose of the 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. The training included a practical demonstration of the Sarstedt syringe that respondents would use for collecting spot samples.

Nurses were also given detailed written instructions covering the aims of the study, methodology and fieldwork procedures.

### ***Data collection procedures overview***

Ethical approval for the comparison study was granted from the MREC.

At the initial telephone contact, once the interviewer had established that there were people resident in the household in the eligible age range (19-64), they established how many were eligible, and made a selection of two if there were three or more eligible within the household. Once the interviewer was speaking to one of the selected adults, they asked a brief questionnaire about eating habits, and then invited the respondent to take part in the 24-hour study. An appointment for a nurse visit was arranged for those who agreed, and a confirmatory letter was sent.

The 24-hour urine collection element of the study used the same protocol and procedures that were used in an equivalent study in England during 2005/ 2006, based on a similar study as part of the HSE 2003. As well as providing urine samples, respondents were asked to take three PABA (para-aminobenzoic acid) tablets at specified intervals. Analysis of PABA excretion provides a measure of the completeness of the 24-hour sample.

At the first nurse visit, the nurse first checked eligibility, and respondents were excluded from the study if they were pregnant; if they were allergic to hair dye, sunscreen or vitamins; or if they were taking sulfonamides, since PABA may interfere with the action of these. The nurse then provided information about the purpose of the study, the procedures involved, supplied all necessary equipment, and made arrangements for collection of urine samples and the timing of the second visit.

### ***Protocol***

Respondents were asked to collect all urine they passed during a 24-hour period starting from the second morning urine pass of the 24-hour collection day, and ending with the first urine pass the following morning. Respondents were given detailed written instructions (see Appendix A), and were provided with the following equipment:

- a 400 ml plastic beaker
- one or two 2 litre screw capped plastic bottles – the collection containers
- a safety pin (as an aide memoire)
- 2 plastic bags for carrying the equipment
- a blister pack of three PABA tablets.

They were instructed to pass urine into the beaker, and then pour it into the large collection container. Plastic bags were provided to carry the equipment 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. 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.

Typically the second nurse visit took place within one day from the 24-hour urine collection. The nurse checked the diary to ensure that PABA tablets had been taken, and took an aliquot from the 24-hour sample during the second visit. Samples were not accepted if all three PABA tablets had not been taken.

After the second nurse visit, all samples were labelled and despatched to The Doctors Laboratory, London, where the analyses of sodium, potassium and creatinine were carried out by ion-selective electrode methods on the Roche/Hitachi systems, using specially prepared aqueous solutions containing a growth-inhibitory preservative. Following lab analysis, an aliquot of the 24-hour sample was sent to the MRC Dunn Human Nutrition Laboratory, Cambridge, for an assessment of the completeness of the 24-hour collection. Completeness was assessed using the para-amino-benzoic acid (PABA) recovery method.<sup>8</sup> In brief, the method involved administering three 80mg PABA tablets over the 24-hour sample collection period. Completion of the collection was determined by the proportion of PABA recovered in the 24-hour sample.

### ***Weighting***

In the majority of households, there are only one or two adults within the age range of 19-64 and therefore eligible for the urine study. However, in a small minority of households there were more than two eligible adults, and in these households two individuals were selected to take part in the study. Selection weighting has been applied to correct for the probability of selection for the adults in these larger households. The selection weight was equivalent to the eligible number of persons in the responding household. Weights greater than four were trimmed to avoid a small number of large weights, since such weights would inflate the standard errors around survey estimates.

As a final correction the individual selection weights were adjusted using rim weighting to adjust the age and sex distribution of the sample to match that of the population. The population figures were taken from the ONS 2005 mid-year population estimates for individuals living in Wales aged 19-64. The table below shows the age and sex distribution of the sample, weighted by the selection weight and the final weight, compared to that of the population.

**The weighted sample**

<b>Age and sex</b>	<b>Sample weighted by the selection weight only</b>	<b>Sample weighted by the final weight</b>	<b>Population estimates</b>
	%	%	%
<b>Men</b>			
19-29	4.5	11.2	11.2
30-39	8.7	10.6	10.6
40-49	11.4	11.4	11.4
50-59	9.5	11.1	11.1
60-64	6.1	4.8	4.8

<b>Women</b>			
19-29	5.7	11.0	11.0
30-39	12.3	11.4	11.4
40-49	16.9	12.0	12.0
50-59	17.2	11.5	11.5
60-64	7.7	5.0	5.0
Base (unweighted)	516	516	1,750,800

### **Statistical analysis**

As in the 2001 National Diet and Nutrition Survey, salt intake was estimated as 1 g salt =17.1 mmol of sodium.

Mann-Whitney tests were used to test for sodium and salt differences between men and women and Kruskal-Wallis tests examined differences among age groups. No statistical tests by sex within age groups were performed due to the relatively small sample sizes of each age group.

#### *Analysis of para-amino-benzoic acid (PABA)*

Twenty-four-hour urine collection containing between 85% and 110% of the PABA marker were considered complete. Additionally, urine samples with 70-84% PABA recovery were included after correction.<sup>9</sup> The correction was made by using the equation:

$$\text{Corrected Sodium} = \text{Sodium} * (93 / \text{Percentage PABA recovery})$$

Urine samples with over 110% of PABA recovery were considered high but they were included in the analysis as excluding them did not change the direction of the results. For both men and women the mean Na and mean estimated salt of those with high PABA were not significantly different to those with complete or adjustable PABA recoveries (p=0.7 for men and p=0.11 for women). Urine samples with a PABA recovery under 70% were excluded as incomplete. In total, 19% of men (n=39) and 20% of women (n=69) were excluded from this analysis. The age profile of the included sample was similar to that of the sample excluded from the analysis (mean 47.0 vs 44.3 years).

The table below shows the different stages at which respondents were excluded from the initial 553 individuals who provided urine samples.

<i>Sample exclusions</i>			
	<i>Men</i>	<i>Women</i>	<i>Total</i>
<b>Total providing sample</b>	209	344	553
<b>No lab result/ missing volume</b>	14	22	36
<b>Ineligible, wrong age group</b>	1	1	2
<b>Excluded:</b>			
<b>Incomplete sample</b>	39	69	108
<b>Total available for analysis</b>	155	252	407

## Results

The table below shows the basic characteristics of the 515 informants that were included in the analysis (excluding those participants with incomplete 24-hour urine samples).

About half (48.0%) of the 24-hour sample collected was found complete with the PABA recovery method. After correction this percentage went up to 66.8% and finally, including 84 samples that were found to have >110% of PABA concentration and were re-analysed using the HPLC method high, 82.7% of the recruited sample was included in the analysis.

<i>Basic characteristics of the sample included in the analysis (unweighted)</i>				
	<i>N</i>	<i>Mean Age</i>	<i>SD</i>	<i>Median age</i>
<b>Men</b>	155	46.7	11.6	47.0
<b>Women</b>	252	47.2	11.6	48.0

Results are shown separately by sex and age group in the attached tables.

## Summary

This brief report presents the results of a 24-hour urine sample study that was designed to provide estimates of salt intake using sodium concentrations in urine. The study was carried out among a representative sample of adults aged 19-64 in Wales. The estimated daily salt intake of the 199 men and 202 women included in the analysis was 9.4 and 6.8 g, respectively (8.1 g/day for the whole sample). These estimates are lower than those reported by the most recent NDNS for adults (9.5mg/day).<sup>7</sup>

In most respects the results from this study should be broadly comparable with those from the NDNS survey. However, comparability may be affected by some differences in methodology, including the way in which the samples were recruited, the offer of an incentive and response rates. The NDNS survey covered a full 12 month period, while most of the fieldwork for this study took place over the a period between May and November 2006, and there may be some differences reflecting seasonal patterns in salt consumption. While PABA analyses were used in this study to exclude incomplete samples, a different methodology was used for most of the NDNS sample.

**Table 1 Mean urinary sodium (mmol/24hr), by sex and age***Corrected 24hr Sodium (mmol/24hr)*

	<b>Age group</b>				Total
	19-24	25-34	35-49	50-64	
<b>Men</b>					
Mean	211	160	155	148	160
Standard Deviation	115	65	61	52	70
Standard Error	23	12	7	6	5
Lower 2.5 centile	101	77	56	60	65
Top 2.5 centile	-	-	314	278	414
Median	195	136	142	145	143
<b>Women</b>					
Mean	108	133	116	109	117
Standard Deviation	51	68	47	44	52
Standard Error	13	10	6	5	4
Lower 2.5 centile	41	34	39	34	36
Top 2.5 centile	-	289	244	220	267
Median	105	112	114	99	111
<b>All</b>					
Mean	171	144	136	129	138
Standard Deviation	107	68	57	52	65
Standard Error	17	8	5	4	3
Lower 2.5 centile	41	34	48	48	42
Top 2.5 centile	414	295	290	235	298
Median	136	124	128	119	125
<i>Bases (weighted)</i>					
<i>Men</i>	25	31	72	71	199
<i>Women</i>	16	45	71	70	202
<i>Bases (unweighted)</i>					
<i>Men</i>	6	19	64	66	155
<i>Women</i>	6	38	89	119	252

**Table 2 Percentage distribution of total urinary sodium (mmol/24hr), by sex and age**

<i>mmol/24hr</i>	<b>Age group</b>				<b>Total</b>
	<b>19-24</b>	<b>25-34</b>	<b>35-49</b>	<b>50-64</b>	
	%	%	%	%	%
<b>Men</b>					
Under 60	-	-	3	1	2
Under 90	-	4	11	12	9
Under 120	26	34	32	35	32
Under 150	42	60	53	50	52
Under 180	42	68	68	73	66
Under 210	58	79	80	90	80
Under 270	79	87	96	98	93
<b>Women</b>					
Under 60	19	11	11	10	11
Under 90	44	29	29	40	34
Under 120	56	55	57	68	60
Under 150	69	64	84	82	78
Under 180	100	78	91	93	90
Under 210	100	85	97	96	94
Under 270	100	91	99	100	98
<b>All</b>					
Under 60	7	7	7	6	7
Under 90	17	19	20	26	21
Under 120	38	47	44	51	46
Under 150	53	62	69	66	65
Under 180	65	74	79	83	78
Under 210	75	83	88	93	87
Under 270	87	89	98	99	96
<i>Bases (weighted)</i>					
<i>Men</i>	25	31	72	71	199
<i>Women</i>	16	45	71	70	202
<i>Bases (unweighted)</i>					
<i>Men</i>	6	19	64	66	155
<i>Women</i>	6	38	89	119	252

**Table 3 Mean estimated salt (g/day), by sex and age**

<i>g/day</i>	<b>Age group</b>				
	19-24	25-34	35-49	50-64	Total
<b>Men</b>					
Mean	12.4	9.4	9.0	8.6	9.4
Standard Deviation	6.7	3.8	3.6	3.1	4.1
Standard Error	1.4	0.7	0.4	0.4	0.3
Lower 2.5 centile	5.9	4.5	3.3	3.5	3.8
Top 2.5 centile	-	-	18.4	16.3	24.2
Median	11.4	7.9	8.3	8.5	8.4
<b>Women</b>					
Mean	6.3	7.8	6.8	6.4	6.8
Standard Deviation	3.0	4.0	2.7	2.6	3.0
Standard Error	0.7	0.6	0.3	0.3	0.2
Lower 2.5 centile	2.4	2.0	2.3	2.0	2.1
Top 2.5 centile	-	16.9	14.2	12.9	15.6
Median	6.2	6.6	6.6	5.8	6.5
<b>All</b>					
Mean	10.0	8.4	7.9	7.5	8.1
Standard Deviation	6.3	4.0	3.4	3.0	3.8
Standard Error	1.0	0.5	0.3	0.3	0.2
Lower 2.5 centile	2.4	2.0	2.8	2.8	2.4
Top 2.5 centile	24.2	17.3	16.9	13.8	17.4
Median	8.0	7.3	7.5	6.9	7.3
<i>Bases (weighted)</i>					
<i>Men</i>	25	31	72	71	199
<i>Women</i>	16	45	71	70	202
<i>Bases (unweighted)</i>					
<i>Men</i>	6	19	64	66	155
<i>Women</i>	6	38	89	119	252

**Table 4 Percentage distribution of estimated salt intake (g/day), by sex and age**

<i>g/day</i>	<b>Age group</b>				<b>Total</b>
	<b>19-24</b>	<b>25-34</b>	<b>35-49</b>	<b>50-64</b>	
	%	%	%	%	%
<b>Men</b>					
3 or Less	-	-	-	-	-
6 or Less	<b>11</b>	<b>17</b>	<b>20</b>	<b>19</b>	<b>18</b>
9 or Less	42	60	55	54	54
12 or Less	58	79	80	90	80
15 or Less	79	87	96	98	93
18 or Less	79	100	99	100	97
<i>Over 6g</i>	<i>89</i>	<i>83</i>	<i>80</i>	<i>81</i>	<i>82</i>
<b>Women</b>					
3 or Less	19	6	7	7	8
6 or Less	<b>44</b>	<b>36</b>	<b>40</b>	<b>52</b>	<b>43</b>
9 or Less	69	64	88	84	80
12 or Less	100	85	97	96	94
15 or Less	100	91	99	100	98
18 or Less	100	100	100	100	100
<i>Over 6g</i>	<i>56</i>	<i>64</i>	<i>60</i>	<i>42</i>	<i>57</i>
<b>All</b>					
3 or Less	7	3	3	3	4
6 or Less	<b>24</b>	<b>29</b>	<b>30</b>	<b>35</b>	<b>31</b>
9 or Less	53	62	72	69	67
12 or Less	75	83	88	93	87
15 or Less	87	89	98	99	95
18 or Less	87	100	99	100	98
<i>Over 6g</i>	<i>76</i>	<i>71</i>	<i>70</i>	<i>65</i>	<i>69</i>
<i>Bases (weighted)</i>					
<i>Men</i>	25	31	72	71	199
<i>Women</i>	16	45	71	70	202
<i>Bases (unweighted)</i>					
<i>Men</i>	6	19	64	66	155
<i>Women</i>	6	38	89	119	252

## APPENDIX A: RESPONDENT INSTRUCTIONS FOR 24-HOUR URINE COLLECTION



**Operations Department**  
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P2562

### Salt levels in 24 hour urine samples

#### 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 to the nurse, or can be collected over a longer period of time i.e. 24 hour period.

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

In this study we will be examining salt levels in a 24 hour sample of urine, collected during a nurse visit.

We will ask each person who takes part in the study to provide a urine sample collected over a full 24 hour period (note that women who are menstruating can still take part in the study). The urine sample will be tested for salt levels. We will not test the sample for drugs or viruses.

The urine sample will be collected on a day agreed by you and the nurse.

The 24 hour sample starts on Day 1 (from the second time you pass urine that day) until Day 2 (the first time you pass urine that morning). All urine collected over the 24 hour period, including that collected on Day 1 (second time you pass urine) and Day 2 (first time you pass urine), should be included in the collection.

Details of the equipment and instructions on how to collect the 24 hour urine samples are shown overleaf.

### **The 24 hour urine sample**

- *The equipment provided for the 24 hour collection*

The nurse will give you the following equipment:

1. a 400 ml plastic beaker
2. one or two 2 litre screw capped plastic bottles – the collection containers
3. a safety pin
4. 2 plastic bags for carrying the equipment
5. a blister pack of three PABA tablets.

**NOTE:** The 2-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 only going out of your home for a short time. If you are female, you may prefer not to make your collection during your period.

Please start your collection from the second morning pass and collect all day and all night 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 **400ml plastic beaker**.
2. Pour urine from the beaker into the **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 urine?*

If during the 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

- any 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*

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