National Centre *for* Social Research

UCL

Joint Health Surveys Unit
9th October 2006

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

Introduction

The FSA (in conjunction with Health departments) 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 England. 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.[1]

In the UK, the Committee on Medical Aspects of Food Policy (COMA) panel on Dietary Reference Values (DRV)[2] 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.[3] The Chief Medical Officer of England endorsed this recommendation,[4] which was also accepted in a recent report on salt and health by the Scientific Advisory Committee on Nutrition[5]. 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.[6] 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.[7]

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

Recruitment, sample, and response rates

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

Respondents were selected from those who had taken part in the Health Survey for England (HSE) 2005. Initially recruitment for the urine study took place during October, November and December HSE fieldwork: after respondents had completed the HSE interview and nurse visit they were invited to take part in the 24-hour urine collection study. Within each household, no more than two adults, aged between 19 and 64, were eligible to take part in the study. Response was monitored to ensure that an approximately equal number of men and women were included, that the sample was representative in terms of age, and to ensure that enough hypertensive respondents were included. Respondents were offered an incentive of £15 per person on successful completion of the study.

From this initial recruitment a total of 377 individuals provided 24-hour urine samples, well short of the target number. An additional exercise was carried out to contact respondents from earlier months of HSE 2005. Pairs of HSE sampling points were selected, and households with at least one adult in the age range of 19-64, who had agreed to a follow up interview, were identified. After a letter explaining the study these households were contacted by telephone to arrange an appointment for a nurse visit. From this second recruitment exercise an additional 153 individuals provided 24 hour samples.

The composite response rate for the two stages of sample was 42.8%, with 38.8% of those followed up directly from HSE, and 57.5% of those contacted by telephone, taking part in the study. However, there was also first stage non response to the HSE: overall, it is estimated that 45.9% of all possible respondents to HSE 2005 received a nurse visit. This response is based on the 'set sample' which takes account of all households where information is known about the number of residents, and assumes the same average household size for households where no information is known. The aggregate response to the urine collection study was therefore 19.7%, the product of the first stage response and response to the urine collection stage.

Response to Urine Collection Study and HSE

	No. issued	*No Achieved*	*Response Rate*
Sample directly following HSE	*971*	*377*	*38.8%*
Extra sample contacted by telephone	*266*	*153*	*57.5%*
Total urine collection study	***1,237***	***530***	***42.8%***
HSE 2005	*11,911*	*5465*	*45.9%*
Aggregate Response			**19.7%**

Overall, 530 adults (217 men, 313 women), aged 19 and over, completed the study and provided a 24-hour sample. Data collection took place between October 2005 and July 2006, with the majority of fieldwork being completed by March 2006. The basic characteristics of the recruited sample are presented in the table below.

Basic characteristics of recruited sample			
	N	*Mean Age*	*SD*
Men	217	45.6	11.9
Women	313	44.8	11.7

During lab analyses it was not possible to provide results for 14 samples, and further edit checks revealed that an individual outside the eligible age range had been included. The analysis in this report was therefore based on samples from 515 individuals.

Nurse training

Nurses working on the last three months of HSE 2005 collected data for the urine study. All selected nurses were working on the Health Survey for England and had experience of the urine collection protocol. Nurses were given detailed written instructions covering the background and purpose of the study, and the methodology and fieldwork procedures. Nurse supervisors attended a briefing session in London, and subsequently telephoned each nurse working on the study to ensure that their written instructions had been fully read and understood.

Data collection procedures overview

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

The study used the same protocol and procedures that were used in a similar study as part of the HSE 2003.

In order not to influence the response rates of the Health Survey, the urine study was introduced to selected informants at the end of the standard HSE nurse visit once the normal HSE protocol had been completed. The nurse first checked eligibility, and respondents were excluded from the study if they had not had their blood pressure taken, 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 chloride 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.[8] 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. In addition, the achieved sample of individuals who provided 24 hour urine samples slightly under-represented men and younger adults. The profile of the sample has therefore also been weighted to match the 2004 mid-year population estimates for adults aged 19-64 in England.

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.[9] The correction was made by using the equation:

Corrected Sodium=Sodium*(93 / 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. A small number of urine aliquots had no 24-hr urine volume recorded and were also excluded as it was not possible for the lab to analyse them. In total, 11% of men (n=23) and 14% of women (n=44) were excluded from this analysis. The included sample was significantly older than the sample excluded from the analysis (mean 46 vs 39 years, $p<0.001$).

The table below shows the different stages at which respondents were excluded from the initial 530 individuals who provided urine samples.

Sample exclusions			
	Men	*Women*	*Total*
Total providing sample	217	313	530
No lab result	6	8	14
Ineligible, wrong age group	0	1	1
Excluded:			
Incomplete sample	23	42	65
Missing volume	0	2	2
Total available for analysis	188	260	448

Results

The table below shows the basic characteristics of the 451 informants that were included in the analysis (excluding those participants with incomplete 24-hour urine samples).

About half (52.3%) of the 24-hour sample collected was found complete with the PABA recovery method. After correction this percentage went up to 68.2% and finally, including high, 87.0% of the recruited sample was included in the analysis.

Basic characteristics of the sample included in the analysis (unweighted)

	N	*Mean Age*	*SD*	*Median age*
Men	188	46.7	11.7	49.0
Women	260	46.0	11.2	47.0

Results are shown separately by sex and age group in the attached tables. Design effects have been calculated for Tables 2 and 4, and details are provided in Appendix B.

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 following up respondents to the 2005 Health Survey for England. The estimated daily salt intake of the 188 men and 260 women included in the analysis was 10.2 and 7.7 g, respectively (9.0 g/day for the whole sample). These estimates are slightly lower than those reported by the most recent NDNS for adults.[7]

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 six months between October 2005 and March 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)

	Age group				
	19-24	25-34	35-49	50-64	Total
Men					
Mean	189	169	173	175	175
Standard Error	12.09	10.37	7.54	8.45	4.58
Standard Deviation	61.6	69.5	66.7	71.6	68.1
Lower 2.5 centile	129	89	83	47	83
Top 2.5 centile	-	404	335	356	375
Median	177	167	158	165	165
Women					
Mean	120	150	135	116	131
Standard Error	6.58	7.59	5.24	5.58	3.35
Standard Deviation	24.2	53.1	45.5	47.8	48.7
Lower 2.5 centile	79	42	63	34	49
Top 2.5 centile	-	288	265	247	253
Median	113	148	132	110	125
All					
Mean	165	159	155	145	153
Standard Error	9.76	6.39	4.85	5.58	3.03
Standard Deviation	61.3	61.9	60.1	67.3	63.2
Lower 2.5 centile	79	63	74	37	59
Top 2.5 centile	379	384	300	311	304
Median	149	151	145	134	145
Bases (weighted)					
Men	*26*	*45*	*78*	*72*	*221*
Women	*13*	*49*	*76*	*73*	*212*
Bases (unweighted)					
Men	*13*	*20*	*67*	*88*	*188*
Women	*6*	*43*	*99*	*112*	*260*

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

mmol/24hr	**Age group**				
	19-24	**25-34**	**35-49**	**50-64**	**Total**
	%	%	%	%	%
Men					
Under 60	-	-	-	2	1
Under 90	-	-	4	7	4
Under 120	-	24	28	21	22
Under 150	31	44	47	39	42
Under 180	50	63	61	59	60
Under 210	66	73	68	72	70
Under 270	94	95	94	92	93
Women					
Under 60	-	2	2	10	5
Under 90	15	10	18	27	19
Under 120	62	31	41	59	46
Under 150	100	51	66	78	68
Under 180	100	77	82	91	85
Under 210	100	86	95	96	93
Under 270	100	98	98	99	99
All					
Under 60	-	1	1	6	3
Under 90	5	5	11	17	11
Under 120	21	28	35	40	34
Under 150	51	48	56	59	55
Under 180	67	70	71	75	72
Under 210	77	80	81	84	82
Under 270	96	96	96	96	96
Bases (weighted)					
Men	*26*	*45*	*78*	*72*	*221*
Women	*13*	*49*	*76*	*73*	*212*
Bases (unweighted)					
Men	*13*	*20*	*67*	*88*	*188*
Women	*6*	*43*	*99*	*112*	*260*

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

g/day	**Age group**				
	19-24	25-34	35-49	50-64	Total
Men					
Mean	11.0	9.9	10.1	10.2	10.2
Standard Error	0.71	0.61	0.44	0.49	0.27
Standard Deviation	3.60	4.06	3.90	4.19	3.98
Lower 2.5 centile	7.5	5.2	4.9	2.8	4.8
Top 2.5 centile	-	23.6	19.6	20.8	21.9
Median	10.4	9.8	9.2	9.6	9.7
Women					
Mean	7.0	8.8	7.9	6.8	7.7
Standard Error	0.39	0.44	0.31	0.33	0.19
Standard Deviation	1.4	3.1	2.7	2.8	2.8
Lower 2.5 centile	4.6	2.5	3.7	2.0	2.9
Top 2.5 centile	-	16.8	15.5	14.5	14.8
Median	6.6	8.6	7.7	6.4	7.3
All					
Mean	9.5	9.3	9.0	8.5	9.0
Standard Error	0.57	0.37	0.28	0.33	0.18
Standard Deviation	3.6	3.6	3.5	3.9	3.7
Lower 2.5 centile	4.6	3.7	4.3	2.1	3.4
Top 2.5 centile	22.1	22.4	17.6	18.2	17.8
Median	8.7	8.8	8.5	7.8	8.4
Bases (weighted)					
Men	*26*	*45*	*78*	*72*	*221*
Women	*13*	*49*	*76*	*73*	*212*
Bases (unweighted)					
Men	*13*	*20*	*67*	*88*	*188*
Women	*6*	*43*	*99*	*112*	*262*

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

g/day	**Age group**				
	19-24	**25-34**	**35-49**	**50-64**	**Total**
	%	%	%	%	%
Men					
3 or Less	-	-	-	2	1
6 or Less	-	15	12	11	11
9 or Less	31	49	47	41	44
12 or Less	59	73	66	71	68
15 or Less	94	95	92	89	92
18 or Less	94	95	97	96	96
Over 6g	*100*	*85*	*88*	*89*	*89*
Women					
3 or Less	-	2	1	6	3
6 or Less	15	16	28	43	30
9 or Less	100	56	69	82	73
12 or Less	100	84	95	95	93
15 or Less	100	98	98	99	99
18 or Less	100	100	100	100	100
Over 6g	*85*	*84*	*72*	*57*	*70*
All					
3 or Less	-	1.2	0.5	4.2	1.8
6 or Less	5.3	15.5	19.6	27.0	20.3
9 or Less	54.8	52.4	58.1	62.0	58.1
12 or Less	73.3	78.7	80.2	83.1	80.3
15 or Less	95.9	96.5	94.9	94.2	95.1
18 or Less	95.9	97.7	98.6	97.8	97.9
Over 6g	*95*	*85*	*80*	*73*	*80*
Bases (weighted)					
Men	*26*	*45*	*78*	*72*	*221*
Women	*13*	*49*	*76*	*73*	*212*
Bases (unweighted)					
Men	*13*	*20*	*67*	*88*	*188*
Women	*6*	*43*	*99*	*112*	*260*

APPENDIX A: RESPONDENT INSTRUCTIONS FOR 24-HOUR URINE COLLECTION

NatCen
National Centre for Social Research

Operations Department
Kings House 101-135 Kings Road Brentwood Essex
CM14 4LX Tel: 01277 200 600
Head Office
35 Northampton Square London EC1V 0AX
A Company Limited by Guarantee Registered in England No. 4392418 Charity No. 1091768

P2516

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 <u>not</u> 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

APPENDIX B

Design effects and complex standard errors for key tables

The tables in the report have only taken the non-response weights into account when calculating standard errors. For the two key tables in this report the standard errors have been generated in a package[1] that takes clustering, stratification and weighting into account.

Data for the English Sodium Study were collected using a complex sample design that was stratified[2], clustered and weighted for non-response. The effect of the sample design on the survey estimates can be measured as the ratio of the actual variance, under the sampling method used, to the variance calculated under the assumption of simple random sampling. This measure is called the design effect (deff). The design effect indicates how much information has been gained or lost by using a complex survey design rather than a simple random sample. A deff of 2 implies the sample size of a complex design needs to be doubled before it gives the same amount of information as a simple random sample. Alternatively, a deff of 0.5 means the same precision would be gained from a complex survey of only half the size of a simple random sample. The design effect will vary for different variables in the same survey since some variables are more affected by clustering and weighting than others.

The square root of deff is the design factor (deft). This factor can be used to adjust the standard errors to take account of the design features, as shown in Tables B1 and B2 below. The complex standard errors for the key variables are generally higher than the standard errors shown in the previous tables. The exceptions appear to be the older age groups. Response was lower amongst younger age groups and lower for men. As a result these groups have larger non-response weights. It is possible that the larger defts for men and amongst the younger age groups are due to the non-response weighting.

[1] The analysis was run in Stata version 9.

[2] The sample was based on the Health Survey for England core sample, which is stratified by Unitary Authority and proportion of the population in non-manual occupations. The clusters are based on postcode sectors or groups of sectors.

Table B1 Mean urinary sodium (mmol/24hr), by sex and age

		Complex			*Bases*	
	Mean	**Std. Err.**	**Deff**	**Deft**	***Weighted***	***Unweighted***
Men						
17-24	189	16.5	2.01	1.42	*26*	*13*
25-34	169	13.0	1.65	1.29	*45*	*20*
35-49	173	7.7	1.08	1.04	*78*	*67*
50-65	175	6.8	0.69	0.83	*72*	*88*
ALL	175	4.8	1.13	1.06	*221*	*188*
Women						
17-24	120	10.0	2.55	1.60	*13*	*6*
25-34	150	7.7	1.09	1.05	*49*	*43*
35-49	135	4.0	0.62	0.79	*76*	*99*
50-65	116	3.7	0.47	0.69	*73*	*112*
ALL	131	2.9	0.78	0.88	*211*	*260*
Men and women						
17-24	165	13.5	2.02	1.42	*39*	*19*
25-34	159	7.6	1.49	1.22	*94*	*63*
35-49	155	5.0	1.09	1.04	*154*	*166*
50-65	145	4.3	0.62	0.79	*145*	*200*
ALL	153	2.9	0.97	0.99	*432*	*448*

Table B2 Mean estimated salt (g/day), by sex and age*

		Complex			*Bases*	
	Mean	**Std. Err.**	**Deff**	**Deft**	***Weighted***	***Unweighted***
Men						
17-24	11.0	0.97	2.01	1.42	*26*	*13*
25-34	9.9	0.76	1.65	1.29	*45*	*20*
35-49	10.1	0.45	1.08	1.04	*78*	*67*
50-65	10.2	0.40	0.69	0.83	*72*	*88*
ALL	10.2	0.28	1.13	1.06	*221*	*188*
Women						
17-24	7.0	0.58	2.55	1.60	*13*	*6*
25-34	8.8	0.45	1.09	1.05	*49*	*43*
35-49	7.9	0.24	0.62	0.79	*76*	*99*
50-65	6.8	0.22	0.47	0.69	*73*	*112*
ALL	7.7	0.17	0.78	0.88	*211*	*260*
Men and women						
17-24	9.7	0.79	2.02	1.42	*39*	*19*
25-34	9.3	0.45	1.49	1.22	*94*	*63*
35-49	9.0	0.29	1.09	1.04	*154*	*166*
50-65	8.5	0.25	0.62	0.79	*145*	*200*
ALL	9.0	0.17	0.97	0.99	*432*	*448*

*Estimates are based on the assumption that 17.1mmol of sodium=1g salt

References:

[1]Sacks FM, Svetkey LP, Vollmer WM et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. New Engl J Med 2001;344:3

[2] Department of Health (1991). Dietary Reference Values for Food, Energy and Nutrients for the United Kingdom. Report on Health and Social Subjects 41. London: The Stationery Office.

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

[4] Department of Health. The Annual Report of the Chief Medical Officer of the Department of Health Department of Health, 2001.

[5] Scientific Advisory Committee on Nutrition Salt and Health. TSO, 2001

[6] Reynolds C et al (1998). Institute of Food Research. The Salt Debate.
Internet site: http://www.ifrn.bbsrc.ac.uk/public/FoodInfoSheets/salt_debate.html.

[7] Food Standards Agency. *National Diet and Nutrition Survey: adults aged 19 to 64 years*, The Stationery Office: London 2003.

[8] 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

[9] Johansson G, Bingham S, Vahter M. A method to compensate for incomplete 24-hour urine collections in nutritional epidemiology studies. Public Health Nutrition:2(4), 587-591.