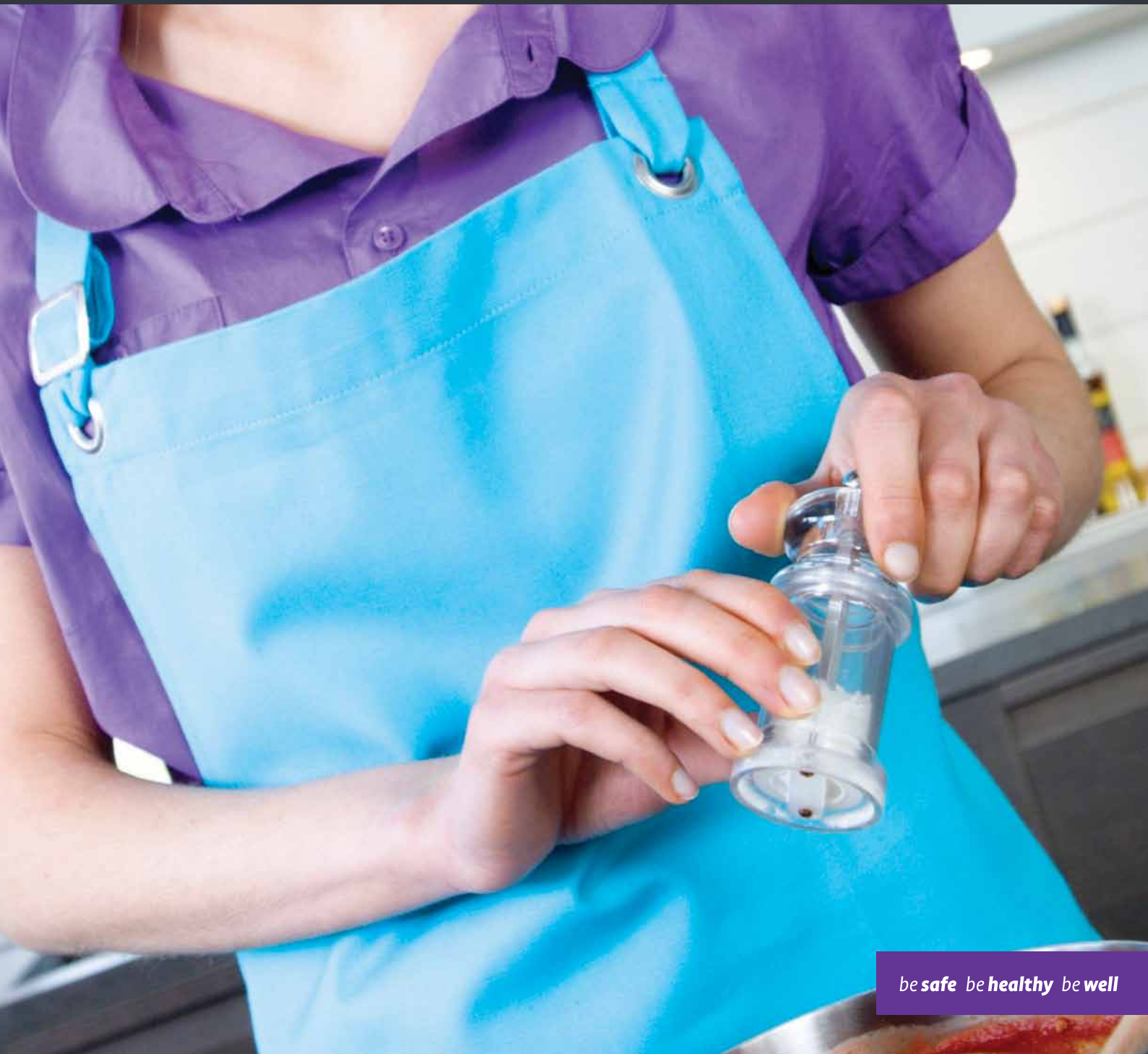


# **Salt: Hard to Shake**

## **Dietary salt intake and related risk factors in the Irish population**





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# Executive Summary

## Introduction

Dietary salt intakes are well in excess of nutritional requirements in most countries worldwide (1). There is now an overwhelming scientific consensus, based on observational studies and clinical trials over the past 40 years, that salt intake in excess of physiological requirements plays a critical causal role in the rise in blood pressure with age and the development of essential hypertension (1-3).

Hypertension is the dominant risk factor for heart disease, stroke and related cardiovascular disease (CVD) in all populations. CVD, including heart disease, stroke and related diseases, is the major cause of death in Ireland, accounting for almost 40 per cent of all deaths. A relatively modest reduction in salt intake has the potential to prevent a significant number of heart attacks and strokes annually (4). In a recent study, based on data from the United States, it was estimated that a population-wide reduction in dietary salt of three grams per day (g/day) would decrease the annual number of new cases of Coronary Heart Disease in the US by a third to 120,000, stroke by a third to 66,000, and myocardial infarction by 54 per cent to 99,000 (4). It was further estimated that a regulatory intervention designed to achieve a reduction in salt intake of three grams per day would save 194,000 to 392,000 quality-adjusted

life-years and between \$10 billion and \$24 billion in US health care costs annually (4).

In 2003, the Scientific Advisory Committee on Nutrition in the United Kingdom (UK), considering the extensive evidence for a direct link between salt intake and high blood pressure, recommended that the average consumption of nine grams of salt per day in adults in the UK should be decreased to six grams per day to reduce high blood pressure and lower the burden of cardiovascular disease (2). These recommendations were echoed in the Irish report published by the Food Safety Authority of Ireland (FSAI) in 2005 (3) which highlighted that Irish people are consuming salt at levels well in excess of tolerable upper limits (UL)<sup>1</sup>.

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<sup>1</sup> Tolerable Upper limit (UL): the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects may increase.

The FSAI report recommended a similar target to that set in the UK: a fall in average salt intake from an estimated ten to six g/day by 2010. This target was set as a potentially achievable population level objective, not a recommended daily allowance (RDA)<sup>2</sup>. It should be noted that in 2005 the US Institute of Medicine proposed an adequate intake (AI) of 3.8 grams (g) and a tolerable upper limit (UL) of 5.8 g of salt daily<sup>3</sup> (5).

The Irish and UK authorities set the 6g salt per day target, while the World Health Organization (WHO) has set a lower target of 5g (6). Current data from EU member states indicates that salt intakes are exceeding this WHO maximum limit. The EU white paper 'A Strategy for Europe on Nutrition, Overweight and Obesity Related Health Issues' urges member states to prioritise salt reduction. The EU Framework for National Salt Initiatives (2008) aims to reduce salt intake and member states are urged to carry out 24-hour urinary sodium excretion surveys, the gold standard method for estimating dietary salt intakes, to accurately assess the magnitude of the problem.

*A relatively modest reduction in salt intake has the potential to prevent a significant number of heart attacks and strokes annually.*



The FSAI report called for greater engagement with the food industry to reduce the salt content of foods on the Irish market. It recommended further research and regular population surveys to accurately assess salt intake in the population and monitor the prevalence of hypertension. It also recommended public awareness and health promotion campaigns aimed at reducing salt intakes.

Health promotion initiatives to highlight the health consequences of excess salt intakes and to support consumers in reducing consumption have been undertaken widely, with **safefood** and the Irish Heart Foundation leading them in Ireland.

In 2007 **safefood** commissioned this study to accurately assess dietary salt intake in the Irish population and its association with relevant lifestyle-related risk factors. The research project was led by Professor Ivan Perry and Dr Gemma Browne, working with a research team in the Department of Epidemiology and Public Health, UCC and the Health Research Board (HRB) Centre for Health and Diet Research.

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- 2 Recommended daily allowance (RDA): the average daily nutrient intake level sufficient to meet the nutrient requirement of nearly all (97 to 98 per cent) of healthy individuals in a particular life stage and gender group.
  - 3 Adequate Intake (AI): the recommended average daily intake level, based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate- used when an RDA cannot be determined.



## **Aims and Objectives**

The overall aim of this study was to provide accurate and well validated estimates of dietary salt intake in the Irish population to support the ongoing evaluation of policy initiatives over the past decade designed to reduce it. The specific objectives were as follows:

To estimate dietary salt intake in the Irish population based on

1. (i) analyses of the existing SLÁN-07 nutritional dataset (7-8) and linked random ('spot') urine samples from this national health and lifestyle survey (Phase I study)  
(ii) studies of additional samples of adults with estimates of salt intake based on 24-hour urinary sodium excretion (Phase II study)
2. To describe variation in salt intake by age, sex, and measures of obesity.
3. To assess the dietary sources of salt.
4. To estimate potassium intakes based on 24-hour urine collection and describe the distribution of sodium to potassium ratio in the population.

## **Methods**

The above objectives were addressed in two studies: SLÁN-07 (Phase I study) and the Phase II study.

### **Phase I study**

The Phase I study was based on further analysis of SLÁN-07 data. SLÁN is a national health and lifestyle study funded by the Department of Health and Children. SLÁN-07 was based on a nationally representative household sample of 10,364 adults (62 per cent response rate) aged 18 years and over, recruited in 2007 (7-8). The study was conducted by a national research consortium led by Professor Hannah McGee at the Royal College of Surgeons (RCSI), in collaboration with the Economic and Social Research Institute (ESRI), NUI Galway (Department of Health Promotion) and UCC (Department of Epidemiology & Public Health). Food Frequency Questionnaire (FFQ) data was available from 9,223 subjects and 'spot' urine samples from 1,207 men and women aged 45 years and older who underwent physical measurements of height, weight, abdominal circumference and blood pressure.

### Phase II study

Dietary data from the FFQ, physical measurements (height, weight, abdominal circumference and blood pressure) and 24-hour urine collections were obtained from a total of 599 adults aged 18 to 81 years based on three sub-samples. These were as follows:

- A general population sample drawn from participants on the SLÁN-07 survey who agreed to re-screening in 2008-09 (n=54) and participants of the 1998 Cork and Kerry Diabetes and Heart Disease Study (n=65) who were re-screened in 2007.
- A group of student volunteers (n=169) from two large academic institutions in the Republic of Ireland.
- An occupational group, sampled from an occupational setting (n=311) from a total staff of approximately 1600 workers.

24-hour urinary sodium excretion is considered the gold standard method to estimate dietary salt intake. In non-sweating individuals living in temperate climates and in steady state sodium and fluid balance, it is estimated that between 90 per cent and 95 per cent of dietary salt intake is excreted in urine. Up to three 24-hour urinary sodium collections are required to adequately characterise salt intake at the individual level. A single measurement, however, is adequate for group-level estimates of salt intake in nutritional surveillance studies.

*24-hour urinary sodium excretion is considered the gold standard method to estimate dietary salt intake.*



In this study we collected and assayed 24-hour urinary samples from the 599 participants in the Phase II study. Para-aminobenzoic acid (PABA), a biologically inert substance which is rapidly excreted in urine, was administered to all participants on the day of urine collection to validate the completeness of the 24-hour collection sample. The PABA-validated estimates of salt intake are based on 488 subjects who had taken PABA and had a measured percentage dose excretion of >70 per cent. The findings on salt intake are expressed as grams per day, mean (sd) and median.

To estimate total sodium excretion in the spot urines, the sodium content was corrected for total 24-hour urine volumes calculated from the validated 24-hour urine samples collected in the Phase II study by gender.

Table 1 provides an overview of the urinary analysis components of the Phase I and II studies.

Table 1 Urinary Analysis Studies

Study	Numbers	Urinalysis	Population
Phase I	1,207	Spot Urine	SLÁN- Irish householders
	Total 1,207		
Phase II	54	24 hour Urine +	SLÁN
	65	24 hour Urine +	Cork and Kerry Diabetes Cohort
	169	24 hour Urine +	Students
	311	24 hour Urine +	Occupational setting
	Total – 599		

### Main findings

The results are organised into six main sub-sections. Dietary intake of salt was estimated using three different methodologies: self-reported food frequency questionnaires; spot urine analysis and 24-hour urine analysis, (see Table 2). Results from the three techniques are reported and compared, together with variation in these estimates by age, gender, blood pressure and obesity.

Table 2 Dietary salt intake estimates

Method	Sample size Age Range (years)	Mean g/d	Std. Dev. g/d	Median g/d
FFQ	SLÁN n= 9,223 (18-90)	8.1 (M)	3.9 (M)	7.4 (M)
		7.6 (F)	3.5 (F)	7.0 (F)
Spot Urine	SLÁN n= 1,207 (36-90)	10.3 (M)	5.0 (M)	9.7 (M)
		7.4 (F)	4.2 (F)	7.1 (F)
24 Hr Urine	n= 599 (18-81)	10.4 (M)	4.3 (M)	9.7 (M)
		7.4 (F)	2.7 (F)	7.1 (F)

1. Estimates of salt intake derived from self-reported dietary intakes and level of agreement with estimates derived from 24-hour urine collection

Self-reported dietary salt intake levels (mean (sd), median) estimated using the SLÁN-07 FFQ in n=9,223 individuals were 8.1g (3.9), 7.4 g/day for men and 7.6g (3.5), 7.0 g/day per day for women. These estimates do not include salt added during cooking or at the table.

When salt intake estimated from 24-hour urine collections from the Phase II study were compared to FFQ estimates it was found that FFQ underestimates salt intake in men by approximately 15 per cent whereas estimates for women are accurate with an error of less than one per cent.

2. Dietary sources of salt

The food groups contributing most to salt intake based on the food frequency questionnaires in SLÁN-07 and the Phase II study are cereals, breads and potatoes followed by meat, fish and poultry products, which together account for over 50 per cent of the salt in our diet, **Table 3**.



**Table 3** SLÁN-07 study: Food groups contributing to salt intake based on Food Frequency Questionnaire data

	<b>Salt (g)</b>	<b>Contribution to overall salt intake (%)</b>
Cereals, breads, and potatoes	2.7	34
Meat, fish and poultry	1.8	22
Soups, sauces, spreads	1.1	14
Vegetables	0.9	11
Dairy products and fats	0.8	10
Sweets, savoury snacks	0.6	8
Drinks	0.1	1
Fruits	0.0	0
Milk	0.0	0

### 3. Dietary sodium intake density

In the recent (2010) US Institute of Medicine report *Strategies to Reduce Dietary Sodium Intake in the United States* dietary sodium intake density (mg of sodium per 1000 calories consumed) is used to analyse secular trends in salt intake based on dietary recall (9-10). In this report we present estimates of dietary sodium intake density for Ireland using both the SLÁN-07 and the Phase II study FFQ data and we compare the findings with recent US data.

In the SLÁN-07 data, the mean (sd) sodium intake density was similar in men and women (1,501 mg /1000 kcal (392) and 1,500 mg/1000 kcal (376)). The findings were similar in the Phase II study. These findings are also broadly consistent with data from the US based on 24-hour diet recall data from the National Health and Nutritional Examination Surveys (NHANES).

In multivariate analyses, sodium intake density increases significantly with age but not with obesity.

### 4. Estimates of salt intake derived from spot urine samples and associations with blood pressure

Using SLÁN-07 spot urine samples corrected for urine volume, the estimates (mean (sd), median) for salt intake per day in adults aged over 45 years were as follows: men, 10.3 grams (5.0), 9.7 grams and women, 7.4 grams (4.2), 7.1 grams.

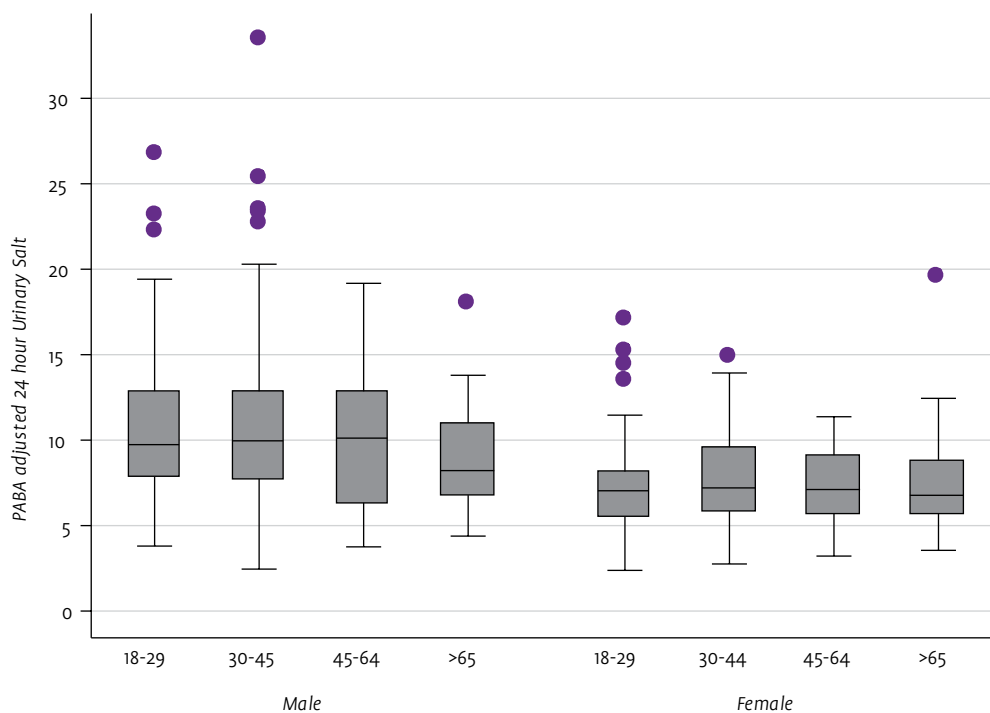
The association between estimated salt intake and blood pressure in the 1,093 subjects who completed the SLÁN-07 physical examination and provided a urine specimen was examined. Following exclusion of those on anti-hypertensive treatment, including diuretics (four per cent of men and three per cent of women in this sample), positive associations with both systolic and diastolic blood pressure were observed.

5. Estimates of salt intake derived from 24-hour urine collection by age, gender and obesity measures

Estimated dietary salt intake (mean (sd), median) based on PABA validated 24-hour urine collections was 9.3 g/day (4.1), 8.5 g/day with higher intakes in men 10.4 g/day (4.3), 9.7 g/day than in women, 7.4 g/day (2.7), 7.1 g/day.

It was found that 86 per cent of Irish men (95 per cent CI 82 – 90 per cent) and 67 per cent of Irish women (95 per cent CI 60 – 74 per cent) consume more than six grams salt per day with only 1.3 per cent and 11.5 per cent consuming less than four grams per day. Significant variation in salt intake with age was not detected. However, there were relatively few participants in the older age categories, (see **Figure 1**).

Figure 1 Phase II study: Distribution of PABA-validated salt intake (g/day) by gender and age



Dietary salt intake was strongly associated with increased general and central obesity in both men and women in analyses adjusted for calorie intake (see **Figure 2 and Figure 3**).

Figure 2 Phase II study: Distribution of PABA-validated salt intake (g/day) by gender and general obesity

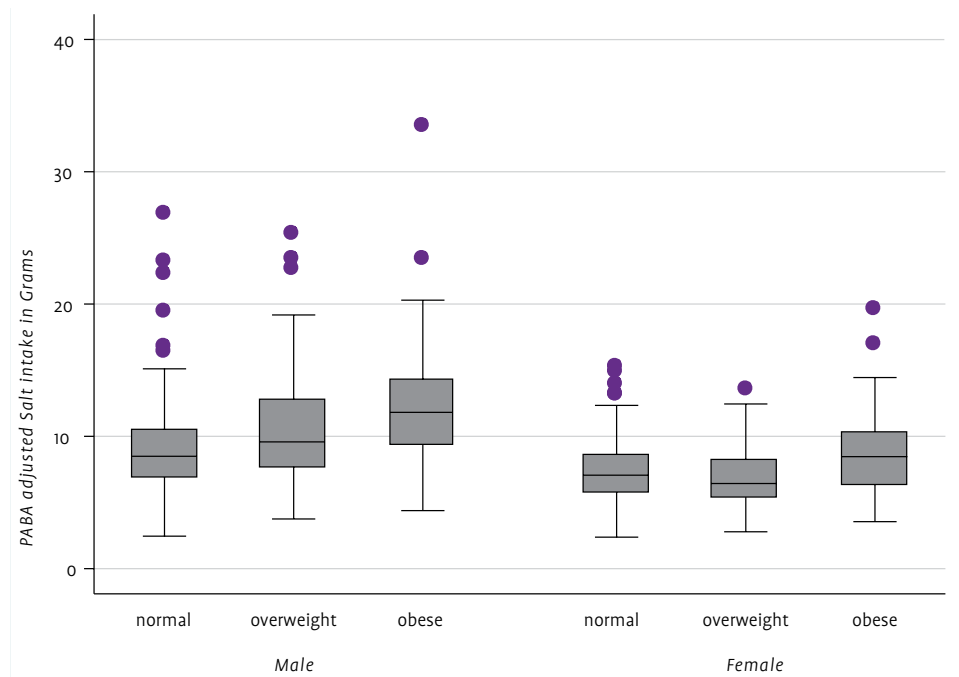
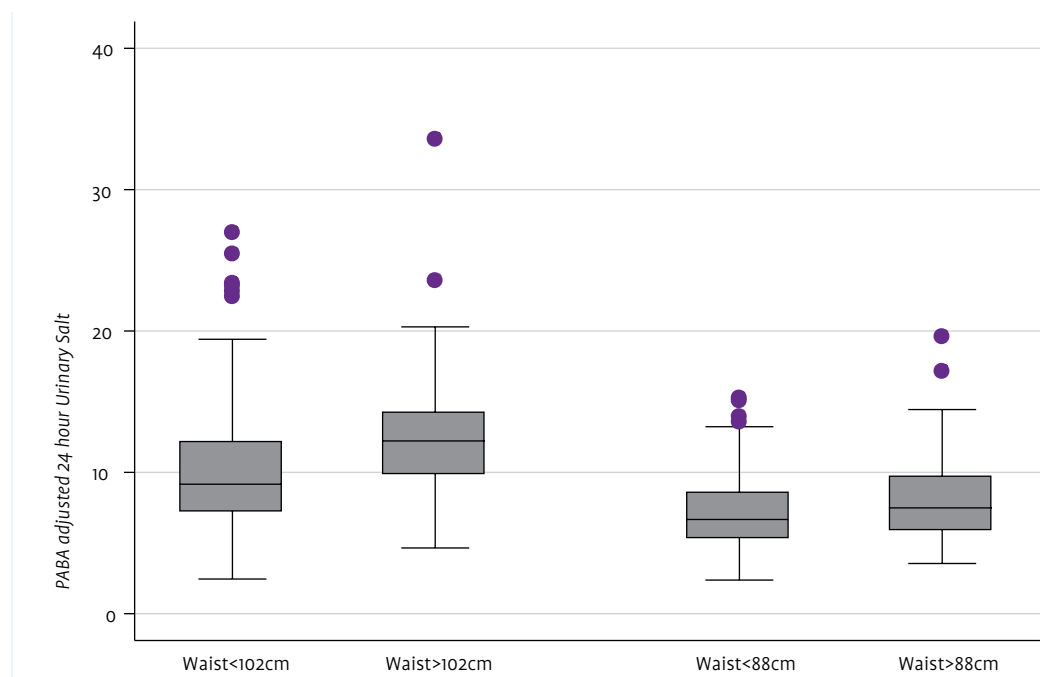


Figure 3 Phase II study: Distribution of PABA-validated salt intake (g/day) by gender and central obesity



#### 6. Estimates of potassium intakes and sodium to potassium ratios derived from PABA validated 24-hour urine collections

The Recommended Daily Allowance (RDA) for potassium is 3,100 mg/day. Estimated intakes (mean (sd), median) for men were 3630 mg/day (1180), 3560 mg/day and for women, 2780 mg/day (1050), 2620 mg/day. Sodium to potassium ratio (mean (sd)) was similar in men 2.0 (0.81) and women 1.93 (0.88) but varied inconsistently with age.

#### Conclusions

The findings from this study provide relevant data for the effective planning and evaluation of public health initiatives which are focused on reducing dietary salt intake in the population. The results highlight gender differences in dietary salt intake, a positive association between dietary salt intake and markers of obesity, and the potential use of spot urines in estimating population dietary salt intakes.

Dietary salt intakes in the Irish population remain high with the overwhelming majority of the population (86 per cent men and 67 per cent women) consuming salt at levels well in excess of the current target of six grams per day. Average (mean) salt intake based on 24-hour urinary collections in the study (Phase II) was 9.3 g/day, with substantially higher rates in men at 10.4 g/day than in women at 7.4 g/day, highlighting a significant gender difference.

The poor response rate for the studies involving 24-hour urine collections (Phase II), which require considerable commitment from volunteers, highlights the challenges we face in monitoring salt intake in the population. It is noteworthy that estimates of salt intake based on random (“spot”) urine samples from the SLÁN-07 study, adjusted appropriately for 24-hour urine volume, provide group level estimates of intakes that are similar to those derived from PABA validated 24-hour urine collections. This observation, if replicated, has

important practical implications for population level nutritional surveillance of salt intakes.

Dietary salt intake was strongly associated with general and central obesity in both men and women. This finding has implications for targeting future health promotion initiatives.

It is likely that we are underestimating average salt intakes in the population, given the potentially significant volunteer biases in both the SLÁN-07 and the Phase II study samples – due to declining response rates for health and nutritional surveys and the particular difficulty of recruitment for studies involving 24-hour urine collections.

There is no clear evidence from this research that salt intakes have declined over the past two decades. It is probable that increasing calorie intakes, reflected in rising levels of overweight and obesity, are now an important factor contributing to high salt intake and may be cancelling the impact of recent modest changes in the salt content of processed food. The findings suggest that current efforts to reduce salt intake in the population through engagement with the food industry need to continue and to be intensified.

#### Key recommendations from this study include the following

As most salt is added to food during processing, the relevant statutory agencies should engage more intensively with the food sector to ensure that further reductions in the salt content of processed food are achieved within a reasonable time scale.

Health promotion initiatives that highlight the health consequences of excess salt intakes and promote lower salt products and the use of less discretionary salt should be adopted to support the work of the food industry and the regulatory food agencies.



In keeping with international best practice, the findings support the need for a multifaceted approach with an emphasis on focused health promotion initiatives.

A key part of the equation are campaigns that raise awareness and promote choosing lower salt products, increasing consumer demand for them and for using less discretionary salt.

The findings also identify specific at risk groups in the Irish population (males and overweight individuals) at whom interventions should be targeted.

The issue of clear and accurate labelling of the salt content of processed food, using simple formats such as the traffic lights system, should be reviewed as a high priority. In particular, the practice within the food industry of referring to a salt intake of six grams per day as a 'guideline daily amount' is misleading, and should be discontinued.

Given the accumulating evidence on the health and economic costs of high salt intake the government, in collaboration with our EU partners should consider, the statutory regulation of the salt content of processed food. As suggested in the (2010) US Institute of Medicine report, *Strategies to Reduce Dietary Sodium Intake in the United States* (9), mandatory changes in permissible salt concentrations in processed food could be phased in over a reasonable time scale to allow consumers and the food industry to adapt.

There is a need for ongoing population monitoring for salt intake as part of national nutrition surveillance systems. In particular, we need reliable data on salt intake in children and adolescents.

Given the difficulties associated with obtaining 24-hour urine collections from representative samples of adults and children, the group level reliability of alternative methods of surveillance of dietary salt intake, such as random ("spot") samples corrected for urinary volume and dietary sodium intake density, should be further assessed.

The annual health and economic costs of excessive salt intake should be modelled for the Republic of Ireland using this data and relevant additional data on morbidity, mortality and costs.

*Dietary salt intakes in the Irish population remain high with the overwhelming majority of the population consuming salt at levels well in excess of the current target of six grams per day.*



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