DISCUSSION DOCUMENT ON SODIUM AND ITS EFFECTS ON FOOD SAFETY AND HUMAN HEALTH

Prepared for the New Zealand Food Safety Authority

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Preface

When writing this discussion document, the term 'sodium' has been used in preference to the term 'salt', 'salt' is used specifically to refer to the compound sodium chloride, as has been the case in the United States of America and Canada. Many documents use the term salt by preference, as over 90 percent of dietary sodium is consumed as salt (sodium chloride) (Medical Research Council Human Nutrition Research, 2005). Where levels of salt are described in reference documents we have generally also calculated levels of sodium using the conversion ratio of sodium:salt of 1:2.5. Many sodium risk management strategies choose to use 'salt' rather than 'sodium', and in describing these the term 'salt' is used.

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Abbreviations

AI	Adequate Intake
ANS08	Adult Nutrition Survey 2008-09
AWASH	Australian division of World Action on Salt and Health
CASH	Consensus Action on Salt and Health
CNS02	Children's Nutrition Survey 2002-03
CVD	Cardiovascular Disease
DALY	Disability Adjusted Life Year
DASH	Dietary Approaches to Stop Hypertension
DIAMOND	Dietary Modelling of Nutritional Data
DSP	Diastolic Blood Pressure
FDA	United States Food & Drug Administration
FSANZ	Food Standards Australia New Zealand
INTERMAP	International study of Macro- and Micro-nutrients and Blood Pressure
INTERSALT	International Study of Electrolyte Excretion and Blood Pressure
IOM	Institute of Medicine
mmHg	Millimeters of mercury
MTL	Multiple Traffic Light
NDNS	National Diet and Nutrition Survey
NGO	Non-governmental organisation
NHANES	National Health and Nutrition Examination Survey
NHF	National Heart Foundation of New Zealand
NIP	Nutrition Information Panel
NNS97	National Nutrition Survey 1997
NZ	New Zealand
NZFSA	New Zealand Food Safety Authority
NZTDS	New Zealand Total Diet Study
PDI	Percent Daily Intake
QALY	Quality Adjusted Life Year
RDI	Recommended Dietary Intake
RNI	Reference Nutrient Intake
SBP	Systolic Blood Pressure
UK	United Kingdom
UKFSA	United Kingdom Food Standards Agency
UL	Upper Level of Intake
USA	United States of America
WASH	World Action on Salt and Health
WCRF	World Cancer Research Fund
WHO	World Health Organization

Conversions

Where conversions are made in the preparation of this document the following conversion factors are used:

1 millimole sodium = 23 milligrams sodium
1 gram sodium chloride (salt) contains 390 milligrams (17 millimoles) of sodium
1 gram sodium = 2.5 grams salt
1 teaspoon salt = 6 grams

Executive Summary

Sodium, mostly in the form of sodium chloride or salt, is widely used in foods to enhance flavour, preserve food, and improve processing. Around three quarters of sodium intake in Western countries is consumed in processed foods with a further 10-15 % added in cooking and at the table. Although sodium is an essential nutrient, the majority of the world's population consumes far in excess of what is required, and more than recommended dietary guidelines. High sodium intake is a cause of high blood pressure, cardiovascular disease, and renal disease. It is associated with an increased risk of stomach cancer, and osteoporosis.

Much of the published work evaluating the risk of high dietary sodium uses modelling to estimate morbidity, mortality and cost of future medical services. Modelling involves simulation of future scenarios based on known associations between sodium intake and blood pressure, stroke and cardiovascular disease, against incidence, prevalence and mortality data in described populations. Although some modelling has been undertaken for New Zealand, risk evaluation could be further informed by further information on population sodium intake and blood pressure measurement, quantification of sodium content in food, research into consumer knowledge, behaviour and use of food labels, and industry research. This information could then form the basis of ongoing monitoring and evaluation of sodium risk management strategies.

Sodium risk management strategies have been identified as one of the most effective and cost effective public health strategies available. Sodium reduction has the potential to substantially reduce mortality and morbidity from cardiovascular disease (particularly stroke and ischaemic heart disease) and reduce health care costs. Effective public health interventions include interventions to reduce both the supply of and demand for dietary sodium. Strategies include:

- Setting targets for population sodium intake and sodium levels in processed foods.
- Collaborating with the food industry to facilitate reformulation to products with lower sodium levels.
- Increasing consumers' knowledge of the risks of high dietary sodium, and increasing their use of food labels. This may involve modification of existing labelling formats to enhance consumers' understanding.
- Introducing monitoring and evaluation programmes to measure population sodium intake, sodium levels in food, and consumer behaviour.

Around the world many countries have committed to sodium risk management strategies. In the United Kingdom the Food Standards Agency has conducted a salt reduction strategy which has been

a co-ordinated, sustained campaign, with evaluation and monitoring suggesting that it has resulted in a population reduction in sodium consumption. In New Zealand some sodium reduction programmes are underway with the New Zealand Food Safety Authority, National Heart Foundation, Stroke Foundation, and some industry groups already active in this area. This work could be strengthened by additional work in a number of areas.

1 Introduction

Although sodium is an essential nutrient, the majority of the world's population consumes far in excess of what is required, and more than dietary guidelines recommend. High sodium intake is a cause of high blood pressure, cardiovascular disease, and renal disease. It is associated with an increased risk of gastric cancer, and osteoporosis.

Sodium has been used in food for more than 5,000 years. Initially used as a preservative, sodium changed diets dramatically enabling people to keep meat and vegetables without spoilage. Now, with the advent of refrigeration and other means of preservation, sodium performs a wider range of functions in food. Sodium, mostly in the form of sodium chloride or salt, has many advantages as a food additive, not the least of which is that it is relatively inexpensive, widely available, palatable, and seen by industry and many consumers as a 'natural' product' (Centre for Science in the Public Interest, 2008).

Sodium reduction strategies have been identified as one of the most effective and cost-effective public health strategies available. Sodium reduction has the potential to substantially reduce mortality and morbidity from cardiovascular disease (particularly stroke and ischaemic heart disease) and reduce health care costs. Effective public health interventions include interventions to reduce both the supply of and demand for dietary sodium.

Internationally a number of regulatory bodies including the United Kingdom's Food Standards Agency (UKFSA), Health Canada and the European Community are addressing salt reduction as a key strategy for reducing the burden of nutrition-related diseases, Recently, the New Zealand Food Safety Authority (NZFSA) agreed to begin a new work programme in this area. This discussion document aims to summarise the food safety and human health risks associated with sodium so that NZFSA can prioritise its risk management activities to areas constituting the greatest risks to consumers.

2 Methodology

This work is the result of a literature search, and consultation with key stakeholders.

A search of peer reviewed literature was conducted using Medline, Web of Science, Scopus and Google Scholar using the key terms *'sodium', 'sodium dietary', 'sodium chloride', 'salt', 'blood pressure', 'hypertension', 'nutrition facts panel', 'nutrition claims', 'health claims', 'disease risks',' food safety', 'food labelling', 'food preservation'*.

Other references were obtained from reference lists in articles. A search of key documents was undertaken from the following sources: Ministry of Health, NZFSA, World Health Organization (WHO), Institute of Medicine (IOM), Centre for Science in the Public Interest, UKFSA, Australian Division of World Action on Salt and Health (AWASH), Consensus Action on Salt and Health (CASH), World Action on Salt and Health (WASH). Key stakeholders were consulted including representatives from NZFSA, the National Heart Foundation of New Zealand (NHF), New Zealand Stroke Foundation, AWASH, and researchers undertaking the New Zealand Adult Nutrition Survey 2008-09 (ANS08).

3 Hazard and Foods

3.1 Sodium

The sodium ion (Na+) is eleventh on the periodic table of elements, and is classified as an alkali metal. Sodium is found in foods, in compound form, most commonly as sodium chloride or salt. Salt is approximately 40% sodium by weight. The molecular weight of sodium is 23 grams per mole (g/mole), and chloride 35g/mole making up the total molecular weight of sodium chloride at 58g/mole.

Sodium is essential to health. The main role of sodium in the body is as the major cation in extracellular fluid, and as such it helps in the regulation of fluid balance and osmolarity through the activity of the sodium potassium pump. The body's sodium content is controlled homeostatically to precise limits through excretion by the kidney (Bray, Cragg, Macknight, Mills, & Taylor, 1986; World Health Organization, 2003). Under normal circumstances the vast majority of sodium excretion occurs via the urine (93%). Some is also lost through the skin in sweat, and in faeces (Sanchez-Castillo, Branch, & James, 1987).

Although sodium is essential to human health, dietary sodium requirements are substantially less than that consumed by the majority of the world's population. Human ancestors ate as little as 0.1g or 100 milligrams per day (mg/day) of sodium, and humans are believed to be genetically adapted to this amount of sodium ingestion (He & MacGregor, 2007; Meneton, Jeunemaitre, De Wardener, & MacGregor, 2005), which is equivalent to the amount naturally occurring in food. A recent review concluded that "sodium balance can be maintained on intakes as low as 69-460mg per day equivalent to 0.175-1.17 grams salt" (Medical Research Council Human Nutrition Research, 2005, p46).[1] Some population groups such as the Yanomamo Indians of South America survive on diets with as little as 1-23mg sodium in 24 hours (estimated by 24-hour urinary excretion) with no obvious adverse effects (Carvalho, et al., 1989).

3.2 Sodium in Foods

The majority (approximately 90%) of dietary sodium is in the form of salt (Mattes & Donnelly, 1991; Medical Research Council Human Nutrition Research, 2005). Other sources of sodium are outlined in Table 1.

In modern food processing salt performs three main functions: taste enhancement, preservation, and processing functions.

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[1] Although under some extreme circumstances such as severe diarrhoea, vomiting or extreme exercise more sodium may be required.

Table 1: Main sources of sodium in foods

Additive	Use
Sodium chloride	Flavouring, processing, preservative
Sodium citrate	Flavouring, preservative
Monosodium glutamate	Flavour enhancer
Sodium cyclamate	Artificial sweetener
Sodium bicarbonate	Yeast substitute
Sodium nitrate	Preservative, colour fixative agent

Source: (Medical Research Council Human Nutrition Research, 2005)

3.2.1 Taste Enhancement

Humans have a natural preference for salty tastes thought to be mediated by specific salt receptors on the tongue. Preference for salty foods is related to salt intake over the previous 8-12 weeks, and humans adjust their salt preferences to either a high salt or low salt diet accordingly. After a gradual but sustained reduction in salt intake, or a low salt diet over this time period, people find foods high in salt content unpalatable (McCaughey, 2007). Similarly, people have adjusted taste preferences to a high salt diet due to the high levels currently in available processed foods, and so the current high salt levels are often maintained by consumer preference (Hutton, 2002). Although a similar salty taste can be provided by other compounds such as potassium chloride (KCl) or lithium chloride (LiCl), these have generally not been widely acceptable to industry or consumers as salt replacements. In addition to providing a salty taste, salt blocks unpleasant tastes such as bitterness, and flavours related to food spoilage, and enhances the effect of other more palatable flavours such as meaty flavours. It also moderates the sweetness of sugars used in breakfast cereals and other confectionary (Man, 2007).

3.2.2 Preservation

Salting is one of the earliest methods of food preservation. Salt slows microbial growth by reducing water activity at particular concentrations. The use of salt as a preservative is particularly important in meat and meat products, pickled vegetables, fermented products (eg soy sauce), sauces, and chilled foods (Man, 2007). In baked products such as bread and cakes, salt delays mould formation thereby extending shelf life (Hutton, 2002). In fermented vegetables the use of salt allows the growth of lactic acid bacterial cultures, while impairing growth of pathogens and spoilage bacteria (Hutton, 2002) (See also section 4.1).

3.2.3 Processing

In processing, salt is reported to improve texture succulence by its ability to retain water in products such as sausages. (Man, 2007) It also allows producers to add weight (and therefore value) to meat products, while maintaining that a product is 'natural' (Centre for Science in the Public Interest, 2008). In cheese, salt helps to control moisture content, while also controlling ripening by influencing water activity and control of cultures and enzymes. In bread and other baked products, salt helps to control the rate of yeast fermentation, influencing texture (Man, 2007). Salt also stabilises gluten making bread dough less sticky during processing (Hutton, 2002).

3.3 Estimates of Total Sodium Intake

Estimates of population total sodium intake vary in methods used. Twenty-four hour urinary analysis of sodium intake is considered the gold standard (Sanchez-Castillo, Branch, et al., 1987), and many surveys use this method. Some surveys have used dietary survey data, which generally underestimates total sodium intake (Espeland, et al., 2001). Not all countries monitor sodium intake data, and many countries have only rough estimates of what their population intake might be. However, it is likely that in most countries sodium intakes exceed that recommended by WHO and other dietary guidelines (Brown, Tzoulaki, Candeias, & Elliott, 2009).

3.3.1 New Zealand

The earliest population 24-hour urinary sodium measurements occurred in Milton in the 1970s and 1980s and showed that in 1975 the average sodium excretion for women was 3,197mg/day, and for men 3,979mg/day. In 1975, 1,209 subjects aged 16 years or more (around 82% of the adult population of Milton) were sampled. The age range was 16-93 years, 96% self identified as European, 1.5% Māori, 0.5% Polynesian, 0.25% Chinese, 0.1% Indian. Results by age group are listed in Table 2. In 1981 mean excretion of sodium for males was 3,956mg/day, and for females 3,082mg/day (see Table 3).

These studies provide the most comprehensive and accurate published estimate of New Zealand sodium intake, however, they are now relatively old and the sample population is not representative of the wider New Zealand population. Estimates of sodium intake for children were also not obtained.

From 1993 to 1998 further 24-hour urinary samples were collected from 724 participants in Dunedin, Waikato and Taranaki. Based on these results, the mean 24-hour sodium intake was estimated to be approximately 3,450mg/day sodium (3,840mg/day sodium for men and 3,100mg/day sodium for women) (Thomson & Colls, 1998).

Other estimates of New Zealand sodium intake have been undertaken using dietary recall questionnaires in the New Zealand Nutrition Surveys: the 1997 National Nutrition Survey (NNS97) and the 2002 National Children's Nutrition Survey (CNS02) (Ministry of Health, 2003; Russell, Parnell, & Wilson, 1999). These are likely to underestimate sodium intake as they do not take account of discretionary salt, and dietary recall estimates of sodium intake are generally less than that obtained through 24-hour urinary sampling (Espeland, et al., 2001). However they do include data from children, and include sample populations more representative of the total population. Thompson (2009) estimated intakes of salt equivalents from 58 processed foods for seven subpopulations from the NNS97 and CNS02. Results are presented in Table 4.

Table 2: Twenty-four hour urinary excretion of sodium (mean) for men and women 1975, with estimated sodium excretion in mg/day (n=1,209)

Age (y)*	Women Sodium (mmol/day)^	Women Sodium (mg/day)	Men Sodium (mmol/day)	Men Sodium (mg/day)
< 20	119	2,737	150	3,450
20-29	139	3,197	177	4,071
30-39	142	3,266	184	4,232
40-49	145	3,335	171	3,933
50-59	149	3,427	163	3,749
60-69	146	3,358	183	4,209
70+	133	3,059	176	4,048
All ages	140	3,197	173	3,979

* y = years
^ mmol/day = millimoles per day. Source: (Simpson, et al., 1978)

Table 3: Twenty-four hour urinary excretion of sodium (mean) for men and women 1981, with estimated sodium excretion in mg/day (n=1,139)

Age (y)	Women Sodium (mmol/d)	Women Sodium (mg/d)	Men Sodium (mmol/d)	Men Sodium (mg/d)
<20	100	2,300	147	3,381
20-29	125	2,875	161	3,703
30-39	141	3,243	175	4,025
40-49	126	2,898	182	4,186
50-59	150	3,450	165	3,795
60-69	152	3,496	184	4,232
70+	138	3,174	194	4,462
All ages	134	3,082	172	3,956

Source: (Simpson, 1982)

Similarly the NZFSA 2003-04 New Zealand Total Diet Study (NZTDS) estimated sodium intake by measuring sodium concentrations in 121 commonly consumed individual foods as consumed. This estimate therefore includes sodium naturally in foods, and sodium added during cooking and processing, but not discretionary salt added at the table, so it is again likely to underestimate sodium intake. However, data showed that most population age groups (with the exception of women 25+ years and infants) exceed their age-gender specific Upper Level of Intake (UL) for sodium just from sodium in foods. Results are presented in Table 5.

The ANS08 includes spot urinary sampling for sodium excretion, which will provide updated estimates of sodium intake. Spot urinary sodium provides a reasonable estimate of 24-hour excretion (see section 7) however the precise relationship between 24-hour sodium excretion and spot urine excretion in the New Zealand population is unclear. Modelling of the relationship between 24-hour urine and spot urine results in a variety of age groups in the New Zealand population will enable a more precise interpretation of the ANS08 spot urine results. The 24-hour urine results from this modelling work will also provide a baseline gold standard measurement from which spot urine results could be used to monitor sodium intake in future years.

3.3.2 International

In Australia, estimates of sodium intake using 24-hour urine data from selected population groups vary from 6.5-12g/day salt. In 2009 FSANZ modelled dietary information from the 1995 Australian National Nutrition Survey against food composition data using DIAMOND software to estimate an average mean salt intake of 5.5 g/day, which equates to 2,150mg/day sodium. Others have estimated that the average Australian consumption to be higher at around 9g/day salt (3,600mg/day sodium) (Food Standards Australia New Zealand, 2009a; Webster, et al., 2009). In the UK, sodium intake has been monitored using 24-hour urinary sodium measurement and shows a recent 10% reduction in sodium intake from an average of 9.5g/day salt (3,800mg/day sodium) in 2000-01 to 8.6g/day salt (3,440mg/day sodium) in 2008 (Food Standards Agency, 2008). In the USA, the National Health and Nutrition Examination Survey (NHANES) has used dietary survey data from 2003-06 to estimate an average sodium intake of 3,614mg/day made up of 4,380mg/day for men and 3,103mg/day for women aged 19 years and over. For adults 19 years of age and over, the total average sodium intake for men was 4,380mg/day and for women was 3,734mg/day (IOM (Institute of Medicine), 2010). Analysis of dietary recall data from NHANES 2005-06 suggests that USA adults consumed an average sodium intake of 3,466mg/day (Peralez Gunn, Kuklina, Keenan, & Labarthe, 2010). Estimates from the China Nutrition and Health Status Survey suggest that in China the average sodium intake is around 4,800g/day (12g/day of salt) (Webster, 2009), and the average sodium intake in Japan was estimated to be around 4,500mg/day in 1996-99 (Anderson, et al., 2010).

Table 4: Dietary intake estimates of salt equivalents g/d (sodium mg/day in brackets)

	Age (y)	Female		Male		Combined	
		Mean	Median	Mean	Median	Mean	Median
CNS02	5-6 y	..	..	..	..	3.5 (1,400)	3.3 (1,320)
	11-14 y	4.2 (1,680)	3.8 (1,520)	5.3 (2,120)	4.6 (1,840)	..	..
NNS97	19-24 y	5.2 (2,080)	3.7 (1,480)	5.2 (2,080)	3.7 (1,480)	..	..
	25+ y	3.9 (1,560)	3.1 (1,240)	5.9 (2,136)	4.6 (1,840)	..	..

Source: (Thomson, 2009)

Table 5: Estimated mean dietary sodium intake (mg/day) for the eight age-sex groups of the 2003-04 NZTDS

Intake (mg/day)	25+ y male	25+ y female	19-24 y male	11-14 y boy	11-14 y girl	5-6 y child	1-3 y toddler	6-12 m^ infant
Sodium intake (mg/day)	3,047	2,150	3,603	3,108	2,496	2,031	1,384	845
Intake as % of UL	132%	93%	157%	155%	125%	145%	138%	Unable to calculate

^ m = months. Source: (New Zealand Food Safety Authority, 2005, p60)

Table 6: Comparison of estimated New Zealand average population sodium intake with international estimates

Country	Year	Measure	Sodium (mg/day)	Salt (g/day)	Source
New Zealand	1978, 1982, 1998	Estimate based on 24-hour urine samples	3,600	9	(Ministry of Health and the University of Auckland, 2003)
Australia	..	Estimate based on dietary survey and 24-hour urine samples	3,600	9	(Webster, et al., 2009)
USA	2005-06	Dietary survey	3,400	8.5	(Peralez Gunn, et al., 2010)
Canada	2004	Dietary survey	3,100	7.8	(Fischer, Vigneault, Huang, Arvaniti, & Roach, 2009)
UK	2008	24-hour urine	3,400	8.6	(Food Standards Agency, 2008)
Japan	1996-99	24-hour urine	4,500	11	(Anderson, et al., 2010)
China	2001	Dietary survey	4,800	12	(Webster, 2009)
Republic of Korea	2003	Dietary survey	5,300 men 4,500 women	13.3 men 11.3 women	(Webster, 2009)

3.4 Major Contributing Foods

Dietary surveys are used to estimate which foods contribute most to sodium intake. However, there are several limitations to dietary survey data including potential for recall bias in retrospective surveys, potential to change dietary intake to more healthy options in prospective surveys, and difficulties assessing quantities of food consumed (although weighing and photographs of food consumed are sometimes used). A major challenge of dietary surveys of sodium intake is difficulty measuring the amount of discretionary salt consumed, and for these reasons it is generally accepted that estimates of sodium intake from dietary surveys is an underestimate of total sodium intake (Espeland, et al., 2001).

In Western countries it is generally accepted that around three-quarters of dietary sodium intake comes from processed foods, 10-15% from sodium naturally inherent in foods, 10% is discretionary added in cooking and at the table and around 1% comes from drinking water (James, Ralph, & Sanchez-Castillo, 1987; Mattes & Donnelly, 1991; Medical Research Council Human Nutrition Research, 2005). Other populations show different patterns of sodium intake. In China, it is estimated that around 78% of sodium intake is added during cooking, and in Japan the main sources of sodium include soy sauce, fish and soups with around 10% as added salt during cooking (see Table 7) (Anderson, et al., 2010; World Health Organization, 2006). There is no information about the proportion of sodium intake from various sources specifically relating to Pacific Island countries, and it is unclear whether minority groups in New Zealand would have sodium intake patterns that reflect a predominantly Western pattern of intake, or that resembling countries of their ethnic origin.

Breads, cereals, and processed meats contribute most to sodium intake from processed food. An analysis of data from the NNS97 survey using Dietary Modelling of Nutritional Data (DIAMOND) computer programme combined consumption data from the nutrition survey with food composition data from the New Zealand Food Composition Database (NZFCDB). This showed that breads were the leading source of dietary sodium, followed by processed meats, sauces, breakfast cereals and baked products (see Table 8).

Results from Thomson (2009) (see section 3.3.1) showed that for all age groups bread made the greatest contribution to sodium intake from processed foods (35-43%). Other foods that contributed more than 2% of intake from processed foods that were common across most age groups included sausages, meat pies, pizza, instant noodles and cheese (Thomson, 2009).

The 2003-04 NZTDS modelled 14 day simulated 'typical' diets for selected population groups based on dietary recall data from the NNS97, and CNS02 as well as additional data from other surveys, and some industry data. One hundred and twenty one foods were then analysed for selected agricultural

compounds and elements including sodium concentration. Results highlight bread, takeaways, dairy products, cereals and pasta, biscuits and cake and meat and meat products as important sources of dietary sodium in New Zealand (New Zealand Food Safety Authority, 2005).

Table 7: Proportion of sodium from various sources*

Population	Naturally occurring in food	Processed food	Used in cooking	Added at the table	Drinking water	Reference
USA	12%	77%	5%	6%	<1%	(Mattes & Donnelly, 1991)
Cambridgeshire, UK	88%		5%	7%		(Sanchez-Castillo, Warrender, Whitehead, & James, 1987)
UK	10%	75%	4%	7%		(James, et al., 1987)
UK NDNS	15%	60-75%	10%		1%	(Medical Research Council Human Nutrition Research, 2005)
Healthy Danish volunteers	88%		12%			(Andersen, Rasmussen, Larsen, & Jakobsen, 2009)
INTERMAP Study China	18%	76%				(Anderson, et al., 2010)
INTERMAP Study Japan	84% [20% total intake from soy sauce]	9.5%				(Anderson, et al., 2010)
NHANES	93%			5%	<1%	Adapted from (IOM (Institute of Medicine), 2010)

* Some figures are adapted from rather than directly taken from sources

Table 8: Foods contributing to sodium intake in New Zealand (excluding table salt)

Food Group	Percentage of sodium intake*	Notes
Breads	25.7	
Processed meats and sausages	10.3	Includes ham and bacon
Potatoes and kumara	6.7	Excludes potato crisps, includes chips
Sauces	6.3	
Breakfast cereals	5.8	Includes porridge
Meat and poultry	5.0	Beef and veal, lamb & mutton, pork, poultry
Cakes, muffins and biscuits	4.5	Includes crackers
Milk and dairy	4.3	Cream, ice cream, sour cream, yoghurt
Bread based dishes	4.3	Sandwiches, burgers, pizza tortilla etc
Butter and margarine	3.8	
Vegetables	3.5	
Grains and pasta	3.2	Rice, flour pasta, noodles
Fish and seafood	3.2	
Pies and pastries	3.1	Meat pies, pastries, sausage rolls, etc
Cheese	2.8	
Beverages	2.0	
Stocks and soups	1.7	

* Methods - NNS97 data modelled using DIAMOND computer programme. Source: (Ministry of Health and the University of Auckland, 2003, p30)

4   Evaluation of Adverse Health Effects

This chapter outlines some beneficial effects of sodium as a preservative and inhibitor of microbial growth, as well as adverse health effects from the over-consumption of dietary sodium. Although sodium is an essential nutrient, most people around the world consume more than the required daily amount and are at risk of adverse health effects (Brown, et al., 2009), and sodium deficiency or hyponatraemia is rarely seen outside of a hospital environment. Sodium depletion can cause symptoms of headache, nausea, vomiting, central nervous system dysfunction and muscle cramps, but is not caused by inadequate dietary intake of sodium. Low serum sodium or hyponatraemia occurs most commonly as a result of medical disorders, post operatively, or due to treatment with thiazide diuretics. Hyponatraemia can also occur with severe vomiting and diarrhoea, or blood loss where acute sodium and fluid losses exceed intake (Adrogue & Madias, 2000). Some authors have suggested that the syndrome of Exercise-Associated Hyponatraemia (EAH) is caused by inadequate sodium intake coupled with sodium depletion through excessive sweating during exercise (for example (Gangopadhyay, Gupta, Vaskar, Gautam, & Toogood, 2010). However, current evidence indicates that EAH is caused by excessive water ingestion, resulting in an absolute increase in total body water, rather than inadequate sodium ingestion, or body sodium depletion (Exercise-Associated Hyponatremia (EAH) Consensus Panel, 2005; Rosner & Kirven, 2007). Observational studies have shown that societies with very low sodium intakes do not exhibit signs of sodium deficiency despite being relatively active (Carvalho, et al., 1989), and a recent review of sodium metabolism in the body led the author to conclude that "it is virtually impossible to generate sodium deficiency by dietary means" (Bie, 2009, p194).

4.1 Foodborne Illness

Salt has been used for many hundreds of years to inhibit the growth of food-borne pathogens and spoilage organisms such as bacteria, fungi, parasites and moulds. While salt continues to be the main sodium compound used in preservation, other sodium containing compounds, such as sodium lactate, sodium nitrite, and disodium phosphate are also used (Doyle & Glass, 2010). Sodium chloride inhibits growth of microorganisms by decreasing water activity (a_w). It does this by exerting an osmotic gradient thereby drawing water out of cells, causing shrinkage of the cytoplasmic volume (plasmolysis). Plasmolysis has a number of effects on pathogenic bacterial cells including inhibition of nutrient uptake, inhibition of replication, and inhibition of toxin synthesis. Salt appears to be more effective at controlling bacterial growth than other compounds which may also exert similar osmotic effect (Taormina, 2010).

Microbes vary in their sensitivity to salt, for example *Campylobacter jejuni* are highly sensitive to salt concentrations, while *Clostridium botulinum* and *Staphylococcus aureus* can tolerate much higher salt

levels. Some microbes such as *Salmonella spp* and *Escherichia coli* can survive high salt concentrations, although their growth is inhibited. The additive use of other methods of preservation such as pH, temperature, and other food additives can affect the sensitivity of microbes to salt in specific foods (Doyle & Glass, 2010; Wilkinson, 2008).

In most products it is usual to have several methods of preservation in which the combined effect of techniques such as pH, temperature, nitrite, and sodium are used. In many chilled meat products the combined effect of the addition of salt and nitrite is used. However, altering proportions of salt and nitrite in cured meats, or replacing salt with salt replacements such as potassium chloride (KCl) or magnesium chloride ($MgCl_2$) can be done without impairing control of microbiological growth and have been identified as potential salt risk management strategies (Desmond, 2006). Although consumer resistance is sometimes cited as a major barrier to salt reduction in processed foods, research indicates that consumers may be receptive to lower sodium processed meat products (Guardia, Guerrero, Gelabert, Gou, & Arnau, 2006). Further research into alternative methods of preservation of a variety of foods is currently being undertaken (Food Standards Agency, 2009a; Matsui, et al., 2010). The development and use of pathogen modelling programmes is a useful tool to estimate the required level of various preservatives including salt. These predictive models have been developed for modelling growth of pathogenic and spoilage microorganisms in a variety of foods (Doyle & Glass, 2010; Hutton, 2002) (See for example United States Department of Agriculture, 2010).

The use of salt in food preservation is particularly important in meat and meat products (including fish and poultry), pickled vegetables, fermented products (such as soy sauce), sauces, and other chilled foods (Man, 2007). In baked products such as cakes and breads salt is used to delay mould formation and increase shelf life, and in fermented vegetable products salt allows the growth of lactic acid bacterial cultures, while impairing growth of bacterial pathogens (Hutton, 2002). A recent review by Taormina (2010) outlines foods that rely on sodium addition for microbiological stability (see Table 9). Foods in the left column could have sodium levels reduced without greatly altering microbiological food safety or quality outcomes. For foods in the right column, however, sodium reduction could potentially compromise food safety, and further research may be necessary to investigate how sodium levels can be reduced safely.

Although risks to microbiological food safety are a potential barrier to salt reduction in some processed foods, surveys show that sodium content in similar foods varies greatly. A survey of industry trade associations of the food and drink manufacturing industry in 1999 showed that there was a substantial variation in the sodium content of foods within individual product categories (Brady, 2002). Similarly, a survey of sodium contents of processed foods in Australia showed concentrations varied substantially within food categories (see Table 10). Therefore, it should be feasible to reduce

salt content in a range of foods without compromising food safety, providing the lowest level of salt already in use remains inhibitory (Webster, Dunford, & Neal, 2009a).

Table 9: Summary of the impact of sodium chloride (NaCl) addition on microbiological stability of some food products

Foods not microbiologically preserved by added NaCl*	Foods for which added NaCl contributes to microbiological stability through inhibition of growth of spoilage and/or pathogenic microorganisms

• Baked breads (eg pre-packaged bread, pita bread, tortillas)
• Dry snack products (eg crackers, chips, popcorn)
• Prepared foods (boxed) (spice and cheeses packets in rice meals, macaroni and cheese packages)
• Breakfast cereals
• Beverages (chilled or shelf stable)
• Flavourings including spice packets
• Frozen foods- (including raw meat, produce and prepared foods, as well as pre-cooked meals)
	• Ready-to-eat, refrigerated
	  o Deli-meats, sausages, hams
	  o Prepared salads and spreads
	  o Soft cheese
	  o Hard cheese
	  o Butter
	  o Pickles and olives
	• Ready-to-cook, refrigerated
	  o Bacon, fresh sausages, meat patties, moisture enhanced meat products
	  o Dough, par-baked bread
	• Ready-to-eat, ambient
	  o Pies, cakes, baked pastries with filling
	• Ready-to-eat, shelf stable
	  o Dry and semi-dry sausages, dry cured ham, pre-cooked bacon, smoked fish
	  o Processed cheese and spreads
	  o Canned foods such as soups, sauces and vegetables
	  o Olives, anchovies
	  o Salad dressings, tomato sauce

* When stored according to manufacturer recommendations in final packaged form. Source: (Taormina, 2010)

Table 10: Sodium content of selected processed foods in Australia

Food Group	Number of products	Range sodium (mg/100g)	UKFSA 2012 target (mg/100g)
Bacon	47	920-1,950	1,150
Sausages and hot dogs	96	229-2,157	450
Salami	80	450-3,300	700
Hard Cheese	294	24-1,740	750
Soft Cheese	134	32-1,900	300

Source: (Webster, et al., 2009a)

4.2 Non-communicable (Chronic) Disease

A number of challenges exist when conducting large-scale clinical trials of nutritional interventions with clinical endpoints of chronic non-communicable diseases. These include difficulties with maintaining dietary change in those in intervention groups over long periods, and the long follow up times required, which make such interventional studies expensive and time consuming. Given these difficulties we often rely on multiple sources of evidence when examining nutritional interventions for chronic disease prevention, including evidence from a variety of study types, and endpoints, some of which may be surrogate rather than clinical disease outcomes. The World Cancer Research Fund (WCRF) has developed a set of criteria to assess evidence for nutrition interventions to prevent chronic disease, and these have been used in several major evidence reviews (World Cancer Research Fund / American Institute for Cancer Research, 2007; World Health Organization, 2003).

Based on these criteria, there is convincing evidence to support a causal association between excess dietary sodium intake and elevated blood pressure, particularly the rise in blood pressure with age seen in many populations. Convincing evidence is defined as:

> evidence based on epidemiological studies showing consistent associations between exposure and disease, with little or no evidence to the contrary. The available evidence is based on a substantial number of studies including prospective observational studies and where relevant, randomized controlled trials of sufficient size, duration and quality showing consistent effects. The association should be biologically plausible (World Health Organization, 2003, p54f).

4.2.1 Cardiovascular Disease

A wide range of evidence from different study types shows a causal association between sodium intake and blood pressure. Elevated blood pressure (hypertension) is a significant risk factor for cardiovascular disease (CVD), including ischaemic heart disease, congestive heart failure, and cerebrovascular disease and stroke (Prospective Studies Collaboration, 2002). Data from the Asia Pacific Region including patients in New Zealand shows a similar association (Asia Pacific Cohort Studies Collaboration, 2003). Hypertension is also a risk factor for other forms of CVD, including left ventricular hypertrophy, chronic renal failure and hypertensive renal disease (Lawes, Vander Hoorn, & Rodgers, 2008; Vupputuri, et al., 2003).

Blood pressure is recorded as two readings: systolic (SBP)/diastolic (DBP). High blood pressure is usually defined as a SBP of ≥ 140mmHg or a DBP of ≥ 90mmHg or both (Guidelines Subcommittee, 1999; Williams, et al., 2004). Therefore people can have isolated systolic hypertension, isolated diastolic hypertension or systolic-diastolic hypertension. Both SBP and DBP show an association with mortality from stroke and ischaemic heart disease. Although SBP is thought by many to be a more useful measure of predicting cardiovascular risk (Williams, Lindholm, & Sever, 2008), in practice, often both measures are used (see for example World Health Organization, 2005). Observational

studies show that the relationship between blood pressure (SBP and DBP) and CVD is log linear, and independent of other risk factors, with lower risk associated with lower blood pressure between at least 115/75mmHg and 185/115mmHg (Prospective Studies Collaboration, 2002). Although guidelines exist for establishing a diagnosis of hypertension it is clear that there are benefits of lowering blood pressure below this level, and, on a population level even a 2mmHg lowering of either SBP or DBP has clear benefits for CVD risk reduction (Cook, Cohen, Hebert, Taylor, & Hennekens, 1995; Medical Research Council Human Nutrition Research, 2005; Prospective Studies Collaboration, 2002).

Cardiovascular disease (particularly ischaemic heart disease and cerebrovascular disease) is the leading cause of death worldwide, including high, middle and low-income countries. New Zealand, like many other countries, has seen mortality rates from CVD drop over the past two decades (Tobias, Sexton, Mann, & Sharpe, 2006). Nevertheless, CVD remains the leading cause of death in New Zealand, and a significant cause of morbidity.

A major systematic review of risk factors to identify attributable burden of disease worldwide identified high blood pressure (SBP and/or DBP) as the leading risk factor contributing to death (causing 7.5 million or 12.8% of deaths in 2004). Importantly, this review took account of burden of disease attributable to blood pressure that was clinically in the 'normal' range (< 140mmHg) but was still higher than ideal. Among high income countries, high blood pressure ranked second only to tobacco use as the leading cause of death, accounting for 16.8% of deaths in 2004 (see Table 11). High blood pressure also accounted for an estimated 6.1% of total Disability Adjusted Life Years (DALYs) lost in high income countries in 2004 (World Health Organization, 2009).

Evidence of an association between dietary sodium intake and cardiovascular endpoints from randomised controlled trials is difficult to obtain because dietary change over the long term is challenging to maintain and measure, and long term follow up periods would be required. Although there is no direct evidence from randomised controlled trials with cardiovascular endpoints, a follow up study of a randomised controlled trial of dietary sodium reduction in the trials of hypertension prevention (TOHP) study found that 10-15 years after the original trial there was a statistically significant reduction in risk of a cardiovascular event of 25-30% among those in the intervention group (Cook, et al., 2007).

A number of ecological (Perry & Beevers, 1992; Xie, Sasaki, Joossens, & Kesteloot, 1992) and prospective (Nagata, Takatsuka, Shimizu, & Shimizu, 2004) studies have shown an association between sodium intake and mortality from stroke. A recent meta-analysis of prospective cohort studies indicated a significant association between dietary sodium intake and risk of stroke, with pooled analysis showing that an increase in sodium intake of approximately 2,000mg/day was

associated with a 23% higher risk of stroke. The authors also analysed the association between sodium intake and risk of CVD, which was of borderline statistical significance. However, following the exclusion of one outlying study (which was thought to have more unreliable estimates of sodium intake) the association was significant with a 17% increased risk of CVD with a 2,000mg/day increase in sodium intake (Appel, 2009; Strazzullo, D'Elia, Kandala, & Cappuccio, 2009).

The relationship between sodium intake and cardiovascular mortality appears particularly strong in overweight and obese adults. A Finnish cohort study identified a significant interaction between sodium excretion and body mass index for both cardiovascular mortality and all-cause mortality in men (Tuomilehto, et al., 2001). Other studies have demonstrated an independent association between sodium intake and cardiovascular and all-cause mortality in overweight people. (He, et al., 1999). Furthermore, it is thought that metabolic syndrome may enhance the blood pressure response to sodium intake (Chen, et al., 2009; Hoffmann & Cubeddu, 2007).

While the most important adverse effect of dietary sodium intake on the CVD risk is through its effect on blood pressure there is also evidence of a direct effect independent of the effect on blood pressure of increased sodium intake and cardiovascular endpoints. Reduced salt intake has been shown to have a beneficial effect in improving distensibility of the central aorta and large peripheral arteries independent of hypertensive action in normotensive adults (Avolio, et al., 1986). A recent New Zealand study showed that increasing dietary sodium intake had adverse effects on arterial wall function independent of blood pressure in hypertensive subjects, demonstrated as increased pulse wave velocity (Todd, et al., 2009). There is also evidence of an independent association between dietary sodium intake and left ventricular hypertrophy independent of blood pressure effects (Kupari, Koskinen, & Virolainen, 1994).

Table 11: Ranking of selected risk factors: Five leading risk factor causes of death by income group, 2004

Risk factor	Deaths (millions)	% of total	Risk factor	Deaths (millions)	% of total
World			**Low income countries***		
1. High blood pressure	7.5	12.8	1. Childhood underweight	2.0	7.8
2. Tobacco use	5.1	8.7	2. High blood pressure	2.0	7.5
3. High blood glucose	3.4	5.8	3. Unsafe sex	1.7	6.6
4. Physical inactivity	3.2	5.5	4. Unsafe water, sanitation, hygiene	1.6	6.1
5. Overweight and obesity	2.8	4.8	5. High blood glucose	1.3	4.9
Middle income countries*			**High income countries***		
1. High blood pressure	4.2	17.2	1. Tobacco use	1.5	17.9
2. Tobacco use	2.6	10.8	2. High blood pressure	1.4	16.8
3. Overweight and obesity	1.6	6.7	3. Overweight and obesity	0.7	8.4
4. Physical inactivity	1.6	6.6	4. Physical inactivity	0.6	7.7
5. Alcohol use	1.6	6.4	5. High blood glucose	0.6	7.0

* Countries grouped by national income per capita. Source: (World Health Organization, 2009, p11)

4.2.2 Blood Pressure

A consistent association between dietary sodium intake and blood pressure has been shown across a range of study types including animal studies (Denton, et al., 1995), observational studies of different human populations (Truswell, Kennelly, Hansen, & Lee, 1972), migration studies (Law, Frost, & Wald, 1991), large epidemiological observational studies such as INTERSALT (a cross-sectional study which examined the association between 24-hour urinary sodium excretion and blood pressure in 32 countries around the world) (Stamler, et al., 1989), population intervention studies (Forte, Miguel, Miguel, de Padua, & Rose, 1989; Takahashi, Sasaki, Okubo, Hayashi, & Tsugane, 2006), and randomised controlled trials of dietary interventions (Sacks, et al., 2001). A Cochrane Collaboration systematic review and meta-analysis of randomised trials demonstrated that for adults a reduction of sodium intake by at least 40mmol (920mg) would lead to an average reduction in blood pressure of 5/3mmHg for hypertensive and 2/1mmHg for normotensive adults. The authors of this meta-analysis concluded that if these changes were to be achieved at a population level this would reduce stroke deaths by approximately 14% and ischaemic heart disease deaths by 9% in adults with hypertension, and 6% and 4% respectively in those with normal blood pressure (He & MacGregor, 2003). Results of public health sodium reduction interventions such as those in Japan and Finland support this conclusion (Nagata, et al., 2004; Tuomilehto, et al., 2001).

Evidence also shows that there is a consistent linear dose response relationship between sodium intake and blood pressure at a population level (He & MacGregor, 2003; Medical Research Council Human Nutrition Research, 2005).

Isolated populations with extremely low dietary sodium intake as low as 18mg/day show low blood pressure throughout the life course, with no age-related increase, and no adverse effects from low sodium intake (Carvalho, et al., 1989). Although some rare genetic causes of high blood pressure have been identified (He & MacGregor, 2009), and other risk factors for high blood pressure such as body mass index, alcohol intake and low dietary potassium intake have been identified (Stamler, et al., 1989), reducing dietary sodium intake has been identified as a key intervention for reducing blood pressure on a population basis. Observational data from Japan show that a nationwide salt reduction campaign was associated with a reduction in blood pressure and a decrease in mortality from stroke of 80%. This is despite population-wide increased consumption of alcohol and tobacco, as well as increasing obesity and dietary fat intake over the same period (He & MacGregor, 2007).

Studies of sodium intake in children have shown a similar association with blood pressure. A meta-analysis of controlled trials investigating association of salt intake and blood pressure in children and adolescents (≤ 18 years) indicated that a modest reduction in sodium intake would reduce blood pressure (He & MacGregor, 2006). This is important because high blood pressure in children and adolescents has been shown to have adverse cardiovascular effects, thereby increasing future CVD

risk. It is also known that early development of risk factors such as poor diet or elevated blood pressure in childhood and adolescence tend to continue into adulthood, increasing likelihood of the development of non-communicable disease (World Health Organization, 2003).

Experimental evidence shows that some individuals are more 'salt sensitive' than others. Some individuals have large changes in blood pressure in response to large abrupt changes in sodium intake, which relates to the ability of the kidneys to excrete a high sodium load (Meneton, et al., 2005). Salt sensitivity increases with age, and is more prevalent among some population groups such as African Americans (Correia, 2007). However, a genetic basis for salt sensitivity has not been firmly established, and there are no widely accepted criteria for identifying salt sensitive individuals (Meneton, et al., 2005). There is little evidence to support the notion that salt sensitivity operates on a population level in response to long-term changes in dietary sodium intake. The overwhelming evidence shows that that the vast majority of both normotensive and hypertensive people will respond to a reduction in dietary sodium intake with a small reduction in blood pressure (Meneton, et al., 2005; Stamler, et al., 1989). There is little evidence to support the notion that only the few 'salt sensitive' individuals need to monitor their dietary sodium intake.

Although there is general consensus that increased dietary sodium intake is associated with increased blood pressure and CVD risk, a few dissenting opinions have been expressed in the peer-reviewed literature. In 1996 the Salt Institute re-analysed data from the INTERSALT cohort study and concluded that their reanalysis showed *"no significant relation between urinary sodium excretion and the rate of increase in blood pressure with age"* (Hanneman, 1996), and in 1995 Alderman et al. published an observational study in which they purported to show that urinary sodium excretion was inversely related to risk of myocardial infarction in treated hypertensive patients (Alderman, Madhavan, Cohen, Sealey, & Laragh, 1995). However both these studies have been discredited due to methodological flaws in their interpretation and statistical analysis of results (Law, 1996; MacGregor & De Wardener, 1998).

The exact mechanism linking high sodium intake and elevated blood pressure is complex and not completely understood. The kidneys play an essential role in regulating both blood pressure and plasma sodium concentration. However kidneys' ability to excrete sodium decreases as we age, and is also impaired with high intakes of dietary sodium leading to sodium (and water) retention. An increase in blood pressure enables the kidneys to excrete the excess sodium consumed, by increasing renal tubular fluid flow (Appel, et al., 2001; Bie, 2009; Karppanen & Mervaala, 2006). However, it is likely that a multitude of other mechanisms also play a role in the relationship between sodium intake and blood pressure.

Sodium and water retention results in expansion of the extracellular volume, increased intracellular sodium and a small but significant rise in plasma sodium. Expansion of extracellular volume, and increased intracellular sodium contribute to vascular smooth muscle cell contraction and increased peripheral vascular resistance, which both increase blood pressure. Vascular endothelial function is also impaired. A pressure natriuresis mechanism operates so that blood pressure is raised to restore normal extra-cellular fluid volume. Increased plasma sodium concentration stimulates thirst mechanisms and therefore raises blood pressure through increased blood volume, as well as other mechanisms (He & MacGregor, 2010; Khalil, 2005; Meneton, et al., 2005). This blood pressure rise also stimulates an auto-regulation mechanism constricting small arterioles, thereby increasing blood pressure further (Guyton, 1991).

4.2.3 Stomach Cancer

Stomach cancer is a leading cause of cancer and cancer-related mortality in the world (De Wardener & MacGregor, 2002). The WCRF has concluded on the basis of a systematic review of evidence (including cohort, case control and ecological studies, as well as meta-analysis of cohort study data), that dietary salt and salted foods are a probable cause of stomach cancer. Several studies suggest an interaction between salt intake and *Helicobacter pylori* (*H pylori*) infection (World Cancer Research Fund / American Institute for Cancer Research, 2007). Subsequent reviews have supported this association, particularly the interaction with *H pylori* infection (Malekzadeh, Derakhshan, & Malekzadeh, 2009; Wang, Terry, & Yan, 2009). It is believed that a high salt diet can cause inflammation of the lining of the stomach, especially in presence of *H pylori* infection, and may predispose to colonisation with *H pylori* (De Wardener & MacGregor, 2002). Forest plots generated during the WCRF systematic review appear in Figure 2 and Figure 3.

Figure 1: Relationship between reduction in 24-hour urinary sodium and change in blood pressure - a meta-analysis of trials of modest sodium reduction*

Dose-response to Salt Reduction
(Meta-analysis of Modest Salt Reduction Trials of 1 month or longer)
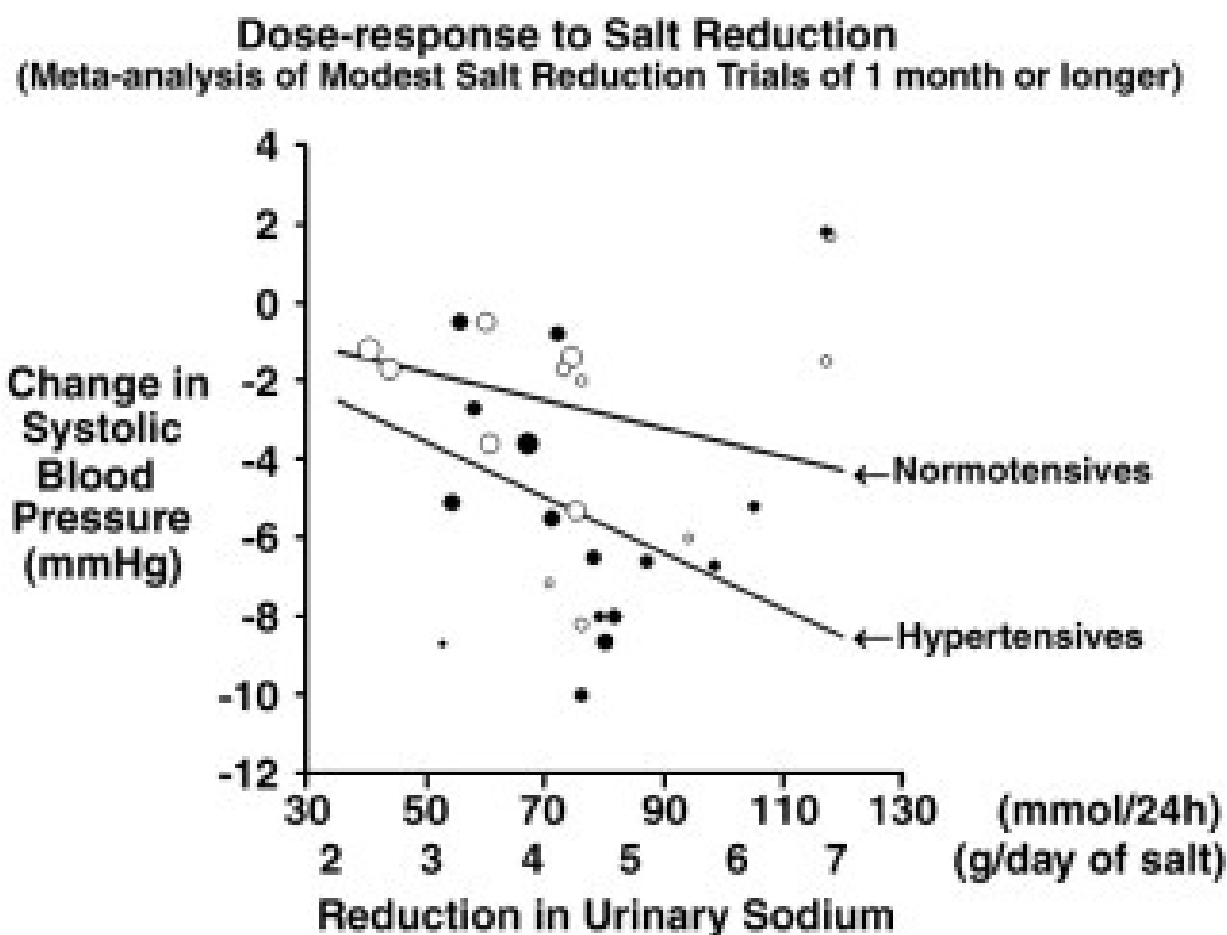
* Note: The open circles represent normotensives and the solid circles represent hypertensives. The slope is weighted by the inverse of the variance of the net change in blood pressure. The size of the circle is in proportion to the weight of the trial. Source (He & MacGregor, 2010)

Figure reproduced with the permission of the authors

Figure 2: Total salt use and stomach cancer; cohort and case-control studies
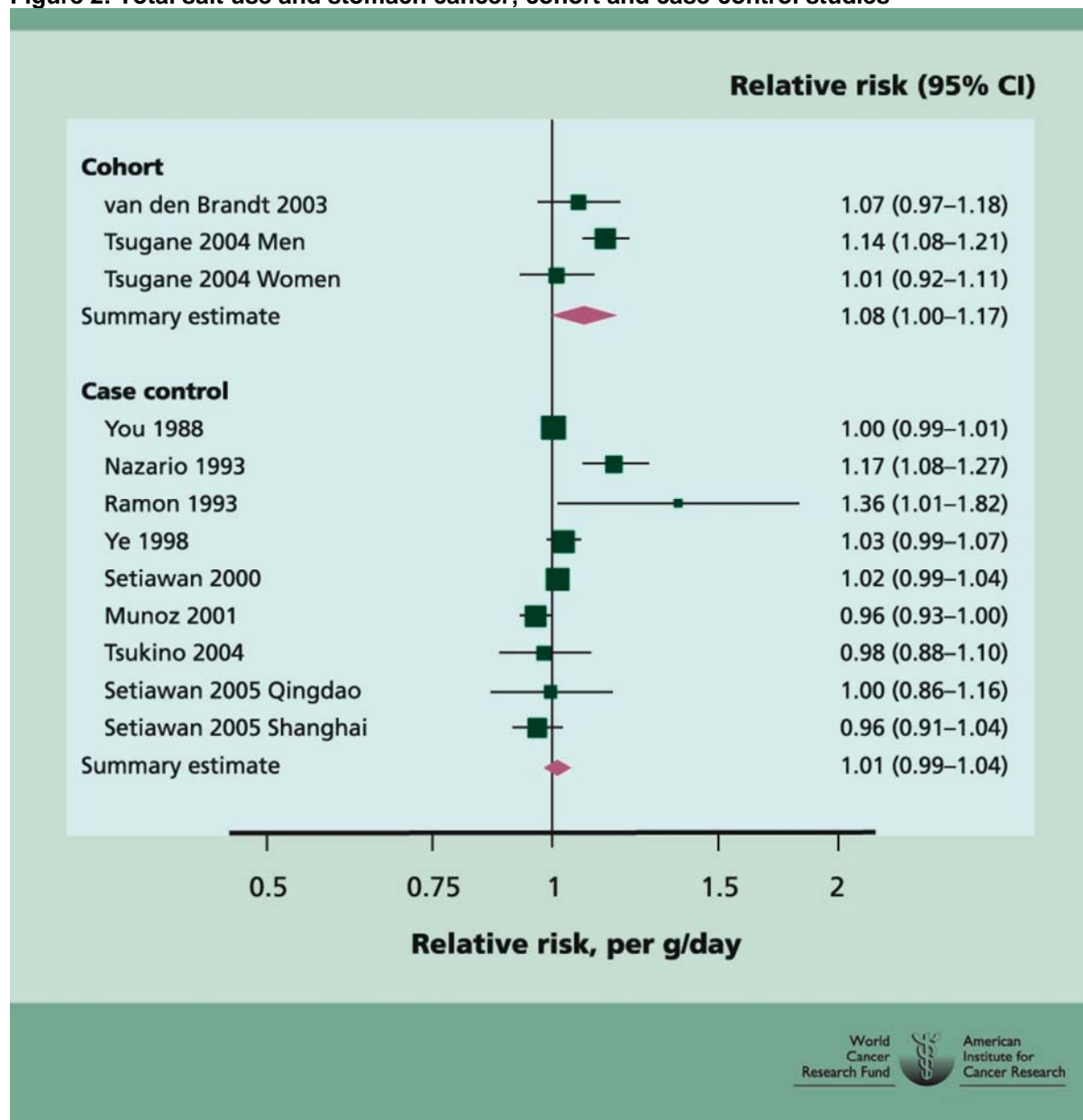
Source: (World Cancer Research Fund / American Institute for Cancer Research, 2007, p145)

Figure reproduced with the permission of World Cancer Research Fund / American Institute for Cancer Research

Figure 3: Salty/salted foods and stomach cancer; cohort and case-control studies

Relative risk (95% CI)

Cohort
Galanis 1998	1.14 (0.61–2.13)
Ngoan 2002	1.21 (0.68–2.16)
Khan 2004 Men	1.76 (0.58–5.32)
Khan 2004 Woman	6.01 (0.85–42.61)
Summary estimate	1.32 (0.90–1.95)

Case control
Demirer 1990	116.86 (13.16–1037.90)
Hirayama 1992 Men	2.85 (2.13–3.81)
Hirayama 1992 Women	3.53 (2.34–5.34)
Ward 1999	113.13 (3.76–3403.01)
Sriamporn 2002	3.98 (0.65–24.22)
Summary estimate	5.20 (2.49–10.83)

0.5 1 2   6

Relative risk, per serving/day
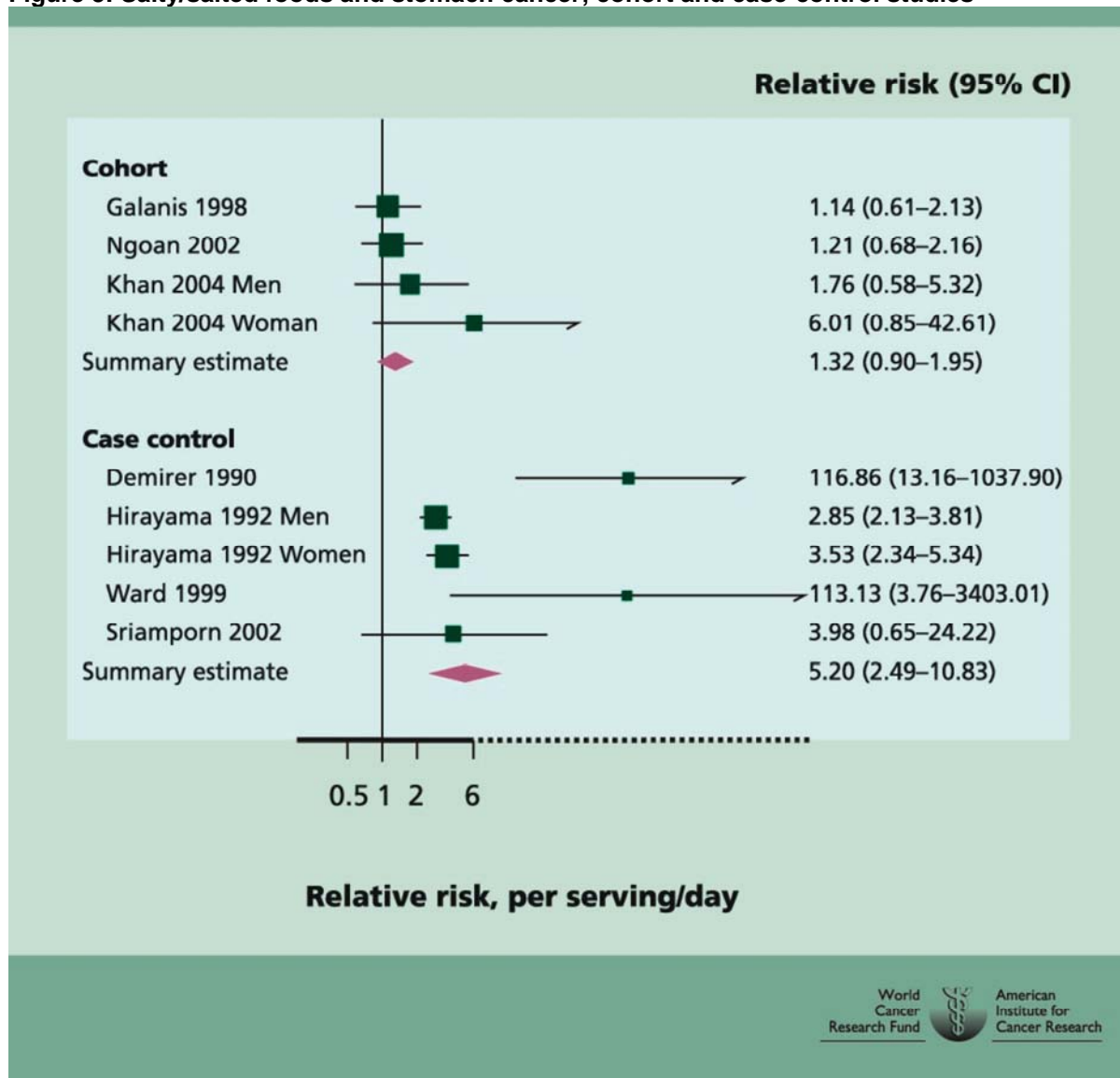
Source: (World Cancer Research Fund / American Institute for Cancer Research, 2007, p146)

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4.2.4 Iodine Deficiency

Iodine is essential for normal thyroid function and for normal physical and mental growth and development. Because New Zealand soil is low in iodine, iodine has been added to salt since 1924.[2] Despite this, mild iodine deficiency is still prevalent among children (Ministry of Health, 2003; Rose, Gordon, & Skeaff, 2009) and some adults (Food Standards Australia New Zealand, 2008a; Thomson, 2004).

Until recently almost all salt in processed foods was non-iodised (Thomson, 2004). Since 2009 there has been mandatory use of iodised salt in bread at 25-65mg of iodine per kilogram of salt (Food Standards Australia New Zealand, 2008a). A reduction in dietary salt intake in New Zealand may lead to decreased iodine consumption, particularly if discretionary iodised salt use was decreased significantly. Monitoring of population iodine status, particularly in childhood, will be an essential component of salt reduction work. Options to minimise potential harm from sodium risk management strategies include:

- Increasing the concentration of iodine in iodised salt if iodine deficiency is threatened
- Mandating the use of iodised salt in all processed foods
- Making iodisation of other staple foods such as oil, bread, drinking water, sugar and animal feeds mandatory (Mann & Aitken, 2003; World Health Organization, 2006).

As the majority of sodium intake is consumed in processed foods rather than discretionary intake, it is possible that sodium risk management strategies will have little impact on iodine status, particularly since the introduction of iodised salt in bread in 2009. However, NZFSA has signalled its intention to monitor iodine levels in the food supply (New Zealand Food Safety Authority, 2009a), and monitoring of iodine status through nutritional monitoring should be continued in the future.

4.2.5 Other Adverse Health Effects

There is some evidence that increased sodium intake (and consequent urinary sodium excretion) increases urinary protein excretion and can exacerbate renal failure in some individuals (He & MacGregor, 2009; Swift, Markandu, Sagnella, He, & MacGregor, 2005). Increased urinary sodium excretion also increases urinary calcium excretion, and may lead to bone loss through remodelling. With an adequate dietary calcium intake osteoporosis is thought to be unlikely (Heaney, 2003),

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[2] Iodisation of salt was introduced in New Zealand in 1924, the concentration was increased in 1938 and remains at that level. The joint Australian New Zealand Food Standards Code (Standard 2.10.2) stipulates that iodised salt must contain potassium iodide or iodate, or sodium iodide or iodate equivalent to no less than 24mg and no more than 65mg of iodine per kilogram. (Mann and Aitken 2003)

however a high sodium intake may predispose to increased formation of renal stones (De Wardener & MacGregor, 2002).

4.3 Reference Values for Safe Dietary Sodium Intake

4.3.1 New Zealand

New Zealand and Australia have jointly determined nutrient reference values for sodium. An Adequate Intake (AI) has been estimated, as a Recommended Daily Intake (RDI) could not be determined due to lack of suitable dose response trial data (Australian Department of Health and Ageing, National Health and Medical Research Council, & New Zealand Ministry of Health, 2006). The AI levels are set at 460-920mg/day for adults "to ensure that basic requirements are met" (Australian Department of Health and Ageing, et al., 2006, p231).   For children and adolescents AI values are based on those recommended for adults and altered for relative energy intake. Adequate Intake levels for infants are based on estimates of the amount of sodium an infant would obtain from breast milk over a 24 hour period.

The Australia and New Zealand UL for adults is set at 2,300mg/day sodium, and for children and adolescents has been extrapolated at a lower level based on proportional energy intake. For infants, no UL has been set. (see Table 13) The adult UL has been set at this level based on observational data (largely that from the INTERSALT study (Stamler, et al., 1991)) which shows relatively low levels of hypertension with intakes of 2,300mg/day sodium, but also no evidence of adverse effects of sodium deficiency below this level.

The New Zealand guidelines state that for some people (older or overweight people and those with existing hypertension) a lower Suggested Dietary Target (SDT) of 1,600mg/day sodium would be beneficial (Australian Department of Health and Ageing, et al., 2006). This is consistent with the WHO guidelines, and is based on evidence from the Dietary Approaches to Stop Hypertension (DASH) trial, which showed that participants randomised to a sodium intake of 65mmol/day (1,495mg/day) benefited by a significantly lowered SBP and DBP with no adverse effects (Vollmer, et al., 2001).

4.3.2 International

The WHO recommends a population average salt consumption should be less than 5g/day salt (2,000mg/day sodium) except where lower recommended maximum levels have been set. (For example the American Dietary Guidelines recommend a maximum daily intake of 2,300mg/day sodium except for individuals with hypertension, blacks, middle aged and older adults whom it recommends a maximum daily intake of 1,500mg/day) (U.S. Department of Health and Human

Services and U.S. Department of Agriculture, 2005; World Health Organization, 1983, 2003). In the UK the Reference Nutrient Intake (RNI) (defined as "the amount required to meet the needs of 97.5% of the population" (Medical Research Council Human Nutrition Research, 2005, p45) is 4g/day of salt (approximately 1,600mg/day sodium) for adults with levels for children proportionately less. The maximum recommended is 6g/day of salt (approximately 2,400mg/day sodium) for adults and this has formed the basis of salt intake targets for adults. Although the salt intake target in the UKFSA salt reduction campaign has been set at 6g/day for adults this has been described as a pragmatic rather than ideal target:

> The 2010 salt intake targets for adults and children do not represent ideal or optimum consumption levels but achievable population goals, designed to bring measureable clinical benefits. In the longer term, developments in food technology and changes in acquired food preferences among the population may allow for further reductions (Medical Research Council Human Nutrition Research, 2005, p43).

Table 12: Nutrient Reference Value Definitions

Adequate Intake (AI): The average daily nutrient 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
Recommended Dietary Intake (RDI): The average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97-98%) healthy individuals in a particular life stage and gender group
Suggested Dietary Target (SDT): A daily average intake from food and beverages for certain nutrients that may help in prevention of chronic disease
Upper Level of Intake (UL): The highest average daily nutrient intake level likely to pose no adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects increases

Source: (Australian Department of Health and Ageing, et al., 2006, p1)

Table 13: New Zealand Nutrient Reference Values for Sodium

Population group	Age	AI (mg/day)	UL (mg/day)	SDT (mg/day)
Infants	0-6 m	120	N/A*	..
	7-12 m	170	N/A*	..
Children & adolescents	1-3 y	200-400	1,000	..
	4-8 y	300-600	1,400	..
	9-13 y	400-800	2,000	..
	14-18 y	460-920	2,300	1,600
Adults	>18 y	460-920	2,300	1,600
Pregnancy	14-50 y	460-920	2,300	..
Lactation	14-50 y	460-920	2,300	..

* Unable to be determined. Source: (Australian Department of Health and Ageing, et al., 2006, p230-231)

5 Evaluation of Risk

Much of the published work evaluating the risk of high dietary sodium uses modelling to estimate morbidity, mortality and cost of future medical services. Modelling involves simulation of future scenarios based on known associations between sodium intake and blood pressure, stroke and CVD, against incidence, prevalence and mortality data in described populations.

5.1 New Zealand

Hypertension prevalence has been estimated by the 2006-07 New Zealand Health Survey by asking adult participants whether they had ever been told by a doctor they have high blood pressure (other than during pregnancy) and whether they currently took any medication for this high blood pressure. Overall around 14% of adults reported that they were currently taking medication for high blood pressure in the survey. Prevalence of self reported doctor diagnosed hypertension increases with age with nearly half of men and women aged 75 years and over currently taking antihypertensive medication. Asian adults were less likely to report taking antihypertensive medication, followed by Māori and Pacific adults, and those identifying with European/Other ethnic groups the most likely to report taking antihypertensive medication (see Table 14 and Figure 4).

The forthcoming results from the ANS08 will update this information, and also include recorded blood pressure measurements. The advantage of measured blood pressure over self-reported hypertension information about blood pressure that is clinically in the 'normal' range (< 140mmHg) but is still higher than ideal is obtained.

Modelling work was undertaken in 2003 to estimate the effects of reductions of systolic blood pressure, and sodium intake.(Ministry of Health and the University of Auckland, 2003) This study estimated that in 1997 elevated systolic blood pressure contributed to 13% of all deaths in New Zealand (3,699 deaths). The authors modelled an intervention, which produced a reduction of sodium intake in 2003 of around 1,000mg/day and would lead to an overall 1.0mmHg decrease (a 16% shift) in the mean population systolic blood pressure (producing a 4-6mmHg decrease in systolic blood pressure in adults ≥ 65 years of age). This 1g/day sodium reduction would result by 2011, in:

- Reduced ischaemic heart disease mortality by 179 deaths per year (3-11% of deaths attributable to ischaemic heart disease) and 1,808 years of life lost per year from 2011
- Reduction in deaths due to stroke of 103 per year (1-9%) and 805 years of life lost per year
- A total reduction of 282 deaths and 2,613 years of life lost per year from 2011 (Ministry of Health and the University of Auckland, 2003).

As there is a linear relationship between sodium intake and blood pressure (He & MacGregor, 2004), and blood pressure and CVD risk (Prospective Studies Collaboration, 2002), it can be assumed that any reduction in population sodium intake would have some benefits in terms of CVD incidence and mortality, and reduction greater than that modelled above would have even greater benefits.

Stomach cancer, while not a leading cause of cancer in New Zealand, has a relatively high mortality rate, and both incidence and mortality rates show large ethnic inequalities (see Figure 5) (Ministry of Health, 2002). Since dietary sodium intake is a probable cause of stomach cancer (World Cancer Research Fund / American Institute for Cancer Research, 2007), population-wide dietary sodium reduction (including equivalent dietary sodium intake among Māori) has the potential to reduce inequalities from stomach cancer in New Zealand. Modelling of this scenario may help clarify the extent to which this might occur, although absolute numbers are small compared to those affected by cardiovascular disease.

5.2 International

Recent modelling work from the USA indicates that sodium reduction is an extremely effective and cost effective intervention for the prevention of mortality and morbidity. A reduction in sodium intake of up to 1,200mg/day would substantially reduce the annual number of new cases of coronary heart disease and stroke, reduce the annual number of deaths, and save billions of dollars in health care costs. Estimates showed that such a reduction would reduce the annual number of new cases of coronary heart disease by 60,000-120,000, stroke by 32,000-66,000, and myocardial infarction by 54,000-99,000 and reduce the annual number of deaths from any cause by 44,000-92,000. All population groups would benefit from such an intervention. Even if a smaller reduction of 400mg/day in sodium intake were achieved, sodium risk management strategies would still be more cost-effective than treating those with hypertension with medication (Bibbins-Domingo, et al., 2010).

Similarly Smith-Spangler et al (2010) modelled the impact of two public health interventions: collaboration with industry to set voluntary maximum sodium targets in processed food to achieve a 9.5% reduction in population sodium intake such as that achieved by sodium reduction programmes in the UK, or a sodium tax achieving a 6% reduction in population sodium. They predicted that a 9.5% reduction in population sodium would achieve an associated population decrease in mean systolic blood pressure of 1.25mmHg, and result in 513,885 fewer strokes, 480,358 fewer cases of myocardial infarction and gain 1.3 million life-years lived and over 2 million quality adjusted life years (QALYs) over the lifetime of adults aged 40-85 years currently alive in the USA. It would also result in savings of USA$32.1 billion in direct medical costs.

Table 14: Medicated high blood pressure for adults by ethnic group (unadjusted)

Ethnic Group*	Prevalence (95% CI)	Number of adults
European/Other	14.3 (13.5-15.0)	363,600
Māori	10.3 (9.2-11.4)	36,600
Pacific	10.6 (8.6-12.6)	17,400
Asian	9.0 (7.5-10.5)	25,000

* Total response standard output for ethnic groups has been used. Source: (Ministry of Health, 2008)

Figure 4: Medicated high blood pressure for adults (unadjusted prevalence)
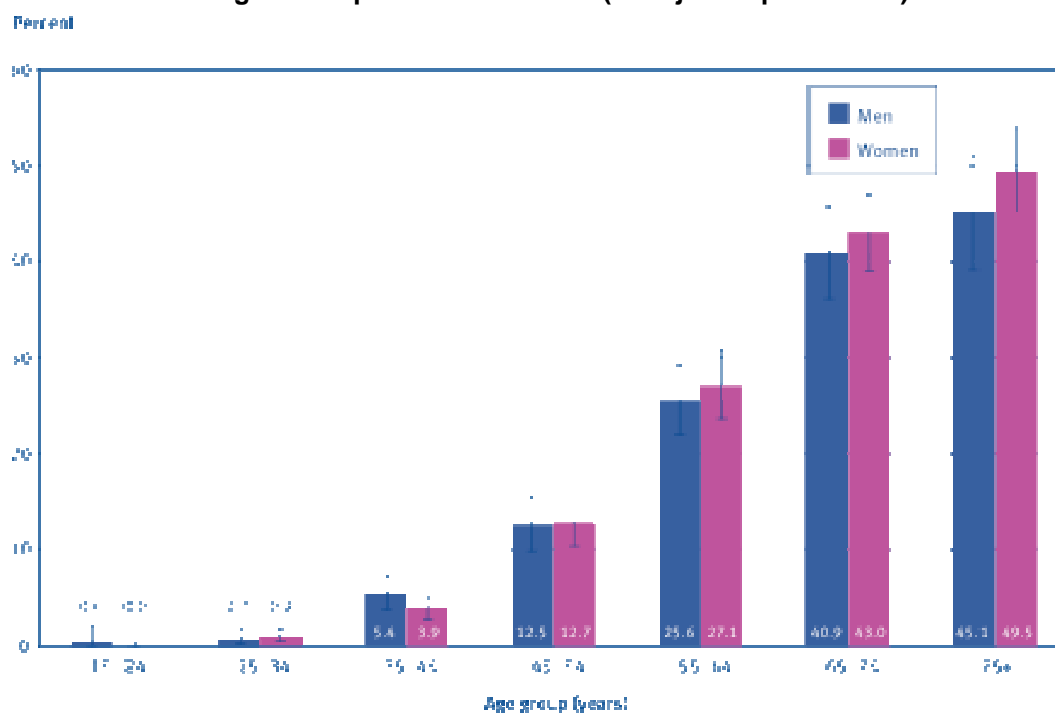
Source: (Ministry of Health, 2008, p120)

Figure reproduced with the permission of the Ministry of Health

Figure 5: Cancer of the stomach, registrations and deaths by ethnicity, 2004

Note: rates per 100 000, age standardised to the Segi's world population.
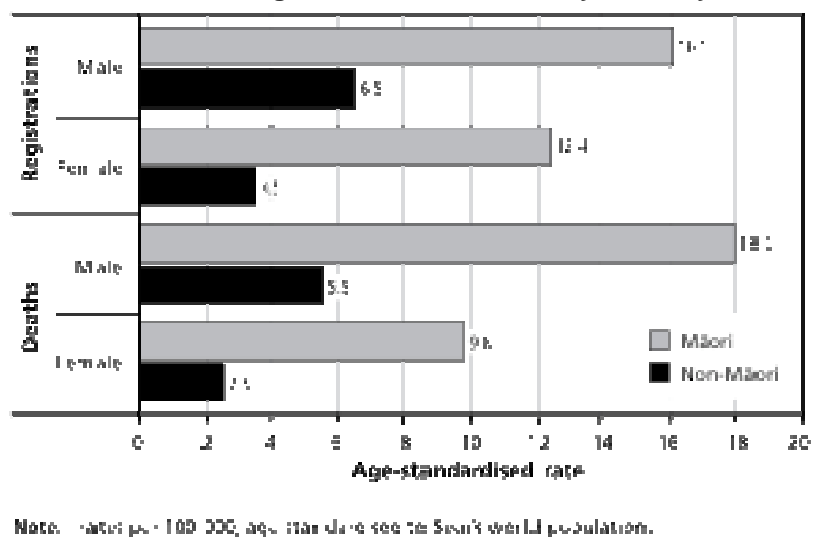
Source: (New Zealand Health Information Service, 2007, p38)

Figure reproduced with the permission of the Ministry of Health

5.3 Data Gaps and Uncertainties

Although some modelling has been undertaken for New Zealand, risk evaluation could be further informed by further information on population sodium intake and blood pressure measurement, quantification of sodium content in food, consumer research and industry research. This information could then form the basis of ongoing monitoring and evaluation of sodium risk management strategies.

5.3.1 Population Monitoring

Estimates of New Zealand population sodium intake suggest an average intake of around 3,600mg/day or around 9g/day salt.(Ministry of Health and the University of Auckland, 2003) An estimate of sodium intake from a nationally representative sample could further inform risk assessment. The New Zealand Adult Nutrition Survey 2008-09 is a nationally representative sample of New Zealand adults, and spot urinary sodium results from this survey will update estimates of population sodium intake and help to identify whether there are particular population groups with particularly high sodium intakes. Modelling work to assess the relationship between spot urine sodium and 24-hour urinary sodium excretion in the New Zealand population would enhance the interpretation of spot urine results. A programme of ongoing population monitoring could be undertaken to monitor changes over time, and to assess the effectiveness of sodium risk management strategies. The New Zealand Adult Nutrition Survey 2008-09 will also provide measured blood pressure data.

5.3.2 Monitoring of Sodium Content in Food

Monitoring of the sodium content in processed foods could form part of a comprehensive sodium risk management strategy. This could involve documenting both an average sodium content in food groups, and the sodium content of individual products (from Nutrition Information Panel (NIP) data). Testing and monitoring of sodium levels in restaurant and takeaway foods could also be considered. Validation of the accuracy of sodium content information of foods in the NZFCDB will enhance the accuracy of estimates of which foods contribute most to dietary sodium intake from dietary recall information. Dietary survey data from ANS08 could also be used to estimate which foods contribute most to sodium intake.

5.3.3 Consumer Research

Research is currently being developed into New Zealand consumers' understanding of the difference between 'sodium' and 'salt', and their awareness of health risks associated with high sodium intake.

Further research could include an examination of how different formats of food labelling about sodium content influence consumer behaviour, particularly for consumers of low socio-economic status.

5.3.4 Industry Research

Further research into the development of methods to reduce sodium in processed foods while maintaining consumer acceptance, microbiological safety, and processing methods may be required.

6   Risk Management Approaches

6.1 Population versus Individual Strategies

Much has been written about the benefits of a population approach to blood pressure lowering to reduce the risk of CVD across a population (Rose, 1981, 2001), although an accompanying high-risk strategy in which those individuals with hypertension are identified and treated in a clinical setting is also appropriate (Lewis, Mann, & Mancini, 1986). The linear relationship between blood pressure and CVD risk with no obvious threshold (below 115mmHg systolic) means that the majority of the population with 'normal' blood pressure would still benefit from blood pressure lowering (Prospective Studies Collaboration, 2002; World Health Organization, 2009). As a population, great benefits would be seen from a very small shift in total blood pressure. For example, a 2mmHg reduction in mean population diastolic blood pressure could result in a 6% reduction in coronary heart disease risk and a 15% reduction in the risk of stroke (Medical Research Council Human Nutrition Research, 2005).

Similarly, sodium risk management strategies may encompass both a high-risk and a population approach. A high-risk approach involves identifying individuals who are particularly at risk (such as those with a particularly high sodium intake, those with hypertension or at risk of developing hypertension) and providing support for them to cut down on dietary sodium intake, usually in a clinical setting.   Although for particular individuals a high-risk approach may be appropriate, the majority of the New Zealand population probably has dietary sodium intake above the UL and so a population strategy is more appropriate as the main approach. The advantage of a population approach, particularly one that gradually reduces sodium levels in processed foods, is that even those who do not choose to actively reduce sodium intake will benefit. Population sodium reduction intervention studies have demonstrated a small but significant reduction in blood pressure with reduced sodium intake (Forte, et al., 1989). A recent cost effectiveness study modelled a 9.5% reduction in sodium intake (which would equate to a decrease in population systolic blood pressure by 1.25mmHg) which would prevent around 510,000 strokes and 480,000 myocardial infarctions over the lifetime of adults aged 40-85 years alive today in the USA, thereby saving $32.1 billion in medical costs (Smith-Spangler, Juusola, Enns, Owens, & Garber, 2010). Although the benefit to the individual of a decrease in blood pressure of this nature would be minimal, on a population level it would equate to a substantial reduction in stroke, coronary heart disease and all-cause mortality. A population approach also has the potential to reduce inequalities by benefiting all population groups, not just those that access health care and act on dietary advice (Bibbins-Domingo, et al., 2010). Population sodium risk management strategies have been the basis of the successful UKFSA salt risk management strategy.

6.2 Control Measures

A range of population based control measures have been recommended by authoritative scientific bodies. These include:

- The setting of population sodium intake targets
- Standards or targets for sodium content of foods
- Government, public health and consumer agencies working with food industry to voluntarily reduce sodium content of processed foods
- Food industry voluntarily reducing sodium content in food
- Improvements in food labelling to enhance consumers' understanding of the sodium content of food
- Consumer education and support so that consumers are able to voluntarily reduce sodium intake
- Monitoring and surveillance regarding sodium intake measurement, salt taste preference, and sodium content of foods
- Monitoring and evaluation of salt reduction programmes and initiatives.

(IOM (Institute of Medicine), 2010; World Health Organization, 2006).

These are discussed in further detail below.

6.2.1 Advisory

6.2.1.1   Consumer Education Campaigns

Research that emerged in the 1970s and 1980s reinforced the association between a high sodium intake and adverse health effects, and led to campaigns that attempted to raise consumers' awareness of this association and the benefits to them from decreasing their sodium intake.

These early campaigns focused on changing behaviour and included public education programmes that encouraged consumers to reduce sodium intake by decreasing the amount of discretionary salt used in cooking and at the table (IOM (Institute of Medicine), 2010). However, discretionary salt is only a small proportion of the total amount of sodium consumed in developed countries, thus reducing the amount of salt used in cooking and at the table was unlikely to impact significantly on overall sodium consumption (Mattes & Donnelly, 1991).

Since these early campaigns consumers' awareness of the association between a high sodium intake and adverse health effects appears to have decreased. For example, the Institute of Medicine (2010) reports that the proportion of people surveyed in the United States Department of Agriculture's (USDA) Diet and Health survey who believed that they should moderate their salt intake dropped from 62% to 52% between the 1989-91 and 1994-96 surveys. By 2002, the Food and Drug Administration's (FDA) Health and Diet Survey revealed that only 28% of people were attempting to

reduce their sodium intake, and 46% of people believed that they did not need to moderate their sodium intake (IOM (Institute of Medicine), 2010).

Two main reasons have been advanced to explain this decrease in consumers' awareness of sodium intake and their concern about sodium levels. Firstly, a public relations campaign conducted by the salt industry under the umbrella of the newly formed Salt Manufacturers' Association and the Salt Institute questioned the link between sodium, blood pressure and adverse health effects (Hanneman, 1996; MacGregor & De Wardener, 1998). Secondly, other nutritional messages and campaigns, particularly with respect to fat, cholesterol and sugar, may have overshadowed sodium reduction messages through the 1980s and 1990s (IOM (Institute of Medicine), 2010).

Recently, however, several countries and organisations have sought to raise consumers' awareness of the risks associated with a high sodium intake. In the UK, a public awareness campaign undertaken as part of a wider sodium risk management strategy has informed consumers about the risks of a high salt intake and advised how they might reduce their salt consumption. Evaluation of this programme found consumers reported cutting down on their salt intake and checking labels for sodium/salt levels, and exhibited greater awareness of the recommended maximum daily salt intake (Food Standards Agency, 2009a). Although it is unclear to what extent these findings are evident in changed purchasing and eating behaviour, population surveys show a reduction in dietary sodium intake of around 10% over the same period (Food Standards Agency, 2008).

In New Zealand NZFSA has commissioned consumer research due to be undertaken in 2010 that will examine to what degree consumers are aware of the difference between sodium and salt, health risks associated with sodium, and what their actual and recommended dietary sodium intakes might be. The results from this study will help establish benchmarks against which initiatives to improve consumers' awareness may be assessed.

6.2.1.2   Point-of-Purchase Interventions

Recent initiatives have examined how consumers' behaviour could be influenced at the point of purchase. A major review of nutrition and physical activity policy interventions for cancer prevention found a "medium" level of evidence for the "introduction or strengthening of standard uniform explicit systems of food labelling" (World Cancer Research Fund / American Institute for Cancer Research, 2009, p64). These findings complement other studies that have explored how food labelling might promote healthier food choices (Cowburn & Stockley, 2005).

As around 75% of Western consumers' sodium intake comes from processed foods (Mattes & Donnelly, 1991), food labelling systems that consumers can understand and use may assist them to differentiate between products with stronger and weaker nutrition profiles. In principle, if consumers

can identify foods with differing nutrition profiles, they may be better able to make healthier food choices (R. Wilkinson & Marmot, 1998). However, in practice, consumers over-estimate their use of nutritional information and read information less than expected (Ni Mhurchu & Gorton, 2007; Tanner & Carlson, 2009). Many consumers find nutritional information labels too time consuming to read (Signal, et al., 2008) and may lack both the mathematical ability to understand the information and the nutritional knowledge to interpret the information provided (Ni Mhurchu & Gorton, 2007; Rothman, et al., 2006). Rapid decision-making such as that typical of most supermarket visits may preclude adequate label review (Hutchinson & Alba, 1991).

Four main food labels are commonly in use (see Figure 6 to Figure 9). Nutrition labelling with the NIP has been mandatory in New Zealand since 2002. More recently, several food manufacturers have voluntarily introduced front of pack Percent Daily Intake (PDI) labels that they believe complement the mandatory NIPs (New Zealand Food and Grocery Council, 2010). The PDI for sodium is based on the sodium UL of 2,300mg/day (Australian Food and Grocery Council, 2008). The PDI label has been criticised in two major USA reports that claim use of a UL for PDI labelling is potentially misleading, and suggest instead using the recommended USA AI of 1,500mg/day sodium (IOM (Institute of Medicine), 2010; Silverglade & Ringel Heller, 2010). In Australasia, the NHF run a nutrition signposting scheme (The Tick Programme) in which manufacturers enter into a formal licensing agreement with the NHF where payment occurs via a royalty schedule depending on sales of particular products that meet specific nutritional criteria (also see Section 6.3.1.1) (Young & Swinburn, 2002). In 2007, the UKFSA introduced a voluntary front of pack labelling scheme that uses multiple traffic lights (MTL) to communicate fat, saturated fat, salt and sugar levels of a food. The MTL uses 'salt' rather than 'sodium' and there are set criteria for salt level in foods.

The plethora of initiatives and emerging research evidence has led to considerable debate over the form, content and effects of front of pack nutrition labelling. A recent review of front of pack label formats commissioned by the UKFSA found that a combination of MTL and PDI information enhanced comprehension and consumer awareness of the nutritional content of foods (Malam, Clegg, Kirwan, & McGinigal, 2009). These conclusions are consistent with New Zealand research, which supported the use of MTL formats to enhance consumers' ability to understand nutrition information and discriminate between similar products with different nutritional profiles (Gorton, 2007; Gorton, et al., 2008; Maubach, Hoek, & Gendall, 2009). However, few studies have explored the relationship between consumers' understanding of nutrition labels and their subsequent behaviour, particularly among low-socioeconomic and ethnic minority population groups (Gorton, 2007; Ni Mhurchu & Gorton, 2007; Signal, et al., 2008). Studies that have examined self-assessed motivation to purchase products based on different nutrition labelling formats suggest that MTL labels reduce disparities in consumers' ability to act on nutrition information (Maubach, et al., 2009).

The use of the words 'sodium' or 'salt' in consumer education campaigns and on food labels is an important distinction. Although over 90% of sodium is consumed as salt, salt comprises only 40% sodium (Mattes & Donnelly, 1991). In the UK and Australia consumer education campaigns have used 'salt', while in the USA 'sodium' is used. The MTL label uses the word 'salt' rather than 'sodium' while NIP and PDI formats use the term sodium.

A study undertaken in 2006 suggests consumers have difficulty understanding the relationship between 'sodium' and 'salt' on food labels (Gilbey & Fifield, 2006) This study of 226 shoppers in a small city in the North Island showed that only 10% were able to correctly identify the value for the sodium UL when expressed as salt (6g/day). Although 67% of participants reported that they monitored their salt intake, only 2% were able to correctly identify the amount of salt in a can of baked beans, based on information on sodium content in the NIP. The majority of participants believed that the terms 'salt' and 'sodium' were interchangeable (Gilbey & Fifield, 2006). More recent findings suggest that there is little knowledge of the difference between salt and sodium in New Zealand, and the MTL enables consumers to better differentiate between high and low sodium foods (McLean, Hoek, & Mann, 2010).

Nutrition claims such as 'light', 'reduced salt', 'low salt' may also enhance understanding of sodium content (Food Standards Australia New Zealand, 2010). An Australian study found that 70% of shoppers reported previously purchasing products labelled 'reduced salt' (Grimes, Nowson, & Lawrence, 2008). In New Zealand a product can be labelled 'low salt' if it contains less than 120mg/100g of sodium, and labelled 'reduced salt' if the food has at least 25% less sodium than the comparative reference food.

A health claim may be defined as *"any representation in labelling and advertising that states, suggests, or implies that a relation exists between the consumption of foods or food constituents and health"* (L'Abbe, Dumais, Chao, & Junkins, 2008, p1221S). Some authors suggest that health claims have the potential to be an effective tool for raising consumer awareness about associations between foods and health risks, enabling consumers to more easily discriminate between healthy and less healthy food options (Roe, Levy, & Derby, 1999). Health claims also have the potential to increase sales according to research that indicates the presence of a health claim may make consumers 10-26% more likely to purchase products, equivalent to a 20% increase in sales (Jew, Vanstone, Antoine, & Jones, 2008). However, some health claims may be misleading, and evidence shows that even if consumers can understand the NIP, in practice they ignore it and instead rely only on the health claim when one is present. Consumers may also ignore the presence of other harmful nutrients in the face of a health claim about a different nutrient. Therefore the presence of a health claim, no matter how ambiguous or misleading, may over-ride the effect of a NIP that describes actual nutritional content (Roe, et al., 1999).

Current New Zealand legislation prohibits health claims relating to disease prevention (other than for folate). However, FSANZ is developing a Nutrition, Health and Related Claims Standard (Proposal P293) that will outline requirements for nutritional content claims, general level health claims and high level health claims. Claims regarding disease treatment or prevention will not be permitted (Tapsell, 2008). It is important to investigate how health claims could influence consumer purchasing behaviour with respect to claims regarding sodium and salt prior to their implementation in New Zealand.

A summary of selected international health claim criteria is outlined in Appendix A.

Figure 6: Example of a Nutrition Information Panel

NUTRITION INFORMATION		
Servings per can: 2		
Serving size: 210g		
	Average Quantity Per serving	Average Quantity Per 100g
ENERGY	895kJ	425kJ
PROTEIN	10.8g	5.1g
FAT: TOTAL	1.2g	0.6g
-SATURATED	0.2g	0.1g
CARBOHYDRATE	33.7g	16.1g
-SUGARS	15.5g	7.4g
DIETARY FIBRE	11.9g	5.7g
SODIUM	252mg	120mg
POTASSIUM	650mg	310mg
IRON	2.7mg	1.3mg

Figure 7: Example of a Percent Daily Intake label

| Energy	Protein	Fat	Sat Fat	Carbs	Sugars	Sodium
895kJ	10.8g	1.2g	0.2g	33.7g	15.5g	252mg
DI* 10%	DI* 22%	DI* 1%	DI* 1%	DI* 11%	DI* 17%	DI* 11%

*Per 210g serve consumed
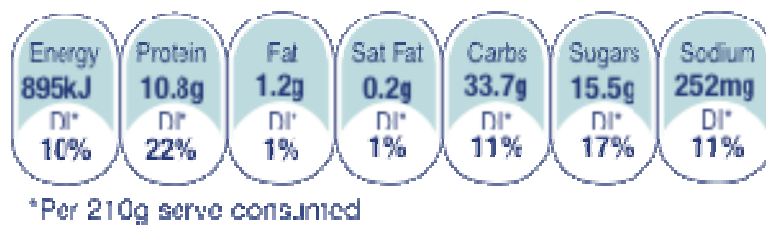
Source: Graphics courtesy of Manson Wright

Figure 8: The National Heart Foundation Tick Logo

Figure reproduced with the permission of the National Heart Foundation of New Zealand

Figure 9: Example of a Multiple Traffic Light (MTL) label
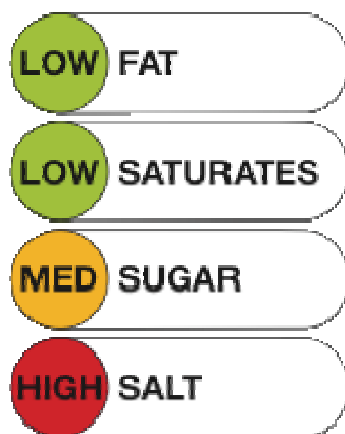
Source: Graphics courtesy of Manson Wright

Table 15: Multiple traffic light labelling criteria for salt (and sodium) concentration (United Kingdom)

Colour	Salt concentration	Equivalent sodium concentration
Green (low)	≤ 0.30g/100g	≤ 120mg/100g
Amber (medium)	> 0.30 to ≤ 1.50g/100g	> 120mg/100g to ≤ 600mg/100g
Red (high)	> 1.50g/100g or > 2.40g/portion	> 600mg/100g or > 960mg/portion

Source: (Food Standards Agency, 2007)

6.2.2 Regulatory

6.2.2.1 Compositional Targets and Reformulation

The development of compositional targets for sodium content in processed foods has been an important component of sodium risk management strategies around the world. Targets provide benchmarks against which sodium control measures in the food supply can be evaluated. To date targets for sodium content have been voluntary, which may facilitate a more collaborative relationship between government and food industry and many food companies have committed to voluntary sodium reduction programmes based on voluntary targets. Mandatory targets, on the other hand, could be effective where industry is reluctant to reformulate products (Moss, 2010). Some industry representatives have claimed that lower salt foods are less commercially successful, especially when competitors do not reduce sodium levels. Mandatory targets would therefore provide a "level playing field" ensuring that all foods of a particular type contain similar sodium levels so that companies are not penalised commercially for reducing sodium in selected products (IOM (Institute of Medicine), 2010, S-6). In a review of strategies to reduce sodium intake in the USA, IOM notes that voluntary strategies could achieve meaningful reductions of sodium intake but goes on to state that they [voluntary standards]:

> …will not be sufficient to provide adequate breadth and sustainability of reductions and do not guarantee the level playing field that is important to realizing meaningful sodium reduction in the food supply. (IOM (Institute of Medicine), 2010, S-12).

Reformulation of foods to contain less sodium is an important component of a sodium risk management strategy, and requires a sustained commitment from members of the food industry. For some products sodium reduction is relatively straightforward, while for others more complex reformulation is required. A range of techniques exist for sodium in meat and poultry including the use of salt substitutes such as potassium chloride, the use of alternative flavour enhancers to increase salty taste from reduced salt levels, and altering the physical form of salt so the salty taste is more bio-available (Havas, Roccella, & Lenfant, 2004). New technologies are currently being investigated and may enable further substantial sodium reduction in processed foods in the future (Food Standards Agency, 2009a; Matsui, et al., 2010).

6.3 Existing Control Measures

6.3.1 New Zealand

6.3.1.1 Advisory

Nutrient reference values have been produced with a UL for adults of 2,300mg/day and proportionally less for children and adolescents (Australian Department of Health and Ageing, et al., 2006).

However, no specific sodium reduction targets have been set. Although it is likely that a sodium reduction target would align with the UL, a target may confer additional benefits beyond the nutrient reference values. A target would indicate a level of commitment to sodium reduction, encourage the development of strategies to achieve the target level, and provide a benchmark against which progress can be measured (World Health Organization, 2006).

The New Zealand Stroke Foundation has also identified salt reduction as a priority strategy to reduce blood pressure and stroke risk. In April 2010 the Stroke Foundation issued a press release calling for mandatory sodium levels in processed food in line with recommendations from the IOM report Strategies to Reduce Sodium Intake in the United States (Otago Daily Times, 2010). The Foundation has a focus on consumer education, and has worked with NZFSA and Consumer Magazine to develop resources to educate consumers how to reduce dietary sodium intake (personal communication H. Kizito, Stroke Foundation, 29 April 2010).

The NHF has had a commitment to sodium reduction for many years. It introduced a food signposting system for food labels in New Zealand, known as the Heart Foundation Tick, in 1996. Food manufacturers are permitted to use the Tick logo (see Figure 8) on foods that meet the Tick nutrition criteria, which include saturated fat, *trans* fat, sodium, energy (kilojoules), fibre, and calcium in relevant food categories. Manufacturers enter a formal licensing agreement with the NHF and pay a licence fee, which is based on the combined sales of their approved products. Fees are used for the administration of the programme. A strength of this programme is that it encourages companies to reformulate products to meet the Tick criteria. It has been estimated that between July 1998 and June 1999 companies reduced salt levels in bread, breakfast cereals and margarine by around 33 tonnes (Young & Swinburn, 2002). Other NHF salt reduction work has included the publication in 1999 of an evidence based nutrition statement regarding sodium (Roberts, 1999) the publication in 2004 of the significant differences in the nutritional composition of lower cost food products when compared with similar higher cost foods (Monro, Young, Wilson, & Chisholm, 2004), and Project Target 450 in which the NHF worked with New Zealand bread manufacturers to reduce sodium in breads to a target of 450mg/100g (National Heart Foundation, 2008). In early 2010 Project HeartSAFE was launched to encourage further sodium reduction in manufactured and pre-prepared foods, with an initial focus on breakfast cereals and processed meats. This is an industry-led collaboration between food companies, industry associations and government, and facilitated by NHF and Network Public Relations. Key outputs are tools to empower industry - such as sodium guidelines by sub-category, case studies of best practice examples, a web site and e-news releases. Project HeartSAFE is contracted by the Ministry of Health, and is aligned with NZFSAs focus on sodium reduction (Gorton, Jayasinha, & Monro, 2010).

Members of the food industry have committed to sodium reduction and have reduced sodium in a range of products. Watties has had a sodium reduction programme since 2005 (Watties, 2010), Unilever Australiasia had a nutrition enhancement programme which includes sodium reduction (Unilever, 2010).

6.3.1.2 Regulatory

Regulations relating to sodium and salt in food are outlined in the Australia New Zealand Food Standards Code (Food Standards Australia New Zealand, 2010). These regulations relate to the composition of salt, salt mixtures and salt substitutes (Standard 2.10.2 – Salt and Salt Products), and labelling and claims (Standard 1.2.8- Nutrition Information Requirements). Standard 1.2.8 outlines how sodium content is to be expressed in the NIP, which is mandatory for most processed foods, and the PDI Panel, which remains voluntary. Standard 1.2.8 also outlines regulations around claims of sodium content such that:

> (1) A claim to the effect that a food is low in salt or sodium content must not be made unless the food contains no more than 120mg of sodium per 100 g of the food.

> (2) Where a nutrition claim is made in respect of the salt, sodium or potassium content of a food, or any two or all of them, then particulars, including particulars relating to both the sodium and potassium content of the food, must be provided in relation to the food in accordance with subclause 5(1). (Food Standards Australia New Zealand, 2010)

NZFSA has identified the reduction of sodium in the diet as a component of the work programme outlined in its Nutrition Strategy 2009-2012. It aims to work with the Ministry of Health, food industry and other stakeholders to this end. The following activities are identified:

- Collaborate with key stakeholders to develop an integrated approach to sodium reduction in the foods supply including effective monitoring
- Update the estimates of daily intake of sodium among age-sex groups and report on key food contributors to intake within the NZTDS 2009
- Use food composition information from the NZTDS to report on variability of sodium within key food categories
- Undertake appropriate risk assessment activities
- Identify other nutrition inputs that will complement or add value to existing risk management initiatives, and
- Apply social research to determine consumer use and understanding of salt and sodium on food labels, and apply these findings to risk communication strategies (New Zealand Food Safety Authority, 2009b, p23)

In June 2010 NZFSA signed a memorandum of understanding with the NHF aligning efforts to reduce sodium intake in New Zealand (New Zealand Food Safety Authority, 2010).

6.3.2 International

It is beyond the scope of this report to outline the many sodium risk management strategies currently underway around the world, and these have been summarised in other reports (see for example (Penny, 2009; Webster, 2009). In addition to country level strategies, a number of regional

organisations have sodium reduction groups including the European Salt Action Network, and the Pan American Health Organization (European Salt Action Network, 2009; Pan American Health Organization, 2010). The WHO held a meeting in Singapore in June 2010 in which the possibility of a Western Pacific Regional Salt Reduction Network was discussed, although no formal commitment has been made to date in this regard.

6.3.2.1   United Kingdom

The UKFSA salt risk management strategy is seen as a leader for salt reduction around the world (He & MacGregor, 2010). The strategy is underpinned by a target of 6g/day salt intake (2,400mg/day sodium) for adults as achievable population goal (Medical Research Council Human Nutrition Research, 2005). A 'salt model' was developed which outlined how such a reduction could be achieved, through a combination of reformulation of processed foods, and consumers' reducing discretionary salt intake (see Table 16).

Specific initiatives have included:

- Reformulation work: The UKFSA has sought to engage with all sectors of the food industry (including retailers, manufacturers, trade associations, caters and suppliers) to promote and facilitate reformulation of processed foods to contain less sodium (salt). This has resulted in the setting of voluntary sodium reduction targets,(see for example (Food Standards Agency, 2009c)) formal commitments from food industry partners, the provision of guidance for salt reduction, and funding of research in partnership with industry to facilitate salt reduction reformulation.
- Public Awareness Campaign: The public awareness campaign has been ongoing and focused on three phases, supported by a consumer focused website (Food Standards Agency, undated). The three phases of the public awareness campaign were:
  i.   From September 2004 the campaign sought to educate consumers about the adverse health effects of a high salt intake;
  ii.   From October 2005 the campaign encouraged consumers to check food labels;
  iii. From March 2007 the campaign focused on educating consumers about salt levels in processed foods, and aimed to persuade them to choose low salt options (Food Standards Agency, 2009a).

These initiatives have been informed by a system of ongoing monitoring and evaluation, which has involved the monitoring of sodium levels in food through a processed food data bank, monitoring industry commitments to salt reduction, trade association reports and market labelling data (Food Standards Agency, 2009a). An evaluation of the consumer awareness campaign was undertaken in 2009 (Food Standards Agency, 2009b). Sodium intake has been monitored using 24-hour urinary sodium measurement. This shows a 10% reduction in sodium intake from an average of 9.5g/day salt

(3,800mg/day sodium) in 2000-01 to 8.6g/day salt (3,440mg/day sodium) in 2008 (Food Standards Agency, 2008).

The advocacy group CASH also operates in the United Kingdom with the aim of reducing dietary sodium intake, and has successfully worked with the food industry and government to promote salt reduction (He & MacGregor, 2010).

Table 16: The 'Salt Model' strategy for reducing salt intake in the United Kingdom

Salt intake		Target intake	
Source	**Salt (g/day)**	**Reduction needed**	**Salt (g/day)**
Table/ cooking salt (Discretionary) 15%	1.4g	40% reduction	0.9g
Naturally occurring	0.6g	No reduction	0.6g
Salt from processed foods 80%	7.5g	40% reduction	4.5g
Total	9.5g	..	Target: 6g

Source: Adapted from (He & MacGregor, 2009)

6.3.2.2   Australia

The Australian Heart Foundation implements the healthy food 'Pick the Tick' signpost programme in collaboration with the New Zealand NHF (see Section 6.3.1.1) (Young & Swinburn, 2002). The Australian Department of Health and Ageing's Food and Health Dialogue was established in 2009 to engage with industry and encourage food reformulation to reduce levels of salt, saturated fat, energy and sugar, and increase fibre (Australian Department of Health and Ageing, 2010). In 2010, the Food and Health Dialogue announced voluntary sodium targets for bread and breakfast cereals in Australia (Butler, 2010).

A key player is the AWASH, an advocacy group affiliated with WASH. In May 2007, AWASH launched the *"Drop the Salt!"* campaign, to reduce population salt intakes to 6g/day over five years by reducing the sodium content in processed foods by 25%, increasing consumer awareness of the benefit of low sodium diets, and promoting food labelling that is easily understood by consumers (Webster, et al., 2009). The campaign has three main strategies and is underpinned by ongoing research and monitoring. The three strategies involve:

- Engagement with the food industry to promote and facilitate reformulation of processed foods so that they contain less sodium. A food composition database has also been established to monitor sodium levels in food.
- A media and communications strategy aims to educate consumers about the benefits of sodium reduction. It is complemented by a website (www.awash.org.au) and has involved holding meetings, issuing press releases, writing articles and papers, speaking at conferences, and producing consumer education material. Alerting consumers to sodium levels in commonly consumed foods has been a focus of this strategy (see for example (Australian Division of Word Action on Salt & Health, 2009).
- AWASH has also engaged with government to encourage the development of a salt reduction strategy as a national priority area.

AWASH also undertakes ongoing monitoring of salt levels in food, media coverage, and conducts regular consumer polls (Australian Division of World Action on Salt and Health, 2010; Webster, et al., 2009).

6.3.2.3   Canada

In 2007 the Canadian government announced plans to develop a Sodium Working Group, and a Canadian Sodium Reduction Strategy is due to be released in 2010. The Sodium Working Group includes a wide range of stakeholders including food industry groups, NGOs, consumer advocacy

groups, health professionals, and scientists (Health Canada, 2010a; Ogilvie, 2010). To date the Sodium Working Group has:

- Identified a public health goal for sodium reduction of 2,300mg/day by 2016. This is compared to the current estimated average daily intake of 3,400mg/day sodium, and equates to a 5% reduction per year.
- Engaged with the food industry to develop a range of targets for sodium levels in processed foods. These targets will be voluntary, and based on those of the UKFSA targets. Initially targets will be produced for food groups that contribute most to sodium intake in the Canadian diet which includes bakery products, cereals, combined dishes, dairy products, fats and oils, fish and seafood, processed meats, sauces, snacks and soups (Health Canada, 2010b). The publication of these targets, planned for late 2010, is accompanied by a proposed timeline for the food industry to meet the targets, and a plan for monitoring and evaluation (Ogilvie, 2010).
- Identified the need for consumer education in this area (Health Canada, 2010b).

7   Monitoring and Evaluation

Monitoring and evaluation are a key part of any sodium risk management strategy. Baseline population sodium intake data provide a benchmark for monitoring progress on dietary sodium reduction, and may identify population groups at particular risk. A database of sodium content of foods such as the NZFCDB enables monitoring of sodium reduction in processed foods and informs collaboration with industry (Crop & Food Research, undated). Data regarding sodium content in individual foods can also inform the development of targets for sodium in foods. Monitoring of consumer knowledge of health risks associated with sodium intake, understanding of food labels, and behaviour with respect to food purchase and use of discretionary sodium are also important. Finally, evaluation of specific programmes will inform development of further sodium reduction work.

7.1 Measurement of Dietary Sodium Intake and Excretion

Dietary recall data has been used to estimate sodium intake, and has the advantage of allowing estimates of the main sources of sodium in the diet. Surveys may include 24-hour, three or seven day diet recall questionnaires, with or without measurement of duplicate portions. These are then modelled against food composition data to give an estimate of total intake. Most questionnaires, however, do not take account of discretionary salt use, which is very difficult to measure. This method also relies on accurate food composition data over a wide range of different food types and brands, which are not always available. Most comparisons between dietary estimates and 24-hour urine measurements show therefore that dietary assessment of sodium intakes underestimate total intake by around 10-20% (Espeland, et al., 2001; Khaw, et al., 2004). Some studies have attempted to measure discretionary salt as part of dietary recall by providing pre-measured salt (Micheli & Rosa, 2003). However this is problematic due to difficulty measuring the amount of salt lost in cooking. It has been estimated that only around a quarter of salt added to vegetables during cooking is retained, the rest is discarded with the cooking water (James, et al., 1987), although this will vary with different cooking techniques. Table salt is hygroscopic, so weight changes substantially with variation in ambient moisture content, so weighted discretionary salt use is unreliable. Dietary recall questionnaires sometimes include questions about the use of discretionary salt, but these are seldom quantitative.

The most accurate method of estimating quantities of discretionary sodium intake is to use a lithium-marker technique where subjects are given lithium tagged salt and urinary sodium and lithium are measured in subsequent 24-hour urine collections. This method will give a more accurate estimate of discretionary salt use and has been used in studies estimating proportion of sodium intake from various sources (Andersen, et al., 2009; Sanchez-Castillo, Branch, et al., 1987).

The most accurate method of measuring dietary sodium intake is to measure excretion via collection of a 24-hour urine sample. Around 90% of dietary sodium is excreted in the urine, with small amounts being lost in faeces and in sweat (Sanchez-Castillo, Branch, et al., 1987). Although under some circumstances (such as extreme heat, vigorous continued exercise, and diarrhoea) sweat and faeces loss will be greater, 24-hour urine specimens are considered the 'gold standard' for estimating dietary sodium intake (Dyer, Elliott, Chee, & Stamler, 1997). There are a number of disadvantages in this method however: it has a high level of respondent burden and samples may be incomplete for this reason. The use of p-aminobenzoic acid has been used to assess completeness of 24-hour urine samples (Hulthen, et al., 2009; Johansson, Bingham, & Vahter, 1999). Day-to-day variation of salt intake is believed to be considerable, and so an accurate measure of an individual's sodium intake will require several 24-hour assessments, thereby placing considerable burden on individuals (Dyer, et al., 1997; Ovesen & Boeing, 2002). For population studies, a reasonably large sample size is required in order to minimise effects of incomplete sample size, and day-to-day variation of intake (WHO/PAHO Regional Expert Group for Cardiovasular Disease Prevention through Population-wide Dietary Salt Reduction, 2010). Twenty-four hour urine results may give the best estimate of total sodium intake, but do not give information about where in the diet sodium has come from or in what proportions. Nevertheless, 24-hour urine sampling has been the method used in a number of key population studies and surveys such as INTERSALT (Henderson, et al., 2003; Stamler, et al., 1991).

Spot urine, overnight urine and 12-hour urine sampling have also been used to estimate 24-hour urine sodium excretion. The main advantage of these methods is that they place considerably less burden on participants, and therefore do not generally have problems with incomplete collection. They may therefore be more suitable for large population samples. However this method is less accurate than 24-hour urine sampling due to the diurnal variation of sodium excretion (Laatikainen, et al., 2006). Modelling work has been undertaken using the ratio of spot urine sodium and creatinine to estimate 24-hour urine excretion which suggests that, at least on a population level, this method can give a good estimate (Kawasaki, et al., 1982). Correlational studies have also indicated a reasonable correlation between spot and 24-hour urine results (Tanaka, et al., 2002). Spot urine sampling has been used to estimate sodium intake in the ANS08, and is likely to be used in the 2011 Australian Nutrition Survey. Further modelling work will be required to indicate the accuracy of spot urine samples in the New Zealand population.

7.2 Sodium Levels in Processed Foods

Assessment and monitoring of sodium concentrations in processed foods is vital to planning and evaluation of sodium risk management strategies, especially if targets for sodium content are published, as they have been in the United Kingdom. The NZFCDB is jointly owned by the New Zealand Institute for Plant & Food Research Limited and the Ministry of Health (Crop & Food Research, undated). This information can be used with dietary recall data to estimate total sodium

intake and sources. The New Zealand Food Safety Authority is commissioning research to assess the accuracy of data from the food composition database with respect to sodium content.

Direct measurement of sodium in food sources has also been used. This is particularly useful when NIP data is not available, such as in restaurant and takeaway food sources. Results of this type of assessment have produced alarming results with some restaurant meals containing more than the total maximum daily salt intake. This has led to calls for compulsory nutrition information of restaurant and takeaway foods by many public health advocates (Centre for Science in the Public Interest, 2009; Webster, et al., 2009a).

Although sodium content in processed foods is usually expressed as mg per serving or mg per 100g, some have suggested an alternative labelling format of mg per 1000 calories (known as a sodium intake density) (IOM (Institute of Medicine), 2010).

7.3 Iodine Intake

Iodine intake is related to sodium intake through its fortification in table salt and more recently in salt used in commercially prepared breads. It is important that iodine status is monitored (primarily through urinary iodide excretion), particularly if sodium risk management strategies are implemented. However, as the majority of salt intake is from processed foods that use non-iodised salt, it is unlikely that sodium risk management strategies will adversely affect iodine levels. The New Zealand Food Safety Authority has indicated that monitoring of iodine levels in food will continue in New Zealand (New Zealand Food Safety Authority, 2009a).

Table 17: Potential advantages and disadvantages of various methods of estimating dietary sodium intake

Method	Potential Disadvantages	Potential Advantages
Dietary recall	Errors in self reporting Inaccurate or incomplete food tables Missing data Most measures do not account for discretionary salt use The hygroscopic nature of salt leads to error in weighted measures of discretionary salt use.	Able to provide information about sources of sodium in the diet
Lithium marker technique	Measures discretionary salt only. Requires 24-hour urine collection	Best measure of discretionary salt use
24-hour urine	Varying excretion rates Losses through other metabolic pathways eg sweat, faeces Incomplete urine collection Differences between assay protocols	Most accurate: 'gold standard' Completeness of samples can be estimated using para-amino benzoic acid
Spot urine	Imprecise because diurnal variation in sodium excretion	Low respondent burden

Source: (Espeland, et al., 2001; Laatikainen, et al., 2006)

8 Appendix A: Health Claims: Regulatory Frameworks

8.1 New Zealand and Australia

Current New Zealand legislation prohibits health claims relating to disease prevention (other than for folate). However, FSANZ is developing a Nutrition, Health and Related Claims Standard (Proposal P293) that will outline requirements for nutritional content claims, general level health claims and high level health claims. Claims regarding disease treatment or prevention will not be permitted (Tapsell, 2008). Submissions on the consultation paper and the draft variations to the standard have been received, and FSANZ is due to report to the Ministerial Council in 2010.

It is likely that the new Standard will include permitted high level health claims regarding sodium or salt and either maintenance of normal blood pressure or reduction of blood pressure provided the food can be classified as 'low salt', and the claim is for adults, and in the context of a "healthy diet with a variety of foods low in salt or sodium" (Food Standards Australia New Zealand, 2008b, 2009b).

8.2 European Union

European Union (EU) Regulation 1924/2006 was implemented in 2007 and outlined regulation, which permitted health claims on foods to be applied across the 27 member states of the EU. Table 1 contains the relevant Articles pertaining to health claims, notably Article 13, which relates to general health claims, Article 13.5 which relates to applications based on newly developed science and/or proprietary data, and Article 14 which relates to children and disease risk reduction health claim applications.

Health claim applications are assessed by the European Food Safety Authority, and are published on a community register of authorised health claims published in 2010 (Asp & Bryngelsson, 2008; European Food Safety Authority, 2010). To date, there are no sodium or salt related health claims published on the register (European Commission, 2010). Some European countries have continued with existing voluntary codes of practice relating to health claims pending full implementation of the EU Regulation. For example Sweden has allowed a limited range of health claims since 1990, which include claims regarding an association between dietary sodium or salt and the risk of high blood pressure and cardiovascular disease for those foods that meet specific criteria for sodium content by weight (Asp & Bryngelsson, 2007, 2008).

Table 18: European Union Regulation 1924/2006: Article 13 and 14: Health and Reduction of Disease Risk Claims

Article 13

Health claims other than those referring to the reduction of disease risk and to children's development and health

1. Health claims describing or referring to:

      (a) the role of a nutrient or other substance in growth, development and the functions of the body; or

      (b) psychological and behavioural functions; or

      (c) without prejudice to Directive 96/8/EC, slimming or weight-control or a reduction in the sense of hunger or an increase in the sense of satiety or to the reduction of the available energy from the diet,

which are indicated in the list provided for in paragraph 3 may be made without undergoing the procedures laid down in Articles 15 to 19, if they are:

      (i) based on generally accepted scientific evidence; and

      (ii) well understood by the average consumer.

2. Member States shall provide the Commission with lists of claims as referred to in paragraph 1 by 31 January 2008 at the latest accompanied by the conditions applying to them and by references to the relevant scientific justification.

3. After consulting the Authority, the Commission shall adopt, in accordance with the procedure referred to in Article 25(2), a Community list of permitted claims as referred to in paragraph 1, and all necessary conditions for the use of these claims by 31 January 2010 at the latest.

4. Any changes to the list referred to in paragraph 3, based on generally accepted scientific evidence, shall be adopted in accordance with the procedure referred to in Article 25(2), after consulting the Authority, on the Commission's own initiative or following a request by a Member State.

5. Any additions of claims to the list referred to in paragraph 3 based on newly developed scientific evidence and/or which include a request for the protection of proprietary data shall be adopted following the procedure laid down in Article 18, except claims referring to children's development and health, which shall be authorised in accordance with the procedure laid down in Articles 15, 16, 17 and 19.

Article 14

Reduction of disease risk claims and claims referring to children's development and health

1. Notwithstanding Article 2(1)(b) of Directive 2000/13/EC, reduction of disease risk claims and claims referring to children's development and health may be made where they have been authorised in accordance with the procedure laid down in Articles 15, 16, 17 and 19 of this Regulation for inclusion in a Community list of such permitted claims together with all the necessary conditions for the use of these claims.

2. In addition to the general requirements laid down in this Regulation and the specific requirements of paragraph 1, for reduction of disease risk claims the labelling or, if no such labelling exists, the presentation or advertising shall also bear a statement indicating that the disease to which the claim is referring has multiple risk factors and that altering one of these risk factors may or may not have a beneficial effect.

Source: (European Union, 2006)

8.2.1 Canada

In Canada health claims are permitted subject to subsection 5.(1) of the Food and Drugs Act (FDA), which states that :

> No person shall label, package, treat, process, sell or advertise any food in a manner that is false, misleading or deceptive or is likely to create an erroneous impression regarding its character, value, quantity, composition, merit or safety (Canadian Food Inspection Agency, 2010).

The Canadian Food Inspection Agency's "*Guide to Food Labelling and Advertising"* outlines how the Food and Drug Act is to be interpreted, and includes definitions for the following types of claims:

> **Disease risk reduction claims** are generally statements that link a food or a constituent of a food to reducing the risk of developing a diet-related disease or condition (e.g. osteoporosis, cancer, hypertension) in the context of the total diet. **… Therapeutic claims** … are claims about treatment or mitigation of a health-related disease or condition, or about restoring, correcting or modifying body functions. …**Nutrient function claims**, formerly known as biological role claims, are a subset of function claims that describe the well-established roles of energy or known nutrients that are essential for the maintenance of good health or for normal growth and development. … **General health claims** are broad claims that promote health through healthy eating or that provide dietary guidance. These claims do not refer to a specific or general health effect, disease, or health condition (Canadian Food Inspection Agency, 2010).

All health claims on foods must be approved by Health Canada, and be consistent with acceptable scientific evidence. New disease risk reduction claims and therapeutic claims require assessment by the Food Directorate of Health Canada and if approved a subsequent amendment to the Food and Drug Regulations to permit their use on food. The Canadian Food Inspection Agency may request food manufacturers or importers to provide scientific evidence to support a food's compliance with a health claim (Canadian Food Inspection Agency, 2010; L'Abbe, et al., 2008). Table 19 outlines sodium related health claims currently permitted for use in Canada.

Table 19: Canadian Permitted Disease Risk Reduction Claims: sodium

Permitted Disease Risk Reduction Claims for sodium:
The Regulations now provide for claims which deal with the following relationships: 　* a diet low in sodium and high in potassium, and the reduction of risk of hypertension; 1. Disease Risk Reduction Claims with Respect to Sodium and Potassium (1) "A healthy diet containing foods high in potassium and low in sodium may reduce the risk of high blood pressure, a risk factor for stroke and heart disease. (Naming the food) is sodium-free." (2) "A healthy diet containing foods high in potassium and low in sodium may reduce the risk of high blood pressure, a risk factor for stroke and heart disease. (Naming the food) is low in sodium." (3) "A healthy diet containing foods high in potassium and low in sodium may reduce the risk of high blood pressure, a risk factor for stroke and heart disease. (Naming the food) is a good source of potassium and is sodium-free." (4) "A healthy diet containing foods high in potassium and low in sodium may reduce the risk of high blood pressure, a risk factor for stroke and heart disease. (Naming the food) is a good source of potassium and is low in sodium." (5) "A healthy diet containing foods high in potassium and low in sodium may reduce the risk of high blood pressure, a risk factor for stroke and heart disease. (Naming the food) is high in potassium and is sodium-free." (6) "A healthy diet containing foods high in potassium and low in sodium may reduce the risk of high blood pressure, a risk factor for stroke and heart disease. (Naming the food) is high in potassium and is low in sodium."

Source: (Canadian Food Inspection Agency, 2010; L'Abbe, et al., 2008)

8.3 United States of America

The FDA oversees food labelling legislation in the USA. Two key pieces of legislation are involved in what might be regarded as health claims:

1. The Dietary Supplement Health and Education Act (1994) permits Structure / Function claims. These are "statements about role of substance on general well being or on maintaining normal structures or functions of the body… [but] may not include, or imply, a relationship with a disease or health-related condition" (Rowlands & Hoadley, 2006). Structure/function claims are not subject to FDA approval. Examples of structure / function claims include *"calcium builds strong bones"* (Rowlands & Hoadley, 2006) or that a nutrient "helps maintain a healthy heart" (Silverglade & Ringel Heller, 2010).

2. The Nutrition Labeling and Education Act (NLEA) (1990) places restrictions on the use of food label health claims unless authorised by the FDA. The FDA authorises health claims providing 'significant scientific agreement' (SSA) standard applies, and the FDA publishes a list of authorised health claims that meet this standard (see table 3) which are issued through letters of enforcement direction. However, since a 1999 U.S. Court of Appeal decision (*Pearson v Shalala)* qualified health claims have been permitted. These are health claims that do not meet criteria for significant scientific agreement but include a qualifying statement intended to convey some degree of uncertainty. These claims are therefore not under the influence or control of the FDA (Rowlands & Hoadley, 2006; Silverglade & Ringel Heller, 2010).

8.4 Codex Alimentarius

Codex Alimentarius is an international body created by Food and Agriculture Organisation of the United Nations (FAO) and WHO to develop an international food code and provide international guidance on matters of food quality and safety. The Codex Alimentarius Guidelines for use of Nutrition and Health Claims (CAC/GL 23/1997) (1997) state that:

> Health claims should be consistent with national health policy, including nutrition policy, and support such policies where applicable. Health claims should be supported by a sound and sufficient body of scientific evidence to substantiate the claim, provide truthful and non-misleading information to aid consumers in choosing healthful diets and be supported by specific consumer education. The impact of health claims on consumers' eating behaviours and dietary patterns should be monitored, in general, by competent authorities (Codex alimentarius, 1997).

Table 20: Federal Regulation § 101.74   Health claims: sodium and hypertension: Specific Requirements

(2) *Specific requirements —(i) Nature of the claim.* A health claim associating diets low in sodium with reduced risk of high blood pressure may be made on the label or labeling of a food described in paragraph (c)(2)(ii) of this section, provided that:

    (A) The claim states that diets low in sodium "may" or "might" reduce the risk of high blood pressure;

    (B) In specifying the disease, the claim uses the term "high blood pressure";

    (C) In specifying the nutrient, the claim uses the term "sodium";

    (D) The claim does not attribute any degree of reduction in risk of high blood pressure to diets low in sodium; and

    (E) The claim indicates that development of high blood pressure depends on many factors.

(ii) *Nature of the food.* The food shall meet all of the nutrient content requirements of §101.61 for a "low sodium" food.

    (d) *Optional information.* (1) The claim may identify one or more of the following risk factors for development of high blood pressure in addition to dietary sodium consumption: Family history of high blood pressure, growing older, alcohol consumption, and excess weight.

    (2) The claim may include information from paragraphs (a) and (b) of this section, which summarizes the relationship between dietary sodium and high blood pressure and the significance of the relationship.

    (3) The claim may include information on the number of people in the United States who have high blood pressure. The sources of this information must be identified, and it must be current information from the National Center for Health Statistics, the National Institutes of Health, or "Nutrition and Your Health: Dietary Guidelines for Americans," U.S. Department of Health and Human Services (DHHS) and U.S. Department of Agriculture (USDA), Government Printing Office.

    (4) The claim may indicate that it is consistent with "Nutrition and Your Health: U.S. Dietary Guidelines for Americans, DHHS and USDA, Government Printing Office.

    (5) In specifying the nutrient, the claim may include the term "salt" in addition to the term "sodium."

    (6) In specifying the disease, the claim may include the term "hypertension" in addition to the term "high blood pressure."

    (7) The claim may state that individuals with high blood pressure should consult their physicians for medical advice and treatment. If the claim defines high or normal blood pressure, then the health claim must state that individuals with high blood pressure should consult their physicians for medical advice and treatment.

(e) *Model health claims.* The following are model health claims that may be used in food labeling to describe the relationship between dietary sodium and high blood pressure:

    (1) Diets low in sodium may reduce the risk of high blood pressure, a disease associated with many factors.

    (2) Development of hypertension or high blood pressure depends on many factors. [This product] can be part of a low sodium, low salt diet that might reduce the risk of hypertension or high blood pressure.

[58 FR 2836, Jan. 6, 1993; 58 FR 17100, Apr. 1, 1993]

Source: (U.S. Government)

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