Methodology Report for the 2008/09 New Zealand Adult Nutrition Survey

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Glossary

24-hour recall	A dietary assessment method that collects information on all foods and drinks consumed in a 24-hour period.
95% confidence interval	An indicator of the accuracy of a survey estimate. The 95% confidence interval (95% CI) is the interval that would be expected to contain the true population value 95% of the time, if many samples were taken.
Adjustment	This is where rates or results have been adjusted to take account of differences in the distribution of other factors (such as age) between different groups (eg, ethnic groups).
Anthropometry	The measurement of body size (eg, height and weight).
Body mass index (BMI)	A measure of weight adjusted for height used to classify people as underweight, normal, overweight or obese. BMI is calculated by dividing weight in kilograms by height in metres squared (kg/m^2).
Design effect (DEFF)	The ratio of the variance (a measure of precision) of an estimate achieved by a complex design, relative to the variance of the same estimate that would be achieved by a simple random sample of the same size.
Dietary supplements	Products containing vitamins, minerals, herbs or botanicals, amino acids and various other dietary substances that are intended to supplement the diet rather than be an entire meal or diet. They are intended for ingestion as a pill, capsule, tablet or liquid and do not usually resemble conventional foods.
Estimated average requirement (EAR)	A daily nutrient level estimated to meet the requirements of half of the healthy individuals in a particular life stage and gender group.
Food security	Access to adequate, safe, affordable and acceptable food. In contrast, food insecurity occurs when the availability of nutritionally adequate and safe foods, or the ability to acquire such foods, is limited or uncertain.
FOODfiles	An electronic subset of the New Zealand Food Composition Database.
Fortification	The permitted addition of nutrients to food. Nutrients can be added to correct a demonstrated deficiency in the population, to replace nutrients lost during processing, storage or handling, or for other reasons.
Glycated haemoglobin (HbA1c)	A measure of average blood glucose over the past 4–6 weeks. HBA1c is measured as a percentage.
Kish grid	A widely used standard technique for randomly selecting one household member for participation in a survey. Developed by Lesley Kish in 1949.

Meshblock	The smallest geographic unit for which statistical data are collected by Statistics New Zealand. Meshblocks vary in size from part of a city block to large areas of rural land. Each meshblock abuts another to cover all of New Zealand.
Neighbourhood deprivation	A measure of the socioeconomic status of an area (see New Zealand Deprivation Index 2006).
New Zealand Deprivation Index 2006 (NZDep2006)	The New Zealand Index of Deprivation 2006 is an area-based index of deprivation, which measures the level of socioeconomic deprivation for each neighbourhood (meshblock) according to a combination of the following 2006 Census variables: income, benefit receipt, transport (access to a car), household crowding, home ownership, employment status, qualifications, support (sole-parent families), and access to a telephone.
New Zealand Food Composition Database	A database containing data on the nutrient composition of foods and drinks commonly consumed in New Zealand.
Nutrient reference values (NRVs)	A set of recommendations for intakes of energy and nutrients aimed at avoiding deficiency and excess/toxicity. They also include guidance on the dietary patterns needed to reduce the risk of chronic disease.
PC-SIDE	Computer software used to estimate distribution of usual nutrient intake for a group.
Prevalence	The proportion of people with a health-related state (typically a disease or risk factor) within a specific population. It is defined as the total number of cases in the population, divided by the number of individuals in the population.
Quintile	A quintile contains a fifth (20%) of the data. For example, each quintile of the New Zealand Index of Socioeconomic Deprivation (NZDep2006) contains approximately 20% of the population.
Total response ethnic group	A categorisation of ethnicity whereby each person is assigned to all those ethnicities they identify with. Total response ethnicity has been used in this publication.
Usual intake	The distribution of observed intakes from a single 24-hour recall, adjusted to remove the effects of within-person (or intra-individual) variability. This can be achieved by collecting two 24-hour recalls from a representative sub-sample of the group.

Abbreviations

AMDR	acceptable macronutrient distribution range
BMI	body mass index
CAPI	computer-assisted personal interview
CURF	confidentialised unit record file
DHB	district health board
EAR	estimated average requirement
FFQ	food frequency questionnaire
HbA1c	glycated haemoglobin
LINZ®	Life in New Zealand Nutrition and Activity Research Unit, University of Otago
LINZ24©	a data capture software package of the LINZ® Nutrition and Activity Research Unit, University of Otago
MFD	Manufactured Food Database
NHANES	United States National Health and Nutrition Examination Survey
NRV	nutrient reference value
NZANS	New Zealand Adult Nutrition Survey (2008/09)
NZDep2006	New Zealand Deprivation Index (2006)
NZFCDB	New Zealand Food Composition Database
USDA	United States Department of Agriculture

1   Introduction

The 2008/09 New Zealand Adult Nutrition Survey (NZANS) is a component of the New Zealand Health Monitor, an integrated programme of household surveys and cohort studies managed by the Ministry of Health, and it is a key element of the cross-sector programme of Official Social Statistics. The 2008/09 NZANS is the fourth national population-based nutrition survey in adults and the second survey by the Ministry of Health. Earlier nutrition surveys were the 1997 National Diet Survey (Birkbeck 1983), the 1989 Life in New Zealand Survey (Russell and Wilson 1991), and the 1997 National Nutrition Survey (Russell et al 1999).

As a signatory to the Protocols of Official Statistics (Statistics New Zealand 1998), the Ministry of Health employs best-practice survey techniques to produce high-quality data through the 2008/09 NZANS. Standard frameworks and classifications with validated questions were utilised, where possible, to allow for the integration of NZANS data with data from other sources. Ethical approval for the 2008/09 NZANS was gained through the Multi-Region Ethics Committee.

The fielding of the 2008/09 NZANS required the services of two organisations in the provider team. Recruiting a sample and conducting a specialist interview require different sets of skills and experience, and so to ensure high-quality data collection the recruitment of participants into the 2008/09 NZANS was managed by a separate organisation to that which conducted the data collection.

This methodology report details the procedures and protocols that were followed to ensure the 2008/09 NZANS produced the high-quality and robust data expected of official statistics.

2 Background

The 2008/09 NZANS assessed dietary intake and eating patterns, dietary supplement use, food security, body size, blood pressure and biochemical measures in the usually resident New Zealand adult population aged 15 years and over living in private dwellings. The Survey involved face-to-face interviews with 4721 adults, with 4503 participants providing anthropometric measurements, 3348 participants giving a blood sample and 3315 giving a urine sample.

The Health and Disability Intelligence Unit of the Ministry of Health developed the objectives and content of the 2008/09 NZANS in consultation with stakeholders and an External Technical Group. The fielding of the survey was contracted to specialist survey providers CBG Health Research Ltd, who undertook the recruitment. The University of Otago worked with CBG to access participants, collected data, and worked with the Ministry of Health to analyse and interpret the data.

2.1 Survey objectives

The objectives for the 2008/09 NZANS were to:

- assess the consumption of food and food groups, and their contribution to nutrient intake, and where possible to compare the results with the New Zealand *Food and Nutrition Guidelines for Healthy Adults* and the *Food and Nutrition Guidelines for Healthy Older People*

- assess the nutrient intakes of the population and assess dietary adequacy against the *Nutrient References Values for Australia and New Zealand*

- assess the consumption of dietary supplements

- assess the nutritional status of the adult population using a range of anthropometric, biochemical and clinical measures

- examine factors associated with dietary intake, including food security and dietary patterns

- estimate the prevalence of nutrition-related chronic diseases, such as cardiovascular disease and diabetes

- estimate the prevalence of risk factors that influence dietary intake and nutritional status.

2.2 Consultation

In July 2006 a communication document was sent to stakeholders. The document provided background information on the NZANS and outlined the proposed objectives, sampling strategy and content. Stakeholders were invited to comment on the draft objectives and content. A list of stakeholders is provided in Appendix 1.

2.3   External Technical Group

The External Technical Group was involved in the development of the survey methodology and content. Members were appointed for their expertise relating to food and nutrition, population health surveys, dietary assessment, biochemical assessment, anthropometry, food composition, epidemiology, public health, survey design, statistical methodology and Māori cultural expertise. The External Technical Group met on five occasions during the survey development phase and once when the survey was in the field to discuss any issues and plan analyses.

2.4   Ethical approval

The New Zealand Health and Disability Multi-Region Ethics Committee granted approval for the 2008/09 NZANS (MEC/08/04/049), confirming that the study met the following ethical principles:

- validity of research
- minimisation of harm
- privacy and confidentiality
- informed consent
- cultural and social responsibility.

3   Population and Frame

This section discusses the target population, the survey population and the sample frame for the 2008/09 NZANS.

The target population is the population the survey aims to represent. All statistics for the survey refer to the target population. The survey population is the population that was covered in the survey. For various reasons (discussed below), a small proportion of people could not be covered by the survey. As a result, the survey population is slightly smaller than the target population. The sample weights are designed to reflect the target population, so that the weighted statistics produced from the 2008/09 NZANS can be taken to be representative of this population.

The sample frame is the list of areas, and the lists of dwellings and people within these areas, that were used to select the 2008/09 NZANS sample from the survey population.

3.1   Target population

The target population for the 2008/09 NZANS was the usually resident civilian population aged 15 years and over living in private dwellings in New Zealand. The target population comprised approximately 3.2 million adults (aged 15 years and over).

For reasons of practicality and cost-effectiveness, the target population is defined to include only permanent private dwellings including homes for the disabled, which means temporary private dwellings such as caravans, boats, and cabins and tents in a motor camp are excluded. The target population also excludes non-private dwellings, such as hotels, motels, guest houses, boarding houses, homes for the elderly, hostels, motor camps, hospitals, barracks and prisons.

Table 1 presents the proportion of people in each age group who were in non-private or non-permanent dwellings, as measured by the 2006 Census. Once these dwellings are excluded, the target population contained 94% of the total usually resident population.

Table 1:   Proportion (%) of people in non-private or non-permanent dwellings, 2006

Age group (years)	Proportion (%)
0–4	2.5
5–9	2.4
10–14	5.9
15–24	7.4
25–34	5.2
35–44	4.6
45–54	4.9
55–64	5.6
65–74	6.8
75+	30.6
Total population	6.0

People were eligible to be interviewed at their usual residence only. If they were temporarily visiting a household that was selected into the 2008/09 NZANS, they were not eligible to be selected as part of that household. This process ensured that no one had a double chance of being selected in the survey.

People were in the scope for the survey if they were usually resident in a private dwelling in New Zealand, even if they were temporarily overseas for some of the survey period. In the great majority of cases, these individuals had a chance of being selected in the survey because the survey provider made repeated call-backs to non-contacted households in the sample over the survey period. The benchmarks used in weighting the survey also included usual residents temporarily overseas.

3.2   Survey population

A total of 98.9% of New Zealand's 1.4 million permanent private dwellings (households) were eligible for participation in the 2008/09 NZANS. For practical reasons a small number of households that were part of the defined target population were excluded from the survey population, but these have been accounted for in the final estimates via the survey weights. Households not included were those in meshblocks with fewer than nine occupied dwellings (according to the 2006 New Zealand Census of Population and Dwellings) and those located off the main islands of New Zealand (North, South and Waiheke), such as those on sparsely inhabited off-shore islands, on-shore islands, waterways and inlets. Due to the small number of households omitted, any possible bias is likely to be extremely small.

3.3   Sample frame

An area-based frame of Statistics New Zealand's meshblocks was used, based on New Zealand 2006 Census meshblocks (32,173 geographically defined areas). From this, some meshblocks with very small populations (fewer than nine people and those that cover only offshore islands) were omitted because it was not practical to survey them. Note that this omission amounts to less than 2% of the population.

A sample of 607 meshblocks was selected from this frame. Interviewers listed all the addresses in each of these areas. These lists of dwellings were then used as a frame from which a sample of dwellings was selected from each meshblock. One eligible adult (aged 15 years and over), if any, was then selected from each selected dwelling. The sample design is described in more detail in the next chapter.

4   Sample Design

The 2008/09 NZANS, like other national health surveys run by the Ministry of Health, used a multi-stage, stratified, probability-proportional-to-size (PPS) sample design, with increased sampling of some ethnic groups and age groups, primarily through a 'screened' sample. This sample design was developed jointly by the Centre for Statistical and Survey Methodology, University of Wollongong, New South Wales, Australia, and the Health and Disability Intelligence Unit of the Ministry of Health, New Zealand.

4.1   Objectives of the sample design

The sample design was developed based on the following requirements.

- Robust national estimates for key outcomes can be produced.

- Estimates for all ages over 15 years are required, preferably by the following age groups: 15–18, 19–30, 31–50, 51–70 and 71+ years.

- Estimates by ethnic group are required (Māori, Pacific and New Zealand European and Other), with Māori estimates having approximately the same relative standard error/accuracy as the non-Māori population estimates (equal explanatory power), to the extent that this can reasonably be achieved.

- The design should avoid large variation in estimation weights, in order to reduce standard errors of key estimates and to support analysis of the survey data by multiple users.

- The 2008/09 NZANS design should not vary too much from the design of the 1997 National Nutrition Survey, so that comparisons can be made between the surveys.

The second and third sample design objectives were the most challenging. The final design achieved the aims of producing robust age and ethnicity data by using *disproportionate sampling*, targeting populations of Māori and Pacific people, the younger age group (below 19 years) and the older age group (over 70 years). These groups were sampled at a slightly higher rate by using two *screening* samples, whereby:

- in screening sample 1 only those respondents who identified as being Māori or Pacific people, or as falling into the younger (below 19 years) or older (over 70 years) age groups, were eligible for the survey

- in screening sample 2, only those respondents who identified as being Pacific people were eligible for the survey.

Note that the Pacific population (but not other groups) was targeted in this way to make the design more efficient, because the Pacific population is quite geographically clustered.

4.2 Sample selection

A three-step selection process was used to achieve the sample.

Step 1: Selection of meshblocks

The selection of meshblocks was done after stratifying them into district health boards (DHBs), which ensured the final sample was geographically representative. Meshblocks vary considerably in size and were therefore selected by PPS design within each DHB, so that the size measure was the number of occupied dwellings in the meshblock according to the 2006 Census. In other words, larger meshblocks had an increased chance of selection in the design.

Step 2: Selecting dwellings from within each meshblock

A process of enumeration was used to list all the dwellings in each meshblock. This involved physically walking around the meshblock and listing all the separate dwellings except the non-private dwellings. A systematic random sampling method was used to select three samples from each meshblock (core sample, first screening sample, and second screening sample). Seven dwellings were selected for the core sample, 20 dwellings for the first screening sample (to screen Pacific, Māori and the 15–18 and 71+ years age groups) and a further 13 dwellings for the second screening sample (to screen for Pacific people only).

Step 3: Selection of respondents within households

The procedure for selecting respondents in the 'core' and 'screened' households was essentially the same. Within each household of the 'core' sample, all eligible adults (those aged 15 years and over who usually resided at that dwelling) were identified first. The names of all eligible respondents were then listed in descending order of age on a sampling Kish grid (Kish 1949), and the ethnic group (obtained by proxy from the person who answered the door using the Statistics New Zealand question) of all household members was recorded. One adult (15 years and over) was selected, based on whose names matched predetermined indicators on the sampling Kish grid.

In the two screening samples, all household members were listed first, and their age, sex and ethnicity were established. If they were part of the target group of the screen, they were included in the selection list and the 'Kish method' was used again to select one adult (15 years and over) person from the selection list.

4.3 Sample size

Overall, 4721 interviews were completed by respondents aged 15 years and over in the 2008/09 NZANS. There was no substitution of households or respondents if the selected household or respondent was not contactable or was unavailable.

Table 2 shows the distribution of the sample numbers of final interviews and measurements. The sample size includes respondents who provided any valid data for a section (eg, answered at least one question or had at least one measurement). Pregnant women were excluded from the examination component (anthropometry, blood pressure, biochemical indices). The sample size for some population subgroups was small, particularly for Māori and Pacific aged 15–18 years.

Table 2: Number of respondents for each component of the survey, by age, sex, ethnicity and NZDep2006 quintile

		Number of respondents										
		Initial demography	24-hour diet recall		Dietary habits	Nutrition-related health	Additional sociodemography	Food security[1]	Blood pressure	Anthropometry BMI[2]	Blood analysis HbA1c[3]	Urine analysis sodium[4]
			Initial	Repeat								
Total New Zealand sample		4721	4721	1180	4718	4714	4713	4635	4407	4503	3348	3315
Age												
Males	15–18	326	326	88	326	326	326	299	319	321	195	192
	19–30	284	284	63	284	283	283	282	274	277	152	150
	31–50	598	598	140	598	598	598	595	577	583	381	379
	51–70	378	378	98	378	377	377	377	354	368	319	314
	71+	480	480	123	480	480	480	478	450	454	423	418
	Total	**2066**	**2066**	**512**	**2066**	**2064**	**2064**	**2031**	**1974**	**2003**	**1470**	**1453**
Females	15–18	373	373	90	373	373	373	347	359	359	228	220
	19–30	434	434	101	434	434	434	429	392	395	240	239
	31–50	746	746	176	745	745	745	740	675	698	508	508
	51–70	517	517	142	517	516	516	512	482	495	420	419
	71+	585	585	159	583	582	581	576	525	553	482	476
	Total	**2655**	**2655**	**668**	**2652**	**2650**	**2649**	**2604**	**2433**	**2500**	**1878**	**1862**
Māori												
Males	15–18	49	49	18	49	49	49	45	48	49	27	27
	19–30	94	94	22	94	94	94	93	89	89	41	41
	31–50	161	161	37	161	161	161	160	153	154	103	102
	51+	101	101	31	101	100	100	100	93	96	75	75
	Total	**405**	**405**	**108**	**405**	**404**	**404**	**398**	**383**	**388**	**246**	**245**
Females	15–18	62	62	15	62	62	62	59	59	58	38	37
	19–30	177	177	33	177	177	177	177	155	157	82	82
	31–50	250	250	57	250	250	250	249	223	235	161	161
	51+	146	146	47	146	146	146	144	133	139	113	113
	Total	**635**	**635**	**152**	**635**	**635**	**635**	**629**	**570**	**589**	**394**	**393**

		Number of respondents										
		Initial demography	24-hour diet recall		Dietary habits	Nutrition-related health	Additional sociodemography	Food security[1]	Blood pressure	Anthropometry BMI[2]	Blood analysis HbA1c[3]	Urine analysis sodium[4]
			Initial	Repeat								
Pacific												
Males	15–18	29	29	10	29	29	29	27	27	27	13	13
	19–30	82	82	14	82	82	82	82	80	82	35	35
	31–50	166	166	35	166	166	166	166	160	163	97	97
	51+	72	72	20	72	71	71	70	67	66	58	57
	Total	**349**	**349**	**79**	**349**	**348**	**348**	**345**	**334**	**338**	**203**	**202**
Females	15–18	44	44	11	44	44	44	40	41	40	15	15
	19–30	120	120	24	120	120	120	119	106	105	61	60
	31–50	167	167	41	167	167	167	164	150	157	107	107
	51+	77	77	20	77	77	77	74	69	72	52	52
	Total	**408**	**408**	**96**	**408**	**408**	**408**	**397**	**366**	**374**	**235**	**234**
New Zealand European and Other												
Males	15–18	275	275	71	275	275	275	253	270	271	170	167
	19–30	161	161	40	161	160	160	160	155	158	96	94
	31–50	343	343	80	343	343	343	341	334	338	225	223
	51+	718	718	179	718	718	718	717	675	691	634	625
	Total	**1497**	**1497**	**370**	**1497**	**1496**	**1496**	**1471**	**1434**	**1458**	**1125**	**1109**
Females	15–18	312	312	77	312	312	312	291	303	304	201	194
	19–30	224	224	62	224	224	224	220	208	210	148	148
	31–50	425	425	107	424	424	424	423	389	399	304	304
	51+	916	916	248	914	912	911	907	838	874	764	757
	Total	**1877**	**1877**	**494**	**1874**	**1872**	**1871**	**1841**	**1738**	**1787**	**1417**	**1403**

		Number of respondents										
		Initial demography	24-hour diet recall		Dietary habits	Nutrition-related health	Additional sociodemography	Food security[1]	Blood pressure	Anthropometry BMI[2]	Blood analysis HbA1c[3]	Urine analysis sodium[4]
			Initial	Repeat								
NZDep2006												
Males	1	341	341	85	341	341	341	335	335	336	266	263
	2	352	352	91	352	352	352	340	342	344	262	257
	3	349	349	87	349	348	348	345	332	339	254	254
	4	448	448	103	448	447	447	443	418	427	317	309
	5	576	576	146	576	576	576	568	547	557	371	370
	Total	**2066**	**2066**	**512**	**2066**	**2064**	**2064**	**2031**	**1974**	**2003**	**1470**	**1453**
Females	1	323	323	85	322	322	322	310	307	308	245	242
	2	477	477	127	477	476	475	467	447	456	355	351
	3	412	412	102	411	411	411	407	381	398	313	312
	4	624	624	166	624	623	623	614	559	583	434	429
	5	819	819	188	818	818	818	806	739	755	531	528
	Total	**2655**	**2655**	**668**	**2652**	**2650**	**2649**	**2604**	**2433**	**2500**	**1878**	**1862**

Notes: Includes respondents who provided valid data for each section (ie, answered at least one question or had at least one measurement).

Dietary habits includes eating habits and dietary supplements.

1   Cell sizes are based on the final food security categories.

2   Other components of anthropometry may have different cell sizes.

3   n = 3359 gave blood but the greatest number for an individual component was HbA1c (n = 3348).

4   Other components of urinary analysis may have different cell sizes.

4.4 Rationale for the sample design

This sample design was selected from multiple options as the best possible way to meet the objectives of the 2008/09 NZANS while producing limited variation in the weights and the lowest possible design effects. The simplest possible sample design would be a simple random sample of all people in New Zealand, so that everyone has an equal and independent chance of being selected in the sample. However, a design of this type would not be feasible because:

- there is not a sufficiently accurate list of all addresses in New Zealand that can be used as a sampling frame
- the sample would be geographically very spread out, requiring interviewers to travel great distances between interviews.

Also, a simple random sample would not result in large enough numbers of Māori and Pacific people in the sample to enable adequate statistics for these groups. Because of this, the 2008/09 NZANS, like most household surveys, uses a complex sample design.

Complex designs have two features that affect the precision of statistics coming from the survey.

Different people have a different chance of selection. This is captured in the 'weight', which is the number of people that each survey respondent represents in the target population. In the 2008/09 NZANS, people in different DHBs have different weights, and Māori, Pacific and 15–18 and 71+ years age groups have lower weights than other people, to reflect the fact that these groups had an increased chance of selection in the sample relative to simple random sampling. Sampling of one adult (aged 15 years and over) per household also leads to different weights, in that people in larger households receive a larger weight.

The sample is 'clustered'. In the 2008/09 NZANS a sample of meshblocks was selected and a sample of households was selected from each meshblock. If the households in the sample were shown on a map of New Zealand they would appear clumped. This makes the survey more affordable because interviewers do not have to travel between as many areas as they would if simple random sampling were used.

The net effect of a complex design can be measured by the 'design effect' (or DEFF). The DEFF is the ratio of the variance (a measure of precision) of an estimate achieved by a complex design, relative to the variance of the same estimate that would be achieved by a simple random sample of the same size. The closer the DEFF is to 1, the closer the design is to simple random sampling. Design effects of between 2 and 4 are typical in health surveys, which means the variance is larger than would have been obtained using a simple random sample. Even though the DEFF is greater than 1, it does not mean that a simple random sample should be used, as this would be prohibitively expensive. A complex design like that used in the 2008/09 NZANS is less precise than a simple random sample of the same sample size, but is much more precise than could be achieved by a simple random sample with the same budget.

Nevertheless, DEFFs should not be too large. In particular, it is appropriate for weights to vary across the sample otherwise it would not be possible for Māori, Pacific and 15–18 and 71+ years age groups to have an increased chance of selection in the sample. If the variation in weights is too extreme, however, then the DEFF will be very large, and this would be counter-productive for all statistics, even for Māori and other subpopulation groups. The best statistical methods available for sampling subpopulations were used to ensure the design was appropriate for achieving adequate precision for national and subpopulation estimates within the survey budget.

Design effects are different for each statistic, and Table 3 presents the design effects for selected nutrients from the 2008/09 NZANS. The median design effects over the 12 key nutrients were 2.2 for males and 2.1 for females.

Table 3: Design effects for dietary intake of selected nutrients in the 2008/09 NZANS

	All		Pacific		Māori	
	Males	**Females**	**Males**	**Females**	**Males**	**Females**
Energy	2.1	2.3	2.4	0.9	2.4	0.9
Dietary fibre	2.6	1.9	1.8	0.9	1.8	0.9
Sucrose	1.9	2.6	2.1	0.8	2.1	0.8
Total vitamin A	1.5	1.3	1.5	1.2	1.5	1.2
Riboflavin	2.3	2.6	1.3	1.0	1.3	1.0
Folate	2.0	1.9	1.5	1.2	1.5	1.2
Vitamin B_{12}	2.4	1.5	1.5	1.0	1.5	1.0
Calcium	2.6	2.3	1.5	1.1	1.5	1.1
Iodine	2.2	1.7	1.4	1.0	1.4	1.0
Iron	2.2	2.1	2.1	1.1	2.1	1.1
Selenium	2.0	2.1	1.2	1.3	1.2	1.3
Zinc	2.2	2.0	1.6	1.6	1.6	1.6
Median	2.2	2.1	1.5	1.1	1.5	1.1

5   Participant Recruitment

5.1   Overview

Once the meshblocks for the 2008/09 NZANS had been selected, they were enumerated by CBG Health Research Limited recruiters to determine which addresses referred to households. Enumeration was completed in September 2008. A sample of residences in each enumerated meshblock was then selected for participant recruitment.

Recruiters visited each of these selected residences, assessed the eligibility of prospective participants, informed prospective participants about the survey and collected written consent from those who agreed to be contacted by a University of Otago interviewer. Screening and recruitment took place from 13 October 2008 to 4 October 2009.

5.2   Recruiter training

The recruiters were given two types of training: generic training in recruiting, provided by CBG Health Research, and specialised training in recruitment for the 2008/09 NZANS. The generic training in recruiting comprised four theory modules:

- public policy surveying
- interviewing skills
- enumeration skills
- approach and response rates.

Once a suitable standard had been reached for these modules, recruiters were required to carry out a series of mock recruitments and were given feedback by the trainer and the interviewee involved.

A training day was held to provide specialised training in recruitment for the survey. The training was facilitated by CBG Health Research, with input from the University of Otago and the Ministry of Health. Topics included:

- an overview of the survey
- the purpose of the survey
- recruitment techniques
- how to use the CBG 2008/09 NZANS training manual.

Support material was available on the CBG survey website throughout the study and included material on:

- cultural awareness
- personal safety
- handling dogs.

Recruiter performance was monitored using web-based reports that were updated hourly. Recruiters were provided with feedback on non-contact rates, not-occupied rates and adjusted response rates. Progress reports were reviewed by supervisors and managers. Recruiters were offered support, when needed, to improve performance, including mentors, 'buddies' and individualised training packages.

5.3 Call pattern

The recruiters made up to 10 visits to each sampled dwelling, at different times of the day and on different days of the week, in order to establish contact with the household. After 10 unsuccessful visits a household was described as a 'non-contact' household.

5.4 Recruitment process

Once households had been selected from the enumerated meshblocks, their addresses were loaded on to laptops. This enabled software to be used to guide the recruitment process, record work completed (including contact attempts), record data and upload results to the CBG main office daily.

Recruiters visited each selected household in person. At the visit they collected information from the person who answered the door on the age and ethnic group of all adults (aged 15 years and over) in the household. Statistics New Zealand level 1 ethnic group prioritisation was applied to classify occupants as Māori, Pacific or Other. The eligibility of occupants was determined electronically by the sample manager software running on the surveyor laptop.

A respondent was selected from all eligible occupants using an algorithm that implemented the standard Kish grid (Kish 1949) respondent selection procedure. The eligible prospective participant was informed about the study verbally and was given a copy of the information pamphlet about the survey (see www.moh.govt.nz) and a letter from the Ministry of Health (appendix 2). There was the opportunity to ask questions. If they were interested in participating, prospective participants were asked to sign an electronic consent form agreeing to being contacted by an interviewer. Contact details were then collected to facilitate the transition to the interviewer, who would return to the house to carry out the survey interview.

5.5 Informed consent to be contacted by an interviewer

Participation in the 2008/09 NZANS was voluntary. There was no inducement to participate. Consent to participate in the survey was in two parts: consent to be contacted by an interviewer to arrange a survey interview (collected by the recruiter at first contact), and consent to participate in the survey (collected by the interviewer at the survey interview).

Prospective participants were given an information pamphlet about the survey in person by the recruiter (see www.moh.govt.nz). The pamphlet was available in eight languages (English, Māori, Samoan, Tongan, Chinese, Korean, Hindi and Punjabi). Prospective participants were given an opportunity to ask questions and have them answered. If they agreed to being contacted by an interviewer then they were asked to sign a consent form on the recruiter's laptop.

6 Data Collection

6.1 Overview

Contact details collected by CBG recruiters were transferred to the University of Otago project office via a secure connection. The University of Otago interviewers arranged interview dates and times. The aim was to achieve a relatively even spread of interviews by day of week, with a minimum of 10% of interviews on both Saturday and Sunday.

The 2008/09 NZANS interviews were carried out in the participants' homes by 22 University of Otago interviewers. In most cases, one interviewer conducted the interview, although the interviewer would be accompanied by another person if an interpreter was needed. Data collected in the interview were:

- 24-hour diet recall
- questionnaire (dietary habits, dietary supplements, nutrition-related health, food security, and sociodemographics)
- blood pressure
- anthropometric measurements (height, weight, and waist circumference).

Participants consenting to provide blood and urine samples were asked to go to a local Canterbury Health Laboratories affiliated laboratory at a later date. The interviews took place from 27 October 2008 to 28 October 2009.

6.2 Pre-test

A survey pre-test was carried out from July to August 2008 to trial the 24-hour diet recall, questionnaire, and clinical and anthropometric measures; refine the data flow systems from field interview to project office; and refine the training protocols for field staff. A convenience sample of 62 adults aged 15+ years was recruited from the wider Dunedin City area, and complete dietary and questionnaire data were collected from 61 individuals. All age bands for the proposed survey analyses were represented in the sample, and participants from the following ethnic groups were included: Māori, Pacific, and New Zealand European and Other. As a result of the pre-test, changes were made to the food source component of the 24-hour diet recall, the questionnaire and the interviewer training manual. Interview data collected in the pre-test were not included in the 2008/09 NZANS data set.

6.3 Interviewer training

The interviewers attended a two-week training programme in October 2008 on how to conduct the 2008/09 NZANS interviews, and were also provided with a detailed interviewer training manual. Topics included:
- the origin and purpose of the survey
- making contact with participants
- the consent process

- administering the 24-hour diet recall
- administering the questionnaire
- blood pressure measurement
- collecting anthropometric data
- blood-testing procedures
- Māori cultural awareness
- Pacific protocols and foods
- equipment use and responsibilities
- defensive driving
- personal safety.

In the second week of training the interviewers each carried out a full interview (except requesting a blood test) in a volunteer's home. The data were uploaded to the project office and scrutinised for accuracy and completeness by project office staff, and feedback was provided.

Two regional supervisors were given training beyond that described above, covering:
- contact and support of interviewers
- quality control procedures.

One-day interviewer retraining days were conducted in January and June 2009. Topics included:
- revision of data collection protocols
- revision of blood pressure technique
- quality control procedures
- recruiting Pacific participants.

Throughout the survey, interviewers were provided with feedback from project office staff on the accuracy and completeness of the data they collected. Interviewers were accompanied at interviews on a rotating basis by a field supervisor and given feedback on their performance. Random telephone checks were carried out on approximately 10% of completed interviews to check participant satisfaction and interviewer adherence to the survey protocol. Interviewers were offered support when needed to improve performance, including top-up training (one half-day programme) and remedial training (1.5-day programme).

6.4   Interview process

Regional supervisors assigned participants who had been identified by the CBG recruiters to interviewers. The interviewer then contacted the participant by telephone to arrange a time for the interview in the participant's home. A reminder phone call was made the day before the scheduled interview. Respondents who could not be contacted by telephone were visited in person. At least five attempts to contact by telephone and two to contact in person were made before a person was described as a 'non-contact'.

Informed consent to participate in the survey was collected at the start of the interview. Data were collected during the approximately 90-minute interviews in the following order:

- 24-hour diet recall
- questionnaire (dietary habits, dietary supplements, nutrition-related health, food security and sociodemographics)
- blood pressure measurement
- height, weight and waist circumference measurement.

The interviewer recorded participant responses directly into a laptop computer using computer-assisted personal interview (CAPI) software. The data were uploaded on a regular basis to the project office via a secure HTTP connection.

At the end of the interview, consenting participants (excluding pregnant women) were given a box containing collection materials for the blood and urine samples, and information on their closest Canterbury Health Laboratories affiliated laboratory. They were asked to attend the laboratory for their blood and urine test within two weeks of the interview.

A random sample of 33% of participants were contacted after their interview and asked to complete a second 24-hour diet recall within a month of the first interview in order to collect a repeat 24-hour diet recall in 20% of participants.

6.5   Informed consent to participate in the survey

At the start of the interview the interviewer checked that the respondent had read and understood the information brochure on the survey (see www.moh.govt.nz), and any questions were answered. The interviewer then asked the respondent to sign the consent form (see www.moh.govt.nz), and then the interviewer signed it.

The interview consent form included: (a) consent to take part in the 2008/09 NZANS and (b) consent to provide a blood and urine sample. Participants could therefore participate in the 2008/09 NZANS without providing these samples. The consent form also allowed participants to:

- agree to their samples being stored for additional nutrition-related tests approved by the Multi-Region Ethics Committee
- if desired, organise an appropriate karakia (blessing) to be performed before their stored samples were disposed of.

6.6 Proxy reporting

Data were only collected from participants who were able to participate in the survey themselves, so adults with a health condition or cognitive impairment that prevented them participating were excluded. The only proxy reporting was of age and ethnic group in order to determine eligibility. This information was collected from the person who spoke to the surveyor at the recruitment visit.

6.7 Language assistance

The information pamphlet (see www.moh.govt.nz) was available in eight languages (English, Māori, Samoan, Tongan, Chinese, Korean, Hindi and Punjabi). Language interpreters were available in most areas but were very rarely requested. It was more common for language assistance to be provided by a friend or family member of the participant.

6.8 Participant feedback

All participants who provided a blood sample were sent a personalised letter reporting selected results and providing a generic explanation of their significance (appendix 3). These results covered:

- height
- weight
- body mass index
- waist circumference
- systolic blood pressure
- diastolic blood pressure
- plasma total cholesterol concentration
- plasma HDL cholesterol concentration
- haemoglobin concentration
- serum ferritin concentration.

If any result was outside the expected range, they were advised to approach their doctor to discuss these but an abnormal pattern of results was checked by a registered medical specialist. Where these abnormal patterns indicated presence of a medical condition of serious concern the participant was contacted by the medical specialist.

6.9 Grocery voucher

Participants who provided a blood and urine sample were posted a grocery voucher when the project office received their blood results from Canterbury Health Laboratories. The $50 grocery voucher was for the supermarket of the participant's choice (a choice of two supermarket chains was offered). All participants received a bag with the survey logo at the time of the interview, whether or not they provided a blood or urine sample.

7   Data Collection Instruments

7.1   24-hour diet recall

Background

A 24-hour diet recall is a dietary assessment method whereby a trained interviewer asks subjects to recall all foods and drinks consumed during the previous 24 hours or on the preceding day (eg, midnight to midnight on the previous day). Detailed information is collected on all foods and drinks, including food preparation and cooking methods, and the amount consumed.

A 24-hour diet recall is the dietary assessment method used in most national nutrition surveys because it is more cost-effective and imposes less respondent burden than a diet record. This method is used in the United States National Health and Nutrition Examination Survey (NHANES), and was used in the 2004 Canadian Community Health Survey (Nutrition Cycle) and the 1995 Australian National Nutrition Survey. A 24-hour diet recall was also used for New Zealand's 1997 National Nutrition Survey and the 2002 National Children's Nutrition Survey.

Multiple-pass 24-hour diet recall description

In the 2008/09 NZANS, a multiple-pass 24-hour diet recall was used to collect detailed and quantitative information on all foods, drinks and dietary supplements the participant consumed the previous day (from midnight to midnight). It included all foods, drinks and dietary supplements consumed both at and away from home.

The 24-hour diet recall was interviewer administered using the LINZ24© module of the Abbey software package (LINZ® Health & Activity Research Unit, University of Otago, Dunedin, New Zealand). LINZ24© was used for both the 1997 National Nutrition Survey (Parnell, Wilson et al 2001; Quigley and Watts 1997) and the 2002 National Children's Nutrition Survey (Ministry of Health 2003). The approach is analogous to the United States Department of Agriculture (USDA) Automated Multiple-Pass Method, which is used to collect dietary data in the US NHANES (Blanton et al 2006), without the 'forgotten foods list' step.

The 24-hour diet recall is conducted in four stages using a standardised computer-prompted protocol. In the first stage, a 'quick list' of all foods, beverages and dietary supplements consumed during the preceding day (midnight to midnight) is obtained.

In the second stage, detailed descriptions of all the foods and beverages consumed are collected. For each item there are specific programme-controlled questions and prompts that guide collection of the following information:

- cooking method
- recipe for mixed dishes, where it is known
- any additions made 'on the plate' before consumption (eg, milk with breakfast cereal)

- brand and product name, determined using a bar code scanner if the packaging is available, for selected items where the composition is unique to the brand (eg, different brands of cornflakes are fortified at different levels)
- time consumed
- where the food (or its main ingredient) was sourced (eg, shop, home-grown).

In the third stage, estimates of the amounts of all foods and beverages consumed are obtained. The amount eaten is described by volume, wherever possible (eg, cups, tablespoons). In addition, food photographs, shape dimensions, food portion assessment aids (eg, dried beans) and packaging information are used.

Finally, in the fourth stage, the foods are reviewed in chronological order and the information collected (including descriptions and amounts eaten) is checked. Any additions and changes are made at this point.

On completion of the 24-hour diet recall, the interviewer asked the participant to show them any container in which salt used by the household was purchased. Once it had been sighted, the interviewer recorded whether or not it was iodised.

Updating the 24-hour diet recall for the 2008/09 NZANS

Extensive revisions were made to the 24-hour diet recall programme for the 2008/09 NZANS. Because the food supply changes over time, and the 24-hour diet recall programme requires the interviewer to choose foods from a food list and uses food-specific prompts to collect detailed information about the foods consumed, both the food list and the associated prompts need to be updated for each survey. The revisions can be summarised as follows.

New foods were identified

Foods that had become available since 2002 (ie, since the most recent full revision of the 24-hour diet recall programme) were identified by:
- purchasing ACNielsen market research data
- LINZ® nutritionists searching supermarkets, websites and liquor stores before the start of the survey
- identification of new foods in the three-month and six-month data sets for the 2008/09 NZANS during the survey.

New prompts were developed

Where new foods were identified, prompts were developed that allowed matching of the food to the most appropriate nutrient data. For example, the prompts for muffins were altered to enable capture of specific information on fillings and toppings, because muffins were commonly sold with intrinsic fillings and toppings in 2008 whereas this had been unusual in 2002, when the prompts were used for the 2002 National Children's Nutrition Survey.

Food composition data were updated

Updates to the New Zealand Food Composition Database (NZFCDB) that had been made by Plant & Food Research (formerly Crop & Food Research) since 2002 were accessed. In addition, food composition data for new foods were determined by:

- matching the food with another similar food for which there were food composition data

- calculating a new recipe (eg, altering the milk content of latte and cappuccino coffee), or

- requesting a new analysis from Plant & Food Research.

Removal of foods

Foods were removed if they were no longer available in New Zealand.

Programme changes

Some changes were made to the programme to increase its usability.

Iodised salt

Questions on the use of iodised salt were added to the 24-hour diet recall programme to determine the use of iodised salt. This question had been included with the eating habits questions, but experience from previous surveys and cognitive testing showed that participants did not understand the term 'iodised'. Therefore, it was decided that the best way to establish an understanding of iodised salt use was to view any salt packaging in the household and record whether or not the salt was iodised.

Repeat sample

Dietary intake for individuals varies from day to day. To estimate day-to-day intra-individual variation in nutrient intakes, a random sample of 33% of participants were asked to complete a repeat 24-hour diet recall within one month of the first interview (see section 6.4). One-quarter (1180) of participants completed a repeat 24-hour diet recall – slightly more than the expected 20%. Using data from the second 24-hour diet recall, nutrient intakes from the first 24-hour diet recall were adjusted to reflect usual intakes of the population (using the PC-SIDE program). PC-SIDE adjusts for day of the week.

Quality control

The quality of the dietary data collected was maximised by the use of food-specific prompts within the 24-hour diet recall program. This ensured that complete data were collected at the time of the interview, and that the data were collected in the same way by different interviewers. In addition, quality control steps were carried out at three specific points as follows.

During collection of the 24-hour diet recall

Warning messages were displayed when unlikely amounts of food or beverage were reported (eg, 5 L of milk).

At the project office

The 24-hour diet recalls were checked at the project office as soon as possible after the days of collection. Where problems were identified, the interviewer was contacted and asked to explain an unusual situation or call back the participant to clarify intake. These checks covered:

- whether the reported amounts of food and beverage consumed were realistic

- consistency within the 24-hour diet recall (eg, if all but one coffee was reported as having milk added, was the absence of milk from one coffee an error or a correct report?)

- clarity (eg, if four slices of bread were reported and 3 g of spread – was this 3 g per slice of bread, or only on one slice?)

- whether the data had been collected in the manner requested (eg, if volumes were asked for, was a weight measurement correct?)

- whether enough detail was provided to allow nutrient matching (this was a particular risk for foods that were consumed but did not appear in the food list, and so were described without specific food prompts).

During analysis

When the 24-hour diet recalls were analysed, nutrient distributions were checked for outliers (ie, values that were extremely high or low in comparison to the rest of the data set) and decisions made as to whether the value was plausible. A check was also made if energy intake was less than 4200 kJ.

7.2   Questionnaire

The questionnaire covered dietary habits (eating habits and use of dietary supplements), nutrition-related health, food security and sociodemographics. The interviewer recorded participant responses directly into a laptop computer using CAPI software.

The modules in the 2008/09 NZANS questionnaire are summarised in Table 4, and more information is provided in the following sections.

Table 4: Summarised content of the 2008/09 NZANS questionnaire

Module	Topics	Details
Dietary habits	Eating habits: food groups, food preparation and cooking practices, use of low-fat and low-salt products, consumption of high-fat, high-sugar foods, meal patterns, use of iodised salt.	Frequency of consumption or dietary habit, type of food or product used most often.
Dietary supplements	Supplements used in the past 12 months.	For each supplement: product description, frequency of use and whether prescribed.
Nutrition-related health	Long-term conditions: heart disease, stroke, diabetes, osteoporosis.	Prevalence of ever-diagnosed condition, age at diagnosis, treatment.
	Risk factors: tobacco use, alcohol consumption, diagnosed high blood pressure and high blood cholesterol, adult weight gain.	Prevalence of risk factors, treatment.
Food security	Afford to eat properly, food runs out, lack variety of foods, rely on assistance for food, stress related to food provision.	Frequency of experiencing indicator.
Sociodemographics	Sex, age, ethnicity, country of birth, languages spoken, education, income, employment, household composition.	Standard questions and classifications.

The 2008/09 New Zealand Adult Nutrition Questionnaire is available from www.moh.govt.nz.

Dietary habits

The Dietary Habits Questionnaire was designed to collect information on eating habits and dietary behaviours associated with diet quality and nutrition-related health status. Questions were sourced from the qualitative food frequency questionnaire used in the 1997 National Nutrition Survey, and from questionnaires used in overseas nutrition surveys, including the NHANES Diet Behaviour and Nutrition Questionnaire, the National Diet Nutrition Survey (UK) Survey Habits Questionnaire, the Australian 1995 National Nutrition Survey food related questions, and the Australian Food and Nutrition Monitoring Unit short dietary questions.

In order to reduce respondent burden, the number of questions on eating habits was limited to 25. The focus of questions was on the frequency of the following: eating key foods or food groups (eg, vegetables and fruit), eating breakfast, preparing foods with minimal fat and salt (eg, removing excess fat, addition of salt), and choosing low-fat or reduced-salt foods. Questions on specific foods focused primarily on dietary fat intake by examining the type of milk, spreads and cooking fats usually used. The recall period for the frequency of consumption questions was the 'past four weeks'. The aim was to have a time period that provided an estimate of the participant's *usual* eating habits without being too difficult to recall.

The Dietary Habits Questionnaire was cognitively tested by a specialist group (TNS New Zealand) to assess the target population's understanding of the questions, the recall period and the response categories. TNS conducted in-depth interviews with a representative sample of 30 adults. The purpose of the cognitive testing was to provide information on how people understood and answered questions about dietary habits, and it focused on four main processes: comprehension, retrieval, judgement and response. Some minor changes were made to questions after cognitive testing, including clarifying definitions of foods and beverages, revising response options, adding prompts and interviewer notes.

Dietary supplements

Dietary supplements were defined as anything the participant considered to be a supplement to their diet. Supplements therefore included a range of substances, from vitamins and minerals to 'other' dietary supplements such as flaxseed oil, garlic and spirulina. Participants were asked to recall all dietary supplements consumed in the past 12 months. Each supplement was then classified into one of the following categories: single vitamin, single mineral, multi-vitamin, multi-mineral, multi-vitamin and multi-mineral, oil, or other supplement (eg, ginkgo, St John's Wort, meal replacements).

The following data were collected to allow classification of supplements into these categories:
- brand and product name (by scanning the barcode of a container if it was available)
- dosage (eg, the number of tablets or other units to be taken a day)
- strength (eg, the amount of the active component in a single dose)
- whether the supplement was prescribed by a doctor, nurse practitioner or midwife
- frequency of consumption.

Nutrition-related health

Dietary intake can influence the risk of certain long-term conditions (eg, high blood cholesterol, heart disease, diabetes). In turn, some of these conditions, and their risk factors (eg, smoking), can influence food choices and thus dietary intake. Questions in the nutrition-related health module were sourced from the 2006/07 New Zealand Health Survey.

Participants were asked if they had been diagnosed by a doctor with any of the following long-term health conditions: heart disease, stroke, diabetes, osteoporosis, high blood pressure or high blood cholesterol. Participants were also asked about age of diagnosis and treatments for these conditions.

Participants were asked a series of questions on risk factors, including tobacco smoking, weight gain during adulthood and alcohol use. The Alcohol Use Disorders Identification Test (AUDIT) instrument was used to assess potentially hazardous drinking patterns.

Food security

Household food security was determined using the series of eight statements that had been used in the 1997 National Nutrition Survey and the 2002 National Children's Nutrition Survey. The eight statements were developed to determine whether participants considered that their household had a compromised food intake for financial reasons (Parnell et al 2001). Participants were asked to report how often a statement such as 'Food runs out in my/our household due to lack of money' applied to them.

Sociodemographic information

Sociodemographic information about participants is vital in order to assist with analysis of the various determinants of health outcomes, and to monitor inequality and changes in health disparities. This module included questions on basic demographics (age, sex and ethnic group/s), education, personal and household income, income support and employment, labour-force status, and household composition.

7.3   Blood pressure

Measurement

Blood pressure was measured using an OMRON HEM 907 instrument. This is a highly sophisticated instrument with automatic cuff inflation, which records pulse, systolic and diastolic blood pressure three times, with one minute between measurements. The instruments were tested against a static pressure to ensure they were reading accurately. Any instrument reading outside the limits was replaced, as these instruments cannot be calibrated.

The OMRON HEM 907 kit comes with three blood pressure cuff sizes: small (17–22 cm), medium (22–32 cm) and large (32–42 cm). Because of the limitation of the cuff sizes, the 2008/09 NZANS was not able to obtain a blood pressure measurement in the 22 participants with an upper arm circumference greater than 42 cm. Blood pressure was not measured in pregnant women because pregnancy alters a woman's blood pressure.

Quality control

The interviewer entered blood pressure measurements directly into the blood pressure module of the Abbey software package (LINZ Health & Activity Research Unit, University of Otago, Dunedin, New Zealand), minimising data entry errors. The data were transferred to the project office immediately following the interview to check for outliers, implausible values and refusal rates.

7.4 Anthropometric measurements

Measurements were made on consenting participants, except pregnant women and participants who were unable to stand. Participants were asked to remove heavy outer clothing and shoes before measurements were taken. The first measurements were taken in the following order: height, weight and waist. A second measure of height, weight and waist was then made. If the first two measurements differed by more than 1%, the interviewer was prompted to take a third measurement.

Height

Height was measured using a portable stadiometer (Seca 214). The participant was asked to stand on the centre of the base with their back to the stadiometer, their feet together and heels touching the bottom of the stadiometer upright. The buttocks and upper part of the back should touch the stadiometer upright. The head does not have to touch the stadiometer.

The respondent's head should be in the Frankfort plane. This is achieved when the lower edge of the eye socket (the orbitale) is horizontal with the tragion. The vertex will be the highest point on their head. If a participant's head was not aligned properly, they were asked to raise or lower their chin until it was in the Frankfort Plane. The headboard was lowered until it was in contact with the head (the hair is compressed if needed). The reading was taken to the nearest 0.1 cm.

Weight

Weight was measured using electronic weighting scales (Tanita HD-351), with a maximum weight of 200 kg. The participant was asked to stand on the centre of the scales without support, their arms loosely by their sides, head facing forwards and with their weight distributed evenly on both feet. The reading was taken to the nearest 0.1 kg.

Waist circumference

Waist circumference is the circumference of the abdomen at its narrowest point between the lower costal (10th rib) border and the top of the iliac crest, perpendicular to the long axis of the trunk. Waist circumference was measured using a tape measure (W606PM anthropometric measuring tape). Measurements were made over light clothing using the cross-hand technique. The objective was to minimise the gaps between the tape and the body surface, and to minimise indentations of the body surface wherever possible. The reading was taken to the nearest 0.1 cm.

Quality control

The interviewer entered anthropometric measurements directly into the anthropometry module of the Abbey software package (LINZ Health & Activity Research Unit, University of Otago, Dunedin, New Zealand), to minimise data entry errors. The data were transferred to the project office following the interview to check for patterns of unusual values or refusal rates to identify systematic error in the collection of the data. The data distribution was also checked for outliers to identify implausible values.

7.5 Blood and urine samples

The Ministry of Health, in consultation with the Expert Technical Group, compiled the following priority list of blood and urine indices for analysis:

- complete blood count (CBC)
- blood lipids (total and HDL cholesterol)
- iron status (C-reactive protein, serum ferritin, zinc protoporphyrin, transferrin receptor)
- folate status (whole blood folate, serum folate, red blood cell folate)
- diabetes (HbA1c)
- electrolytes (urinary sodium, potassium, creatinine)
- iodine (urinary iodine, thyroglobulin)
- vitamin D (serum 25-hydroxyvitamin D and parathyroid hormone).

Collection of samples

Blood and urine samples were not collected from pregnant women because pregnancy alters biochemical indices. Each participant who gave informed consent to provide a blood and urine sample was provided with a specimen collection kit, which contained the following: an information sheet for participants, a list of Canterbury Health Laboratories affiliated specimen collection sites at local laboratories, specimen collection instructions for local laboratories, two 4 mL tubes containing ethylene diamine tetra-acetic acid (EDTA), one 10 mL tube for collecting serum (no additive), and a 10 mL tube for urine.

Participants chose the specimen collection site that was most convenient. To enhance response rates, participants were not asked to fast before attending the collection site.

Blood samples

Blood was collected from a forearm vein into three vacutainers (two containing EDTA and one with no additive).

4 ml vacutainer containing EDTA (EDTA 1)

This blood was used at the local laboratory to determine complete blood count (CBC). Indices measured from this sample included:

- mean cell volume
- packed cell volume
- haematocrit
- haemoglobin
- platelets
- red blood cell count
- white blood cell count
- red cell distribution width.

4 ml vacutainer containing EDTA (EDTA 2)

This blood was transported to Canterbury Health Laboratories at 4°C, where three whole blood aliquots were taken. Two of these whole blood aliquots were analysed at Canterbury Health Laboratories for:

- HbA1c
- zinc protoporphyrin.

One of these aliquots was transported to the Department of Human Nutrition at 4°C, University of Otago for analysis of whole blood folate. The remaining whole blood was separated and the plasma transferred to up to two 0.5 mL aliquots, which were transported overnight to the Department of Human Nutrition, University of Otago, for storage at -80°C.

10 ml vacutainer with no additive

This blood was allowed to separate at the local laboratory and the serum was then transported to Canterbury Health Laboratories at 4°C for analysis of:

- total cholesterol
- HDL cholesterol
- serum ferritin
- C-reactive protein
- transferrin saturation
- serum iron.

The remaining serum was transferred to up to four aliquots of 0.5 mL and transported overnight to the Department of Human Nutrition at 4°C, University of Otago, where one of the aliquots was analysed for serum folate. The remaining aliquots were stored at –80°C at the Department of Human Nutrition, University of Otago.

Participants were given the option to have their sample stored for additional nutrition-related tests in the future or to have their sample disposed of safely in the laboratory once testing was completed. A total of 184 participants chose to have their sample disposed of, and a karakia (blessing) was requested by 1017 participants.

Urine samples

A spot urine sample (collected mid-stream) was collected on the same occasion as the blood sample. Urine samples were sent to Canterbury Health Laboratories at 4°C for analysis of urinary:

- sodium
- potassium
- iodine
- creatinine.

Analysis of samples

The blood and urine samples were analysed by Canterbury Health Laboratories or affiliated laboratories and the Department of Human Nutrition, University of Otago. The analytical methods are outlined in Table 5.

Table 5: Methods used to analyse blood and urine samples

Index	Method
Serum total cholesterol[1]	Enzymatic assay on the ARCHITECT cSystem, Abbott
Serum HDL cholesterol[1]	Ultra HDL assay on the ARCHITECT cSystem, Abbott
Serum ferritin[1]	ARCHITECT ferrin assay, a chemilumunescent microparticle immunoassay, Abbott
Serum C-reactive protein[1]	Immunoturbidmetric assay on the ARCHITECT cSystems, Abbott
Whole blood zinc protoporphyrin[1]	Assayed using haematofluorimetry on the Helena Laboratories Protofluor-Z
Serum transferrin[1]	Immunotubidimetric assay on the ARCHITECT cSystems, Abbott
Transferrin saturation[1]	By calculation: (iron umol/L / transferrin g/L) x 3.98
Serum iron[1]	Direct colorimetric method with deproteinisation using the ARCHITECT cSystems, Abbott
Whole blood folate[2]	A microbiological assay on 96-well microtiter plates with chloramphenicol-resistant *Lactobacillus casei* as the test micro-organism
Serum folate[2]	A microbiological assay on 96-well microtiter plates with chloramphenicol-resistant *Lactobacillus casei* as the test micro-organism
Whole blood HbA1c[1]	Bio-rad VARIANT II Hemoglobin A1c Program using ion-exchange high-performance liquid chromatography
Urinary sodium[1]	Abbott C8000 biochemical analyser using an ion selective electrode and integrated chip technology
Urinary potassium[1]	Abbott C8000 biochemical analyser using an ion selective electrode and integrated chip technology
Urinary iodine[1]	Sandell-Kolthoff colorimetric method
Urinary creatinine[1]	Alkaline pitrate assay on the ARCHITECT cSystems, Abbott
Serum 25-hydroxyvitamin D[1]	HPLC tandem-mass spectrometry
Serum parathyroid hormone[1]	2-site sandwich (immunometric) principle. Electrochemiluminescence detection. Roche/Elecsys 2010
Serum thyroglobulin[1]	One step, immunoenzymatic (2-site or 'sandwich') assay with chemiluminescent detection

1   Analysed by Canterbury Health Laboratories or affiliated laboratories, who are members of the Royal College of Australasia Quality Assurance Program.

2   Analysed by the Department of Human Nutrition, University of Otago.

Quality control

Canterbury Health Laboratories subscribes to the Royal College of Pathologists of Australasia Quality Assurance Program. The results of the analyses Canterbury Health Laboratories were responsible for were sent to the project office electronically to minimise data entry errors. The distributions of the results for each test were checked for implausible values, which were removed.

Whole blood and serum folate concentrations were analysed by the Department of Nutrition, University of Otago, using a microbiological assay with the test organism *Lactobacillus casei*, as described by O'Broin and Kelleher (1992). Red blood cell (RBC) folate concentrations were calculated using the following equation:

$$RBC\ folate = whole\ blood\ folate - \frac{serum\ folate\ x\ (1 - haematocrit)}{haematocrit}$$

The accuracy of the microbiological assay was determined using a three-level certified reference material for serum folate from the National Institute of Standards Technology (NIST, USA).

8   Final Response Rates

The main measure used to assess the overall quality of a survey is the final weighted response rate. This is a measure of how many people that were selected to take part in the survey actually participated. A high response rate means that the survey results are more representative of the New Zealand population.

8.1   Response rate

The final weighted response rate for the 2008/09 NZANS was 61%. The refusal and non-contact rates were 31% and 8%, respectively. Because the numbers of respondents who gave blood and urine samples were lower, the final weighted response rates were calculated separately for the blood and urine samples, and they were both 44% of the respondents who were recruited.

These response rates are considered good for a population nutrition survey, which imposes high respondent burden. Although it is difficult to compare surveys between countries, the response rates are very similar to those achieved in population nutrition surveys in Australia, the United Kingdom and Ireland (McLennan and Podger 1998; Bates et al 2010; Harrington et al 2007).

The response rate reflects the proportion of people interviewed from those who were selected into the sample, and describes the success of the study in terms of achieving co-operation from the population being measured. Note that it was not possible to calculate the overall response rate by demographic subgroups such as sex, ethnicity, age group and NZDep2006, due to the unavailability of such information for some participants at the recruitment stage. However, partial response rates by demographic subgroups (Table 6) indicate good participation by Māori and Pacific people.

There are four components to the response rate calculation:

- ineligibles (eg, vacant sections, vacant dwellings and non-residential dwellings)
- eligible responding (interview conducted, respondent confirmed to be eligible for the survey)
- eligible non-responding (interview not conducted, but enough information collected to indicate that the household did contain an eligible adult – almost all refusals were in this category)
- unknown eligibility (eg, non-contacts and refusals who provided insufficient information to determine eligibility).

The response rate was calculated as follows:

$$\text{Response rate} = \frac{\textit{number of eligible responders}}{\left[\begin{bmatrix}\textit{number of eligible} \\ \textit{responders}\end{bmatrix} + \begin{bmatrix}\textit{number of eligible} \\ \textit{non–responders}\end{bmatrix} + \begin{bmatrix}\textit{estimated number of} \\ \textit{eligibles from the unknowns}\end{bmatrix}\right]} \times 100$$

The third term in the denominator accounts for the proportion of unknowns who were likely to be eligible if contact could have been made.

The estimated number of unknown eligibles was calculated as follows:

$$\begin{bmatrix} Estimated\ number \\ of\ eligible\ from \\ the\ unknowns \end{bmatrix} = \begin{bmatrix} number\ of \\ unknowns \end{bmatrix} \times \frac{\begin{bmatrix} number\ of\ eligible \\ responders \end{bmatrix} + \begin{bmatrix} number\ of\ eligible \\ non-responders \end{bmatrix}}{\begin{bmatrix} number\ of\ eligible \\ responders \end{bmatrix} + \begin{bmatrix} number\ of\ eligible \\ non-responders \end{bmatrix} + \begin{bmatrix} number\ of \\ ineligibles \end{bmatrix}}$$

8.2   Weighted response rate

The weighted response rates are first calculated separately for each of the three sample groups (ie, the core sample and the two screening samples). To calculate these rates, instead of counts, the weighted counts based on the selection weights within each sample group are used (see section 10.2). The weights used to combine the weighted response rates into one overall response rate ($R_{overall}$) are based on the final calibrated weights (see section 10.3):

$$R_{overall} = \sum_{i=1}^{3} \left(\frac{\sum_{j=1}^{n_i} w_{ij}}{\sum_{j=1}^{n} w_{ij}} \right) . R_{w,i}$$

where:
$R_{w,i}$ =   the weighted response rate in the sample group i
n_i =   number of subjects in the sample group i and $n = n_1 + n_2 + n_3$
w_{ij} =   calibrated weights for subject j in sample group i.

Table 6 presents the partial response rates at the interview, blood analysis and urine analysis stages, by demographic group. Overall these rates are fairly reasonable, but they do show some differences between ethnic groups, especially for blood and urine analysis data. However, the results obtained in this report are adjusted by the calibrated weights (see section 10.3) incorporating the counts of the benchmark population of the ethnic groups as well. On the whole, this should give readers confidence that the results presented in the report are indeed generalisable to the New Zealand population.

Table 6: Partial response rates (%) for the 2008/09 NZANS, by demographic group

		Interview stage			Blood analysis	Urine analysis
		Response rate	Refusal rate	Non-contact rate	Response rate	Response rate
Total New Zealand sample		75	17	8	55	54
Sex	Males	75	17	8	54	54
	Females	75	18	7	56	55
Ethnic group	Māori	65	24	11	38	38
	Pacific	61	26	13	39	38
	Other	78	16	6	60	59
Age group	15–18	75	16	9	48	46
	19–30	71	19	10	43	43
	31–50	75	18	7	52	53
	51–70	78	17	5	66	66
	71+	80	16	4	69	68
NZDep2006 quintile	1 (least deprived)	81	15	4	61	61
	2	79	15	6	59	58
	3	77	17	6	58	58
	4	72	20	8	50	49
	5 (most deprived)	70	21	9	47	47

8.3   24-hour diet recall, by day of week

The aim was to achieve a relatively even spread of interviews by day of week, with a minimum of 10% of interviews on both Saturday and Sunday. However, weekends are protected time for most families and this target was not quite achieved. The day of the primary interview (first 24-hour diet recall) is shown below (Table 7). Note that the 24-hour diet recall collected information from midnight to midnight on the day before the diet interview.

Table 7: Number and percentage of primary 24-hour diet interviews, by day of week

Day of week	Number	Percent
Monday	755	16.0
Tuesday	812	17.2
Wednesday	902	19.1
Thursday	790	16.7
Friday	635	13.5
Saturday	440	9.3
Sunday	387	8.2

9 Data Processing

This chapter outlines the processes used to collect, check and output the data for the 2008/09 NZANS.

9.1 Capture

Multiple-pass 24-hour diet recall and questionnaire responses, and blood pressure and anthropometry results, were entered directly on to interviewers' laptop computers using Abbey Research software and the LINZ24© module (LINZ® Health and Activity Research Unit, University of Otago, Dunedin, New Zealand). Results of the blood and urine analysis were captured electronically on analysis at local laboratories, Canterbury Health Laboratories or the University of Otago, and the results were transferred to the project office.

9.2 Coding

As part of the multiple-pass 24-hour diet recall, food items that were not listed within the LINZ24© software were recorded in free text during the interview. When the file was submitted to the project office for checking, the food was either (a) re-categorised as an existing food, or (b) added as a new food item. These decisions were made by a team of nutritionists overseen by a registered dietitian.

9.3 Matching to nutrient data

Foods and beverages from the 24-hour recall were matched to food composition data to estimate nutrient intake. The New Zealand Food Composition Database (NZFCDB) was the main source of food composition data for the 2008/09 NZANS. The Ministry of Health contracts Plant & Food Research to maintain and develop the NZFCDB. Plant & Food Research worked closely with the University of Otago to match food items to nutrient data.

FOODfiles (August 2010), an electronic subset of data from the NZFCDB, was the main source of food composition data. An updated version of FOODfiles (March 2011) was used to estimate folate intake from fortified foods. A total of 11,850 distinct food item descriptions were reported by participants. For each food item description the following process was used to match a food item description to a nutrient line (see Appendix 4 for flowcharts). Where possible, each food item was matched to a nutrient line from FOODfiles (see Appendix 4, Figure 1). This occurred for approximately 3000 food items (25%).

If a direct match was not found in FOODfiles, overseas food composition databases were considered. If appropriate, the food item was matched to a nutrient line in an overseas database. The overseas databases used were NUTTAB 2006 Food Composition Tables (Australia), USDA-ARS Nutrient Database for Standard Reference (USA), *McCance and Widdowson's Composition of Foods* (UK), *Food Composition Table for Use in East Asia*, *Standard Tables of Food Composition in Japan*, Malaysian Foods Composition Database, Health Promotion Board – Nutrient Composition of

BFoods (Singapore), and Pacific Islands Foods: Description and Nutrient Composition of 78 Local Foods.

If it was not appropriate to use overseas food composition data, and the frequency of consumption was high and/or the food contributed significantly to energy or nutrient intake, consideration was given to analysing the food (subject to time and cost constraints). If a decision was made to analyse the food, it was added to the NZFCDB.

When a food or beverage could not be completely described by the participant (eg, the person did not know the type of milk they had), it was matched to a composite of the various types of milk (based on data from the NZFCDB), weighted to reflect use in the survey.

For fortified foods, a direct match was sought in the NZFCDB (see Appendix 4, Figure 3). If a match was found, Plant & Food Research checked that fortificant levels were up to date. If fortificant levels were not up to date, the NZFCDB and overseas databases were checked for a close match. If no match was found, fortificant values were sought from the 2008 Manufactured Food Database (MFD) and Plant & Food Research created a new nutrient line and added this to the NZFCDB. The MFD is a database with information on the presence or absence of allergens, additives and some nutrients (including fortificants) in manufactured foods. Food manufacturers voluntarily provide information, so the database is not complete.

For fortified foods not listed in the MFD, fortificant information was sourced from product packaging and/or the manufacturers. Where no New Zealand analytical data were available for a fortified food, it was either matched to an existing record in FOODfiles, or, where there was no suitable match, a recipe was developed from basic ingredients. Plant & Food Research then amended the record to incorporate fortificants and created a brand- and product-name-specific nutrient composition.

Changes to the level of fortificants in a product during the data collection period could not be taken into account due to an unknown and variable time lag between a change in manufacturing procedure and product consumption. However, for Milo, a commonly consumed beverage powder, fortification levels changed halfway through the survey period. To account for this, Plant & Food Research re-analysed Milo and a composite record was made, including 50% each of the old and new Milo records. In addition, products that previously were unfortified and became fortified during data collection could not be taken into account. However, completely new fortified products were matched to a fortified record.

If an appropriate nutrient line was not available from any of the above sources, then a recipe was created by Plant & Food Research using their Food Information Management System recipe calculator (see Appendix 4, Figure 2). All recipes were calculated for nutrients per 100 g, with modifications made for the following as appropriate: moisture loss or gain, nutrient loss, and overriding of nutrient amounts for fortified foods. A total of 4920 recipes were calculated.

If a recipe could not be supplied for a mixed food item, it was matched to a standard recipe. Preparation of recipes was carried out by examining appropriate recipes already in FOODfiles and checking commonly used recipes from top-selling New Zealand cook books and popular New Zealand websites. Modifications were made to standard recipe ingredients to correspond with frequent responses to the ingredient probe questions (eg, type of fat, milk or cheese used). These modified recipes were matched to mixed food items where the respondent, although unable to supply the entire recipe, had been able to give some information in response to the probe questions. The nutrient composition of these recipes was calculated by Plant & Food Research, allowing for weight and nutrient loss in cooking.

Food composition data are presented as the nutrient amount per 100 g of food. All food intake data were converted to intakes in grams (see Appendix 4, Figure 4). For example, food intake data in volumes were converted to grams by applying a density factor.

For dietary supplements, manufacturer-reported composition was obtained whenever possible by using the product label, by contacting the manufacturer or by accessing the website. Generic nutrient lines were devised for commonly consumed vitamins and minerals.

9.4   Accuracy of nutrient estimates

The accuracy of nutrient estimates depends on two factors: the accuracy of information provided by participants in the 24-hour diet recall and the accuracy of the food composition data. Key considerations relating to these two potential sources of error are outlined below.

24-hour diet recall

Misreporting of a food intake, especially under-reporting, is a well-known problem in all types of dietary surveys regardless of the dietary assessment method used. If food intake is under-reported, energy and nutrient intakes may also be underestimated and estimates of inadequate intake may be overestimated. It is difficult to quantify under-reporting, but research shows that the degree of under-reporting varies according to personal characteristics and across types of foods. For example, under-reporting is more common in those with a high BMI, in females, and in some age groups (Livingstone and Black 2003). Certain foods are more likely to be under-reported, especially those perceived as less healthy (eg, cakes, biscuits, desserts and fats). International studies suggest that reasons for misreporting include difficulty recalling all foods and beverages, difficulty estimating portion size, and social desirability bias (ie, under-reporting of unhealthy foods and over-reporting of healthy foods).

The multiple-pass 24-hour software is specifically designed to help participants to accurately recall their food and drink intake. It starts with a 'quick list' to mention all foods consumed during the preceding day (midnight to midnight) in any order, and is followed by a series of food-specific prompts to elicit detailed descriptions of all foods consumed (including cooking methods and recipes), visual aids and tools to help participants estimate the amount of food consumed, and then a review of all foods as a final check. The software ensures complete data are collected and unlikely values are checked. Once uploaded to the project office, data were thoroughly checked by trained nutritionists. Implausible data were also referred back to interviewers for an explanation.

Food composition data

The NZFCDB includes more than 2740 foods and 55 core nutrients. Approximately 70% of foods in the NZFCDB are sampled from New Zealand sources and 50% of nutrient values are New Zealand analytical values (actual or derived), with the remaining values derived from other sources such as overseas databases. For a summary of the analytical techniques used for the analysis of nutrients in the NZFCDB, see Appendix 5.

The Ministry of Health contracts Plant & Food Research to maintain and develop the NZFCDB. A minimum of 2600 analytical values (approximately 50 foods) are added or updated each year. In preparation for the 2008/09 NZANS, priorities for analysis were foods known to contribute significantly to energy and nutrient intake in New Zealand.

During the 2008/09 NZANS the University of Otago worked closely with Plant & Food Research to match food consumption data to an appropriate nutrient line. This process was rigorous and involved checking the quality of food composition data and creating nearly 5000 nutrient lines specifically for the survey.

Due to limitations in food composition data, dietary intake data for folate, iodine, vitamin D and sodium were not included in *A Focus on Nutrition*. The reasons for excluding estimates of dietary intake for these nutrients are outlined below.

Folate

Folate in foods is made up of folate in its natural form and folic acid added to fortified foods. Folate intake is measured as dietary folate equivalents, which are calculated from folate and folic acid, based on the bioavailability of each form:

dietary folate equivalents (DFE) = food folate (µg) + 1.67 folic acid (µg).

Historically a range of methods have been used to measure folate and folic acid in food, with no international consensus on the most appropriate method. The method now recommended has limitations. The NZFCDB includes complete data for natural food folate based on analytical measures or carefully considered estimations derived from known analytical values for folate. However, data for folic acid are largely based on the manufacturer's claims on product labels, which are often higher than analytical values (Bailey et al 2010). As a result, intake of dietary folate equivalents could not be reliably estimated.

Folate status can be assessed by measuring folate in serum and red blood cells. Red blood folate concentration is an indicator of long-term status, while serum folate indicates folate status at the time the blood sample was drawn. Red blood cell folate and serum folate levels were measured in the survey to assess folate status.

Iodine

Iodine is found in a limited number of foods and is regarded as one of the most difficult inorganic elements to measure (Greenfield and Southgate 2003). Many of the iodine values in the NZFCDB are estimates rather than direct analytical measures. Furthermore, the 24-hour diet recall did not collect information on discretionary use of iodised salt (ie, salt added to food during cooking and at the table). Therefore, iodine intake could not be reliably estimated.

More than 90% of iodine is excreted in the urine, so urinary iodine is a good indicator of recent iodine status. Urinary iodine was measured in the survey to assess iodine status. Iodine is an essential component of thyroid hormones, which play a critical role in maintaining the body's metabolic rate and normal growth and development. Thyroglobulin, which is used by the thyroid gland to produce thyroid hormones, was also measured as an indicator of iodine status.

Vitamin D

Two forms of vitamin D are found in foods: cholecalciferol (D3) and ergocalciferol (D2). Vitamin D3 is the most widely distributed (Greenfield and Southgate 2003). Estimates of the relative activities of cholecalciferol, ergocalciferol and their metabolites vary. Vitamin D in foods is found at a very low concentration, and analytical methods are complicated and not widely available. Much of the vitamin D data in the NZFCDB are borrowed from overseas, estimated from calculations, with only a small proportion of values based on New Zealand analytical data. Therefore, vitamin D intake could not be reliably estimated.

Vitamin D status is generally maintained by exposure to sunlight (NHMRC 2006), so dietary intake is not a particularly good indicator of vitamin D status. Serum 25-hydroxyvitamin D is a better indicator of vitamin D status and this was measured in the survey to assess vitamin D status. Parathyroid hormone, an indicator of bone turnover, was also measured.

Sodium

It is not possible to measure total sodium intake because discretionary salt use (ie, salt added to food during cooking and at the table) cannot be accurately quantified. Sodium intake from foods was not estimated due to concerns about the reliability of sodium data in the NZFCDB. Key concerns included insufficient documentation in the NZFCDB to determine whether some foods (eg, cooked vegetables) included added salt, and concerns that the NZFCDB was not sufficiently up to date to reflect current sodium levels in processed foods given recent reformulation initiatives.

Approximately 90% of sodium is excreted in the urine, so urinary sodium excretion is a good indicator of recent sodium intake. Because sodium excretion fluctuates during the day, a 24-hour urine sample is usually required to accurately estimate sodium intake, but this is impractical for a population survey. In the 2008/09 NZANS sodium was measured in spot urine samples. However, results were not reported in *A Focus on Nutrition* because further analysis is required to reliably estimate sodium intake from spot urine samples.

9.5 Security of information

Any information collected in the survey that could be used to identify individuals has been treated as strictly confidential. Data were transferred from interviewers' laptops to the project office by a secure internet upload facility. Names and addresses of people who participated in the survey have not been stored with response data. Unit record data were stored in a secure area and were only accessible on a restricted ('need to know') basis.

9.6 Creation of derived variables

A number of derived variables were created for the 2008/09 NZANS data set.

Multiple-pass 24-hour diet recall method

Percentage energy from macronutrients per day was calculated from day 1 of recall as follows (NHMRC 2006):

- percent energy from fat per day = (fat [g per day] x 37.7 kJ/g) / energy per day (kJ)

- percent energy from carbohydrate per day = (carbohydrate [g per day] x 16.7 kJ/g) / energy per day (kJ)

- percent energy from protein per day = (protein [g per day] x 16.7 kJ/g) / energy per day (kJ)

- percent energy from alcohol per day = (alcohol [g per day] x 29.3 kJ/g) / energy per day (kJ).

Questionnaire

Age group

Age was derived from date of birth and the interview start date, or reported age. Age was then grouped as follows: 15–18, 19–30, 31–50, 51–70, and 71+ years. The age groups used are those used in the *Nutrient Reference Values for Australia and New Zealand* (NHMRC 2006).

Ethnic group

Ethnic group was derived from the question on ethnicity, which allowed respondents to report affiliation with up to nine different groups (using the Statistics New Zealand standard ethnicity question). Participants' ethnicity (Statistics New Zealand Level 4) was output to the following three ethnic groups: New Zealand European and Other, Māori, and Pacific. The 'Other' ethnic group (comprising mainly Asian, Middle-Eastern, Latin-American and African ethnicities) has been combined with 'European' to avoid small number problems. The small number of participants who reported 'New Zealander' as their ethnicity or refused the ethnicity question (n = 34) were included in the New Zealand European and Other ethnic group.

Participants were counted in each of the three output ethnic groups, and so the sum of the ethnic group populations exceeds the total New Zealand population. This is referred to as 'total response standard output' by Statistics New Zealand (Statistics New Zealand 2005). A total of 450 adult participants (9.5% of adults) in the 2008/09 NZANS were assigned to more than one of the three ethnic groups, based on their self-reported multiple ethnic groups.

NZ Index of Deprivation 2006

The New Zealand Index of Deprivation 2006 (NZDep2006) is an area-based index of deprivation that measures the level of socioeconomic deprivation for each neighbourhood (meshblock) according to a combination of the following 2006 Census variables: income, benefit receipt, transport (access to car), household crowding, home ownership, employment status, qualifications, support (sole-parent families), and access to a telephone (Salmond et al 2007).

Dietary habits

For some dietary habits questions, response categories were combined to make comparisons against specific nutrition guidelines or recommendations. However, for most foods and drinks there were no specific guidelines about levels of dietary intake, and so, where possible, responses were combined in order to present results in a meaningful way. Without combining categories, the number of participants in each response category was often too small to present results by the full range of sociodemographic variables used. Therefore, only selected results are presented in the descriptive report, with more detailed results reported in web tables.

Food security

The responses to the eight statements regarding components of household food security were subjected to Rasch analysis. This was done to confirm that each of the components contributed meaningfully to the construct and that they could be ordered on a uni-dimensional scale in order of difficulty.

Rasch analyses were performed using BIGSTEPS 2.82 (a DOS-based Rasch measurement program; Linacre and Wright 1998) to generate a measure of the *severity of food insecurity* for each participant. The statement 'I/we can afford to eat properly' was anchored at 0, with values being assigned by Rasch analysis according to the number and severity of the indices the participant responded to positively (Parnell 2005).

Based on the distribution of the respondents' propensities to affirm these statements (ability scores in the Rasch model), and considering the meanings of these scores in terms of item responses (including the item difficulty scores in the Rasch model), households were then assigned to the following three categories:

- fully/almost fully food secure – this included households providing no affirmative response to any of the eight statements and households responding to only one statement, which was most likely to be 'the variety of food is limited'

- low food security – this included households most likely to report 'relying on others for food or money for food' and 'using special food grants or food banks to acquire the food they needed'

- moderate food security – this included households likely to respond positively to the remaining five statements.

Blood pressure

Three diastolic and systolic blood pressure measurements were made. Because the first blood pressure reading is considered the most unreliable (Egan et al 2010), the mean of the second and third measurements was calculated and used to represent mean *diastolic blood pressure* and *systolic blood pressure*. In cases where three measurements were not recorded for a participant (n = 78), blood pressure data were excluded from analyses.

Anthropometry

Two measurements each of *weight*, *height* and *waist circumference* were made. If the first two measurements differed by more than 1%, a third was taken. For each index, the closest two measurements were determined and the mean of these two measurements was used to represent the index. Where the three measurements were equidistant, the mean of all three measurements was calculated and used to represent the index.

Quetelet's *body mass index* (BMI) = weight (kg) / height (m)^2

The World Health Organization principal BMI cut-offs (World Health Organization 2007) were used to indicate *BMI status* in participants aged 19+ years, as follows:
- underweight: BMI < 18.50 kg/m2
- normal weight: BMI 18.50–24.99 kg/m^2
- overweight: BMI 25.00–29.99 kg/m2
- obese: BMI ≥ 30.00 kg/m^2.

The Cole sex and age-specific BMI cut-offs were used to indicate *BMI status* in participants aged 15–18 years (Cole et al 2007; Cole et al 2000).

Blood and urine analysis

Folate status

Red blood cell folate concentration was calculated using measurements of whole blood folate, serum folate and haematocrit, as follows (Senti and Pilch 1985):

$$\text{RBC folate (units)} = \frac{\text{WB folate (units)} - (\text{serum folate (units)} \times (1 - \text{Hct}))}{\text{Hct}}$$

The following cut-points were used to classify low folate status (Wright et al 1998):
- low serum folate: < 6.8 nmol/L
- low red blood cell folate: < 317 nmol/L.

For women of child-bearing age, higher cut-points were used to define maximum protection against neural tube defects (Daly et al 1995):
- high risk of neural tube defects: red blood cell folate ≤ 339 nmol/L
- low risk of neural tube defects: red blood cell folate ≥ 906 nmol/L.

Glycated haemoglobin

Values for HbA1c were converted from a percentage to mmol/mol as follows:
- HbA1c (mmol/mol) = (HbA1c% x 10.93) – 23.5 mmol/mol
- HbA1c (%) = (HbA1c mmol/mol x 0.0915) + 2.15%.

In participants that had not been told by a doctor they had diabetes, *undiagnosed diabetes* was defined as HbA1c ≥ 6.5% (World Health Organization 2011). In participants with doctor-diagnosed diabetes, good management among those diagnosed with diabetes was defined as HbA1c < 7.0% (Powers 2011).

Urinary iodine

Where urinary iodine concentration was measured as 0–10 µg/L it was replaced with the value 10 µg/L, which is the lowest detectable limit of the assay. The International Council for the Control of Iodine Deficiency Disorders (ICCIDD) recommends that no more than 50% of the population have a median urinary iodine concentration (MUIC) < 100 µg/L and no more than 20% of the population have an MUIC < 50 µg/L (WHO 2007).

Iron status

The cut-offs used to indicate iron status are shown in Table 8 and are the same as those used in the 1997 National Nutrition Survey. Note that participants with a serum C-reactive protein > 8 mg/L were not included in calculations of either mean serum ferritin, low serum ferritin or iron deficiency (Martinez and Coli 1987). Note also that the terms 'iron deficiency' and 'iron deficiency anaemia' are not mutually exclusive.

Table 8:   Iron status measures

Status	Measures and cut-offs
Low iron stores	Serum ferritin < 12 μg/L
Low haemoglobin	Haemoglobin: < 136 g/L (15–19 years, male) < 137 g/L (20–49 years, male) < 133 g/L (50–69 years, male) < 124 g/L (70+ years, male) < 120 g/L (15–69 years, female) < 118 g/L (70+ years, female)
Iron deficiency (with or without anaemia)	Serum ferritin < 12 μg/L *and* zinc protoporphyrin > 60 μmol/mol
Iron deficiency anaemia	Serum ferritin < 12 μg/L *and* zinc protoporphyrin > 60 μmol/mol *and* low haemoglobin (see above cut-offs for low haemoglobin)

References for cut-offs: serum ferritin (Looker et al 1997); zinc protoporphyrin (Hastka et al 1996); haemoglobin (Looker et al 1997).

10 Weighting

To ensure that no group is under- or over-represented in estimates from the survey, 'weights' are calculated for every survey participant. The weight can be thought of as the number of people in the population represented by a given survey participant.

10.1 Overview of weighting process

Most national surveys have complex sample designs, where different groups have different chances of being selected in the survey. These complex designs are used for a variety of purposes, including:

- reducing interviewer travel costs, by ensuring the sample is geographically clustered or 'clumped'
- ensuring all subpopulations, in particular the Māori and Pacific populations, have a sufficient sample to enable adequate estimates.

To ensure no group is under- or over-represented in estimates from a survey, a method of calculating estimates that reflects the sample design must be used.

Estimation weights are used to achieve this aim. A weight is calculated for every respondent, and these weights are used to calculate estimates of population totals (counts), averages and proportions. Typically, members of groups who have a lower chance of selection are assigned a higher weight, so that these groups are not under-represented in estimates. Conversely, groups with a higher chance of selection (eg, Māori, Pacific peoples) receive lower weights. Also, groups that have a lower response rate (eg, young men) are usually assigned a higher weight so that these groups are correctly represented in all estimates from the survey.

Weights are designed to:
- reflect the probabilities of selecting each respondent
- make use of external population benchmarks (typically obtained from a population census) to correct for any discrepancies between the sample and the population benchmarks – this improves the precision of estimates and reduces bias due to non-response.

The first aim can be achieved by setting weights equal to 1 divided by the probability of selection for the respondent. This method is called inverse probability weighting or selection weighting, and is discussed below in section 10.2. However, a better method is calibrated weighting, which can achieve both aims. This is the method used for the 2008/09 NZANS, and is discussed below in section 10.3.

Once weights have been calculated for all respondents, estimates of proportions and means can be calculated as follows.

Proportions

The proportion of the population who belong to a particular group (eg, the proportion of the population who use trim milk) is estimated by calculating the sum of the weights for the respondents in the group, divided by the sum of the weights of all respondents.

Proportions within subgroups

The proportion of people in a subgroup of interest (eg, the proportion of Māori who use trim milk) is estimated by calculating the sum of the weights for the respondents in the subgroup (Māori who use trim milk), divided by the sum of the weights for the respondents in the population group (Māori).

Averages (means)

The population averages (eg, the average calcium intake per day per person) are estimated by calculating the sum, over all respondents, of the weight multiplied by the value of the variable of interest divided by the sum of the weights of all respondents.

Averages within subgroups

The average within a subgroup of interest (eg, the average calcium intake per day per person among males) is estimated by calculating the sum, over respondents in the subgroup, of the weight multiplied by the value of the variable of interest, divided by the sum of the weights of respondents in the subgroup.

10.2 Selection weights

This notation will be used in this section:

n = number of PSUs (meshblocks) to be sampled from the stratum (district health board)

N = number of PSUs in the stratum

x_i = number of dwellings in the ith PSU as at Census 2006

m_i = number of core dwellings sampled in the ith PSU

s_i = number of dwellings sampled in screener 1 in the ith PSU

$s2_i$ = number of dwellings sampled in screener 2 in the ith PSU

y_i = number of dwellings in the ith PSU enumerated by the interviewer

e_j = number of eligible people (for core) within the jth sampled dwelling

$e2_j$ = number of eligible people (for screener 1) within the jth sampled dwelling

$e3_j$ = number of eligible people (for screener 2) within the jth sampled dwelling

d_i = NZDep (NZ deprivation) adjustment factor.

Individuals are selected through a three-stage process:

- stage 1: meshblocks are selected with probability proportional to size
- stage 2: dwellings are selected randomly in each meshblock (into three samples – core, screener 1 and screener 2)
- stage 3: one adult is selected from each dwelling.

At each stage different probabilities have been applied and need to be calculated, as follows.

(i) The probability of selecting a meshblock is $\dfrac{n * \dfrac{x_i}{N}}{\sum\limits_{i=1}^{N} x_i}$

At this stage a small adjustment was made to account for any (random) imbalances by NZDep category, so these first stage weights (which equal the inverse of the meshblock probabilities) are summed, added up in each NZDep category and then an NZDep adjustment factor is calculated as follows:

d_i = (number of meshblocks in NZDep category i) /
(sum of first stage weights for meshblocks in NZDep category j).

(ii) The probability of selecting an individual's dwelling (which depends on whether the individual is eligible for: the core only, core plus screener 1, or core plus screener 1 plus screener 2) is:

$\dfrac{m_i}{y_i}$ or $\dfrac{s_i + m_i}{y_i}$ or $\dfrac{s2_i + s_i + m_i}{y_i}$

(iii) The probability of selecting an individual from a selected dwelling (which depends on whether the dwelling has been selected into: the core, the screener 1 or screener 2) is:

$\dfrac{1}{e_j}$ or $\dfrac{1}{e2_j}$ or $\dfrac{1}{e3_j}$

The overall selection probabilities are the product of the three stages, as follows.

The probability of selection for non-Māori, non-Pacific and aged from 19 to 70 years is:

$$n * \dfrac{x_i}{\sum\limits_{i=1}^{N} x_i} * d_i * \dfrac{m_i}{y_i} * \dfrac{1}{e_j}$$

The probability of selection for Māori or someone aged less than 19 or older than 70 is:

$$n * \dfrac{x_i}{\sum\limits_{i=1}^{N} x_i} * d_i * \dfrac{s_i}{y_i} * \dfrac{1}{e2_j} + n * \dfrac{x_i}{\sum\limits_{i=1}^{N} x_i} d_i ** \dfrac{m_i}{y_i} * \dfrac{1}{e_j}$$

The probability of selection for Pacific is:

$$n * \frac{x_i}{\sum\limits_{i=1}^{N} x_i} * d_i * \frac{s2_i}{y_i} * \frac{1}{e3_j} + n * \frac{x_i}{\sum\limits_{i=1}^{N} x_i} * d_i * \frac{s_i}{y_i} * \frac{1}{e2_j} + n * \frac{x_i}{\sum\limits_{i=1}^{N} x_i} * d_i * \frac{m_i}{y_i} * \frac{1}{e_j}$$

The selection weight is:

> 1 / probability of selection.

This selection weight is then calibrated using the generalised regression estimation weighting process (also known as GREGWT).

10.3 Calibrated weights

The most commonly used method for survey weighting is calibrated weighting, and this is what was used for the 2008/09 NZANS. Calibrated weights are calculated using population benchmark information obtained externally from the survey. In the case of the 2008/09 NZANS, this benchmark information consists of population counts from the 2006 Census, broken down by age, sex and ethnic group and adjusted to 2008/09 population estimates. The idea is to incorporate this external information about the population into the weights.

Calibrated weighting means that if the sample differs from the population according to any of the benchmarking categories, then the estimation weights will correct for the discrepancy. For example, if young men are under-represented in the sample relative to the Census counts (as is often the case due to non-response), the weights for young male respondents would be increased so that this group is correctly represented in estimates.

Calibrated weights are calculated to achieve two requirements.

a)   The weights should be close to the inverse of the probability of selecting each respondent.

b)   The weights are calibrated to the known population counts for a range of subpopulations (eg, age-by-sex categories). This means that the sum of the weights for respondents in the subpopulation must exactly equal the known benchmark for the subpopulation size.

To be more mathematically precise, the weights are chosen to minimise a measure of the distance between the weights and the inverse selection probabilities, subject to (b) being satisfied. Requirement (a) ensures that estimates have low bias, while requirement (b) improves the precision of estimates and achieves consistency between the survey estimates and external benchmark information.

A number of distance measures are in common use. A chi-square distance function (case 1 in Deville and Sarndal 1992: 378) was used for the weighting of 2008/09 NZANS, which corresponds to generalised regression estimation.

The inverse selection probability is sometimes called the initial weight. The final calibrated weights are sometimes expressed as:

final weight = initial weight x g-weight.

The g-weight indicates the factor by which calibration has changed the initial weight.

A key decision in developing any weighting scheme is which and how many population benchmarks to incorporate into the weighting. The main issues to consider in this decision are as follows.

a)   Key output categories should be included as population benchmarks to ensure good precision for these categories, and to give consistency with benchmark population data (eg, the Census).

b)   Classifications that are related to variables of interest should be used. For example, many health conditions are related to age. Using population benchmarks by age group is therefore a sensible strategy.

c)   Classifications related to non-response should be used. For example, young males typically have lower-than-average response rates. This suggests that age-by-sex benchmarks should be used in weighting.

d)   Not too many benchmarks should be used, as this can make weights unstable and may worsen the precision of estimates. Typically, the number of benchmarks should be less than 10–20% of the sample size. Another relevant measure is the relative variance of the g-weights. This should usually be 0.1–0.2 or less. However, these measures are very approximate and there are many legitimate reasons to depart from them.

10.4 Benchmark populations used for the 2008/09 NZANS

The benchmarks used in the 2008/09 NZANS weighting were population counts by:
- age group (15–18, 19–30, 31–40, 41–50, 51–60, 61–70, 71+ years)
    by
- sex (male, female)
    by
- total response ethnic group (Statistics New Zealand Level 1 classification) (Māori, Pacific, Other).

Age, sex and ethnicity were included because these variables are related to many health conditions and to non-response, and were a key output classification for the survey.

Population benchmarks for weighting the NZANS were compiled as follows.

- Statistics New Zealand provided 2006 Census counts for usual residents in private dwellings by age, sex and ethnicity.

- The Census counts are known to be subject to Census undercount of approximately 4.3% for adults. These undercount estimates come from Statistics New Zealand's post-enumeration survey conducted shortly after the Census. An undercount factor of 1.043 for adults and 1.024 for children was applied to the Census counts.

- The Census was conducted in March 2006, whereas the NZANS was conducted from October 2008 to October 2009. The Statistics New Zealand-estimated resident population (ERP) series was used to estimate population growth between March 2006 and March 2009 ,which is roughly the middle of the survey period from October 2008 to October 2009. Growth factors were calculated by taking the ratios of the 2009 ERP to the 2006 ERP, by sex and age.

The growth factors were applied to the undercount-adjusted Census counts. This gave estimates of the usually resident population in private dwellings in March 2009. Some assumptions were involved in these calculations.

- The Census undercount adjustment was calculated for both private and non-private dwellings, but was applied only to private dwellings. In reality, the undercount would differ to some extent between private and non-private dwellings.

- A single undercount adjustment was applied for adults and another for children. In reality, undercount would differ by age, sex and ethnicity.

These approximations were necessary given the data available and would have only a minor effect on estimated counts from the NZANS and an even smaller effect on prevalence estimates.

10.5 Replicate weights

Standard errors are a measure of the precision of an estimate, and replicate weights are a method for obtaining standard errors for any weighted estimate. In the 2008/09 NZANS, 100 replicate weights were produced for every respondent in the sample. For any weighted estimator, 100 'replicate estimators' can be calculated using these replicate weights. The standard error of the population estimate is based on the variation of the replicate estimates. This process can be done automatically in a number of statistical packages, including SUDAAN, STATA and R. The SAS and STATA programs developed for analyses incorporate these replicate weights.

It should be noted here that another set of 100 replicate weights was produced separately for the blood and urine analysis data, as the response rates for this data set were comparatively low (see Table 6 in section 8.2). This set of replicated weights was used in all the analysis of blood and urine data.

The replicate weights were produced using the GREGWT package, which was provided by the Australian Bureau of Statistics. Each of the 100 replicate estimators corresponds to removing a group of meshblocks, reweighting the remaining sample and applying an appropriate scaling factor. This is called a grouped jack-knife method. For technical information on replicate variance estimation in surveys, see Rao and Wu (1988) and Shao and Tu (1995).

11 Analysis of Dietary Data

11.1 Determining usual intake distribution

An individual's day-to-day diet is likely to be highly variable, so the distribution of intake for a dietary component measured on a single day will be wider than the distribution for their usual intake. To determine the distribution of usual intakes for a group, the distribution of observed intakes from a single 24-hour recall needs to be adjusted to remove the effects of within-person (or intra-individual) variability. This can be achieved by collecting two 24-hour recalls from a representative sub-sample of the group.

In the 2008/09 NZANS, a random sample of 33% of participants was asked to complete a second 24-hour recall within a month of the first interview. One-quarter (1180 of participants completed a repeat 24-hour recall, slightly more than the expected 20%.

The software package PC-SIDE (Version 1.0, Iowa State University) was used to estimate the distribution of usual intakes of dietary components. This software can be used when daily intake observations are repeated at least once on a subsample of individuals in the survey population. PC-SIDE adjusts for day of the week.

PC-SIDE carries out four main steps when estimating usual intake distributions for dietary components:
- preliminary data adjustments
- semi-parametric transformation to normality
- estimation of within- and between-individual variances for intakes
- back transformation into the original scale.

Detailed information on the PC-SIDE methodology can be found in Nusser et al 1996, Dodd 1996 and Carriquiry 2003.

11.2 Determining nutrient adequacy

Nutrient reference values

For the 2008/09 NZANS, nutrient requirements to determine nutrient adequacy were sourced from the *Nutrient Reference Values for Australia and New Zealand* (NMHRC 2006). The nutrient reference values are presented as a range of recommendations for nutrient and energy intake aimed at avoiding deficiency and excess/toxicity (see Table 9). They also include guidance on the dietary patterns needed to reduce the risk of chronic disease.

Table 9: Definitions of nutrient reference values

Term	Definition
Estimated average requirement (EAR)	A daily nutrient level estimated to meet the requirements of half of the healthy individuals in a particular life stage and gender group.
Recommended dietary intake (RDI)	The average daily dietary intake level that is sufficient to meet the needs of nearly all (97–98%) healthy individuals in a particular life stage and gender group.
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.
Estimated energy requirement (EER)	The average dietary energy intake that is predicted to maintain energy balance in a healthy adult of a defined age, gender, weight, health and level of physical activity, consistent with good health. For children and pregnant and lactating women, the EER is taken to include the needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health.
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. Unless otherwise stated, the UL includes dietary intake from all sources, including fortified foods, dietary supplements or medicines.
Acceptable macronutrient distribution range (AMDR)	An estimate of the range of intake for each macronutrient (expressed as percent contribution to energy), which would allow for an adequate intake of all the other nutrients while maximising good health (applies only to adults and young people aged 14 years and over).
Suggested dietary target (SDT)	A daily average intake for certain nutrients that may help in the prevention of chronic disease (applies only to adults and young people aged 14 years and over).

Source: Nutrient Reference Values for Australia and New Zealand (NHMRC 2006).

It is important to consider how NRVs are derived when interpreting estimates of nutrient adequacy. Actual nutrient requirements are seldom known and will vary considerably between individuals. Therefore, NRVs are estimates of nutrient requirements, based on the best available evidence and expert opinion. Setting NRVs in not an exact science, which is why different countries set different levels even when using the same evidence base.

Prevalence of inadequate intake

For groups, the EAR is used to estimate the prevalence of inadequate intake. The EAR used to determine the adequacy of nutrient intake in the 2008/09 NZANS is shown in Table 10. The adequacy of protein, vitamin A, riboflavin, vitamin C, thiamin, niacin, vitamin B_6, vitamin B_{12}, iron, calcium, zinc and selenium intakes were evaluated by probability analysis (Subcommittee on Interpretation and Uses of Dietary Reference Intakes and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board and Institute of Medicine 2000). Comparison with the EAR (shortcut probability approach) was used to evaluate nutrient intake in all populations except iron intakes in women aged 15–50 years. Iron requirements for these women were assumed to be highly skewed as a result of menstruation, so the iron intake of this age group was evaluated using full probability analysis. For vitamin E and potassium, the adequacy of intakes could not be evaluated by probability analysis because there was no EAR. Note that nutrient reference values differ for pregnant women, but the number of pregnant females in the survey was insufficient for separate analyses.

Probability analysis compares nutrient intakes with the corresponding requirement distribution and calculates the likelihood (probability) that a particular nutrient intake would fail to meet the requirement. Lower nutrient intakes are associated with a higher probability of inadequacy because they are less likely to meet the requirement, while higher nutrient intakes have a low probability of inadequacy. This approach is preferable to making direct comparisons with recommended intakes because the variation in requirement between individuals is taken into account: an individual may still meet their own requirement despite not consuming the recommended intake.

The probability of intake being inadequate was calculated using nutrient intakes first adjusted to remove the effects of day-to-day (intra-individual) variation using PC-SIDE software, as described above. This is important because on any given day a number of people will have unusually low or high intakes which do not reflect their usual intake. Nutrient requirements represent the required long-term average (usual) intakes, not the amounts that must be consumed each day. Without adjusting for intra-individual variation, the prevalence of inadequate intakes will be over- or underestimated depending on where the intake distribution lies in relation to the requirement distribution.

Table 10: Estimated average requirements (EARs) per day used in the probability analysis

Nutrient	Age group	EAR[1]	
		Males	**Females**
Protein (g)	15–18 years	49	35
	19–70 years	52	37
	71+ years	65	46
Vitamin A (µg RE)	15–18 years	630	485
	19+ years	625	500
Vitamin C (mg)	15–18 years	28	28
	19+ years	30	30
Thiamin (mg)	15+ years	1.0	0.9
Riboflavin (mg)	15–70 years	1.1	0.9
	71+ years	1.3	1.1
Niacin (mg NE)	15+ years	12	11
Vitamin B_6 (mg)	15–18 years	1.1	1.0
	19–50 years	1.1	1.1
	51+ years	1.4	1.3
Vitamin B_{12} (µg)	15+ years	2.0	2.0
Folate (µg DFE)	15–18 years	330	330
	19+ years	320	320
Calcium (mg)	15–18 years	1050	1050
	19–70 years	840	–
	19–50 years	–	840
	71+ years	1100	–
	51+ years	–	1100
Iron (mg)	15–18 years	8	8
	19+ years	6	–
	19–50 years	–	8
	51+ years	–	5
Zinc (mg)	15–18 years	11	6
	19+ years	12	6.5
Selenium (µg)	15+ years	60	50

1 EARs are from the Nutrient Reference Values for Australia and New Zealand (NHMRC 2006).

The acceptable macronutrient distribution range (AMDR) is an estimate of the range of intake for each macronutrient for individuals (expressed as percent contribution to energy) that would allow for an inadequate intake of all the other nutrients while maximising general health outcomes (NHMRC 2006). The AMDRs are summarised in Table 11.

Table 11: Acceptable macronutrient distribution range

Nutrient	Lower end of recommended intake range	Higher end of recommended intake range
Protein	15% of energy	25% of energy
Fat	20% of energy	35% of energy
Saturated + trans fatty acids	No lower limit	10% of energy
Carbohydrate	45% of energy	65% of energy

When interpreting the prevalence of inadequate intakes it is important to note the following.

- The prevalence of inadequate intakes reflects the criterion on which the requirement is based. For example, if the requirement for nutrient X is based on maintaining body stores (assuming normal losses), and it is estimated that 15% of the population have inadequate intakes, this indicates that 15% are not consuming enough nutrient X to maintain body stores but it does not indicate functional impairment or a deficiency disorder. It also does not indicate which specific individuals in the population have inadequate intakes to maintain their body stores.

- Nutrient intake estimates depend on the accuracy of information provided by participants in the 24-hour diet recall and the accuracy of the food composition data.

- Nutrient intakes estimates are from food and drinks only (ie, they exclude intake from dietary supplements, except supplements providing energy).

- Accurate assessment of nutritional status requires a combination of dietary, anthropometric, biochemical and clinical measurements. Adequacy or inadequacy of nutritional status cannot be determined from dietary data alone.

11.3 Nutrients from food groups

In order to calculate sources of nutrients by 'food type', food items reported in the primary 24-hour diet recall were allocated to food groups (Table 12). Mixed dishes were classified as follows. If the participant was able to provide a recipe or detailed description for a mixed dish then the individual ingredients were assigned to their separate food groups. If no recipe or detailed description could be provided, then a generic recipe that most closely matched the description of the food was used, and the dish was assigned to the food group of its main ingredient. For example, macaroni cheese would be assigned to *Grains and pasta* because pasta is its main ingredient, although it contains cheese and milk.

To enable comparisons between nutrition surveys, the 2008/09 NZANS began with the food groups used during the 1997 National Nutrition Survey and updated these to include new foods. However, some food items may not be assigned to the same food group as in the 1997 National Nutrition Survey, so care should be taken when making comparisons of food group data between the two surveys.

Table 12: Food groups used in the 2008/09 NZANS

Food group	Examples of food items included
Grains and pasta	Rice (boiled, fried, risotto, sushi, salad), flour, pasta/noodles, bran, cereal-based products and dishes (pasta and sauce, lasagne, pasta salad, noodle soup, chow mein)
Bread	All types of bread (rolls, pita, foccacia, garlic), bagels, crumpets, sweet buns
Breakfast cereals	All types (muesli, wheat biscuits, porridge, puffed/flaked/extruded cereals)
Biscuits*	Sweet biscuits (plain, chocolate coated, fruit filled, cream filled), crackers
Cakes and muffins*	All cakes and muffins, slices, scones, pancakes, doughnuts, pastry
Bread-based dishes	Sandwiches, filled rolls, hamburgers, hotdogs, pizza, nachos, doner kebabs, wontons, spring rolls, stuffings
Puddings and desserts	Milk puddings, cheesecake, fruit crumbles, mousse, steamed sponges, sweet pies, pavlova, meringues
Milk	All milk (cow, soy, rice, goat and flavoured milk), milkshakes, milk powder
Dairy products	Cream, sour cream, yoghurt, dairy food, ice-cream, dairy-based dips
Cheese	Cheddar, edam, specialty (blue, brie, feta, etc), ricotta, cream cheese, cottage cheese, processed cheese
Butter and margarine	Butter, margarine, butter/margarine blends, reduced-fat spreads
Fats and oils	Canola, olive, sunflower and vegetable oils, dripping, lard
Eggs and egg dishes	Poached, boiled, scrambled and fried eggs, omelettes, self-crusting quiches, egg stir-fries
Beef and veal	All muscle meats (steak, mince, corned beef, roast, schnitzel, etc), stews, stir-fries
Lamb and mutton	All muscle meats (chops, roast, mince, etc), stews, stir-fries, curries
Pork	All muscle meats (roast, chop, steak, schnitzel, etc), bacon, ham, stews, stir-fries
Poultry	All chicken, duck, turkey and muttonbird muscle meats and processed meat, stews and stir-fries
Other meat	Venison, rabbit, goat, liver (lambs fry), pâté (liver), haggis
Sausages and processed meats	Sausages, luncheon, frankfurters, saveloys/cheerios, salami, meatloaf and patties
Pies and pasties	All pies including potato top, pasties, savouries, sausage rolls, quiche with pastry
Fish and seafood	All fish (fresh, frozen, smoked, canned, battered, fingers, etc), shellfish, squid, crab, fish/seafood dishes (pies, casseroles and fritters), fish/seafood products
Vegetables	All vegetables (fresh, frozen, canned) including mixes, coleslaw, tomatoes, green salads, legumes and pulses, legume products and dishes (baked beans, hummus, tofu), vegetable dishes
Potatoes, kumara and taro	Mashed, boiled, baked potatoes and kumara, hot chips, crisps, hash browns, wedges, potato dishes (stuffed, scalloped potatoes), taro roots and stalks
Snack foods	Corn chips, popcorn, extruded snacks (burger rings etc), grain crisps
Fruit	All fruit, fresh, canned, cooked and dried

Food group	Examples of food items included
Nuts and seeds	Peanuts, almonds, sesame seeds, peanut butter, chocolate/nut spreads, coconut (including milk and cream), nut-based dips (pestos)
Sugar and sweets	Sugars, syrups, confectionery, chocolate, jam, honey, jelly, sweet toppings and icing, ice-blocks, artificial sweeteners
Soups and stocks	All instant and homemade soups (excluding noodle soups), stocks and stock powder
Savoury sauces and condiments	Gravy, tomato and cream-based sauces, soy, tomato and other sauces, cheese sauces, mayonnaise, oil and vinegar dressings, chutney, marmite
Non-alcoholic beverages	All teas, coffee and substitutes, hot chocolate drinks, juices, cordial, soft drinks, water, powdered drinks, sports and energy drinks
Alcoholic beverages	Wine, beer, spirits, liqueurs and cocktails, ready-to-drink alcoholic sodas (RTDs)
Supplements providing energy*	Meal replacements, protein supplements (powders and bars)
Snack bars*	Muesli bars, wholemeal fruit bars, puffed cereal bars, nut and seed bars

Some foods may not be assigned to the same food groups as in the 1997 National Nutrition Survey so care should be taken when making direct comparisons. For example, Muesli bars were assigned to biscuits in the 1997 National Nutrition Survey, but to snack bars in the 2008/09 NZANS.

* Comparable with 2002 National Children's Nutrition Survey but not comparable with the 1997 National Nutrition Survey.

12 Technical Notes for Analysis

12.1 Overview

Stata Version 11.0 (StataCorp, Texas, USA) and SAS Version 9.1 (SAS Inc, Cary, NC, USA) were used for all statistical analyses except the estimation of the distribution of usual intakes of dietary components, which was conducted using PC-SIDE (Iowa State University, IA, USA), as detailed previously. All data were weighted to compensate for the complex survey design.

Specific techniques used during the statistical analysis of the 2008/09 NZANS are described below.

12.2 Weighting

Weights were used in all analyses so that estimates of means, medians, percentiles and proportions presented in this report can be said to be representative of the total resident population (aged 15 years and over) of New Zealand.

12.3 Small numbers

Small sample numbers can affect both the reliability and the confidentiality of results. Problems with reliability occur when the sample becomes too small to adequately represent the population from which it has been drawn. Problems with confidentiality can occur when it becomes possible to identify an individual, usually someone in a subgroup of the population within a small geographical area.

The study has been designed so that there are approximately 30 or more people in each of the key categories analysed in this report. Generally speaking this ensures the survey data presented are reliable and also protects the confidentiality of the participants. In addition, for the estimates which are the focus of the commentary confidence intervals are published. This gives readers a more explicit assessment on the level of sampling error affecting these key measures.

There are some exceptions to this quality assurance practice which are explained below:

- There were 29 respondents who were Pacific males aged 15–18 years. Although this was strictly below the sample size minimum, results were included in the report because the key estimates have confidence intervals presented, so that readers can judge when these estimates are affected by large amounts of sample error.

- There were only 13 Pacific male respondents aged 15–18 years and 15 Pacific female respondents aged 15–18 years who gave blood samples. This was judged to be too small a sample to use and where even confidence intervals might not be reliable, so results were suppressed.

- For the estimates of the inadequate intake proportions a method for consistently producing plausible confidence intervals was not available. Instead an asterisk (*) is displayed where the estimates were considered to be imprecise due to a large relative sampling error (Note: if the estimates were close to zero and had standard error less than 2.5% they were not asterisked as in these cases the readers can be confident the estimated proportion inadequate is less than 5%).

- There were a very small number of estimates where no standard error could be produced. This can occur when some of the model assumptions in the usual intake analysis are violated, which can be due to daily intakes being very skewed or variable. In these cases the estimates were marked with a hash (#).

- For the dietary habits section, results have not been output for ethnic group (stratified by age group and sex) or for NZDep2006 (stratified by sex). This was because for many of the questions there were up to eight response options. When there were no specific recommendations regarding the amount or frequency of consumption of a particular food or drink, it was not possible to aggregate responses in a meaningful way. Without aggregating categories, the number of responses for each response category was often too small to present results by the full range of sociodemographic variables used in other sections of this report.

- For estimates which are not presented with a confidence interval or are not estimated inadequate intake proportions, readers can make some assessment of the reliability by looking at the sample size underpinning the different categories analysed (see Table 2), and also by taking into account that these sample sizes are likely to be affected by the clustering and weighting processes used for this study. Generally speaking it is sensible to assume a 'design effect' of 2 for these sorts of complex survey designs. This means that the 'effective sample sizes' are about half the actual sample sizes given in Table 2.

12.4 Confidence intervals

Ninety-five percent confidence intervals have been used to represent the sample error for estimates. A 95% confidence interval means there is a 95% chance that the true value of the estimate (if we were to survey the whole population) lies between the lower and upper confidence interval values.

Differences in means, medians and proportions between subgroups were considered to be statistically significant if the 95th confidence interval surrounding the two estimates did not overlap. It should be noted that testing for a significant difference between two subgroups using the above method is conservative compared to testing at the two-sided 0.05 level.

Only statistically significant differences have been discussed in the text. However, if there was no statistically significant difference between subgroups, this does not necessarily mean there was no difference; it could be because the sample size was too small to detect a significant difference at the 95% level based on non-overlapping confidence intervals.

When calculating confidence intervals for percentages, if:

- the numerator (number of respondents with the variable of interest) was less than 30, or
- the lower confidence interval resulted in a value less than 0, or
- the upper confidence interval resulted in a value greater than 100

then the Korn and Graubard (1998) method was used to calculate the confidence interval. This means that where a confidence interval spreads outside the range of a percentage, the confidence interval may be asymmetrical.

12.5 Age groups

Age was derived from date of birth and the interview start date, or reported age. Age was grouped according to the *Nutrient Reference Values for Australia and New Zealand* (NHMRC 2006) age groups: 15–18, 19–30, 31–50, 51–70 and 71+ years. Total population and NZDep2006 analyses were possible using all five age groups. For analyses by ethnic group, the latter two age groups were collapsed to 51+ years to account for small numbers of Māori and Pacific people aged 71+ years. For comparability this was applied to the New Zealand European and Other ethnic group.

Note that sample sizes for Pacific males and females aged 15–18 years were small, particularly for the blood and urine analysis (see Table 2, section 4.3). Therefore, some data for these subgroups have been suppressed (see section 12.3 'Small numbers').

12.6 Ethnic groups

Participants were counted in each of the three output ethnic groups they identified with, and so the sum of the ethnic group populations exceeds the total New Zealand population. This is referred to as 'total response standard output' by Statistics New Zealand (Statistics New Zealand 2005). Ethnicity was output to the following three ethnic groups: New Zealand European and Other, Māori, and Pacific. The 'Other' ethnic group (comprising mainly Asian, Middle-Eastern, Latin-American and African ethnicities) has been combined with European to avoid small number problems.

Using total response standard output means ethnic groups overlap, so it is not appropriate to make comparisons *between* ethnic groups. Comments in the text are limited to age group differences *within* ethnic groups. No comments were made with respect to the New Zealand European and Other ethnic group because this is similar to the total population. Additional reports presenting results for Māori compared to non-Māori and Pacific compared to non-Pacific will be released in late 2011.

12.7 Neighbourhood deprivation

Neighbourhood deprivation refers to the New Zealand Index of Deprivation 2006 (NZDep2006), which measures the level of socioeconomic deprivation for each neighbourhood (meshblock) according to a combination of the following 2006 Census variables: income, benefit receipt, transport (access to car), household crowding, home ownership, employment status, qualifications, support (sole-parent families), and access to a telephone.

Results are presented for NZDep2006 quintiles 1–5, with commentary in the text focused on significant differences between quintiles. Quintile 1 represents the 20% of areas with the lowest levels of deprivation (least deprived areas) and quintile 5 represents the 20% of areas with the highest level of deprivation (most deprived areas).

In addition to examining significant differences between NZDep2006 quintiles, the data from all quintiles were used to calculate a line of best fit (regression line), adjusted for age group, sex and ethnic group. This additional analysis was undertaken because ethnicity confounds the relationship between socioeconomic deprivation and nutrition outcomes. That is, ethnicity is associated with neighbourhood socioeconomic deprivation (different NZDep2006 quintiles have differing ethnic compositions) and is independently and causally linked to nutrition outcomes. If socioeconomic deprivation analyses are not adjusted for ethnicity and age, then the effects found will not reflect the independent effect of socioeconomic deprivation, but instead will be a mix of socioeconomic deprivation and ethnicity. Results were also adjusted for age group and sex, because these are such fundamental determinants related to most health outcomes. Where appropriate, an additional comment is made in the text regarding the results of this overall test for trend (gradient) by neighbourhood socioeconomic deprivation.

Although ethnic groups based on total response were used as the basis for reporting ethnicity in the report, a prioritised ethnic group variable was used as an adjustment variable in models because it was simpler to include in the regression model, and is a very good approximation of using a full set of total response ethnic group indicators as adjustment factors in a regression model.

For nutrient intake, comparisons between NZDep2006 quintiles are adjusted for intra-individual variation using PC-SIDE, whereas to simplify analysis the overall test for trend (gradient) is not adjusted for intra-individual variation. Note that this shortcut gave the same results when tested for selected nutrients.

12.8 Time trends

Where possible, comparisons between the 2008/09 NZANS and 1997 National Nutrition Survey have been reported in the 'Have we changed?' chapter of *A Focus on Nutrition: Key Findings of the 2008/09 New Zealand Adult Nutrition Survey*. Time trend analyses were restricted to nutrition indicators that were considered comparable across surveys (see the section 13 for details). Changes in nutrition indicators from 1997 to 2008/09 were considered statistically significant if the 95% confidence intervals surrounding the two estimates did not overlap.

Because the age and ethnic structure of the New Zealand population has changed since 1997, time trends were re-examined after adjusting for age group and ethnic group. For most indicators, this adjustment did not affect the results. However, for a few indicators, adjustment for age and ethnicity meant changes were no longer statistically significant or became statistically significant.

13 Comparability with the 1997 National Nutrition Survey

Data from the 2008/09 NZANS were compared to data from the 1997 National Nutrition Survey. These surveys are considered comparable because they were similar in many respects. For example, they had the same target population, similar sample sizes and response rates; collected data via face-to-face interviews in participants' homes; used the same electronic multiple-pass 24-hour diet recall and protocols for anthropometric measurements; and included some of the same questions. However, caution is still advised when comparing data across surveys because there were some differences in survey design and data collection methods, and these may influence the comparability of results.

The 2008/09 NZANS was a 'stand-alone' survey with its own sampling frame, with the recruitment and data collection conducted by separate organisations: CBG Health Research recruited participants and the University of Otago undertook the data collection. The 1997 National Nutrition Survey was 'piggy-backed' onto the 1996/97 New Zealand Health Survey. Specifically, people selected to participate in the 1996/97 New Zealand Health Survey were asked to participate in the 1997 National Nutrition Survey. The 1996/97 New Zealand Health Survey was conducted by Statistics New Zealand and the 1997 National Nutrition Survey was conducted by the University of Otago.

Table 13 summarises the key design and data collection methods for the 2008/09 NZANS and the 1997 National Nutrition Survey. Details of the 1997 National Nutrition Survey methodology can be found in the Ministry of Health publication *Food Comes First: Methodologies for the National Nutrition Survey of New Zealand* (Quigley and Watts 1997). Note that where definitions or cut-offs used in the original survey analyses differed to those used in the 2008/09 NZANS, earlier data were re-analysed to ensure comparability. For example, data from the 1997 National Nutrition Survey were re-analysed using the BMI cut-offs for overweight and obesity used in the 2008/09 NZANS.

Comparisons are only made between indicators considered comparable between surveys, meaning the questions, instruments and/or data collection methods were the same. For some indicators included in both surveys, data were not considered comparable due to differences in instruments (eg, blood pressure) and question wording (eg, dietary supplements).

Table 13: Summary of adult nutrition surveys

	1997 National Nutrition Survey	**2008/09 NZANS**
Target population	Usually resident, non-institutionalised, civilian adult population (15+ years) living in permanent private dwellings	Usually resident, non-institutionalised, civilian adult population (15+ years) living in permanent private dwellings
Sampling frame	Area-based frame	Area-based frame
Design	Linked to the 1996/97 New Zealand Health Survey, which had a complex, cluster sampling design	Multi-stage, stratified, probability-proportional-to-size (PPS) sampling design
Oversampling	New Zealand Māori and Pacific	New Zealand Māori and Pacific; some age groups (15–18, 70+ years)
Recruitment agency	Statistics New Zealand	CBG Health Research
Data collection agency	University of Otago	University of Otago
Data collection period	December 1996 to November 1997	October 2008 to October 2009
Location of data collection	Participant's home	Participant's home (local clinic for blood)
Day of primary interview	Monday 14.5%, Tuesday 17.5%, Wednesday 17.7%, Thursday 17.0%, Friday 12.9%, Saturday 11.4%, Sunday 9.0%	Monday 16.0%, Tuesday 17.2%, Wednesday 19.1%, Thursday 16.7%, Friday 13.5%, Saturday 9.3%, Sunday 8.2%
Sample size	24-hour recall: 4636 Repeat 24-hour recall: 695 Anthropometry: 4420 Blood: 3369	24-hour recall: 4721 Repeat 24-hour recall: 1180 Anthropometry: 4503 Blood: 3348
Response rate	50% (taking into account response rate to 1996/97 New Zealand Health Survey)	61%
24-hour diet recall	Computer based Three pass Detailed probe questions Repeat on subsample (15%)	Computer based Three pass Detailed probe questions Repeat on subsample (25%)
Questionnaires	Self-administered qualitative food frequency questionnaire (FFQ), checked with participant by interviewer and electronically scanned Interviewer-administered (CAPI) questionnaire, including modules on dietary supplements and food security	Interviewer-administered (CAPI) questionnaire, including modules on dietary habits, nutrition-related health and food security
Anthropometric measurements	Participant in light clothing, no shoes	Participant in light clothing, no shoes
Biochemical measures	Non-fasting blood sample	Non-fasting blood sample and spot urine

14   Dissemination of Data

There are several ways to access the results and data from the 2008/09 NZANS: through publications, online data tables or confidential unit record files (CURFs), or by contacting the Ministry of Health.

14.1 Publications

Reports and technical papers for the 2008/09 NZANS will be available on the Ministry of Health website at www.moh.govt.nz/hdi/publications. The report *A Focus on Nutrition: Key results of the 2008/09 New Zealand Adult Nutrition Survey* will be released in September 2011. This report presents the key findings of the 2008/09 NZANS by sex, age group, ethnic group and neighbourhood deprivation. Where possible, results were compared with the 1997 National Nutrition Survey. Additional reports presenting results for Māori compared to non-Māori and Pacific compared to non-Pacific will be released in late 2011.

In addition to this methodology report, several other technical reports and papers related to the 2008/09 NZANS have been published. These include the Content Guide and Questionnaire for Questionnaires for the 2008/09 NZANS.

14.2 Online data tables

To see the data for additional key descriptive analyses (some of which are presented in *A Focus on Nutrition*), go to www.moh.govt.nz where you can access the data tables online in Excel format.

14.3 Access to unit record data

The analyses presented in publications are only a small proportion of those that could be undertaken. The Ministry of Health encourages researchers to use 2008/09 NZANS data to explore topics of interest. The 2008/09 NZANS CURFs, with accompanying documentation and user guides, will be available from early 2012.

CURFs have had all identifying information about individuals removed, and have been modified to protect individual information. Approval is subject to certain criteria terms and conditions and the researcher's organisation must sign a microdata access agreement with the Ministry of Health. Refer to the Ministry's Microdata Data Access Protocol online for more information and to download the application form (www.moh.govt.nz).

14.4 Contacting Health and Disability Intelligence, Ministry of Health

Health and Disability Intelligence
Ministry of Health
PO Box 5013
Wellington
New Zealand

Tel: +64 (4) 816 2000
Fax:+64 (4) 816 2340

Email: hdi@moh.govt.nz

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Appendices

Appendix 1: Stakeholder consultation

The following stakeholders were personally invited to comment on the proposed objectives and content of the 2008/09 NZANS. Responses were received from those marked with an asterisk (*).

External

- Agencies for Nutrition Action
- Asian Health Foundation*
- Association of NZ Advertisers
- Auckland University – Clinical Trials Research Unit*
- Auckland University – School of Population Health
- Auckland University of Technology*
- Australian Food and Grocery Council
- Cancer Society of New Zealand
- Consumers Institute of New Zealand
- Crop and Food Research
- Diabetes New Zealand
- Canterbury District Health Board*
- Hawke's Bay District Health Board*
- Lakes District Health Board*
- Auckland Regional Public Health Service*
- Taranaki District Health Board
- Edgar National Centre for Diabetes Research
- Food Standards Australia New Zealand*
- Health Sponsorship Council
- Manufactured Food Database
- Māori Women's Welfare League
- Massey University – Institute of Food, Nutrition and Human Health*
- Ministry of Women's Affairs*
- National Heart Foundation
- Nutrition Society
- NZ Dietetic Association
- NZ Food and Grocery Council
- NZ Food Safety Authority
- Obesity Action Coalition
- Quigley and Watts Ltd*
- Sport and Recreation New Zealand*
- Statistics New Zealand

- Te Hotu Manawa Māori
- University of Otago – Department of Human Nutrition
- Wellington School of Medicine and Health Science – Department of Public Health

Internal (Ministry of Health and district health boards)

- Clinical Services Directorate
- DHB Funding and Performance
- Māori Health Directorate
- Public Health Directorate – Non-communicable Diseases Policy
- Public Health Directorate – Pacific Health Team
- Sector Policy Directorate

Appendix 2: Household invitation letter

Dear Householder

The Ministry of Health invites you to take part in the 2008/09 New Zealand Adult Nutrition Survey.

Your household has been selected by chance to participate in the NZ Adult Nutrition Survey. The survey collects information about the eating habits and health of New Zealand adults. This information is used to develop nutrition policies and guidelines to improve the health of New Zealanders.

On behalf of the Ministry of Health, CBG Health Research Limited and the University of Otago are working together to conduct the NZ Adult Nutrition Survey. CBG Health Research will recruit people to participate in the survey, and then a trained interviewer contracted through the University of Otago will visit your house to conduct the interview at a time that suits you.

One adult (aged 15 years or above) from your household will be invited to take part. Interviewing will take place throughout New Zealand from October 2008 to September 2009.

The NZ Adult Nutrition Survey has two parts: an interview and the sample collection. After you have answered the questions in the interview, you will be asked if you are willing to provide small blood and urine samples. If you agree, this will be done at a clinic close to your house.

Participation in this survey is entirely voluntary, but the Ministry of Health hopes that you will agree to participate. All of your answers will be strictly confidential.

Your participation is important and valuable for improving the nutrition-related health of New Zealanders.

Yours faithfully

Stephen McKernan
Director-General of Health
Ministry of Health

Appendix 3: Participant feedback letter

Dear

We are very grateful for your willingness to take part in the 2008/09 New Zealand Adult Nutrition Survey. Your involvement has been extremely helpful and we appreciate your availability and co-operation.

Results of your assessments are listed below and an explanation is given over the page. If any of your values are outside the desirable range we suggest you approach your regular doctor to discuss these results.

Height (cm):
Weight (kg):
Body Mass Index (BMI):

Waist (cm):

Systolic blood pressure (mmHg):
Diastolic blood pressure (mmHg):

Total cholesterol (mmol/L):
HDL cholesterol (mmol/L):

Haemoglobin (g/L):
Ferritin (µg/L):

Remember to check the explanation over the page and if any of these results concern you please discuss them with your doctor.

Please find enclosed your .... supermarket vouchers.
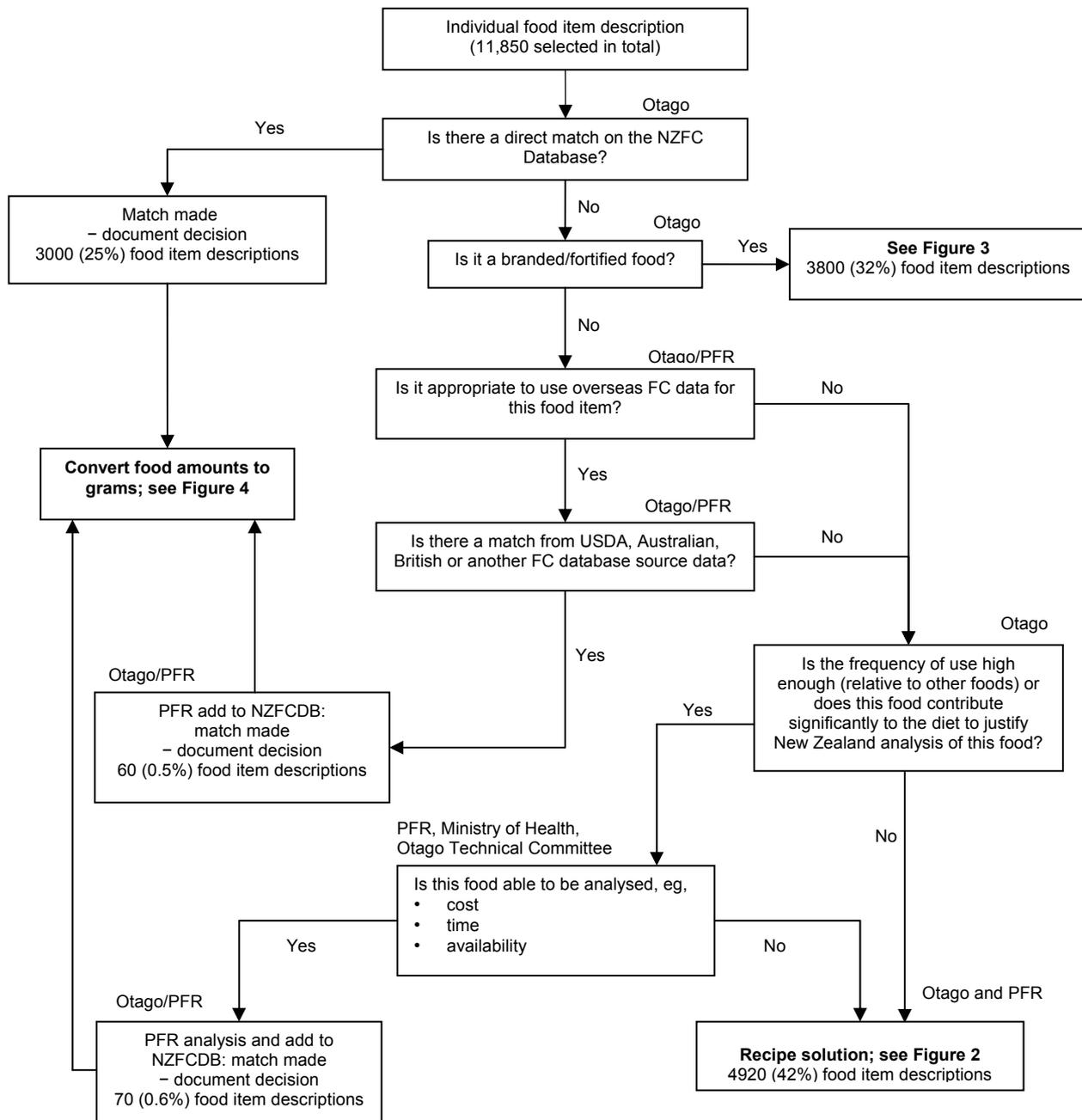
Again, very many thanks for your help.

Yours sincerely

Dr Winsome Parnell
Nutrition Director

Appendix 4: Food/nutrient matching flowcharts

Figure 1: Matching foods to nutrient lines in food composition databases


```
                        ┌─────────────────────────────────┐
                        │  Individual food item description│
                        │    (11,850 selected in total)    │
                        └─────────────────────────────────┘
                                        │
                                        ▼               Otago
                        ┌─────────────────────────────────┐
        Yes             │  Is there a direct match on the  │
    ┌───────────────────│           NZFC Database?          │
    │                   └─────────────────────────────────┘
    ▼                                   │ No          Otago
┌──────────────────┐      ┌─────────────────────────────┐   Yes   ┌──────────────────────────────┐
│  Match made      │      │ Is it a branded/fortified    │────────▶│      See Figure 3             │
│  − document      │      │          food?                │         │ 3800 (32%) food item          │
│  decision        │      └─────────────────────────────┘         │ descriptions                  │
│  3000 (25%) food │                     │ No                      └──────────────────────────────┘
│  item            │                     ▼             Otago/PFR
│  descriptions    │      ┌─────────────────────────────┐   No
└──────────────────┘      │ Is it appropriate to use     │──────────────────┐
    │                     │ overseas FC data for this     │                   │
    │                     │        food item?             │                   │
    ▼                     └─────────────────────────────┘                   │
┌──────────────────┐                    │ Yes          Otago/PFR             │
│ Convert food     │      ┌─────────────────────────────┐   No               │
│ amounts to       │      │ Is there a match from USDA,  │──────────┐        │
│ grams; see       │      │ Australian, British or       │          │        │
│ Figure 4         │      │ another FC database source   │          │        │
└──────────────────┘      │ data?                        │          │        │
    ▲  ▲                  └─────────────────────────────┘          │        │
    │  │                              │ Yes                         ▼  ◀─────┘   Otago
    │  │   Otago/PFR                  │           ┌──────────────────────────────┐
    │  │ ┌──────────────────┐         │           │ Is the frequency of use high  │
    │  └─│ PFR add to       │◀────────┘     Yes   │ enough (relative to other     │
    │    │ NZFCDB:          │◀────────────────────│ foods) or does this food      │
    │    │ match made       │                     │ contribute significantly to   │
    │    │ − document       │                     │ the diet to justify New       │
    │    │ decision         │                     │ Zealand analysis of this food?│
    │    │ 60 (0.5%) food   │                     └──────────────────────────────┘
    │    │ item             │                         │                  │ No
    │    │ descriptions     │       PFR, Ministry      ▼                  │
    │    └──────────────────┘       of Health,    ┌──────────────────┐    │
    │                               Otago Technical│ Is this food able│    │
    │                               Committee      │ to be analysed,  │    │
    │                                              │ eg,              │    │
    │                                              │  • cost          │    │
    │                                              │  • time          │    │
    │                                              │  • availability  │    │
    │                                              └──────────────────┘    │
    │      Otago/PFR                         Yes    │          │ No         │
    │    ┌──────────────────┐ ◀─────────────────────┘          ▼            ▼
    └────│ PFR analysis and │                       ┌──────────────────────────────┐
         │ add to NZFCDB:   │                       │  Recipe solution; see Figure 2│
         │ match made       │          Otago and PFR│  4920 (42%) food item         │
         │ − document       │                       │  descriptions                 │
         │ decision         │                       └──────────────────────────────┘
         │ 70 (0.6%) food   │
         │ item             │
         │ descriptions     │
         └──────────────────┘
```

Key
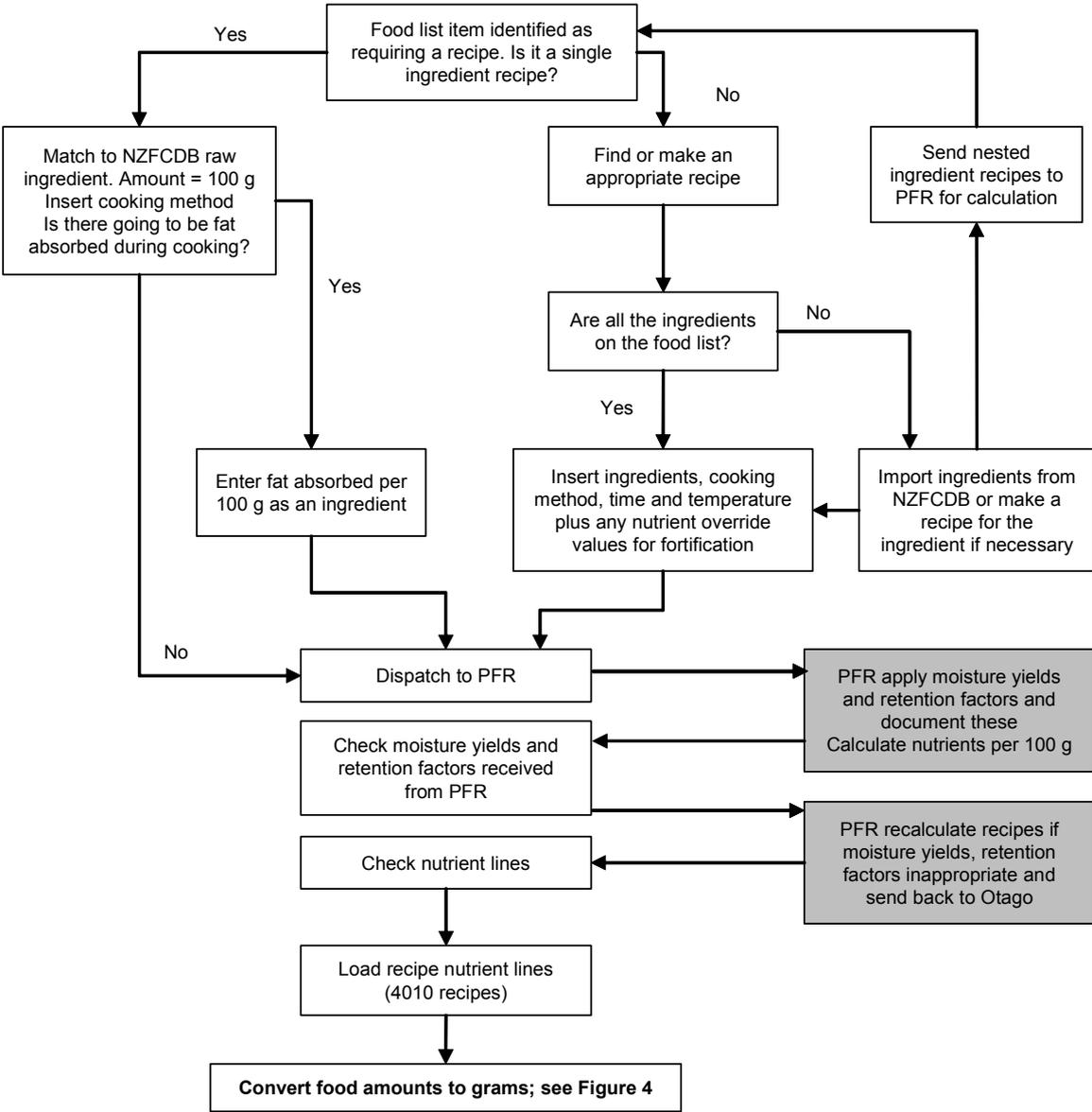
Otago – University of Otago

PFR – Plant & Food Research

FC – food composition
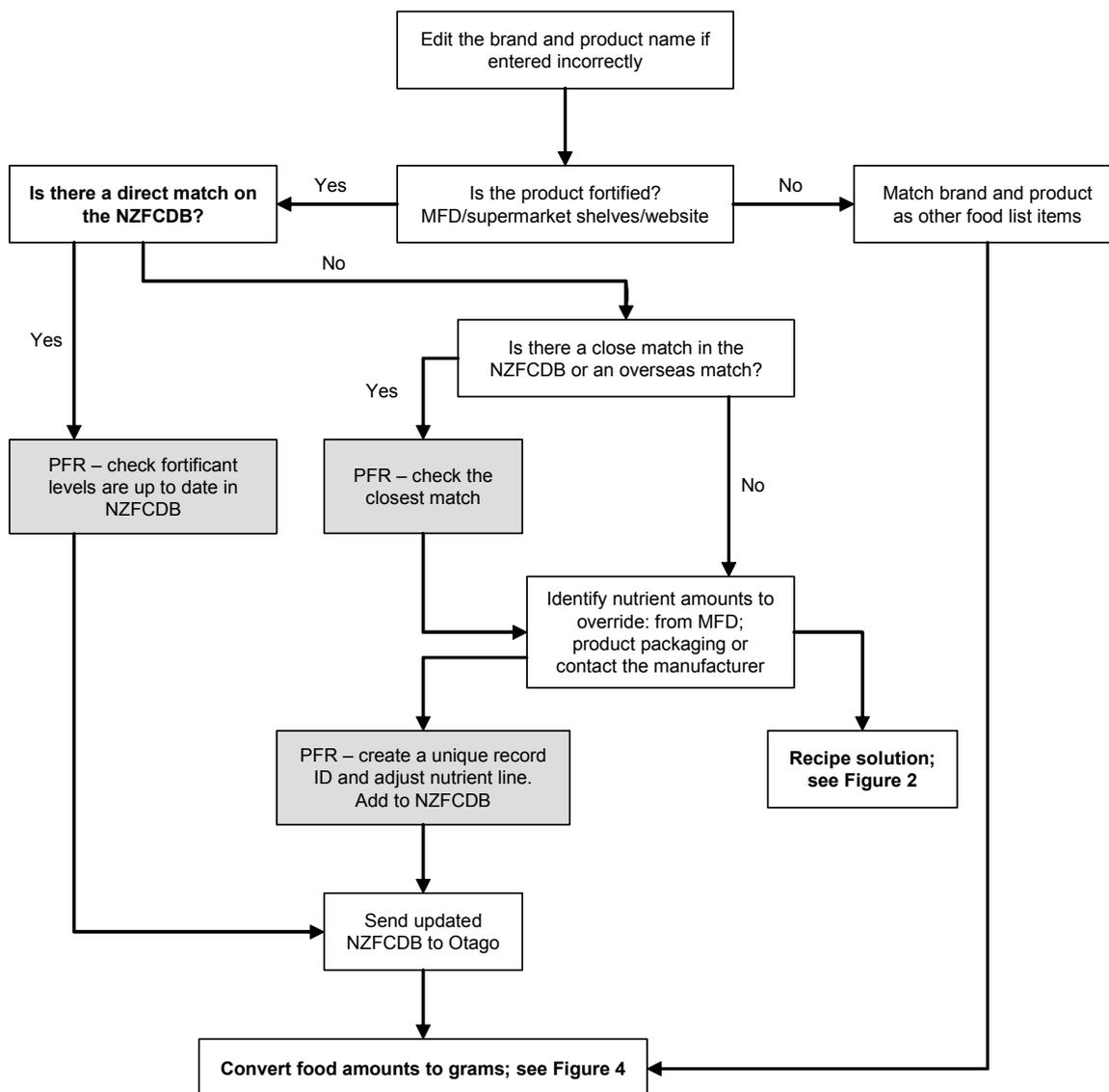
USDA – United States Department of Agriculture

NZFCDB – New Zealand Food Composition Database

Figure 2: 2008/09 NZ Adult Nutrition Surveys recipes

Key

Otago – University of Otago

PFR – Plant & Food Research

NZFCDB – New Zealand Food Composition Database

Figure 3: Brand and product name nutrient matching
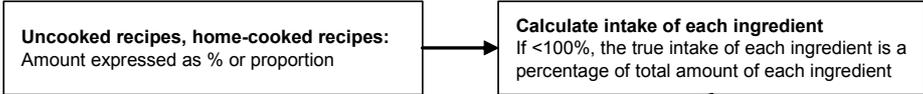

Key

MFD – Manufactured Food Database

PFR – Plant & Food Research

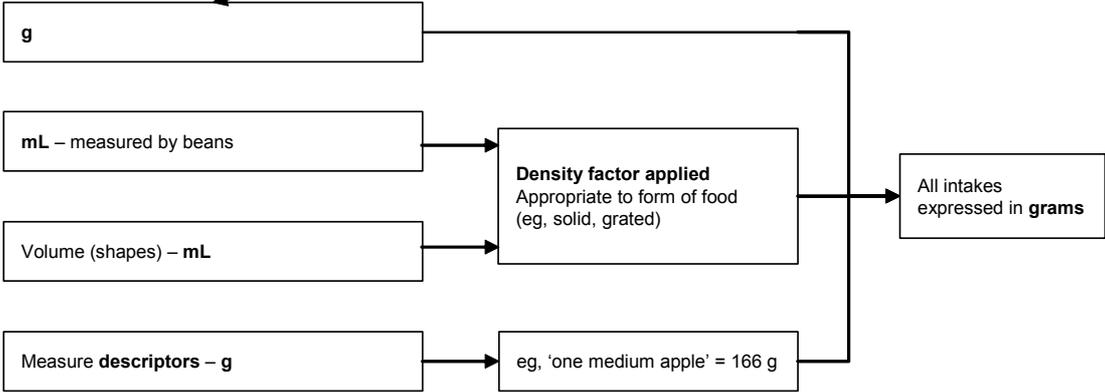NZFCDB – New Zealand Food Composition Database

Record ID – unique alphanumeric number for each food item

Figure 4: Food amounts converted to grams

a) Recipes

| Uncooked recipes, home-cooked recipes: Amount expressed as % or proportion | → | Calculate intake of each ingredient If <100%, the true intake of each ingredient is a percentage of total amount of each ingredient |

b) Foods

g

mL – measured by beans

Volume (shapes) – mL

Density factor applied Appropriate to form of food (eg, solid, grated)

All intakes expressed in **grams**

Measure **descriptors** – g

eg, 'one medium apple' = 166 g

Appendix 5: Analytical techniques for nutrients in the NZFCDB

Table A5.1: Analytical techniques for nutrients

Nutrient	INFOODS tagname[1]	Units	Method
Energy	ENERC	kJ	Calculated as follows: protein = 16.7 kJ/g; total fat = 37.7 kJ/g; available carbohydrate = 16.7 kJ/g; alcohol = 29.3 kJ/g. Energy from fibre is not included.
Protein	PROCNT	g	Calculated from total nitrogen; generally FAO/WHO conversions factors
Total fat	FAT	g	Several methods depending on food matrix
Saturated fat	FASAT	g	Sum of individual saturated fatty acids; GC of methyl esters
Monounsaturated fat	FAMS	g	Sum of individual monounsaturated fatty acids; GC of methyl esters
Polyunsaturated fat	FAPU	g	Sum of individual polyunsaturated fatty acids; GC of methyl esters
Cholesterol	CHOLE	mg	GC
Carbohydrate	CHOAVL	g	Available carbohydrate; sum of mono-, di- and oligosaccharides, starch and glycogen; or enzymatic digestion and colorimetry
Dietary fibre	PSACNS	g	Non-starch polysaccharides/fibre; Englyst method
Total sugars	SUGAR	g	Total available sugars, sum of individual mono- and disaccharides; GC or HPLC
Fructose	FRUS	g	Available fructose, sum of individual d-fructose monosaccharides; GC or HPLC
Sucrose	SUCS	g	Available sucrose, sum of individual sucrose disaccharides; GC or HPLC
Lactose	LACS	g	Available lactose, sum of individual lactose disaccharides; GC or HPLC
Alcohol	ALC	g	Alcohol / ethyl alcohol, hydrometer or GC
Vitamin A equivalents	VITA	µg	Total vitamin A equivalents / retinol equivalents; equals (µg retinol) + (0.166 x µg β-carotene equivalents); HPLC. Conversion factors used for vitamin A equivalents were 6 for β-carotene and 12 for other carotenoids
Retinol	RETNOL	µg	All trans retinol only, HPLC
β-carotene	CARTBEQ	µg	Beta-carotene equivalents; equals (µg β-carotene) + (0.5 x µg other provitamin A carotenoids); HPLC
Vitamin C	VITC	mg	HPLC and titration
Vitamin E	VITE	mg	Vitamin E/α-tocopherol equivalents; equals (mg α-tocopherol) + (0.4 x mg β-tocopherol) + (0.1 x mg gamma-tocopherol) + (0.01 x mg delta-tocopherol) + (0.3 x mg alpha-tocotrienol) + (0.05 x mg β-tocotrienol) + (0.01 x mg gamma-tocotrienol); HPLC
Thiamin	THIA	mg	HPLC, fluorescence detection of thiochrome
Riboflavin	RIBF	mg	HPLC, fluorescence detection
Niacin equivalents	NIAEQ	mg	Total niacin equivalents; equals (mg preformed niacin (HPLC, UV detection)) + (1/60 x mg tryptophan (HPLC))
Vitamin B_6	VITB6C	mg	HPLC, fluorescence detection
Vitamin B_{12}	VITB12	µg	Microbiological

Nutrient	INFOODS tagname[1]	Units	Method
Folate	FOLDFE	µg	Dietary folate equivalents (a combination of synthetic and naturally occurring folate); radioassay or microbiological. Dietary folate equivalents (FOLDFE) = food folate (FOLFD) + folic acid (FOLAC) x 1.67
Calcium	CA	mg	Biological material digestion, ICP-OES
Phosphorus	P	mg	Biological material digestion, ICP-OES
Magnesium	MG	mg	Biological material digestion, ICP-OES
Iron	FE	mg	Biological material digestion, ICP-OES
Zinc	ZN	mg	Biological material digestion, ICP-MS
Potassium	K	mg	Biological material digestion, ICP-OES
Selenium	SE	µg	TMAH (tetra methyl ammonium hydroxide) micro digestion, ICP-MS

Notes:

GC = gas chromatography

HPLC = high performance liquid chromatography

ICP-OES = inductively coupled plasma – optical emission spectroscopy

ICP-MS = inductively coupled plasma – mass spectroscopy

1   Klensin et al 1989. The up to date listing can be found on: http://www.fao.org/infoods/