SURVEY OF SALT IN PROCESSED FOODS

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by

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SURVEY OF SALT IN PROCESSED FOODS

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TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES

GLOSSARY

CNS	National Children's Nutrition Survey: a 24 hr diet recall survey of 3275 New Zealand school children 5-14 years of age, conducted in 2002
CV	coefficient of variation = standard deviation of results divided by the mean as a percentage
FSANZ	Food Standards Australia New Zealand
MFD	Manufactured Foods Database
mg/100g	milligrams per 100 grams
Na	The chemical abbreviation for sodium
NNS	National Nutrition Survey: a 24 hr diet recall survey of New Zealand consumers aged over 15 years, conducted in 1997
NZTDS	New Zealand Total Diet Survey
RM	Reference material used for analytical quality control

SUMMARY

Key data gaps for sodium concentration of processed foods were filled through the analysis of 21 targeted foods to augment existing data from the 2003/04 New Zealand Total Diet Survey and the New Zealand Food Composition Database.

Concentration information from these three sources was consolidated into a database of sodium concentrations in 58 processed foods and used as the basis to estimate the intake of non-discretionary salt for seven sub populations. Consumption information for 25+ year males, 25+ females, 19-24 young males and 19-24 young females was obtained from the 1997 National Nutrition Survey. Intakes of salt for 11-14 year boys, 11-14 year girls and children 5-6 years were estimated from consumption information in the 2002 National Children's Nutrition Survey.

Mean salt intakes from processed foods were: 5.9 g/day for 25+ year males, 3.9g/day for 25+ females, 6.9 g/day for 19-24 young males, 5.1 g/day for 19-24 young females, 5.2g/day for 11-14 year boys, 4.2 g/day for 11-14 year girls and 3.5 g/day for children 5-6 years old. Intake data was right skewed for each population group with most respondents consuming less than the mean for that population group. If salt is used as a vehicle of iodine fortification, the range and distribution of the salt intake will impact on iodine intakes.

A wide range of processed foods were found to contribute to salt intake with bread clearly accounting for the greatest contribution across each of the 7 sub populations (35 to 43% of total salt intake). Other foods that contributed 2% or more to salt intake and were common across the age groups were sausage, meat pies, pizza, instant noodles (except for the 25+ males) and cheese (except for the 5-6 year old children). Foods that accounted for 2% or more for specific age-gender groups were:

- for the 25+ year old males; bacon, margarine, corned beef, ham and butter
- for the 25+ year old females; cake, margarine, muffin, bacon, soup, butter, corned beef and yeast extract
- for the young males; hamburgers, tomato sauce and pasta sauce
- for the young females; bacon, tomato sauce, corned beef, soup, margarine and flavoured snacks
- for the 11-14 boy; ham, biscuits, tomato sauce, flavoured snacks, corned beef, and potato crisps
- for the 11-14 girl; flavoured snacks, biscuits, ham, potato crisps, corned beef, and tomato sauce and
- for the children 5-6 years; plain biscuits, flavoured snacks and potato chips, ham, tomato sauce and canned spaghetti.

New Zealand and Australia are currently considering mandatory fortification of iodine as a risk management option to redress the issue of low iodine intake. Appropriate food vehicles and levels are yet to be determined but the salt survey provides useful directions if salt fortification is considered.

1 INTRODUCTION

Information on the sources and intake of salt in the New Zealand diet is key for two public health issues of current concern, namely, the high intake of sodium and low intake of iodine by most New Zealanders (Vannoort and Thomson, 2005). Dietary salt includes the salt that occurs naturally in most foods, that which is added as an ingredient of processed foods and that, which is added at the time of cooking or at the table. Naturally occurring and salt in processed foods is termed non-discretionary since the consumer cannot choose its occurrence, whereas salt added at the time of cooking, or at the table, is termed "discretionary" because there is an element of consumer choice as to whether they add it or not. Data for sodium, and hence salt, concentrations in New Zealand foods are available from the Food Composition Database (FOODfiles 2004, 2004) and the 2003/04 New Zealand Total Diet Survey (Vannoort and Thomson, 2005). However, not all foods that are consumed in New Zealand have been analysed for salt.

The intake of iodine is below recommended levels for all age-sex groups of the New Zealand population (Vannoort and Thomson, 2005) and Food Standards Australia New Zealand (FSANZ) is currently working on proposal P230 for the Mandatory Fortification of Iodine as a risk management option to redress the issue of low iodine intake. New Zealand table salt has been iodised at a low level since 1924 and at the current level of 25-65 mg iodine per kg salt (Food Standard 2.10.2, FSANZ, 2002), since 1939. However non-iodised salt is widely available and almost all salt used in processed foods is non-iodised salt (Thomson, 2003).

Processed foods are the major source of salt in our diet, contributing between 60-70% of sodium, and hence, salt intake (BNF, 1994, Mattes and Donnelly 1991). Therefore information on the major contributors of salt from processed foods is important for modeling the impact of iodine fortification and/or for assessing the effects of any public health measures undertaken to reduce the use of salt in processed foods.

Chemically, salt is sodium chloride comprising sodium and chloride ions and therefore salt intake could potentially be derived from either sodium or chloride levels in foods. In practice, sodium content has been cited as the basis for estimates of salt intake (Brady 2002, IFST 2003, SACN 2003) with no reports of chloride intakes retrieved. Labelling of foods for sodium is mandatory (FSANZ, 2002) so there is more information on sodium than chloride levels in foods. Sodium makes up 39% of salt by weight and therefore salt intake can be calculated from information on sodium concentrations with an adjustment factor (0.9) to account for non-salt sources of sodium in processed foods. Sources of sodium other than salt are, for example sodium bicarbonate and monosodium glutamate, and have been estimated to contribute in the order of 10% of total sodium intake (Fregly, 1984, NRC, 1989).

1.2 Data on sodium levels in New Zealand foods

A collation of data for sodium and chloride levels in food is available from the New Zealand Food Composition Database with the most current version being FOODfiles 2004 (Crop & Food Research, McLauglin, personal communication, Sept. 2005). The source of the data is variable being New Zealand analytical data, Australian, British or USDA data, derived from a related food, computer generated or "guessed".

Sodium was included as a nutrient of interest in the 2003/04 New Zealand Total Diet Survey (NZTDS) (Vannoort and Thomson, 2005a,b). This survey included 121 foods which were either

nationally or regionally distributed, sampled at two seasons. Individual and consolidated data have been reported (Vannoort 2004a-d, Vannoort and Thomson, 2005b).

1.3 Project Aim

The purpose of the current project was to obtain a database of values for salt in foods and ingredients in the New Zealand food supply to underpin future dietary modelling work and standards development and to derive preliminary estimates of dietary salt intake, including assessment of variability of intake. The values were to be compatible with criteria for inputting into the New Zealand Food Composition Database.

2 MATERIALS AND METHODS

2.1 Assessment of available data

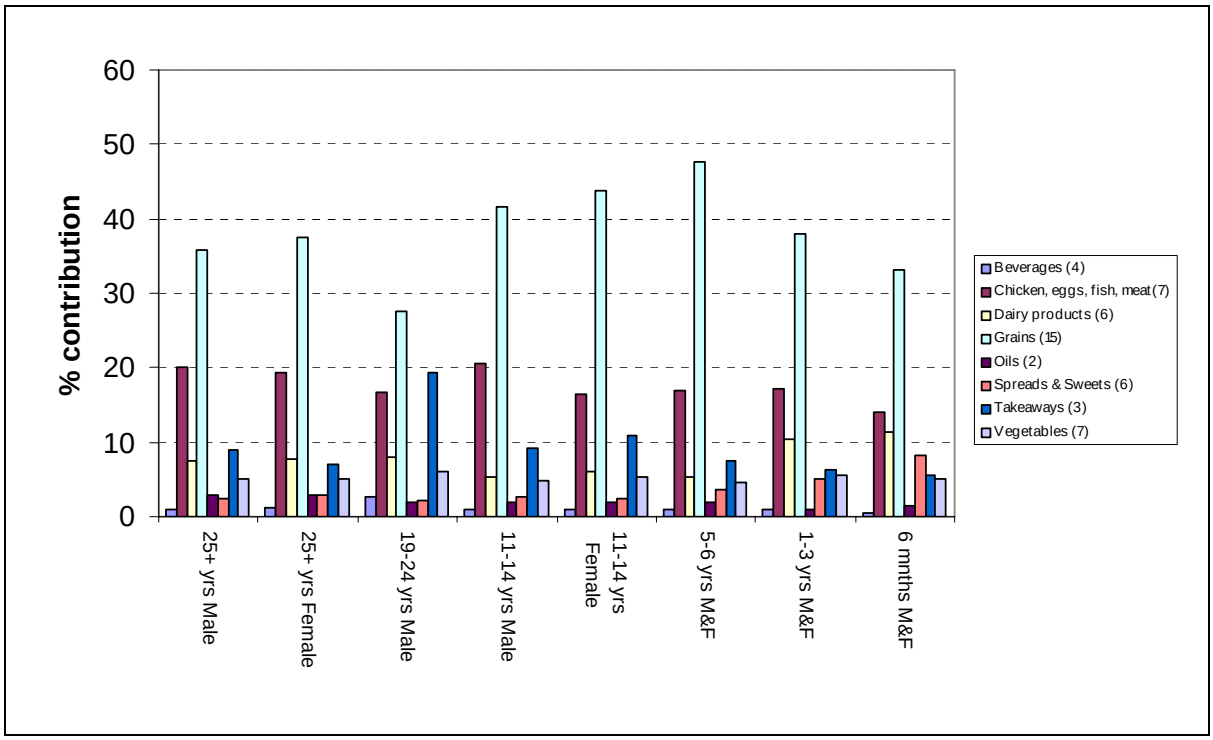
Sodium was a targeted analyte of the 2003/04 NZTDS. The 121 foods included in the NZTDS were considered and the following foods considered inappropriate for further analysis within the current study:

- foods not processed: milk, egg, beef-mince, lamb/mutton, beef-rump, pork chop, whole peanuts, carrot, silverbeet, lambs liver, water, potatoes, cream, cabbage, tomato, celery, kumara, apple
- seafoods: oysters, mussels, fresh fish
- foods that would be inappropriate to fortify: beer, coffee, tea, wine, infant foods
- where discretionary sodium is likely to be highly variable: hot potato chips and takeaways
- foods that made a contribution of <0.05% to sodium intake.

The remaining 51 processed foods contributed between 80 and 90% of estimated sodium intake for 8 population subgroups and comprised beverages (4), chicken, eggs, fish and meat (7), dairy products (6), grains (15), oils (2), spreads and sweets (6), takeaways (3) and vegetables (7). The relative contribution of these eight food groups to sodium intake is shown in Figure 1 and clearly shows that the "grains" group accounts for the greatest proportion of sodium intake. The grains food group included chocolate biscuits, cracker biscuits, plain sweet biscuits, bran flake cereal, bread (white, mixed grain and wheatmeal), cake, cornflakes, muesli, muffins, instant noodles and wheatbix.

Sodium data in Foodfiles 2004 were interrogated and where New Zealand data existed, were collated with the data from the NZTDS. Processed foods for which there is limited NZ data in Foodfiles but which made a significant contribution to sodium intake from the NZTDS assessment included bacon, ham, chicken and pizza. Processed foods that are high in sodium (from Foodfiles) but were not included in the NZTDS exposure estimates included: anchovies, smoked/dried fish, bottled olives in brine, frozen beef patties, beef tongue, pickled beef tongue, canned beef and sheep tongue, ham steak, jellied veal loaf, black pudding, luncheon, pastrami beef, liver pate, salami, sauces (mustard, pickle, soy, chilli) and non chicken soups.

Figure 1: Food groups contributing 80-90% of estimated sodium intake from 2003/04 NZTDS



2.2 Sampling plan

Possible gaps in data on sodium in New Zealand manufactured processed foods were identified by browsing the 5000 foods included in the Manufactured Foods Database (MFD, personal communication, October 2005) along with inspection of products on supermarket shelves for information on the country of origin of potential foods. Samples were restricted to New Zealand manufactured foods.

The foods listed in Table 1 were selected for sodium analyses to augment existing data.

Table 1: Foods selected for sodium analysis

Food	No. of samples	Description	Reason
processed chicken	8	chicken loopys/nuggets/hotdogs	limited data
	8	stuffed chicken products	
	8	crumbed chicken	
	8	KFC	
bacon	8	4 brands, shoulder and middle	limited NZ data, high and variable sodium conc. (1219-1500 mg/100g).
beef pastrami	8		high Na conc. No NZ data.
convenience foods	8	processed potato(cheese medallions, farm animals, potao smiles, hash brown nuggets)	no NZ data
	8	crumbed meats	
	8	prepared dinners	
	8	sushi	
frozen beef patties	8		no NZ data, moderately high levels in UK data
ham and ham steaks	8		limited NZ data, high Na conc. and variable (1219-1500 mg/100g).
luncheon	8		very limited NZ data, high conc., commonly consumed
pate	8		no NZ data, moderately high Na concentration
salami	8	various brands	no NZ data, high Na conc
sauces	8	mayonnaise dressings	limited NZ data
	8	pasta sauces	
	8	chilli sauces	
	8	stir-fry sauces	
	8	piccalilli /chow	
smoked meat/fish	8	various	very limited NZ data, high Na concentration

Na = sodium

2.3 Food sampling and analysis

Foods were purchased from Christchurch retail outlets in October and November 2005. Individual units, or a minimum of 250g of each sample was purchased. Details of the label claim were recorded as a cross reference for the analytical determination of sodium.

A minimum of 250 g of each product was homogenized in a domestic blender. Duplicate 50 ml portions were frozen until analysis. An aliquot of sample was ashed in a muffle furnace at 500ºC, the residue dissolved in concentrated nitric acid, with caesium chloride as an ionization suppressant. Sodium was determined by atomic emission spectroscopy by the ESR Christchurch Science Centre food chemistry laboratory. The laboratory is accredited by IANZ (International Accreditation New Zealand) to the standard NZS/ISO/IEC/17025, 2.72/5 for this analysis.

2.3.1 Quality assurance:

A number of quality assurance procedures were followed to ensure the robustness of the analytical results.

- Thirty two of the 168 samples (19%) were analysed in duplicate, including samples of each food type, to determine variability. A coefficient of variation (CV = standard deviation of results divided by mean x 100%) of less than 10% is considered good but higher values may be acceptable for some matrices, analyte and concentration combinations (Vannoort, personal communication, 2005). Data for duplicate analyses for sodium are provided in Appendix 3.1. The analytical precision and intra-sample variability, based on duplicate analyses was good with all CVs less than, or equal to, 10%.
- Eleven samples were spiked with sodium to correspond to a spike level equivalent to that in the product (i.e. doubling the amount of sodium in an extract between the spiked and unspiked samples). Recovery compares the amount of sodium measured in the spiked sample corrected for the amount of sodium in the unspiked sample, with the amount of sodium added in the spike. Acceptable recoveries for sodium analyses would generally be 70-125%. The recovery of sodium from spiked samples was good, ranging from 84-102%, except the luncheon sample, confirming the general accuracy of the analytical method (Appendix 3.2). The low recovery for the luncheon sample is most likely a single poor result. Four duplicate analyses for luncheon showed a high degree of reproducibility. A comparison of measured sodium levels with label claim do not show a bias towards a low recovery.
- A milk powder reference sample (RM155), supplied by AgriQuality, was analysed with each batch to ensure precision. RMs are stable and homogenous materials with the level of analyte present and its uncertainty uncertainty being certified by the supplier. The analysis of sodium in the RM was acceptable (93-130%) also confirming the accuracy of the analytical method (Appendix 3).

2.4 Concentration data

Mean, minimum and maximum sodium concentration values for each of the 58 selected food items were determined from the aggregated data generated from the results from this study, the 2003/04 NZTDS and Foodfiles 04, where the Foodfile data was sourced within New Zealand. This aggregated data is shown in Appendix 1.

2.5 Assessment of salt intake

Estimates of dietary exposure to salt were made by combining mean sodium levels in processed foods with 24-hour dietary recall information from the 1997 National Nutrition Survey (NNS; Russell *et al*., 1999) and the 2002 National Children's Nutrition Survey (CNS; MoH, 2003) using Microsoft Foxpro.

Food descriptors from the NNS and CNS were mapped to the processed foods of interest for this study. For example, all "muesli bars" in the NNS were mapped to "snack bars". Where a food of interest may be only a component of a described item, such as the bread component of a filled roll, an estimate of the proportion of the food of interest was specified. Each food of interest was assigned a mean sodium concentration (from Appendix 1). The mean sodium concentrations were multiplied by the amount of that food consumed by each respondent in the two consumption surveys, and summed over all foods assessed to estimate the dietary exposure to sodium from processed foods for each individual surveyed. The estimates of dietary exposure were divided by the body weight of the respondent to give a dietary exposure in mg/kg body weight/day.

The sodium intake was converted to a salt intake by adjusting for the difference in molecular weight (58.5/23.0) and to account for non salt sources of sodium (0.9) (Fregly, 1984 and Mattes and Donnelly 1991).

Arithmetic mean, selected percentiles, minimum and maximum exposures were determined using Microsoft Excel.

2.5.1 Age-gender population groups evaluated

The two consumption surveys include respondents 5-14 years and 19 years and over, allowing for exposure estimates for a variety of age and gender groups. The complete sets of dietary exposure estimates were sub-divided to provide information on seven sub-groupings selected for consistency with the 2003/04 New Zealand Total Diet Survey, with the addition of 19-24 year old females (Table 2).

Table 2: Population sub-groups assessed for salt intake from processed foods

Group	Mean body weight (kg)	Number of respondents
25+ year male	82.1	1648
25+ female	70.4	2309
19-24 year male	79.4	141
19-24 year female	67.8	205
11-14 year boy	57.0	567
11-14 year girl	60.1	576
5-6 child	24.6	692

2.5.2 Food contributions

The contribution of a particular food to sodium intake was calculated by summing the contributions to exposure to sodium from each food, across all consumers in a particular age-gender group, and dividing by the sum of all sodium exposures for that group. The resulting proportion was converted to a percentage by multiplying by 100.

2.5.3 Areas of uncertainty in estimated dietary exposures

Whilst the methodology described is considered to provide a realistic estimate of the actual salt intake for the selected sub populations, the following limitations are recognised:

- Foods analysed. Not all sodium containing processed foods have been included in the assessment. Whilst every effort has been made to include the likely major contributors, it is not practicable to include the complete array of foods that is available. Any contribution from non- included foods has not been accounted for.
- Mapping. The foods included in this study (n= 58) were mapped to a wider range of foods described in the NNS/CNS (n=6382). Assumptions have been made that the mapped foods have similar sodium concentrations to the analysed foods. There is a measure of uncertainty around these assumptions.

- Use of 24-hour dietary recall records. The 24-hour dietary recall records from the NNS and CNS are assumed to represent the typical diet for the individual respondent. This is a simplification, as each individual's diet will vary from day to day. Both studies repeated 24-hour dietary recall questionnaires for a proportion of the respondents. These repeat records were used to examine day-to-day variability in individual's dietary exposure.

3 RESULTS AND DISCUSSION

3.1 Concentration of sodium in targeted foods

The choice of foods sampled was limited because of the country of origin. For example, most pasta sauces on supermarket shelves are manufactured in Australia and this study was purposely targeting NZ manufactured foods. Similarly soy, hoisin, Worcester, oyster and chilli sauces are sourced almost exclusively from overseas.

A summary of the mean and range of sodium concentration and percentage of moisture for each of the selected food groups is shown in Table 3. Individual results are shown in Appendix 2.

Table 3: Concentration of sodium and moisture in selected processed foods (mg/100g)

	sodium	Range		
Food type	**conc.**	**max**	**min**	**% moisture**
processed chicken	636	803	402	56.9
stuffed chicken product	464	850	221	61.3
crumbed chicken	313	429	202	64.5
KFC	630	803	434	44.7
bacon	1092	1498	495	59.3
pastrami	1160	1437	913	71.3
processed potato	307	366	174	65.8
crumbed meats	412	557	305	55.5
prepared dinners	345	532	216	76.7
sushi	453	701	243	60.8
beef patties	380	576	100	60.1
ham & ham steaks	1227	1476	943	74.5
luncheon	1038	1253	836	67.2
pate	727	1043	334	55.4
salami	1514	2022	731	52.5
mayonnaise dressing	689	865	350	49.5
pasta sauce	470	767	357	81.3
chilli sauce	1317	2155	765	64.5
stir fry sauce	596	1888	214	71.0
piccalilli	326	548	208	72.1
smoked meat/fish	1032	1730	405	65.3

As expected the highest levels of sodium were found in the processed meat products namely bacon, pastrami, ham, luncheon, salami and smoked meat and fish.

Compliance with label claim was not an objective for this project but label claim information was recorded as a cross check for the analytical measurement of sodium content. Twelve of the 168 samples exceeded the label claim for sodium by more than 50% and included one sample each of processed chicken, prepared dinners, beef patties, luncheon, salami and mayonnaise. Three of the eight samples of bacon and piccalilli/chow had sodium levels in excess of 50% more than the claim on the label.

3.2 Dietary exposure to salt from processed foods

The intakes of salt (mg/day) for seven age sex groups are shown in Tables 4 and 5. Various percentile consumers, including mean, median, maximum and minimum consumers are presented to illustrate the variability of salt intake. The 5th percentile values are the intake for the lowest 5% of the population and thus represent very low sodium (and salt) intakes. Conversely, the 95th percentile is the intake for the top 95% of the population and is indicative of very high intakes. Minimum and maximum values represent extreme intakes for the 24 hr period of collection of the consumption data but are likely to underestimate and overestimate respectively the habitual salt intakes for these consumers (FAO/WHO, 2002).

Table 4: Dietary exposure estimates for sodium and salt for adults (25+ years) and young adults (19-24 years)

	25+ year male		25+ female		19-24 male		19-24 female	
	Sodium mg/day	**Salt mg/day**	**Sodium mg/day**	**Salt mg/day**	**Sodium mg/day**	**Salt mg/day**	**Sodium mg/day**	**Salt mg/day**
mean	2600	5952	1714	3925	3040	6958	2252	5156
median	1996	4570	1344	3077	2389	5469	1607	3678
minimum	0	0	0	0	0	0	0	0
5th percentile	401	919	192	439	223	510	160	366
95th percentile	6137	14048	4198	9611	6440	14742	5567	12744
maximum	22574	51674	21530	49284	13848	31699	13151	30104

Table 5: Dietary exposure estimates for children (11-14 years and 5-6 years).

	11-14 boy		11-14 girl		5-6 child	
	Sodium mg/day	**Salt mg/day**	**Sodium mg/day**	**Salt mg/day**	**Sodium mg/day**	**Salt mg/day**
mean	2291	5245	1838	4208	1548	3544
median	2006	4592	1660	3800	1444	3306
minimum	0	0	0	0	0	0
5th percentile	480	1099	324	742	395	904
95th percentile	5241	11998	4212	9643	3395	7771
maximum	13902	31823	17743	40617	9380	21472

The range of salt intake between the lowest and highest consumers of processed foods (5th and 95th percentiles) varied by a factor of 9 to 35 with the smallest range of intake seen for the younger children, 5-6 years, and the widest range observed for the 19-24 year old female.

These intake assessments were based on 24 hr diet recall information that is recognized as tending to overestimate intake by high consumers (FAO/WHO, 2002). A comparison between the main and repeat data for the NNS and CNS showed agreement within 15% at the 95th percentile of consumers for each sub population, apart from the 5-6 year olds (21% difference between the data sets), and were therefore fair assessments of habitual intake for these sub populations. The estimates of the 5-6 year olds would tend to less accurately reflect habitual exposure than for the older consumers because of the slightly poorer agreement between estimates based on main and repeat data.

For each sub population, the median was less than the mean, indicative of right skewed distributions of intake, illustrated for each sub population in Figure 2. This showed that estimates of mean intake overestimated the intake of the majority of consumers (>50%).

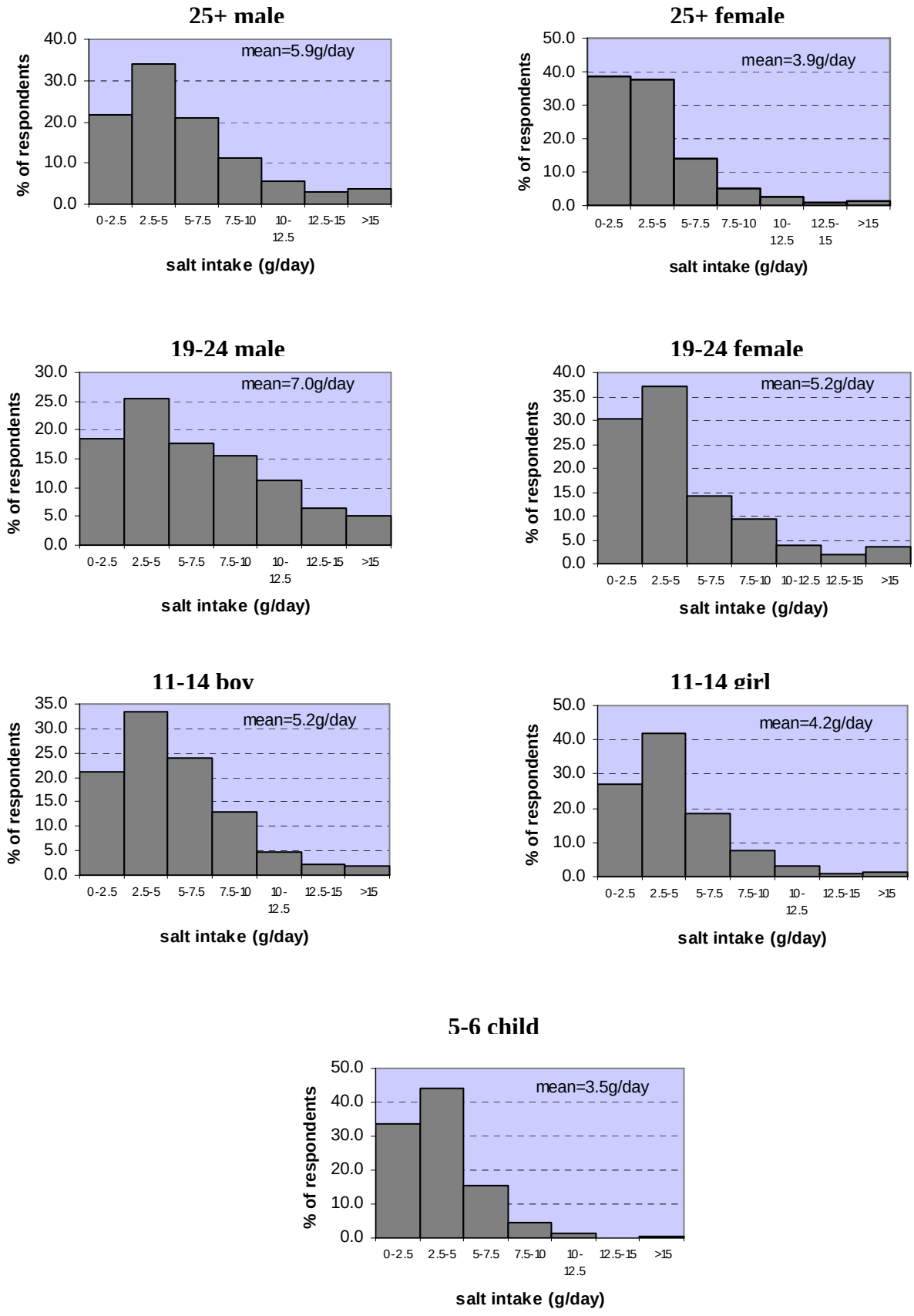


Figure 2: Distribution of salt intake for each population subgroup

The implication of the range and skew of salt intakes is that in the event of salt being fortified with iodine, the intake of iodine will similarly vary by factors of 9-35 for different population groups and the distribution of iodine intake will be influenced by the skew observed for salt intakes.

3.3 Foods contributing to sodium intake

Foods that contributed more than 2% of total salt exposure across all respondents, for each of the sub populations, are shown in Figures 3-9. A tabulation of the proportion that each food makes to the estimated exposure is shown in Appendix 4. Foods not included in the tabulated results were not consumed by that particular sub population.

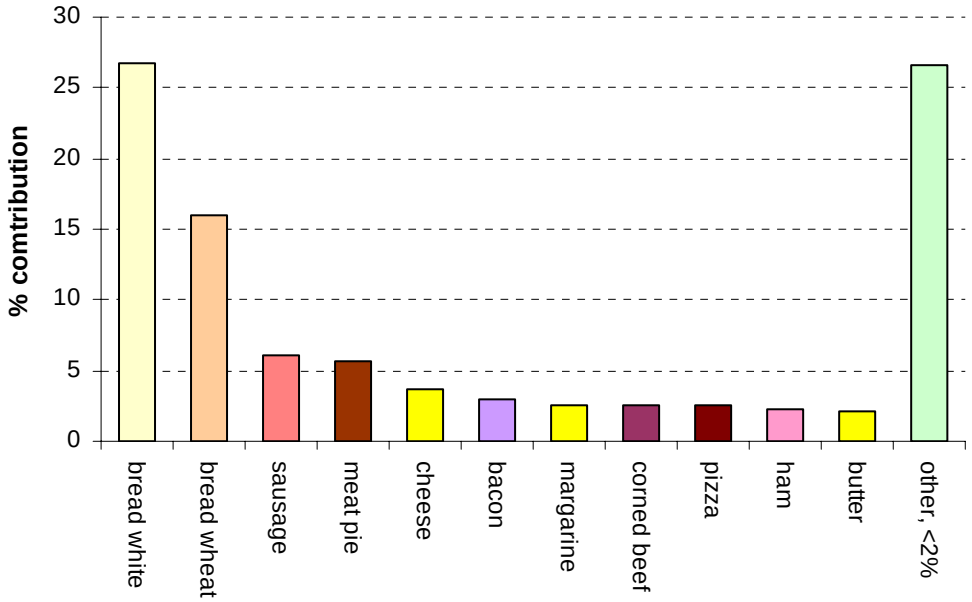


Figure 3: Food groups contributing more than 2% to salt intake for males 25+ years

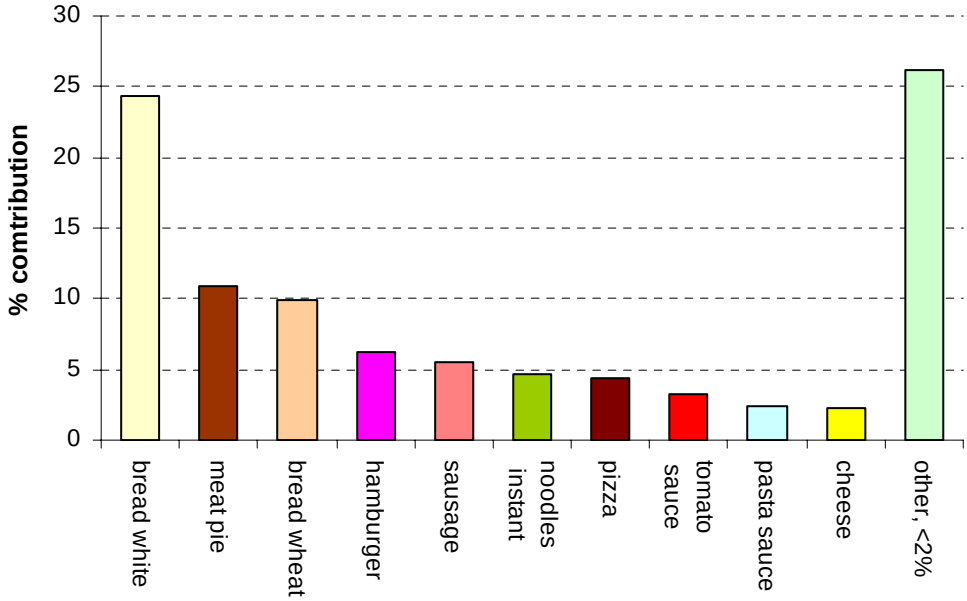


Figure 4: Food groups contributing more than 2% to salt intake for young males 19-24 years

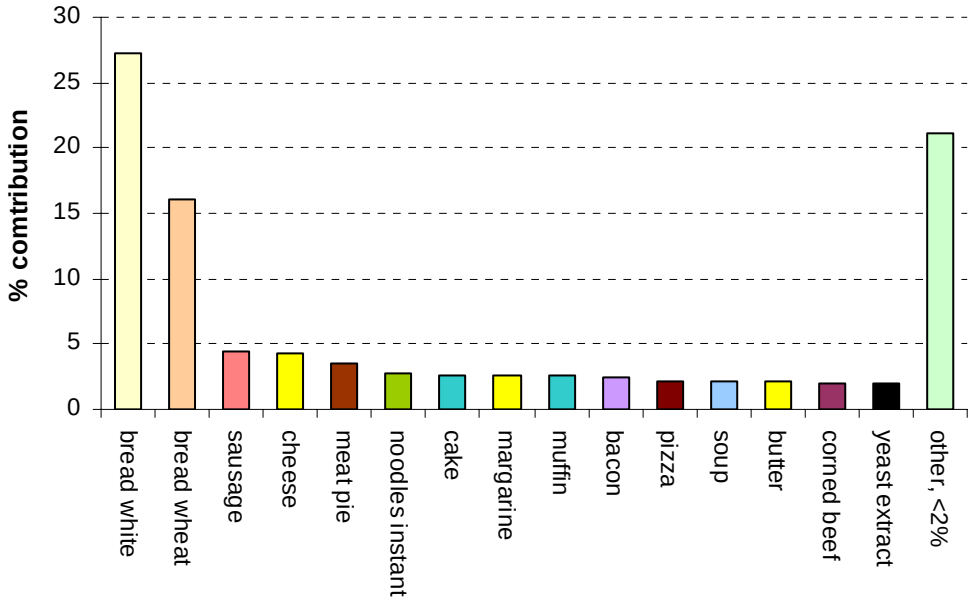


Figure 5: Food groups contributing more than 2% to salt intake for females 25+ years

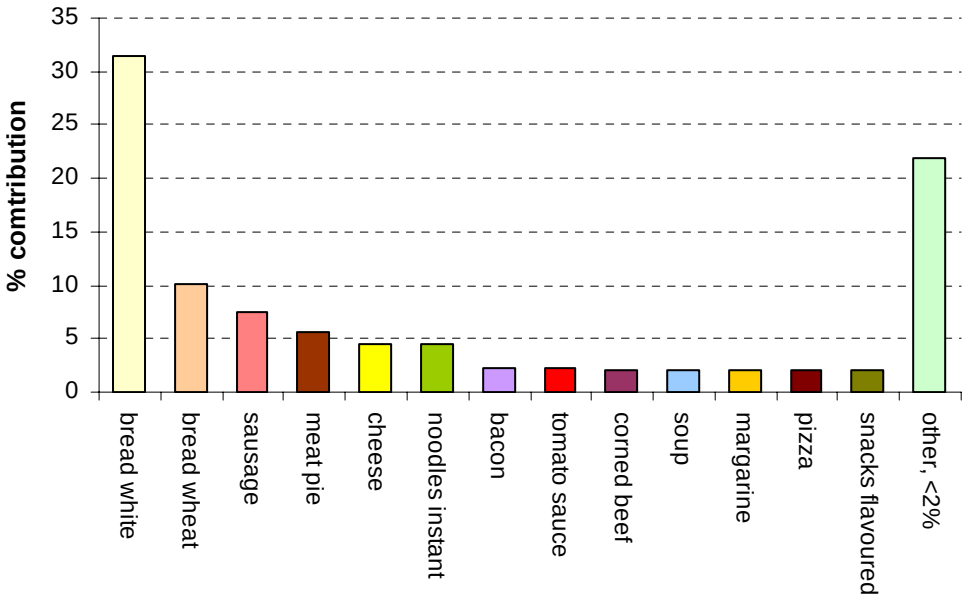


Figure 6: Food groups contributing more than 2% to salt intake for young females 19-24 years

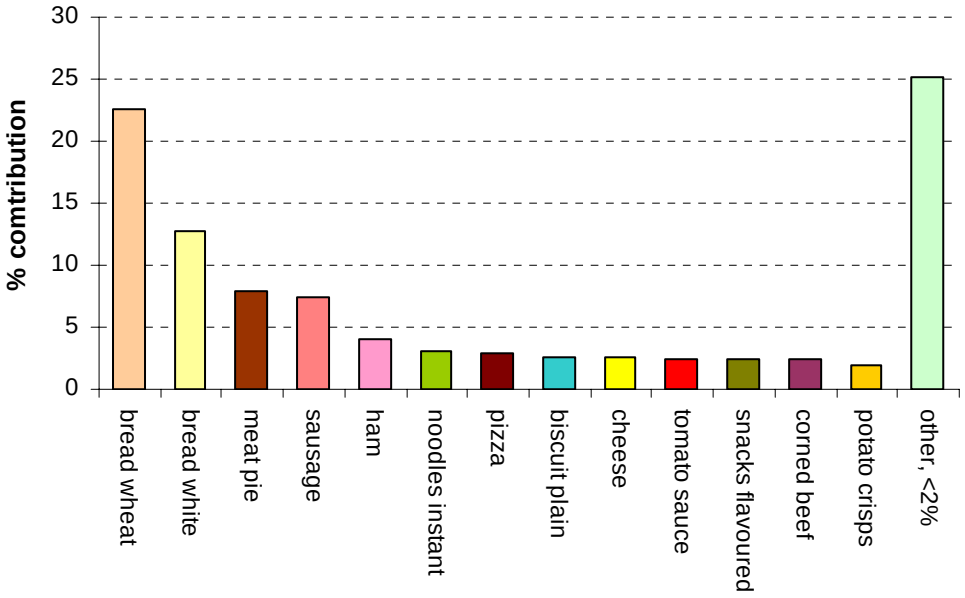


Figure 7: Food groups contributing more than 2% to salt intake for 11-14 boy

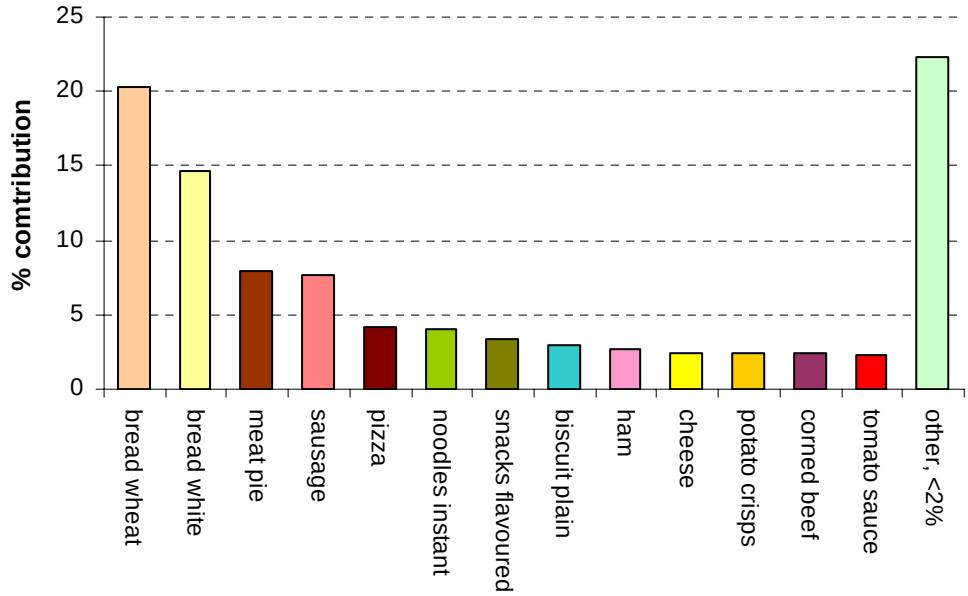


Figure 8: Food groups contributing more than 2% to salt intake for 11-14 girl

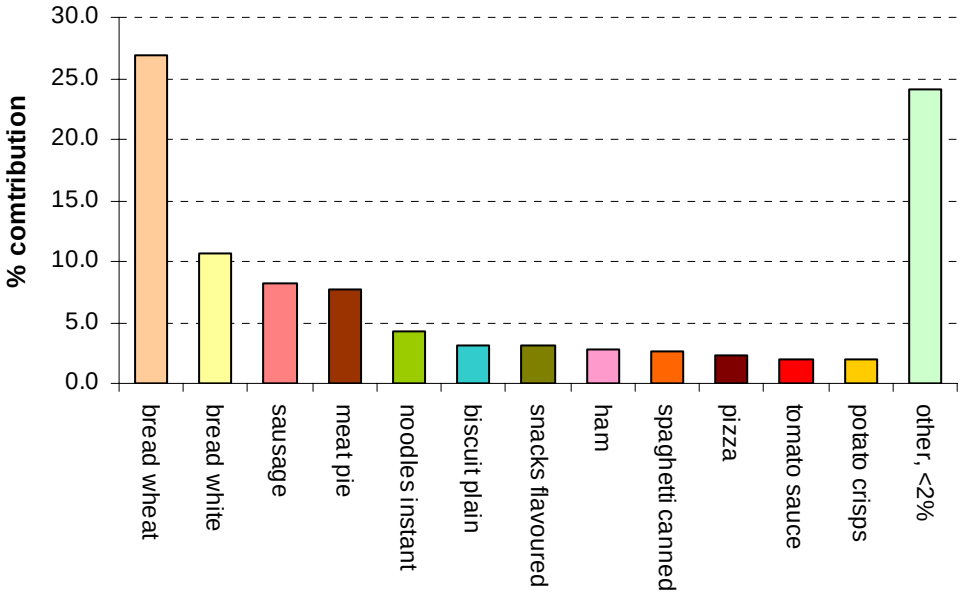


Figure 9: Food groups contributing more than 2% to salt intake for children 5-6 years

Salt was spread across a wide range of foods as represented by the percentage contribution of all the "other" foods, individually contributing less than 2 percent but together comprising 21-27 percent of salt intake from processed foods.

For each of the sub populations, bread, white and wheat combined, clearly made the greatest contribution accounting for 35 to 43% of salt intake. Other foods that contributed 2% or more to salt intake and were common across the age groups were sausage, meat pies, pizza, instant noodles (except for the 25+ males) and cheese (except for the 5-6 year old children). These foods might be targeted for iodine fortification across all population groups.

Foods that were specific to particular age-gender groups were:

- for the 25+ year old males; bacon, margarine, corned beef, ham and butter
- for the 25+ year old females; cake, margarine, muffin, bacon, soup, butter, corned beef and yeast extract
- for the young males; hamburgers, tomato sauce and pasta sauce
- for the young females; bacon, tomato sauce, corned beef, soup, margarine and flavoured snacks
- for the 11-14 boy; ham, biscuits, tomato sauce, flavoured snacks, corned beef, and potato crisps
- for the 11-14 girl; flavoured snacks, biscuits, ham, potato crisps, corned beef, and tomato sauce and
- for the children 5-6 years; plain biscuits, flavoured snacks and potato chips, ham, tomato sauce and canned spaghetti

and might be used to address fortification for a specific age-sex group.

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Appendix 1: Consolidated data of sodium in New Zealand processed foods (mg/kg) (this study, 2003/04 NZTDS [1], Foodfiles 2004[2])

Bacon	Beans, baked, canned	Beef patty	Beetroot, canned	Biscuit, chocolate	Biscuit, cracker	Biscuits, plain sweet	Biscuits, plain sweet cont'd	Bran flake cereal, mixed	Bread, mixed grain	Bread, mixed grain cont'd	Bread, wheatmeal	Bread, white	Butter
17900	3680	3680	1655	1830	5420	3760		3980	4180	4400	5720	5320	5370
17600	4220	4220	1740	1680	3940	6870	**2979**	6730	3970	4400	5020	5470	5770
13200	3730	3730	368	1585	2410	2970	1130	1380	4130		4780	5180	5410
18900	3260	3260	3430	610	7680	3390	6870	50	3900	**4406**	4740	5010	5490
13400	3070	3070	349	2070	3990	3620		7150	4550	3630	5910	4800	5490
12600	5760	5760	1275	1380	6200	2810		1590	5210	6660	4660	5240	5610
14600	5680	5680	1640	2795	3610	2810		2350	5060		4520	4710	5590
13800	1000	1000	2080	1040	3870	2730		1970	4750		4700	4770	5960
14000			3390	3030	2540	3550		4300	6660		5850	8330	4800
14000	**3800**	**3800**		1410	7600	2210		8300	6660		5590	5100	4810
29300	1000	1000	**1770**	1500	8800	3620		9590	3630		5170	5100	
24300	5760	5760	349	2520	5400	2670		110	3650		5090	5100	**5430**
			3430	1570	5800	1730		70	3700		5100	5100	4800
16967				2600	3950	3500		150	4920		5320	5700	5960
12600				1600	8800	3470			4890		6410	4690	
29300				1710	8850	1130		**3409**	4860		7460	4700	
					7500	1820		50	4900		6410	4690	
	Mean			**1808**	7300	3000		9590	3660		4800	4700	
	Min			610	6300	2540			4120		4800	3300	
	Max			3030		3210			4140		4800	4140	
					5787	1770			4110		4800	4800	
					2410	2210			4100			4800	
					8850	3980			3670		**5317**	4800	
						3500			3740		4520	4800	
						1360			3700		7460		
						2770			3700			**5015**	
						3200			4400			3300	
						3200			4400			8330	

Appendix 1 cont'd: Consolidated data of sodium in New Zealand processed foods mg/kg

Cake	Cake cont'd	Cheese	Corn canned	Corned beef	Cornflakes	Crumbed chicken	Crumbed meat	Dairy dessert	Fish fingers	Ham	Hamburger	Icecream	KFC chicken	Luncheon
3750	3250	6160	958	7500	7000	2730	5570	520	3550	12300	4730	647	7630	9110
3270	3230	6940	1020	7930	7630	4290	3440	537	2880	14200	4170	373	6830	11870
3830	1360	6750	1160	8140	8810	3650	3050	693	5670	12100	3760	481	4340	9020
3850		6690	953	7290	5710	3750	4980	507	3150	13300	5090	457	8030	11260
3650	**2600**	5930	1450	9800	6640	2430	4000	564	3280	13300	4810	391	5900	11230
3870	740	6120	2470	11300	9600	3330	4280	723	4650	12600	6870	460	6550	12530
3750	4040	5840	1550	8810	4460	2020	3470	493	3160	13400	3980	430	5530	8360
3470		6000	1080	8860	6980	2860	4170	516	3920	15000	4550	436	5600	9670
3180		5740	1730	10900	9820				8060	13000	4810	460		7450
740		5700		6200	8300	**3133**	**4120**	**569**	8840	11130	5080	410	**6301**	12200
3400		6350	**1375**	6400		2020	3050	493	7240	12320	3510	320	4340	
3600		6800	953	7100	**7495**	4290	5570	723	10000	12060	4080	460	8030	**10270**
1360		3940	2470		4460				7500	14160	5130	490		7450
1290		5090		**8353**	9820				4360	9430	5130	500		12530
1500		6380		6200					4520	14760	3490	400		
2720		6000		11300					3230	11290	4440	720		
4040		6080							4700	13040		600		
3120		8130							2760		**4602**	640		
2060		5270								**12788**	3490	490		
2870		13000							**5082**	9430	6870	340		
1620		7700							2760	15000				
1230		11400							10000			**475**		
890		16900										320		
1170		2600										720		
1600		2400												
3310		**6796**												
2650		2400												
1000		16900												

Appendix 1 cont'd: Consolidated data of sodium in New Zealand processed foods mg/kg

Margarine	Meat pie	Milk, flavoured	Muesli	Muffin	Noodles, instant	Pastrami	Pate	Peanut butter	Piccallili	Pizza	Potato crisps	Prepared meal	Processed chicken	Processed potato
3990	4085	611	230	4980	4520	12550	6670	3580	3430	6010	880	5150	8030	3660
6130	4040	364	2610	4510	2160	10610	9340	6100	2160	6040	6000	2160	4660	3370
6550	4280	400	150	4420	3610	10220	10330	3890	2080	5770	6700	3030	7270	1740
5950	4650	386	910	3760	2800	14370	4620	4190	3580	5250	2880	3270	6020	3510
5920	3840	464	58	4490	1820	10980	9360	1590	2580	5700	6700	5300	4020	3100
5260	5295	352	4820	3690	3600	9130	4030	3340	2730	7240	7600	3010	7840	3590
3450	5280	372	50	3530	2680	10780	3340	5050	5480	5510	7030	2720	6260	3290
6020	5320	334	369	3690	3400	14190	10430	5090	4070	5790	4760	2950	6800	2260
3570	4550	650	470	3420	1300		8540	4350	12000		5450			
7760	4550	730	4240	2400	5600	**11604**	8540		17000	**5914**	3570	**3449**	**6363**	**3065**
7310	2690	680	1140	7300	2870	9130		**4131**		5250	3320	2160	4020	1740
2500	4420	640	4660	2200	2740	14370	**7520**	1590	**5511**	7240	2570	5300	8030	3660
	4520	700	1070		880		3340	6100	2080		1990			
5368	4020	360	1620	**4033**			14370		17000		3210			
2500	2580	360		2200	**2922**						4950			
7760			**1600**	7300	880									
	4275	**494**	50		5600						**4507**			
	2580	334	4820								880			
	5320	730									7600			

Appendix 1 cont'd: Consolidated data of sodium in New Zealand processed foods mg/kg

Mayonnaise dressing	Mayonnaise dressing cont'd	Salami	Sauce chilli/stirfry	Sauce pasta	Sausage	Smoked fish/meat	Snack bar	Snack bar cont'd	Snacks, flavoured	Soup	Soup cont'd	Spaghetti in sauce, canned	stuffed chicken	Sushi
8220	7930	15230	13650	3620	7455	7490	680		9500	3440	3250	3320	2980	2430
5690	6260	14580	7950	3610	6250	5550	1620	**1205**	13700	3540		4140	2210	3480
2190		7310	12970	3910	9180	17300	910	220	12800	4990	**2779**	4790	3900	7010
6290	**7685**	16650	15640	3890	8030	5700	2260	3550	9860	4140	940	4060	6490	4530
7780	2190	20220	7650	3570	6130	4050	3550		8660	4010	4990	3560	8500	4930
8210	12600	11430	13190	7280	7260	13670	3080		11600	3170		4470	4170	5560
4840		19020	21550	7670	8380	15850	640		5130	3070		4450	4990	4130
4810		16650	12780	4060	6130	12950	718		21300	2920		4330	3880	4170
8840			26200	4700	11800	10100	3130		7840	2920		4470		2780
12600		**15136**	3620		11900	12800	920		5350	2180			**4640**	
10000		7310	3970	**4701**	7930	7880	800		7870	2520		**4177**	2210	**4336**
6420		20220	2610	3570	11800	15900	620		7100	2450		3320	8500	2430
6070			8370	7670			860		9750	2510		4790		7010
8190			18880		**8520**	**10770**	1050			3610				
10400			3150		6130	4050	1070		**10035**	2490				
7160			4950		11900	17300	1000		5130	2470				
10900			2140				1300		21300	2890				
9770			25100				1100			2490				
10600							980			2370				
7560			**11354**				950			1620				
9310			2140				930			940				
7340			26200				1210			2250				
6490							1610			2050				
8650							220			2260				
8590							570			2350				
3500							360			3170				
8330							390			2220				

Appendix 1 cont'd: Consolidated data of sodium in New Zealand processed foods mg/kg

Tomato	Tomato sauce	Wheatbix	Yeast extract	Yoghurt
183	5030	3030	34400	404
49	7900	2950	42000	512
1580	7500	50	33100	379
57	7250	3920	41800	434
844	4760	2650	32300	484
1650	8500	2710	40000	425
2330	6960	2810	44000	501
2670	8680	3750		432
1380	6150	2700	**38229**	260
	11500		32300	410
1194		**2730**	44000	490
49	**7423**	50		430
2670	4760	3920		340
	11500			60
				397
				60
				512

Appendix 2: Concentration of sodium (label claim and measured) and moisture content of targeted processed foods

Food	Label* mg/100g	Measured mg/100g	Moisture %
processed chicken	924	803	54.7
	430	466	60.8
	714	727	54.0
	710	602	59.0
	364	402	61.6
	520	784	57.8
	630	626	58.8
	872	680	48.3
mean		**636**	**56.9**
stuffed chicken product	NA	298	61.8
	NA	221	65.7
	407	390	55.8
	625	649	54.0
	621	850	56.2
	374	417	64.6
	472	499	62.8
	417	388	69.3
mean		**464**	**61.3**
crumbed chicken	NA	273	67.8
	390	429	60.4
	NA	365	62.1
	351	375	66.7
	545	243	66.8
	NA	333	63.0
	NA	202	67.4
	545	286	61.8
mean		**313**	**64.5**
KFC coated chicken pieces	NA	763	43.4
	NA	683	47.8
	NA	434	43.1
	NA	803	33.5
	NA	590	49.6
	NA	655	48.0
	NA	553	41.0
	NA	560	51.1
mean		**630**	**44.7**
bacon, Brand 1	1130	979	60.4
	1350	1498	64.9
bacon, Brand 2	580	1014	54.1
	1040	1201	67.1
bacon, Brand 3	650	1099	53.8
	650	1022	62.8
bacon, Brand 4	580	495	50.2
	1040	1425	61.1
mean		**1092**	**59.3**
pastrami	1560	1255	70.8
	NA	1061	70.1
	NA	1022	73.5
	NA	1437	73.8
	970	1098	71.8
	1560	913	69.4

Food	Label* mg/100g	Measured mg/100g	Moisture %
	NA	1078	67.8
	970	1419	73.2
mean		**1160**	**71.3**
processed	453	366	65.1
potato	410	337	67.0
	230	174	66.8
	250	351	60.7
	280	310	79.0
	360	359	59.3
	370	329	68.6
	460	226	60.0
mean		**307**	**65.8**
crumbed meats	620	557	54.1
	NA	344	58.7
	NA	305	63.5
	450	498	53.6
	353	400	49.6
	380	428	52.1
	NA	347	58.4
	450	417	53.6
mean		**412**	**55.5**
prepared dinners	330	515	81.4
	220	216	80.6
	335	303	74.5
	415	327	78.0
	365	532	77.7
	273	301	67.5
	259	272	74.7
	320	295	79.2
mean		**345**	**76.7**
Sushi	NA	243	60.7
	NA	348	60.6
	NA	701	65.0
	NA	453	61.1
	NA	493	56.6
	770	556	63.2
	NA	413	61.1
	NA	417	58.3
mean		**453**	**60.8**
beef patties	155	368	56.9
	560	422	57.2
	500	373	55.1
	275	326	69.6
	292	307	60.6
	570	576	56.7
	550	568	62.6
	110	100	61.8
mean		**380**	**60.1**
ham and ham steaks	1235	1113	73.3
	1100	1232	71.7
	1300	1206	75.6
	1540	1416	77.3
	1100	943	74.5
	1420	1476	75.4
	1140	1129	74.8

Food	Label* mg/100g	Measured mg/100g	Moisture %
	1100	1304	73.5
mean		**1227**	**74.5**
luncheon	940	911	65.1
	950	1187	74.6
	950	902	75.3
	1100	1126	64.4
	650	1123	59.8
	1300	1253	667
	940	836	934
	650	967	1033
mean		**1038**	462
paté	NA	667	936
	1140	934	403
	NA	1033	334
	340	462	1043
	980	936	49.5
	490	403	59.7
	553	334	58.7
	964	1043	61.1
mean		**727**	**55.4**
salami	1216	1523	42.5
	NR	1458	49.7
	950	731	55.5
	1500	1665	39.4
	1300	2022	60.2
	1440	1143	52.2
	1287	1902	61.0
	1277	1665	59.5
mean		**1514**	**52.5**
mayonnaise dressing	665	649	49.1
	1070	865	44.2
	880	859	52.2
	190	350	26.4
	860	833	67.3
	660	642	55.3
	890	793	51.8
	700	626	49.8
mean		**689**	**49.5**
pasta sauce	400	362	85.2
	440	361	81.7
	430	391	79.7
	500	389	77.5
	400	357	85.4
	790	728	77.5
	805	767	80.7
	445	406	82.6
mean		**470**	**81.3**
chilli containing	1360	1365	57.2
sauces	780	795	69.5
	1490	1297	71.6
	1710	1564	49.4
	780	765	69.9
	1490	1319	72.0
	1770	2155	68.8
	1360	1278	57.5

Food	Label* mg/100g	Measured mg/100g	Moisture %
mean		**1317**	**64.5**
stir fry sauces	340	362	67.3
	395	397	72.4
	265	261	78.2
	735	837	61.2
	2020	1888	57.4
	340	315	68.0
	645	495	86.2
	180	214	77.0
mean		**596**	**71.0**
piccalilli, chow	362	343	71.3
	121	216	69.2
	117	208	70.5
	362	358	71.2
	121	258	70.3
	262	273	71.0
	370	548	78.9
	330	407	74.2
mean		**326**	**72.1**
smoked fish	1656	749	70.5
	946	555	67.1
	3000	1730	65.5
	1365	570	61.3
	690	405	52.1
smoked meat	NA	1367	75.4
	1560	1585	62.1
	1570	1295	68.6
mean		**1032**	**65.3**

NA=no nutritional information panel available

Appendix 3: Quality assurance data

A3.1: Duplicate analyses for sodium mg/100g

Food Type	Range of results	No. of duplicates	mean	std dev	%CV
chicken nuggets	474-457	1	465.5	12.0	2.6
stuffed chicken product	286-870	2	573.7	31.6	5.5
crumbed schnitzel	363-366	1	364.5	2.1	0.6
KFC	557-563	1	560.0	4.2	0.8
middle bacon	1019-1624	3	1315	129	9.9
pastrami	1107-1088	1	1097.5	13.4	1.2
processed potato	222-229	1	225.5	4.9	2.2
meat rissoles	345-342	1	343.5	2.1	0.6
chicken chow mein	549-515	1	532.0	24.0	4.5
sushi	421-414	1	417.5	4.9	1.2
beef patties	307-307	1	307.0	0.0	0.0
hamsteak	1231-1232	1	1231.5	0.7	0.1
luncheon	905-1256	4	1118.7	58.0	5.2
pate	448-475	1	461.5	19.1	4.1
salami	1604-1725	2	1665.0	121	7.3
mayonnaise dressing	780-848	2	828.7	35.5	4.3
tomato pasta sauce	715-819	1	767.0	73.5	9.6
chilli sauce	1268-1462	1	1365.0	137.2	10.0
stir fry	343-399	2	379.2	37.0	9.8
piccalilli	196-348	2	275.3	15.2	5.5
smoked meat/fish	732-765	2	748.5	23.3	3.1

A3.2: Percentage recovery of sodium from spiked samples.

Food type	% Recovery
processed chicken	98.9
crumbed chicken	83.9
bacon	98.7
crumbed meat	94.4
prepared dinner	100.5
beef pattie	101.6
luncheon	62.0
mayonnaise dressing	97.1
pasta sauce	102.0
stir fry sauce	95.5
smoked meat/fish	96.1

Appendix 4: Percentage contribution of individual foods to estimated dietary exposure to salt from processed food for adult males (25 years +), young males (19-24) and for children 5-6 years.

25+ male		25+female		19-24 male	
% contribution	food type	% contribution	food type	% contribution	food type
26.7	bread white	27.3	bread white	24.4	bread white
16.0	bread wheat	16.0	bread wheat	10.9	meat pie
6.1	sausage	4.4	sausage	9.9	bread wheat
5.7	meat pie	4.3	cheese	6.2	hamburger
3.7	cheese	3.5	meat pie	5.5	sausage
2.9	bacon	2.8	noodles instant	4.6	noodles instant
2.6	margarine	2.6	cake	4.3	pizza
2.5	corned beef	2.6	margarine	3.2	tomato sauce
2.5	pizza	2.5	muffin	2.4	sauce pasta
2.3	ham	2.4	bacon	2.3	cheese
2.1	butter	2.2	pizza	1.9	yeast extract
1.9	cake	2.1	soup	1.9	bacon
1.8	noodles instant	2.1	butter	1.8	margarine
1.6	biscuit plain	2.0	corned beef	1.7	butter
1.5	yeast extract	2.0	yeast extract	1.6	potato crisps
1.4	bread mixed	1.8	ham	1.6	spaghetti canned
1.3	soup	1.6	biscuit plain	1.5	KFC chicken
1.3	fish finger	1.3	biscuit cracker	1.5	corned beef
1.3	hamburger	1.2	tomato sauce	1.3	processed potato
1.3	luncheon	1.2	sauce pasta	1.2	snacks flavoured
1.2	muffin	1.1	bread mixed	1.2	ham
1.0	tomato sauce	1.1	fish finger	1.0	crumbed chicken
0.9	sauce pasta	1.1	hamburger	0.9	sauce chilli/stirfry
0.9	spaghetti canned	1.0	salad dressing	0.9	biscuit plain
0.8	beans baked	0.8	sauce chilli/stirfry	0.8	cake
0.8	salad dressing	0.8	processed potato	0.6	crumbed meat
0.8	biscuit cracker	0.7	spaghetti canned	0.5	soup
0.7	crumbed chicken	0.7	luncheon	0.5	fish finger
0.6	sauce chilli/stirfry	0.6	potato crisps	0.5	bread mixed
0.5	KFC chicken	0.6	crumbed chicken	0.5	prepared meal
0.5	processed potato	0.5	KFC chicken	0.4	salad dressing
0.5	snacks flavoured	0.5	beans baked	0.4	luncheon
0.4	potato crisps	0.5	snacks flavoured	0.3	processed chicken
0.4	crumbed meat	0.4	crumbed meat	0.3	cornflakes
0.4	cornflakes	0.4	yoghurt	0.3	peanut butter
0.4	prepared meal	0.3	prepared meal	0.2	icecream
0.3	icecream	0.3	icecream	0.2	biscuit cracker
0.3	beef patty	0.3	processed chicken	0.2	beans baked
0.3	muesli	0.2	muesli	0.1	yoghurt
0.3	processed chicken	0.2	biscuit chocolate	0.1	biscuit chocolate
0.2	peanut butter	0.2	beef patty	0.1	corn canned
0.2	biscuit chocolate	0.2	pate	0.1	milk flavoured
0.2	tomato	0.2	tomato	<0.1	muesli
0.2	yoghurt	0.2	beetroot	<0.1	muffin
0.2	piccalilli	0.2	peanut butter	<0.1	salami
0.1	bran cereal	0.2	cornflakes	<0.1	snack bar

25+ male		25+female		19-24 male	
% contribution	food type	% contribution	food type	% contribution	food type
0.1	salami	0.2	piccalilli	<0.1	tomato
0.1	corn canned	0.1	sushi	<0.1	beetroot
0.1	beetroot	0.1	corn canned	<0.1	beef patty
0.1	snack bar	0.1	smoked fish/meat		
<0.1	smoked fish/meat	0.1	bran cereal		
<0.1	stuffed chicken	0.1	snack bar		
<0.1	wheatbix	0.1	salami		
<0.1	pate	<0.1	stuffed chicken		
<0.1	sushi	<0.1	milk flavoured		
<0.1	pastrami	<0.1	dairy dessert		
<0.1	milk flavoured	<0.1	wheatbix		
<0.1	dairy dessert	<0.1	pastrami		

19-24 female		11-14 boy		11-14 girl	
% contribution	food type	% contribution	food type	% contribution	food type
31.4	bread white	22.5	bread wheat	20.3	bread wheat
10.1	bread wheat	12.8	bread white	14.7	bread white
7.5	sausage	7.9	meat pie	7.9	meat pie
5.7	meat pie	7.4	sausage	7.7	sausage
4.4	cheese	4.0	ham	4.2	pizza
4.4	noodles instant	3.0	noodles instant	4.0	noodles instant
2.2	bacon	2.9	pizza	3.4	snacks flavoured
2.2	tomato sauce	2.6	biscuit plain	3.0	biscuit plain
2.1	corned beef	2.5	cheese	2.7	ham
2.0	soup	2.5	tomato sauce	2.5	cheese
2.0	margarine	2.5	snacks flavoured	2.4	potato crisps
2.0	pizza	2.4	corned beef	2.4	corned beef
2.0	snacks flavoured	2.0	potato crisps	2.3	tomato sauce
1.6	ham	1.8	margarine	1.8	cake
1.6	potato crisps	1.8	cake	1.8	hamburger
1.6	hamburger	1.6	luncheon	1.6	margarine
1.4	biscuit plain	1.6	spaghetti canned	1.3	biscuit cracker
1.4	butter	1.5	bacon	1.3	yeast extract
1.1	sauce pasta	1.1	muffin	1.2	muffin
1.1	KFC chicken	1.0	prepared meal	1.2	KFC chicken
1.0	yeast extract	1.0	biscuit cracker	1.1	fish finger
1.0	cake	1.0	fish finger	0.9	bacon
0.9	luncheon	0.9	hamburger	0.9	spaghetti canned
0.9	muffin	0.9	yeast extract	0.8	crumbed chicken
0.9	biscuit cracker	0.9	crumbed chicken	0.8	sauce pasta
0.7	processed potato	0.8	processed chicken	0.7	beans baked
0.7	crumbed chicken	0.8	salad dressing	0.7	processed chicken
0.7	salad dressing	0.7	beef patty	0.6	icecream
0.6	beans baked	0.7	soup	0.6	salad dressing
0.6	bread mixed	0.6	icecream	0.6	butter
0.6	sauce chilli/stirfry	0.6	beans baked	0.5	processed potato
0.6	cornflakes	0.6	KFC chicken	0.5	luncheon
0.5	fish finger	0.5	butter	0.5	beef patty
0.3	beef patty	0.5	peanut butter	0.5	soup
0.3	spaghetti canned	0.4	processed potato	0.4	biscuit chocolate
0.2	peanut butter	0.4	sauce pasta	0.4	crumbed meat
0.2	tomato	0.4	sauce chilli/stirfry	0.4	snack bar
0.2	icecream	0.4	snack bar	0.3	peanut butter
0.2	yoghurt	0.4	crumbed meat	0.2	prepared meal
0.2	corn canned	0.3	muesli	0.2	sauce chilli/stirfry
0.2	biscuit chocolate	0.3	cornflakes	0.2	cornflakes
0.2	stuffed chicken	0.3	biscuit chocolate	0.2	muesli
0.2	sushi	0.2	smoked fish/meat	0.2	bread mixed
0.1	snack bar	0.2	bread mixed	0.1	milk flavoured
0.1	beetroot	0.2	sushi	0.1	yoghurt
0.1	prepared meal	0.1	tomato	0.1	wheatbix
<0.1	pate	0.1	wheatbix	0.1	salami
<0.1	dairy dessert	0.1	milk flavoured	0.1	pastrami
<0.1	muesli	0.1	salami	<0.1	corn canned

19-24 female		11-14 boy		11-14 girl	
% contribution	food type	% contribution	food type	% contribution	food type
<0.1	piccalilli	0.1	yoghurt	<0.1	pate
<0.1	crumbed meat	0.1	bran cereal	<0.1	stuffed chicken
		0.1	corn canned	<0.1	tomato
		0.1	stuffed chicken	<0.1	sushi
		0.1	pastrami	<0.1	dairy dessert
		<0.1	piccalilli	<0.1	piccalilli
		<0.1	pate	<0.1	beetroot
		<0.1	beetroot	<0.1	bran cereal

5-6 child	
% contribution	food type
26.9	bread wheat
10.7	bread white
8.3	sausage
7.8	meat pie
4.2	noodles instant
3.1	biscuit plain
3.1	snacks flavoured
2.7	ham
2.6	spaghetti canned
2.3	pizza
2.0	tomato sauce
2.0	potato crisps
1.8	cheese
1.8	margarine
1.6	luncheon
1.5	muffin
1.4	yeast extract
1.3	corned beef
1.2	hamburger
1.1	processed chicken
1.1	KFC chicken
1.1	cake
0.9	biscuit cracker
0.7	soup
0.6	butter
0.6	fish finger
0.6	snack bar
0.6	icecream
0.5	cornflakes
0.5	sauce pasta
0.5	beans baked
0.5	crumbed chicken
0.4	biscuit chocolate
0.4	peanut butter
0.4	bread mixed
0.3	beef patty
0.3	sauce chilli/stirfry
0.3	sushi
0.3	prepared meal
0.3	salad dressing
0.3	processed potato
0.2	muesli
0.2	wheatbix
0.2	bacon
0.2	yoghurt
0.1	milk flavoured
0.1	bran cereal
0.1	crumbed meat
0.1	tomato
<0.1	dairy dessert

5-6 child	
% contribution	food type
<0.1	corn canned
<0.1	pastrami
<0.1	piccalilli
<0.1	beetroot