Food Safety
AUTHORITY OF IRELAND

Report of the Scientific Committee
of the Food Safety Authority of Ireland

Salt and Health: Review of the Scientific Evidence and Recommendations for Public Policy in Ireland (Revision 1)




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FOREWORD

This report was prepared by the Nutrition Sub-committee and adopted by the Scientific Committee for presentation to the Food Safety Authority of Ireland (FSAI). It aims to provide the FSAI and other stakeholders with an overview of the science and related issues surrounding the problem of excessive salt in the diet. It also provides recommendations for all stakeholders to address and resolve this public health issue.

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SUMMARY

Cardiovascular disease, including heart disease, stroke and related diseases is the single highest cause of death in Ireland, accounting for over two in five (approximately 41%) of all deaths. High blood pressure is one of the major modifiable causal factors in the development of cardiovascular disease. In recent decades, a substantial body of evidence has emerged from observational and experimental research to suggest that high dietary salt intake is an important causal factor in the rise in blood pressure with age and in the development of essential hypertension in industrialised countries such as Ireland. There is also evidence that relatively modest reductions in salt intake have the potential to produce a significant fall in average blood pressure at a population level with a concomitant substantial impact on the burden of morbidity and mortality from cardiovascular disease.

The average daily salt intake in Ireland is high - approximately 10g in adults. Data are lacking on salt intake in children; however, data from the UK suggest that average daily salt intake in children aged 4-6 years and 7-10 years exceeds 5g and 6g, respectively. These intakes are well in excess of physiological requirements. The recommended dietary allowance (RDA) is 1.6g/70 mmol sodium (4g salt) per day for adults. Over 90% of the sodium in the diet is in the form of sodium chloride (salt); 1g of sodium is equivalent to 2.54g of salt.

It is estimated that about 15-20% of total dietary sodium intake is from discretionary sources (salt added in cooking and at table), 15% from naturally occurring sodium in unprocessed foods and about 65-70% from manufactured foods. Two food groups (meat/fish, particularly processed meats and bread) account for over 50% of salt intake from foods, with the remainder contributed by various other processed foods, including milk products, soups and sauces, spreading fats, biscuits/cakes/pastries/confectionery and breakfast cereals.

Two recent major reports on dietary salt and health: the UK Scientific Advisory Committee on Nutrition report on 'Salt and Health' in 2003 and the US Institute of Medicine report on 'Dietary Reference Intakes for water, potassium, sodium, chloride and sulphate' in 2004, provide a detailed and comprehensive review of the evidence on the relationship of salt and health. The Scientific Committee of the FSAI concurs with the main conclusions from these reports as follows:

- There is a direct, independent causal link between dietary salt intake and blood pressure.
- The magnitude of the effect of salt on blood pressure is significant at the clinical and population level.
- As there is a spectrum of responses to dietary salt exposures, there are no agreed criteria to identify salt sensitivity and the concept is of limited relevance.
- Children may be particularly vulnerable to the adverse effects of high salt intake. The short term benefits of salt restriction are likely to be most marked in the elderly because of the high absolute risk of hypertension-related stroke and heart disease in this age group.
- Measures taken to reduce average population salt intake will lead to lower average population blood pressure and reduce morbidity from cardiovascular disease including heart attack and stroke.
- As dietary salt is mostly derived from processed food, advice to individuals to reduce salt intake has limited impact on its own and effective measures to reduce salt intake in the population also requires a reduction in the salt content of processed foods.

RECOMMENDATIONS

General Recommendations

1. In the development of programmes for reducing salt consumption, an achievable target for the adult Irish population is a mean intake of 2.4g/100 mmol sodium (6g salt) per day. Whilst this is considered to be an achievable goal for the population at this time, it should not be regarded as an optimal or ideal level of consumption.
2. As distinct from the achievable population target, advice targeted at individual adults should reflect the RDA for sodium of 1.6g/70 mmol (4g salt) per adult per day is sufficient to meet the physiological needs of 97.5% of the population.
3. The particular vulnerability of children and the elderly to the adverse effects of high salt intake needs to be highlighted in discussion with the food industry regarding new product development and the reformulation of existing products. This should also be considered in health promotion campaigns mounted by public and private bodies.

Recommendations for the FSAI

4. The FSAI should continue to work in consultation with the food industry (manufacturers, retailers, caterers, etc) to achieve gradual, sustained and universal reductions in the salt content of processed and prepared foods. Targets should be set that are consistent with the objective of reducing the mean adult population salt intake to 6g per day within an agreed time frame.
5. The FSAI and other relevant Government bodies should support the clear and comprehensive nutritional labelling of the salt content of all processed pre-packaged food, including information on the proportion of the RDA for sodium (salt) in a single serving.
6. Consideration should be given to the mandatory labelling of foods with salt content above a specific threshold as 'high salt'. The FSAI in collaboration with relevant Government bodies should also work to ensure that the proposed EU health claims legislation sets clear guidelines for the use of claims such as 'low salt' or 'reduced salt' that are consistent with the recommendations of this report.
7. The FSAI should develop structures and methods to monitor the salt content of processed food and food prepared in the food service sector.

Recommendations for Other Agencies

8. The public sector should play a lead role in reducing population exposure to dietary salt through the development of policies and procedures to reduce the salt content of food served to staff and clients in public agencies, including hospitals and institutional care settings.
9. As part of a wider strategy for salt reduction in the diet, the Department of Health and Children and other relevant agencies should work in collaboration with consumer groups and other stakeholders to assist in the development of national information and awareness campaigns addressing:
   - the links between salt, blood pressure, heart attack and stroke
   - the salt content of processed food
   - the need to reduce the amount of salt added during cooking and at table.

   Health education/promotion campaigns addressing salt intake should be integrated as appropriate with other core messages on healthy diet and lifestyle.
10. The Department of Health and Children should commission studies into accurately assessing salt intake in the general population, including relevant sub-groups such as children and the elderly.
11. The Department of Health and Children should commission regular population health monitoring studies addressing the distribution of blood pressure and the prevalence of hypertension in children and adults.

Recommendations for the Food Industry

12. The food industry should work in consultation with the FSAI and other relevant agencies to achieve a gradual, sustained and universal reduction in the salt content of processed foods and foods prepared by the food service sector.
13. The food industry should attach high priority to research aimed at addressing technological, shelf-life, preservation and taste issues in relation to the reduction of the salt content of processed food.

BACKGROUND TO THIS REPORT

In the 1999 Report of the Cardiovascular Health Strategy, 'Building Healthier Hearts' (Department of Health and Children,1999) it was recommended that the FSAI examine salt intake in the Irish diet and advise on national policy in this area. This recommendation reflects the current international scientific consensus that dietary salt intake is an important factor in the development of hypertension, a major determinant of risk of cardiovascular disease, including myocardial infarction (heart attack) and stroke. This report addresses the following issues:

1. The importance of hypertension as a cause of morbidity and mortality in Ireland.
2. The scientific evidence linking high dietary salt consumption to increased blood pressure.
3. The role of salt relative to other factors in the development of hypertension
4. Intake and sources of sodium (salt) in the Irish diet.
5. Recommended levels of salt intake.
6. Recommendations for measures to achieve target reductions in salt intake in children and adults.

The Committee has undertaken a detailed review of the national and international literature on salt intake and health, with particular reference to the link between salt and blood pressure. Two recent major reports on dietary salt and health provided detailed and comprehensive reviews of current research in this area: the UK Scientific Advisory Committee on Nutrition (SACN) report on *'Salt and Health'* (SACN, 2003) and the US Institute of Medicine (IOM) report on *'Dietary Reference Intakes for water, potassium, sodium, chloride and suphate'* (US IOM, 2004). Given the recent publication of these reports, the Committee agreed that a further in-depth review of the scientific evidence is not required at this time. Details of these reports are not reproduced here; however, references to websites where the summaries of each of these reports can be accessed are contained in the list of references. This report will give a brief overview of the scientific evidence linking high dietary salt consumption with increased blood pressure.

CHAPTER 1. HYPERTENSION AND CARDIOVASCULAR DISEASE IN IRELAND

Definition of Hypertension

Blood pressure is a continuous, normally distributed variable in the population. Hypertension is therefore a quantitative phenomenon in which the definition of abnormality is arbitrary and pragmatic. In essence, we define hypertension as the blood pressure level at which the benefits of intervention are adjudged to outweigh the costs. The current internationally agreed

cut-off point for normal blood pressure is at a systolic blood pressure (SBP) of less than 140 mmHg and diastolic blood pressure (DBP) of less than 90 mmHg. An additional category of 'high normal' blood pressure (SBP between 120 and 139 or DBP between 85 and 89 mmHg) is widely accepted on the basis that persons with blood pressures within these ranges are at increased risk of future 'hypertension' and cardiovascular events relative to those with 'normal' blood pressure, and are likely to benefit from non-pharmacological interventions (Chobanian, 2003).

Prevalence of Hypertension

It is estimated that 24% of the US adult population, meet current internationally agreed diagnostic criteria for hypertension, with substantially higher prevalence rates, approaching 70%, in persons aged 70 years and older (Burt *et al*, 1995). In the 2002 Health Survey for England, mean SBP for men was 135 mmHg and for women 131 mmHg (Health Survey for England, 2002). In this national survey, mean SBP increased with age in both men and women, rising from 128 mmHg in men aged 16-24 to 146 mmHg in men aged 75 and over and from 120 mmHg to 152 mmHg in women. In England, it is estimated that 37% of men and 34% of women have hypertension (defined here as a SBP of 140 mmHg or over, or a DBP of 90 mmHg or over) or are being treated for hypertension. The prevalence of hypertension increases with age in both sexes; it is estimated that less than one in twenty women aged 16-24 are hypertensive, compared to more than half aged 55-64 and just under three-quarters aged 65-74. Just under 80% of men and 70% of women with hypertension are not receiving treatment. Of those that are treated, over 60% remain hypertensives (Health Survey for England, 2002).

By contrast with the situation in the UK, there are limited contemporary data on the distribution of blood pressure and the prevalence of hypertension in the Irish population. On the basis of the recent data from England we can estimate that in Ireland, at least 50% of the population aged 50 years and older are hypertensive (Health Survey for England, 2002). In a cross-sectional study carried out in 1998, involving 1,018 men and women aged 50 to 69 years, drawn from General Practice Registers in Cork and Kerry, Creagh and colleagues reported a prevalence of hypertension of 50% in males and 43.5% in females. Only 38% of those meeting current international criteria for hypertension had been previously diagnosed and were on treatment (Creagh *et al*, 2002).

Hypertension and Cardiovascular Disease

Heart disease and stroke are the first and third leading causes of death in most developed countries, including Ireland, and it is estimated that they will rank as first and fourth respectively as causes of the global burden of disease by the year 2020 (Lopez & Murray, 1998). Hypertension is one of the most important modifiable risk factors for both coronary heart disease and stroke. Other major factors include smoking, diet, physical inactivity and diabetes. Data from large-scale observational studies involving follow-up of hundreds of thousands of individuals in the general population show a consistent, linear relation between usual blood pressure levels and risk of coronary heart disease (CHD) and stroke (MacMahon *et al*, 1990; Lewington *et al*, 2002). Elevated blood pressure is also a major predictor of heart failure and of end-stage renal failure (Whelton *et al*, 1996). The findings from randomised controlled trials of blood pressure lowering drugs also provide clear evidence that blood pressure levels are directly and continuously related to the risks of stroke, CHD and other adverse outcomes across the entire distribution of blood pressure in the population (Collins, 1990). Because of the continuous relation between blood pressure and risk, small downward shifts in mean population blood pressure will produce substantial reductions in both the proportion of hypertensives in the upper tail of the distribution and in hypertension related morbidity and mortality (Stamler *et al*, 1989). This has profound implications for public health policy in relation to salt and blood pressure.

CHAPTER 2. OVERVIEW OF EVIDENCE ON SALT AND BLOOD PRESSURE

The contribution of dietary factors such as salt to the rise in blood pressure with age and the development of essential hypertension have been difficult to elucidate because of the poor precision (or reliability) with which dietary exposures are measured in free-living subjects and the limited range of dietary exposures in most populations. There is also the problem of multicollinearity (i.e. the tendency for dietary elements such as sodium, potassium and fat to be intercorrelated at both the individual and population level) (Perry *et al*, 1994). Despite these difficulties, however, the evidence that salt intake plays a critical role in blood pressure regulation is now overwhelming (MacGregor and de Wardener, 2002; Elliott and Stamler, 2002).

The evidence comes from diverse sources, including:

- observational epidemiologic studies (ecological, cross-sectional and migration studies)
- animal and genetic models
- a trial in infants with long term follow-up
- a community intervention study carried out in Portugal
- intervention studies in normotensives (people with normal blood pressure) and hypertensives (people with high blood pressure) and in studies involving middle-aged and elderly population samples.

In an international study including over 10,000 subjects (men and women aged 20–59 years) in 52 different population groups in 32 countries, positive associations between urinary sodium excretion (a marker of salt intake) and blood pressure were observed within and between populations (INTERSALT, 1988; Elliott *et al*, 1996). Within populations, those with higher sodium excretion tended to have higher blood pressure. In the across population analysis (i.e. ecological analysis comparing blood pressure levels in 32 different countries) populations with higher mean sodium excretion had higher mean blood pressures. In men and women at all ages it was estimated that a 100 mmol/day increase in sodium intake was associated with an average increase in systolic blood pressure of up to 6 mmHg. Estimates of association were larger for older people (aged 40–59 years) than for younger people (aged 20–39 years). One of the key findings from this study was a consistent and highly significant association of sodium excretion across populations with the slope or rise of blood pressure with age (INTERSALT, 1988; Elliott *et al*, 1996).

In virtually all mammals, high blood pressure is caused or aggravated by a high salt intake, e.g. it has been shown in chimpanzees that an increase in salt intake from 0.5g daily (their usual intake) to a level between 9g and 15g daily (our usual intake), leads to substantial and reversible increases in blood pressure (Denton, 1995).

In a randomised controlled trial that involved 500 newborn infants in the Netherlands, it was found that infants who were given formula milk and solids with reduced salt content had significantly lower blood pressure at six months of age relative to a control group on a standard infant diet (Hofman, 1983). Intriguingly, on re-examination of a sub-group of these children at age 15 years, there was evidence that the beneficial effects of early salt restriction on blood pressure persisted into adolescence (Geleijnse, 1996). The data from this study combined with the findings from INTERSALT on the positive association between average population salt intake and the rise of blood pressure with age suggest that children are especially vulnerable to adverse effects from high salt intake (INTERSALT, 1988; Elliott *et al*, 1996).

In the community intervention trial in Portugal, the salt intake of an entire village was reduced by reducing salt in cooking and in processed food, including bread. At the end of the observation period, blood pressure was significantly lower than in a control village (Forte *et al*, 1989).

Meta-analyses of Salt Restriction Intervention Studies

The best evidence for the role of salt in blood pressure comes from randomised controlled trials. Feng and McGregor have recently reported the findings from a meta-analysis, based on 17 trials of modest reductions in salt intake in hypertensives and 11 similar trials in normotensives (Feng and McGregor, 2002). Trials of very short duration (one week or less) and acute salt loading and salt depletion experiments were excluded from the meta-analyses. The findings from this meta-analysis are consistent with those of Law and colleagues (1991). The median reduction in salt intake in the trials was approximately 5g per day and this was associated with an average fall in blood pressure of 4.96/2.73 mmHg in hypertensives and 2.03/0.97 mmHg in normotensives. In linear regression analyses, a reduction of 100mmol per day (6g) in salt intake predicted a fall in blood pressure of 7.1/3.9 mmHg in hypertensives and 3.6/1.6 mmHg in normotensives (Feng and McGregor, 2002). It is estimated that an average reduction in blood pressure of this magnitude in the general population of most Western countries would reduce the incidence of stroke by 24% and the incidence of ischemic heart disease by 18% (Stamler *et al*, 1989; Cook *et al*, 1995). This would lead to a reduction in stroke deaths of approximately 600 per year in Ireland (with a similar reduction in the number of non-fatal disabling strokes) and a reduction in deaths from ischaemic heart disease of approximately 1,100 per year. These effects are substantial in population health terms and are consistent with the hypothesis that even a modest reduction in average dietary salt intake at the population level is likely to produce substantial falls in stroke and coronary heart disease mortality.

At least six meta-analyses of salt restriction trials have been conducted to date (summarised in the SACN 2003 report), a number of which reported less marked effects of salt restriction on blood pressure. It is noteworthy, however, that in the dissenting meta-analyses, significant effects of salt restriction on blood pressure were detected in both hypertensives and normotensives but the effect in normotensives was judged to be of insufficient magnitude to be of public health importance (Midgley *et al*, 1996; Cutler *et al*, 1997; Graudal *et al*, 1998).

Salt Restriction in the Elderly

Reductions in salt intake may be of particular benefit in the elderly. In a randomised controlled trial involving men and women aged 60–78 years, a reduction in daily salt intake from 10 to 5g for a period of one month was associated with an average fall in SBP of 7 mmHg. These effects, which were seen in normotensive and hypertensive subjects, translate into an estimated 36% reduction in stroke risk over a five year period in this age group (Cappuccio *et al*, 1997). Given the high underlying incidence of stroke in the elderly, a reduction in stroke incidence of this magnitude (more than one third) would represent a public health triumph. In this, as in other similar studies, there was no evidence of a distinct sub-group of so-called salt-sensitive subjects. This concept that a minority of the population may be salt-sensitive, with the rest of the population being relatively unaffected, has now been discredited (US IOM, 2003).

The Dash Sodium Trial

Observational epidemiological studies and meta-analyses based on trials of varying methodological rigour in different populations and patient groups have provided fertile ground for controversy on the link between salt and blood pressure. In this context, the findings from the DASH Sodium study (dietary approaches to stop hypertension) are particularly important (Sacks *et al*, 2001). This was a well conducted, three month intervention trial, too brief to examine morbidity, but long enough to detect clear effects of diet on blood pressure. Four hundred and twelve participants, ranging in age from 37 - 59 years, were randomly assigned to a control diet typical of the U.S usual diet or the DASH diet (rich in fruit, vegetables, low-fat dairy products, with a reduced total and saturated fat intake (Appel *et al*, 1997). The study included three levels of sodium intake:

- high (150 mmol sodium/9g salt)
- intermediate (100 mmol sodium/6g salt)
- low (50 mmol sodium/3g salt).

The results of the DASH sodium study showed a graded linear relation between salt intake and blood pressure from high through intermediate to low intakes. The effects were seen in patients on both the control and DASH diets, in those with and without hypertension, in both sexes and across racial groups. Among normotensives on the control diet, lower salt intake (50 mmol sodium per day) versus higher (150 mmol sodium per day) decreased blood pressure by 7.0/3.8 mmHg in those older than 45 years of age and by 3.7/1.5 mmHg in those 45 years of age or younger. Of particular importance in this study was the finding that the combination of salt restriction with the DASH study diet produced additive effects on blood pressure in both hypertensives and normotensives. When compared with the control diet with a high sodium level, the DASH diet with a low sodium level led to a mean SBP that was 7.1 mmHg lower in participants without hypertension and 11.5 mmHg lower in participants with hypertension (Sacks *et al*, 2001).

Salt, Left Ventricular Hypertrophy (Cardiac Enlargement) and Stroke

It is suggested that associations between sodium intake and blood pressure in observational studies are attenuated by measurement imprecision reflecting large intra-subject variation in salt intake and blood pressure. Therefore, stronger associations between sodium intake and stable indices of hypertensive end-organ damage such as left ventricular hypertrophy (enlargement of the heart) could be expected. Consistent with this hypothesis, there is accumulating evidence that high salt intake predicts left ventricular hypertrophy (Schmeider *et al*, 1988). This association persists in analyses adjusted for blood pressure. There is also accumulating evidence that in overweight persons higher dietary salt intake is associated with increased risk of CHD, stroke and overall mortality (Tuomilehto *et al*, 2001; He *et al*, 1999). This evidence is summarised in Annex 1 of the SACN report.

CHAPTER 3. THE ROLE OF SALT RELATIVE TO OTHER FACTORS IN THE DEVELOPMENT OF HYPERTENSION

Causes of Hypertension

The fundamental problem in hypertension is the tendency for blood pressure to rise with age. The extent of the blood pressure rise with age and thus the occurrence of hypertension varies considerably both within populations and between populations world-wide (Perry, 1994). Thus hypertension is as much a disorder of populations as of individuals (Rose, 2001).

The development of hypertension reflects a complex and dynamic interaction between genetic and environmental causal factors. Differences in genetic susceptibility probably account for much of the blood pressure variation within a population such as Ireland where we are all exposed to a broadly similar environment, whereas differences in environmental factors largely determine variation in blood pressure levels between populations and within populations over time. The findings from the DASH trial highlight the importance of dietary factors in the development of hypertension, with significant beneficial effects of fruit and vegetables (important sources of potassium, magnesium and fibre) and low-fat dairy products (important sources of calcium and potassium) on blood pressure in addition to the effects of reducing salt intake. The other major determinants of blood pressure levels in the population are overweight and obesity, physical inactivity and high alcohol consumption (Perry *et al*. 1994). As these factors are highly inter-correlated, the relative contribution of each to the overall burden of hypertension cannot be precisely estimated.

Salt is a high priority issue for Ireland in the development of public policy initiatives to control blood pressure for several reasons: current trends in other causal factors (notably obesity and physical inactivity) are unfavourable and are unlikely to be reversed in the short term, we have high mortality and morbidity rates from heart disease and stroke relative to other developed countries and, working in collaboration with the food industry, policy options are available to us which will effectively reduce population exposure to dietary salt without major changes in consumer behaviour. It should also be noted that control of dietary salt intakes at the population level offers an extremely cost effective approach to the control of hypertension relative to alternative, clinically oriented approaches to the problem: disease labelling, poly-pharmacy and clinical supervision over several decades for approximately 50% of the population. In the WHO Global burden of disease study it has been estimated that societal level action to stimulate a reduction in salt content of processed foods could avert over 21 million disability adjusted life years (DALYS) per year worldwide (Murray *et al*, 2003).

Intake and Food Sources of Sodium/Salt in Ireland

Sodium is present naturally in foods and drinking water. As salt (sodium chloride), it is added to foods during processing, cooking and at the table. The main reasons for addition of salt in food manufacture are for flavour, texture and preservation. Sodium chloride (salt) contains about 40% sodium by weight (1g sodium chloride = 0.4g sodium). Other sodium salts are added to foods during manufacture, e.g. sodium nitrate to cured meats for preservation and sodium bicarbonate to bread for texture, but generally in much lower amounts than sodium chloride.

Major dietary sources of sodium are from salt added during the processing and manufacture of foods (non-discretionary) and salt added to food during cooking and at the table (discretionary). It is estimated that about 15-20% of total dietary sodium intake is from discretionary sources, 15% from naturally occurring sodium in unprocessed foods and about 65-70% from manufactured foods (British Nutrition Foundation, 1994; Bull & Buss 1990; Flynn *et al*, 1990; SACN, 2003).

Average daily sodium (salt) intake from foods in Irish adults has been estimated as 3.25g (8.3g salt) (Table 1), with a 95th percentile of 5.23g (13.3g salt). This estimate does not allow for all additions in cooking or any additions at table – assuming about 15-20% of total dietary sodium intake is from discretionary sources would give a total daily sodium intake of about 4g (10g salt). This is similar to the estimate of total daily sodium intake of 3.8g (about 9.5g salt) obtained for UK adults using the

24-hour urinary excretion method, which is considered a more accurate method to determine total salt intake (Henderson *et al*, 2003).

In a study carried out in University College, Cork, in a sample of 114 adult hospital outpatients (77 males and 37 females) with Type 2 diabetes, mean daily sodium intake, estimated from 24-hour urinary output, for all patients was 166 mmol (about 10g salt) (MacLeod *et al*, 2005). Intakes were significantly lower in females, 144 mmol (about 8g salt) compared to males 177.2 mmol (about 10g salt). Dietary assessment using 24-hour recalls indicated that the main food sources of salt were breads and cereals (38%) and meat, including processed meats (35%), with less than 10% from salt added at the table. This study suggests that patients with Type 2 diabetes have a high salt intake, despite clear motivating factors and dietary counselling.

There are no data on salt intakes of children and adolescents in Ireland. In the UK, average daily sodium (salt) intake from foods in 4 to 18 year olds has been estimated as: 4-6 yr, 1.97g (5.0g salt); 7-10 yr, 2.28g (5.8g salt); 11-14 yr, 2.49g (6.31g salt); and 15-18 yr, 2.79g (7.1g salt) (Gregory *et al*, 2000). Again, this estimate does not allow for additions in cooking and at table.

The main food sources of sodium for adults in Ireland are listed in Table 1. Meat, fish and their products, particularly processed meats, provide almost 30% of total sodium (salt) intake, with a further 26% provided by bread and rolls. Other contributing foods include: milk and milk products, soups, sauces and miscellaneous foods, spreading fats, biscuits/cakes/pastries/confectionery and breakfast cereals.

Table 1. Mean daily Sodium Intake from Foods in Irish Adults Aged 18-64 Years by Food Group*

Food/Food Category	g/day	% total
Meat & fish	**0.97**	**29.8**
Cured/processed meats	0.67	20.5
Meat/meat dishes	0.23	6.9
Fish/fish dishes	0.08	2.4
Bread & rolls	**0.84**	**25.9**
Milk & milk products	**0.27**	**8.5**
Cheese	0.12	3.5
Soups, sauces & miscellaneous foods	**0.23**	**7.0**
Spreading fats	**0.19**	**5.9**
Biscuits/cakes/pastries/confectionary	**0.15**	**4.5**
Breakfast cereals	**0.14**	**4.2**
Ready-to-eat breakfast cereals	0.13	4.1
Other	trace	0.1
Vegetables/processed vegetables	**0.13**	**4.0**
Processed vegetables/vegetable dishes	0.04	1.1
Savouries (e.g. pizza, mixed pasta dishes)	**0.095**	**2.9**
Egg/egg dishes	**0.049**	**1.5**
Desserts	**0.035**	**1.1**
Other foods	**0.15**	**4.7**
TOTAL	**3.25**	**100.0**

* Estimated from the North/South Ireland Food Consumption Survey (IUNA, 2001) for Republic of Ireland only (n=776), excluding under-reporters by the method of Black (2000)

Salt Taste Thresholds

There is considerable evidence that salt taste thresholds fall with decreasing intake. Food with a high salt content becomes unpalatable within 4-6 weeks of adopting a low salt diet. The Scientific Committee is of the view that this concept of adaptation to reduced salt intake should be communicated clearly to consumers. There is also evidence that significant incremental reductions in the salt concentration of processed food (up to 10% per year) can be achieved without adverse effects on taste (MacGregor & Sever, 1996). This has clear and significant implications for the food industry.

CHAPTER 4. RECOMMENDED LEVELS OF SODIUM INTAKE

In 1991, the UK Committee on the Medical Aspects of Food and Nutrition Policy (COMA) set a reference nutrient intake (the term RDA, recommended dietary allowance is used in this document) for sodium of 1.6g/70 mmol (4g salt), per day to meet the needs of 97.5% of the population. This was endorsed by the UK Scientific Advisory Committee on Nutrition (SACN, 2003), which succeeded COMA in 2003. The Food Standards Agency (FSA) in the UK and the Institute of Medicine (IOM) National Academy of Science in the USA recommend an upper level of no higher than 2.4g/100 mmol sodium (6g salt) per day. This is considered a population target not an optimal or ideal level of consumption.

The Scientific Committee endorses these recommendations, emphasising that the RDA of 1.6g sodium (4g salt) per day should form the basis of advice targeted at individuals as distinct from the population health target of a mean salt intake of 6g per day. The latter target is regarded as an achievable (as distinct from ideal) goal for the population at this time. It represents a substantial reduction in salt intakes and will require continued co-operation of food manufacturers, caterers and retailers as well as increased awareness of individuals of the need to reduce their own salt intake. This target should be reviewed as average salt intake falls in the population, thereby reducing salt taste thresholds.

Salt intake in children needs to be proportionally lower than in adults (based on body weight). The Committee also endorses the target levels for average daily salt intake recommended for children in the UK SACN report on '*Salt and Health*' (2003):

Age 0-6 months	< 1g
Age 7-12 months	1g
Age 1-3 years	2g
Age 4-6 years	3g
Age 7-10 years	5g
Age 11-14 years	6g

Potential Interventions to Reduce Population Salt Intake

The Committee discussed a wide range of potential initiatives that might be considered in developing measures to reduce population salt intake. Among potential initiatives discussed were the following:

- Advice to individuals and public education programmes to promote a reduction of salt added table in cooking and at table.
- Voluntary reduction of salt in processed food by industry.
- Voluntary reduction of salt in food prepared by the catering industry.
- Promotion of the use of low salt substitutes and herbs/spices[1].
- Regulation of nutritional labelling of the salt content of all processed food.
- Regulation of the salt content in processed food.

[1] Please refer to Annex 1 for an updated opinion from the FSAI Scientific Committee.

Worldwide, interventions have ranged from non-specific advice to the public to reduce dietary salt intake to voluntary collaborations with the food and catering industries to reduce salt content in processed and pre-prepared foods. It is recognised that achievement of the population average salt intake targets will require substantial effort and all of the above approaches should be explored.

However, regarding the use of low sodium salt, the Committee was of the opinion that this approach to reducing population dietary sodium cannot be endorsed at this time. Concerns were raised about the possible vulnerability of certain population sub-groups (including those with Type 1 diabetes, chronic renal insufficiency, end stage renal disease, severe heart failure and adrenal insufficiency) to high potassium load from these salt substitutes. It was also noted that the use of salt substitutes does not address the need to reduce salt taste thresholds in the population[1].

A systematic review by Hooper *et al* (2002) assessed the long-term effects of advice to reduce dietary salt in adults with and without hypertension. Eleven trials were included with follow-up from 6 months to 7 years. The significant blood pressure reductions observed at 6-12 months, were not sustained over time. As most dietary salt intake originates from processed food, this illustrates the difficulties faced by individuals in maintaining a low salt diet and supports the view that a targeted individual approach to salt reduction will have limited impact without concomitant reduction in salt content of foods. A population-based approach is required to achieve a sustained reduction in salt intake.

[1] Please refer to Annex 1 for an updated opinion from the FSAI Scientific Committee.

CHAPTER 5. CONCLUSIONS

Salt intake in the Irish population is high. There is convincing evidence of a causal link between high salt intake and hypertension and of the benefit of reducing salt intake at population level. Hypertension is a significant cause of illness and death in Ireland. With the co-operation of the food industry and increased awareness of individuals of the need to reduce their own salt intake, it is possible to reduce adult population salt intake from an average of about 10 grams per day to about 6 grams per day. There is now a scientific consensus that a reduction of this magnitude will lead to a significant fall in blood pressure and substantial reductions in suffering and death from heart attack, stroke and related conditions.

CHAPTER 6. MAJOR RECOMMENDATIONS

General Recommendations

1. In the development of programmes for reducing salt consumption, an achievable target for the adult Irish population is a mean intake of 2.4g/100 mmol sodium (6g salt) per day. Whilst this is considered to be an achievable goal for the population at this time, it should not be regarded as an optimal or ideal level of consumption.
2. As distinct from the achievable population target, advice targeted at individual adults should reflect the RDA for sodium of 1.6g/70mmol (4g salt) per adult per day is sufficient to meet the needs of 97.5% of the population.
3. The particular vulnerability of children and the elderly to the adverse effects of high salt intake needs to be highlighted in discussion with the food industry regarding new product development and the reformulation of existing products. This should also be considered in health promotion campaigns mounted by public and private bodies.

Recommendations for the FSAI

4. The FSAI should continue to work in consultation with the food industry (manufacturers, retailers, caterers, etc) to achieve gradual, sustained and universal reductions in the salt content of processed and prepared foods. Targets should be set that are consistent with the objective of reducing the mean adult population salt intake to 6g per day within an agreed time frame.
5. The FSAI and other relevant Government bodies should support the clear and comprehensive nutritional labelling of the salt content of all processed pre-packaged food, including information on the proportion of the RDA for sodium (salt) in a single serving.
6. Consideration should be given to the mandatory labelling of foods with salt content above a specific threshold as 'high salt'. The FSAI in collaboration with relevant Government bodies should also work to ensure that the proposed EU health claims legislation sets clear guidelines for the use of claims such as 'low salt' or 'reduced salt' that are consistent with the recommendations of this report.
7. The FSAI should develop structures and methods to monitor the salt content of processed food and food prepared in the food service sector.

Recommendations for Other Agencies

8. The public sector should play a lead role in reducing population exposure to dietary salt through the development of policies and procedures to reduce the salt content of food served to staff and clients in public agencies, including hospitals.
9. As part of a wider strategy for salt reduction in the diet, the Department of Health and Children and other relevant agencies should work in collaboration with consumer groups and other stakeholders to assist in the development of national information and awareness campaigns addressing:
   - the links between salt, blood pressure, heart attack and stroke
   - the salt content of processed food
   - the need to reduce the amount of salt added during cooking and at table.

   Health education/promotion campaigns addressing salt intake should be integrated as appropriate with other core messages on healthy diet and lifestyle.

10. The Department of Health and Children should commission studies into salt intake in the general population, including relevant sub-groups such as children and the elderly.
11. The Department of Health and Children should commission regular population health monitoring studies addressing the distribution of blood pressure and the prevalence of hypertension in children and adults.

Recommendations for the Food Industry

12. The food industry should work in consultation with the FSAI and other relevant agencies to achieve a gradual, sustained and universal reduction in the salt content of processed foods and foods prepared by the food service sector.
13. The food industry should attach high priority to research aimed at addressing technological, shelf-life, preservation and taste issues in relation to the reduction of the salt content of processed food.

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ANNEX 1. UPDATED SCIENTIFIC ADVICE TO SUPPORT WORK ON THE REDUCTION OF SALT INTAKES FOR THE IRISH POPULATION (FEBRUARY, 2016)

Introduction

The relationship between salt intake and hypertension is well established and based on a substantial body of evidence [1-4]. Reducing salt consumption in the diet is important to help reduce the incidence of hypertension, the primary risk factor for cardiovascular disease which is a leading cause of premature death and disability in Ireland [5-6].

Since 2003, the Food Safety Authority of Ireland (FSAI) has coordinated a salt reduction programme working in partnership with the food industry, Food and Drink Industry Ireland (FDII), Retail Ireland and various State bodies and organisations to achieve voluntary, gradual and sustained reductions in the salt content of processed foods [7]. Many other countries have also implemented similar salt reduction programmes [8].

Through the FSAI salt reduction programme, industry was asked to gradually reduce the average salt content of their products and, in tandem, to improve production techniques to tighten the range of salt values for each product. Hence, the salt content of some products within a broad product category would need to be reduced by a greater amount than other products. However, as some categories of processed food are bigger contributors to salt intake in the diet than others, smaller reductions in these categories could provide a bigger impact on dietary salt intakes than larger reductions in smaller contributing categories [7].

In 2005, the FSAI recommended through its report *Salt and Health: Review of the Scientific Evidence and Recommendations for Public Policy in Ireland* that an achievable salt intake target for the Irish adult population was 6g salt/day (2.4g sodium) [9]. Whilst the FSAI considers this to be an achievable target for the Irish population, it does not regard it as an optimal or ideal level of consumption [9]. The World Health Organization (WHO) currently recommends a daily intake of 5g salt/day for adults [10-11]. Furthermore, the physiological requirements for salt, although not well defined, are estimated to be as low as 0.5g to 1.2g salt/day, i.e. 200-500 mg sodium/day [1, 10].

The most recent estimates of salt intake for the Irish population provided through the National Adult Nutrition Survey [12] (which exclude discretionary salt, added during cooking and at the table) indicate that among 18-64 year olds, mean daily intake of salt from foods is 7.4g/day. However, mean daily intake in men is significantly higher, at 8.5g/day, than in women, at 6.2g/day. Adults aged 65 years and over have an estimated mean daily salt intake of 6.3g, with men (7.3g) again having higher mean intake from foods than women (5.4g) [12].

In relation to children, a 2013 study of 1,075 children from 27 primary schools in Cork showed that, in almost half of the children, salt intakes were above the maximum WHO recommended daily allowance of 5g/day. Salt intake was also significantly higher in children who were overweight or obese compared to normal weight children [13]. Estimates from 2011 show that the main contributors to salt intake from foods in the Irish population come from [12]:

- 30% meat and fish products
- 22% bread
- 9% soups and sauces
- 8% milk and milk products
- 7% vegetables

Monitoring data on levels of salt in processed foods collected by the FSAI for over ten years have clearly demonstrated that in some food categories such as bread and breakfast cereals, reformulation by the food industry has significantly reduced salt contents. However, reduction in salt across all categories of processed foods, in particular processed meats, has not achieved the expectations of the FSAI or the commitments of the food industry [7].

The voluntary nature of the FSAI salt reduction programme has yielded some significant reductions in the salt content of foods. However, there has always been an emphasis in the programme that industry should take full responsibility for reducing salt in processed foods. With rising obesity rates there is a move towards more integrated approaches at national, EU and international levels to not only reduce salt, but also excessive use of sugar and fat in our food.

In May 2013, the FSAI announced that the time was appropriate for the food industry to drive its own programme of reformulation of processed foods to reduce salt. To facilitate this process, and other reformulation activities, the FDII has been developing a reformulation platform to drive this agenda forward and transfer the responsibility for realising future salt reduction to the food industry [14]. This reformulation programme will also deal with reformulation of processed foods to reduce sugars, fats and energy.

Coupled with this industry-led reformulation programme will be a continuation of the FSAI's independent surveillance and commentary on the commitments and achievements of the industry in relation to salt reduction. However, the FSAI must continue to look at all options available to further reduce the salt content of processed food and reduce salt intake in the Irish population.

As pressure worldwide to reduce the salt content of processed foods continues to grow, the food industry finds itself in a situation where it must continue to ensure the safety, quality and palatability of foods with lower salt contents. The FSAI is cognisant of this and continually reviews the scientific literature in relation to advances in technologies to reduce salt and research into salt and its role in the diet.

Two issues related to salt reduction, which have arisen recently in the scientific literature, are the use of potassium-based salt replacement ingredients and the influence of low salt diets on the occurrence of cardiovascular disease. This position paper provides a Scientific Committee view on these matters based on research since the FSAI's 2005 report *Salt and Health: Review of the Scientific Evidence and Recommendations for Public Policy in Ireland* [9].

I. Use of Potassium-Based Salt Replacement Ingredients

In food processing there is currently no simple replacement or alternative to salt, i.e. sodium chloride, that can accurately mimic the functionality of salt without causing objectionable characteristics in food [15]. The technological development of salt replacement ingredients is also hampered by the physiological nature of the human tongue which only has receptors that respond to sodium, potassium and lithium salts [16]. As lithium chloride is toxic, potassium chloride remains the most widely used and cost effective salt replacement ingredient. However, as potassium chloride imparts a bitter taste, food technologists have also had to develop the use of additives to mask this effect [15-16].

Based on a 2005 Scientific Committee report on salt and health, the FSAI currently advises against the use of potassium-based salt replacement ingredients to reduce the salt content of processed foods [9]. The 2005 report raised concerns about the possible vulnerability of certain population sub-groups (including those with Type-1 diabetes, chronic renal insufficiency, end stage renal disease, severe heart failure and adrenal insufficiency) to a high potassium load from use of these salt substitutes in processed foods [9]. It was also noted that the use of salt substitutes does not address the need to reduce the threshold for the taste of salt in the Irish population [9].

The relationship between potassium intake and blood pressure has been discussed in the scientific literature for a considerable time. Many cross-sectional and longitudinal studies have shown an inverse relationship between potassium intake and blood pressure [17]. More recent research [17-24] has also highlighted a relationship between potassium intake, its ratio to sodium in the diet and the incidence of cardiovascular disease. Higher dietary intakes of potassium and an increase in the ratio of potassium to sodium in the diet have been associated with lower rates of cardiovascular disease [17-24]. This has stimulated interest in the use of potassium-based salt replacement ingredients, enabling further salt reduction by the food industry and reduction of dietary sodium intakes.

In 2012, the WHO stated that if sodium and potassium were consumed at recommended levels in the ratio of sodium to potassium (2,000:3,510 mg/day) it would be considered beneficial for health, with the added benefit that many of the foods which are naturally high in potassium are low in sodium [25]. The WHO also stated that there was no evidence for adverse effects from increased potassium intake from foods in individuals with unimpaired potassium excretion, and that increased potassium intake has been associated with reduced blood pressure and cardiovascular disease outcomes in cohort and intervention trials. Hence, intervening to increase dietary potassium consumption could make a positive impact on blood pressure and cardiovascular disease [25].

In 2013, the United States National Heart Lung and Blood Institute published a report which stated that the current evidence was not sufficient to determine whether increasing dietary potassium intake lowers blood pressure or whether there is an association between dietary potassium intake and coronary heart disease, heart failure, and cardiovascular mortality [26].

In June 2013, the UK Department of Health asked its Scientific Advisory Committee on Nutrition (SACN) to review current recommendations on potassium-based salt replacers and assess the risks from high potassium intake [27]. Subsequently, SACN has requested the Committee on Toxicity (COT) to advise on the possible effects of increased potassium intakes in vulnerable groups. COT has prepared a draft statement which has not been published to date; it is expected that an integrated approach will be adopted by SACN and COT to assessing risks and benefits of potassium-based salt replacers [28].

In August 2014, the FSAI began publishing archival data on the potassium content of processed foods. As for previously published data on sodium, the data for potassium cover ten categories of processed foods from 2003 to 2015 [29]. These data can be accessed here.

In September 2014, the Irish Universities Nutrition Alliance (IUNA) indicated to the FSAI that, based on data derived from the National Adult Nutrition Survey 2008-2010, the mean daily potassium intakes for Irish adults were 3,784 mg/day for men and 2,945 mg/day for women [30]. These levels are lower than current US recommendations for potassium of 4,700 mg/day, but higher (for men) than WHO recommendations of 3,510 mg/day [25, 31]. Mean urinary sodium: potassium ratios were 2.5:1 for men and 2.8:1 for women. These ratios are significantly higher than the optimal sodium: potassium ratio of 1:1 recommended by the WHO [25].

In February 2015, the United States Department of Agriculture Dietary Guidelines Advisory Committee stated that the current scientific evidence was not sufficient to determine whether increasing dietary potassium intake lowers blood pressure or whether there is an association between dietary potassium intake and coronary heart disease, heart failure, and cardiovascular mortality [31]. However, the advisory committee stated that in observational studies with appropriate adjustments, such as for blood pressure and sodium intake, higher dietary potassium intake is associated with lower risk for stroke [31]. The advisory committee also recognised potassium to be a nutrient of concern and encouraged increased potassium intake through potassium-rich foods such as vegetables and fruits [31].

These findings agreed with the earlier findings of the United States National Heart Lung and Blood Institute in 2013 [26].

In April 2015, the Dutch National Institute for Public Health and the Environment published a report on the risks of potassium intake and hyperkalaemia in the context of high salt consumption in the general population of the Netherlands [32]. The report concluded, based on consumption data, that it was nearly impossible to get an overdose of potassium from natural food sources. Almost the entire daily intake of potassium is excreted by the kidneys in healthy individuals [32].

In August 2015, the WHO stated that evidence shows that increasing potassium intake significantly reduces blood pressure in adults. Potassium is found in a variety of unrefined foods, including beans and peas, nuts, vegetables such as spinach, cabbage and parsley, and fruits such as bananas, papayas and dates. Food processing reduces the amount of potassium in many food products, and a diet high in processed foods and low in fresh fruits and vegetables is often lacking in potassium [33].

Conclusion

Based on current scientific literature, the Scientific Committee concludes that there is scope for increased intake of potassium in the Irish diet through consumption of unprocessed or unrefined fruits, vegetables and nuts. The use of potassium-based salt replacement ingredients by the food industry could also help supplement intakes of potassium by the Irish population.

However, potassium-based salt replacement ingredients should only be used by the food industry where reduction of sodium could be detrimental to food safety and/or the physical or organoleptic properties of foods. Furthermore, potassium-based salt replacement ingredients should not be used for the sole purpose of flavour maintenance, i.e. saltiness or flavour enhancement. There continues to be a requirement for the food industry to work on reducing the salt taste thresholds of the Irish population.

Recommendations

The Scientific Committee recommends that the FSAI should:

- Issue guidelines to the food industry on the use of potassium and other mineral-based salt replacement ingredients. These guidelines should consider the following:
  - Possible effects of the use of these ingredients on vulnerable groups
  - Types of replacement ingredients required by the food industry
  - Types of foods in which these ingredients would be used and at what levels
  - Likely reductions in salt levels in these foods
  - Impact on actual sodium reduction in foods
  - Impact on potassium intakes in the population
- Guidelines to industry on the use of potassium and other mineral-based salt replacement ingredients should be made available to all vulnerable groups
- Continue to monitor the sodium and potassium content of food and periodically re-evaluate intakes

II. Low Sodium Intake and Health

The most frequently cited public health benefit of a low sodium diet is lower blood pressure and a subsequent decrease in rates of cardiovascular disease, particularly in people with mild to moderate hypertension [3, 15]. However, the effect of sodium intake on population health remains a very controversial topic [23-24, 34-38].

In recent years, there has been considerable attention in the scientific literature on the interpretation of cohort analyses used to study the relationship between sodium intake and cardiovascular disease [34-57]. The literature has included systematic literature reviews, meta-analyses and analyses of individual studies [57] and has questioned the public health benefits of interventions to decrease sodium intake in the diet. In some cases, it has pointed towards the increased benefits of focusing instead on weight loss and excessive alcohol consumption as a means to reduce hypertension in the population [15].

In 2013, the Institute of Medicine (IOM) reviewed 39 studies and reported that a low sodium diet, i.e. < 2,300 mg sodium/day, might not be as beneficial as previously thought, particularly for people at a higher risk of heart disease [45]. However, considerable heterogeneity between the 39 studies reviewed meant that the effects of low sodium intakes on health could not always be distinguished from overall dietary changes, making accurate conclusions difficult. The IOM nevertheless concluded that sodium intakes should be reduced as there is a robust link between high sodium intakes and cardiovascular disease [45].

The WHO has recommended that salt reduction is one of its three top priority actions to tackle the global burden of non-communicable disease and its Member States have agreed to reduce global population intake of salt by 30% by 2025 [58].

Conclusion

The Scientific Committee concludes that the available evidence indicates that salt intakes in the Irish population are too high and need to be reduced in order to reduce blood pressure and the risk of cardiovascular disease.

Recommendation

The Scientific Committee recommends that guidance on intakes of sodium should be based on the evidence which links high sodium intake to blood pressure and cardiovascular disease and that the public health policy to reduce sodium intake in the Irish population should continue.

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