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Executive Summary of Nutrient Reference Values for Australia and New Zealand

including

Recommended Dietary Intakes

Commonwealth Department of Health and Ageing, Australia

Ministry of Health, New Zealand

National Health and Medical Research Council

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PREFACE

For more than 75 years the Australian and New Zealand Governments have been providing nutrition advice to the public. This advice includes recommendations about the amounts of specific nutrients required on a daily basis for sustenance or avoidance of deficiency states, as well as the culturally relevant, food and dietary patterns that will not only achieve sustenance, but also reduce the risk of chronic disease; the latter being generally termed Dietary Guidelines. Since the 1950s, there have been a number of publications in both countries dealing with what have been known at various times as Recommended Dietary Intakes or Allowances, the levels of nutrients required at a population level for sustenance or avoidance of deficiency states. The last revision of the Australian Recommended Dietary Intakes called the *Recommended Dietary Intakes for use in Australia* was undertaken over a decade beginning in 1980 and were published in 1991 (NHMRC, 1991). The background review papers for that revision were also published as a book (Truswell et al, 1990). The recommendations were also later formally adopted by New Zealand Government.

In 1997, a workshop of invited experts, including representatives from New Zealand, was held in Sydney in July 1997 to discuss the need for a revision of the 1991 NHMRC *Recommended Dietary Intakes for use in Australia*. Under the auspices of the Strategic Inter-governmental Nutrition Alliance (SIGNAL), a second workshop was held in July 1999 to scope the July 1997 recommendations and define the project parameters for the review. Amongst other considerations, it was agreed that:

- a joint Australia New Zealand RDI review proceed as soon as possible;
- a set of reference values for each nutrient was required and the term 'Nutrient Reference Values' (NRVs) be used to describe the set.
- the review build primarily upon concurrent work being undertaken in the United States, Canada, with consideration given to recommendations from and the United Kingdom, Germany and the European Union, recent dietary survey data collected in Australia and New Zealand, scientific data and unique Australasian conditions;

At the time of the 1999 workshop, the joint US/Canada revision had only just started releasing its recommendations in the form of a series of "Dietary Reference Intakes". By 2001, they had completed a revision of most of the major minerals and vitamins and by 2004, this round of revisions was completed.

Bearing in mind the progress with the joint US/Canada revisions and the high cost and time lines associated with de novo revisions of this kind, in 2001, the Commonwealth Department of Health and Ageing asked NHMRC to undertake a scoping study in relation to a potential revision of the Australian/New Zealand RDIs. During this time, the New Zealand Government funded some initial work for the review process, which provided expert input into the revision of two key nutrients, iodine and selenium. The NHMRC was then commissioned in 2002, to manage the joint Australian/New Zealand revision process. An expert Working Party was appointed to oversight the process with representation from both Australian and New Zealand including end users from the clinical and public health nutrition research sector, the food industry, the dietetics profession and the food legislative sector, as well as from the Australian and New Zealand governments. This publication, its recommendations and its associated Appendix, are the results of that review process. The understanding of many aspects of good nutrition is by no means complete but where expert judgement has to be applied this is done with public health and safety as the priority.

Consumption of food contributes to human life in a variety of ways not just to provide for physiological needs, but also as part of our social and emotional needs. It is possible to prescribe a diet which would meet the physiological needs of a group, even with a margin of safety, and yet fail to meet the social or emotional needs of a significant percentage of the group. Whilst physiological needs are the primary determinant of Nutrient Reference Values, they are developed with consideration given to the other aspects of food intake.

Research has shown that a healthy diet, which contains adequate amounts of the various nutrients, need not be a more costly diet. This is discussed in more detail in the NHMRCs Dietary Guidelines for Australian Adults. The Australian Dietary Guidelines for Adult as well as those for Children and Adolescents and the age-specific series of New Zealand Dietary Guidelines, are companion documents to this publication. Together with the two national guides to healthy eating, the Dietary Guidelines interpret the nutrient recommendations addressed in this document, into food and lifestyle patterns for the community. Revision of all these documents, is an ongoing process as the various sets of recommendations are closely interrelated.

These recommendations are for healthy people and may not meet the specific nutritional requirements of individuals with various diseases or conditions, for pre-term infants, or for people with specific genetic profiles. They are designed for nutrition and health professionals for the dietary assessment of individuals and groups. They may also be used by public health nutritionists, food legislators and the Food Industry, in relation to dietary modelling and/or food labelling and food formulation.

Katrine Baghurst , November 2004

INTRODUCTION

What are Nutrient Reference Values ?

In the 1991 Recommended Dietary Intakes (RDI) for use in Australia (NHMRC, 1991; Truswell et al, 1990) a single RDI value (sometimes a range) was developed for each nutrient. In the 1991 publication, the Recommended Dietary Intake was defined as " *the levels of intake of essential nutrients considered, in the judgement of the NHMRC, on the basis of available scientific knowledge, to be adequate to meet the known nutritional needs of practically all healthy people……they incorporate generous factors to accommodate variations in absorption and metabolism. They therefore apply to group needs. RDIs exceed the actual nutrient requirements of practically all healthy persons and are not synonymous with requirements."*

Nevertheless, the RDIs were often misused in Australia and New Zealand, and indeed in many other countries, to assess dietary adequacy of individuals, and even foods. To overcome this, many countries have now moved to a system of reference values which retains the concept of the RDI but also attempts to identify the average requirements needed by individuals.

In 1991, the UK (Dept Health, 1991) was the first country to develop a set of values for each nutrient and more recently, the Food and Nutrition Board/Institute of Medicine (1997, 1998, 2000, 2001, 2002, 2004) on behalf of the US and Canadian Governments, adopted a similar approach.

After due consideration, the Working Party decided to adopt the approach of the US:Canadian DRI although some of the terminology was varied to retain the RDI terminology. For each nutrient, an Estimated Average Requirement (EAR) was set from which a Recommended Dietary Intake (RDI) could be derived (US:Canadian terminology is Recommended Dietary Allowance or RDA).

Where evidence was insufficient, or too conflicting, to establish an EAR (and thus an RDI) an Adequate Intake (AI) was set, either on experimental evidence or by adopting the current population median intake assuming that the Australian/New Zealand populations were not deficient for that particular nutrient. Both the RDI and AI can be used as a goal for individual intake but there is less certainty about the AI value as it depends on a greater degree of judgement. An AI might deviate significantly and be numerically higher from an RDI could it be determined. Thus AIs should be used with greater care.

Where AIs were based on median population means, these were derived from a re-analysis of the National Nutrition Surveys of Australia (Australian Bureau of Statistics, 1998) and New Zealand (Ministry of Health 1999, 2003).

For each nutrient, an Upper Intake Level (including intake both from food and supplements) was also set which relates to the total potential intake from food and supplements. This is the highest level of a nutrient that is likely to pose no adverse risk to health in almost all individuals in the specified life stage group. The UIL is not supposed to be a recommended level of intake. It is based on a risk assessment of nutrients which involves establishment of a No Adverse Effect Level (NOAEL) and/or a Lowest Adverse Effect Level (LOAEL) and application of an Uncertainty Factor (UF) related to the evidence base and severity of potential adverse effects. Further details of this approach are given in all the FNB:IOM publication "*Dietary Reference Intakes. A risk assessment model for establishing upper intake levels for nutrients"* (1998) and in the relevant nutrient chapters of the DRI publications.

For energy, an Estimated Energy Requirement (EER) was set for a range of activity levels. Finally, for the macronutrients, an additional recommendation was made called an Acceptable Macronutrient Distribution Range (AMDR). This was estimated to be the range of intake for each macronutrient (expressed as % contribution to energy), that would allow for an adequate intake of all the other nutrients, whilst maximising general health outcome. The precise definitions of these terms and their potential uses are given below.

For individuals, the EAR can be used to examine the probability that their usual intake is inadequate and the RDI or AI can be used to indicate the intake at which, or above which, there is a low probability of inadequacy. Intakes in an individual at or above the UIL may place the individual at risk of adverse effects from excessive nutrient intake. Members of the general population should be advised not to routinely exceed the UIL, although intakes above the UIL may be appropriate for some nutrients for investigation in well-controlled clinical trials as long as signed informer consent is given and as long as the trials employ appropriate safety monitoring of trial subjects. Readers are referred to the relevant FNB:IOM documents and the report of the UK Expert Group on Vitamins and Minerals (2003) for more details about the potential toxicological effects of high intakes of nutrients.

Definitions adapted from FNB:IOM DRI process

EAR Estimated Average Requirement
The EAR is the median usual intake estimated to meet the requirement of half the healthy individuals in a life stage/gender group.

RDI Recommended Dietary Intake
The RDI is the average daily dietary intake level sufficient to meet the nutrient requirements of nearly all healthy individuals (97-98%) in a life stage/gender group If the requirement for the nutrient is normally distributed and the standard deviation of the EAR is available, the RDI = EAR + 2 SD_{EAR}. If data about variability are insufficient to calculate anSAD, a coefficient of variation of 10% is assumed and used to estimate SD . $CV_{EAR}=SD_{EAR}/EAR$. Thus the RDI=1.2 x EAR.. When nutrient requirements are not normally distributed, transformations can be used or Monte Carlo simulations summing components of the variability.

AI Adequate Intake
Where an EAR (and therefore an RDI) for the nutrient cannot be determined because of limited or inconsistent data then an Adequate Intake (AI) is determined. The AI can be used as a goal for individual intake but is based on experimentally derived intake levels or approximations of observed mean nutrient intakes by a group of apparently healthy people maintaining a defined nutritional state

EER Estimated Energy Requirement
The average dietary energy intake that is predicted to maintain energy balance in a healthy adult of defined age, gender, weight, height and level of physical activity, consistent with good health. In children and pregnant and lactating women, the EER is taken to include the needs associated with the deposition of tissues or the secretion oif milk at rates consistent with good health.

UIL Upper Intake Limit
Highest level of continuing daily nutrient intake likely to pose no adverse health effects in almost all individuals

For groups, the EAR can be used to estimate the prevalence of inadequate intakes in a community. However, in contrast to past practice, with the availability of the EAR, the RDI should not be used to assess intakes of groups. Intakes of groups at or above the AI means there is a low prevalence of inadequate intakes, however when the AI is not derived from median intakes in the population, this assessment is made with less certainty. The UIL can be used with groups to estimate the percentage of the population at potential risk of adverse effects from excessive intake. Further information about the applications of the Nutrient Reference Values can be found in the FNB:IOM (2000) publication *"Dietary Reference Intakes. Applications in Dietary Assessment"*.

Terms of reference

The Working Party developed the Nutrient Reference Values, with input from many expert reviewers, in keeping with the following terms of reference established by the NHMRC.

In developing a set of new recommendations for Australia and New Zealand, the Working Party will:

- Oversee the review of the 1991 "Recommended dietary intakes for use in Australia" adopted as the current New Zealand RDIs;

- Ensure that the recommendations are based on best available scientific evidence

- Base the review on a consideration of the processes and recommendations of the recent revision in the United States/Canadian, Dietary Reference Intakes taking into account any unique aspects of the populations in Australia and New Zealand including environmental, geographical, physiological, ethnic and cultural factors of both countries.

- Consider new scientific evidence and other recent recommendations from countries such as the UK, the European Union countries or FAO/WHO;

- Follow processes and standards acceptable to the Commonwealth Department of Health and Ageing, the New Zealand Ministry of Health including its obligations under the Treaty of Waitangi and the National Health and Medical Research Council, including liaison with SIGNAL; and

Report to the Commonwealth Department of Health and Ageing (Population Health Division) and to the New Zealand Ministry of Health through the Health Advisory Committee and the National Health and Medical Research Council.

Members of the working party

Dr Katrine Baghurst (Chair)	CSIRO Health Sciences and Nutrition, Adelaide
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Professor Jennie Brand-Miller	Human Nutrition Unit, School of Molecular and Microbial Biosciences, University of Sydney
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Ms Janine Lewis	Food Standards Australian New Zealand
Dr Paul Nestel	Baker Medical Research Institute, Melbourne
Dr David Roberts	Australian Food and Grocery Council
A/Professor Christine Thomson	Department of Human Nutrition, University of Otago, Dunedin, New Zealand
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We are also grateful for the help of Dr Ruth Richards and Mary-Louise Hannah of the NZ Ministry of Health for their assistance during the process.

Expert reviewers

The following people undertook from one to three expert reviews of nutrients according to the proforma included in the Appendix. These expert reviews were used by the Working Party in their decision process but the Working Party takes final responsibility for the draft recommendations. We are very grateful for the input of the following Australian and New Zealand reviewers:

Dr Jane Allen	James Fairfax Institute, The Children's Hospital at Westmead, Sydney
Mr Alan Barclay	Diabetes Australia, Sydney
Dr Marijka Batterham	Smart Foods Centre, University of Wollongong
Dr Trevor Beard	Menzies Centre for Population Health Research, Hobart
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Dr Carol Wham	Institute of Food, Nutrition and Human Health Massey University, Albany
Dr Beverley Wood	Carlton, Victoria
Dr David Woodward	Department of Biochemistry,University of Tasmania

We are also grateful to the New Zealand Government for funding and making available two expert reviews of selenium and iodine (Thomson and Patterson, 2001; Thomson, 2002) as part of the review process.

We are also grateful to the Australian Nutrition Trust for funding and making available three evidence-based reviews of the selenium, calcium and vitamin D recommendations from several overseas countries (Flight and Baghurst, 2003a,b,c) and for funding a nutrient modelling exercise, which was also used as a cross-check for the recommendations, relating to the balance of macro and micronutrients. We also thank Dr Peter Baghurst of the Women's and Children's Hospital, Adelaide and Sally Record of CSIRO Health Sciences & Nutrition, for assisting with the dietary modelling.

The nutrients to be reviewed

In the light of emerging evidence of diet/health interactions and after considering recent recommendations from other countries, the preliminary workshops had identified over 40 nutrients for the Working Party to consider. The previous recommendations *Recommended Dietary Intakes for use in Australia* (NHMRC. 1991), which had also been adopted for use in New Zealand, contained recommendations for 19 nutrients and dietary energy. During this review, dietary energy requirements and requirements for the nutrients listed below, were considered.

Macronutrients	**Vitamins**	**Minerals/ Trace elements**
Energy	Vitamin A	Arsenic
Protein	Thiamin	Boron
Total Fat	Riboflavin	Calcium
n-6 fatty acids (linoleic)	Niacin	Chromium
n-3 fatty acids(α –linolenic)	Vitamin B6	Copper
VLC omega fatty acids	Vitamin B12	Iodine
(DHA/DPA/EPA)	Folate	Fluoride
Cholesterol	Pantothenic acid	Iron
Carbohydrate	Biotin	Manganese
Dietary Fibre	Choline	Magnesium
Water	Vitamin C	Molybdenum
	Vitamin D	Nickel
	Vitamin E	Phosphorus
	Vitamin K	Potassium
		Selenium
		Silicon
		Sodium
		Vanadium
		Zinc

After review, recommendations have been made for all of the nutrients listed above with the exception of total fat (apart from infants), carbohydrate (apart from infants), cholesterol, arsenic, boron, nickel, silicon and vanadium. For these nutrients it was agreed that there was little or no evidence of their essentiality in humans, at this time. This was in line with the findings of the US:Canadian DRI review recommendations. However, the DRI reviews did set some upper limits for some of these nutrients (FNB:IOM, 1998, 2001) and the reader is referred to these for information.

The reviews were based on assessment of the applicability of the recently developed US:Canadian Dietary Reference Intakes (FMB:IOM, 1997, 1998, 2000, 2001, 2002, 2004) to Australia and New Zealand, with reference to recommendations from other countries such as the UK (1991;2003), Germany/Austria /Switzerland (DACH recommendations, 2002) and from key organisations such as the FAO/WHO (2001).

The assessment process

Reviewers were asked to complete a proforma that asked them to assess the suitability of the US:Canadian DRI recommendations for adoption in Australia and New Zealand taking into consideration:

- the completeness and currency of the evidence base;
- the interpretation of the evidence;
- the selection of indicators for estimating requirements;
- the justifiability of recommendations for various age and gender categories
- whether the needs of special groups were considered including vegetarians, formula fed vs breast fed babies; cultural and racial groups; cigarette smokers; oral contraceptive users; those with high alcohol use or drug use, athletes, tropical dwellers or any other special group.
- interactions with other nutrients or non-nutrients including the issue of bioavailability;
- whether the effect of other factors had been considered (socioeconomic status of study populations, customary intake of other competing nutrients, or interfering/enhancing factors, lifestyle characteristics (eg physical labour). prevalence of disease, climatic effects etc);
- whether differences in dietary patterns of Australia and New Zealand were so markedly different from those of the US/Canada as to affect any of the recommendations (particularly relevant to the AI and AMDR recommendations);
- whether the Upper Intake Limit was adequately addressed and whether it was appropriate for Australia/New Zealand;
- whether there was evidence for a chronic disease protective effect of higher than RDI levels of intake;
- whether there was evidence for a chronic disease promoting effect of higher than RDI levels
- whether they had any other considerations that they wished to raise that would affect recommendations for Australia and New Zealand.and
- recommendations from other countries such as the UK, European countries or bodies such as the FAO/WHO or European Commission

They were asked to provide an evidence based assessment of the key papers used in the US:Canadian DRI review to derive the recommendations and to provide an analysis of any key, missing papers or key papers published since the DRI review of that nutrient, using, where possible or relevant, the NHMRC levels of evidence (see below).

Finally, they were asked to state whether they felt that Australia/New Zealand should adopt, adopt with minor changes, adopt with substantial changes or reject the US:Canadian recommendation as unsuitable for use in Australia/New Zealand and to summarise their overall recommendations.

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The expert reviews and recommendations together with the US:Canadian DRI reviews and those of other countries and health bodies were then considered by the Working Party, who made the draft recommendations contained in this book. The evidence tables and rationales for variation from the recommendations of the US:Canadian DRI reviews will be published separately as an Appendix to this report.

The evidence base

The National Health and Medical Research Council (NHMRC) has released a guidebook which explains *"How to use the evidence assessment and application of scientific evidence."* This guidebook, however, relates to evidence assessment in relation to clinical practice. In many cases the development of evidence-based guidelines for clinical practice deals with evidence in relation to a specific disease and a specific therapeutic agent. Similar criteria are not easily used for assessment of evidence related to the level of nutrient intake required for sustenance and avoidance of deficiency disease.

There are a number of initiatives underway around the world to try to develop an evidence-based approach to nutrition and health issues, but this has generally been in response to the need for "proof" in relation to health claims for food components. In Australia, a set of proposed levels of evidence for food or health claims has been developed by FSANZ, which is similar to, but somewhat broader in scope than the NHMRC approach for clinical guidelines. These are primarily intended to assess evidence related to the efficacy of individual nutrients or food components in relation to chronic disease outcome rather than avoidance of deficiency disease.

However, it was considered that it may still be useful to consider the NHMRC designation of levels of evidence for clinical practice, in relation to the scientific data discussed in this document.

NHMRC's Level of Evidence are outlined below:

I	Evidence obtained from a systematic review of all relevant randomised controlled trials.
II	Evidence obtained from at least one properly-designed randomised controlled trial.
III-1	Evidence obtained from well-designed pseudorandomised controlled trials (alternate allocation or some other method).
III-2	Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomised, cohort studies, case-control studies, or interrupted time series with a control group.
III-3	Evidence obtained from comparative studies with historical control, two or more single arm studies, or interrupted time series without a parallel control group.
IV	Evidence obtained from case series, either post-test or pretest/post-test.

Source: *A Guide to the Development, Implementation and Evaluation of Clinical Practice Guidelines NHMRC 1999.*

Six levels of evidence are designated by NHMRC, Level I being based on a systematic review of all relevant randomised control trials with Level II being on evidence obtained from at least one properly designed randomised control trial. With perhaps the exception of calcium, there are few Level I or Level II nutrient intervention trials assessing adequacy of nutrient intake in relation to deficiency states, although a number of nutrient-supplement trials have been undertaken in relation to chronic disease etiology.

Some of the studies used to set nutrient requirements fall within Level III or Level IV the levels of evidence which include study designs such as cohort studies, case-control studies and comparative ecological studies with historical controls or case series. However, much of the evidence comes from animal or human experimental studies that do not fall within these categories, or observational or cross-sectional survey data (eg all the recommendations for infants are based on the composition of milk from healthy mothers and a significant amount of the evidence for the Upper Intake Levels comes from individual case-reports of excessive intakes related to accidentally high intakes or under special conditions such as parenteral feeding).

Because of the nature of the Nutrient Reference Values, the background papers were developed as a result of a process of comprehensive, rather than systematic, review of the literature. In the appendix, a summary is given of key evidence used to set recommendations, including, where relevant, the NHMRC Levels of Evidence.

The NHMRC states that "a decision should be made about what is feasible and appropriate in a given situation and the extent to which reasonable standards have been met by the available body of evidence".

Although these recommendations are, where possible, evidence-based, there are generally very limited data on which to base recommendations. When assessing the literature, life-stage and gender are considered to the extent possible, but for many nutrients and for many age/gender/physiological categories, requirements have to be estimated from one age/gender category (on the basis of metabolic body weight, energy requirements, potentially decreased absorptive capacity, activity levels, additional needs for foetal growth or production of breast milk etc) rather than derived directly from experimental data. For infants, all recommendations are based on the composition of breastmilk from healthy mothers.

Although the reference values are based on data, the data are often scanty or drawn from studies that have substantial limitations. Apart from studies of frank deficiency disease, there are few studies that address the effects of inadequate intake on specific health indicators. While the recommendations are often given as single rounded numbers, it is acknowledged that these values may imply a precision not fully justified by the available human data. Nevertheless they represent our best attempt to identify the requirements of the various age/gender and life-stage groups.

Reference body weights

In developing the recommendations it was necessary to standardise body weights for the various age/gender groups. Assessment of the available data about current body weights in Australia and New Zealand for various age categories, showed that the body weights were not dissimilar to those used in the earlier US:Canadian DRI publications. From the 2002 publication onwards, the US:Canadian DRI review panels changed their standard body weights in response to availability of new data claiming to show markedly lighter body weights than previously used. As the latest

Australian/New Zealand data more closely resembled those in the earlier US:Canadian reports, these were adopted for use throughout these recommendations. The standard body weights for all adults was based on that for 19-30 year olds, although, in reality body weight in the most western populations increase throughout most of adulthood because of increasing body fat.

Reference body weights used in this document *

Gender	**Age**	**Reference weight kg**
Both	2-6 months	7
Both	7-11 months	9
Both	1-3 years	13
Both	4- 8 years	22
Males	9-13 years	40
	14-18 years	64
	19 years plus	76
Females	9-13 years	40
	14-18 years	57
	19 years plus	61

* *the US:Canadian standard body weights used in their 1997-2000 documents have been adopted as they are very similar to the latest available \median body weights for Australia and New Zealand*

Extrapolation processes

Experimental data is often only available for a limited age/gender group. In order to set recommendations for other groups data may have to be extrapolated. This is sometimes done in relation to energy requirements but more commonly on a metabolic body weight basis. In extrapolating data from one group to another, unless otherwise indicated in the text, the processes and formulae used were those developed by the US:Canadian DRI panels.

Extrapolations from adult data to children's requirements were mostly done using the formula:

$$EAR_{child} = EAR_{adult} \times F$$

$$\text{where } F = (\text{Weight}_{child}/\text{Weight}/_{adult})^{0.75} \times (1+ \text{growth factor}).$$

The growth factors used were 0.3 from 7 months to 3 years of age and 0.15 for 4-13 years of age for both genders. For boys aged 14-18 years, the growth factor used was 0.15 but for girls of this age the growth factor was set at zero.

When extrapolating from younger infants aged 0-6 months, to older infants aged 7-12 months, the formula used was:

$$AI_{7\text{-}12 \text{ months}} = AI_{0\text{-}6 \text{ months}} \times F$$

$$\text{where } F = (\text{Weight}_{7\text{-}12 \text{ months}} / \text{Weight}_{0\text{-}6 \text{ months}})^{0.75}$$

When estimating the Upper Intake Limit for children, the UIL was extrapolated down from the adults UIL using the formula:

$$UIL_{child} = UIL_{adult} \times Weight_{adult} / Weight_{child}$$

This allows for both body mass and metabolic differences between adults and children to be incorporated as necessary. For more details please refer to the methodology sections of the United States/Canadian FNB:IOM reports.

The consultation process

After the Working Party had made its initial deliberations, the draft recommendations will be submitted for public consultation in Australia and New Zealand between November 2004 and February, 2005 allowing three months for consultation. Notification in Australia will be published in the Commonwealth Government Gazette and on the NHMRC website as well as through direct notification to key bodies. In New Zealand, the NZ Government will ensure notification to key bodies and the public. Copies of draft documents and supporting information will be made available free of charge from the Office of NHMRC and on the NHMRC website. In addition, notices will be included in other publications and media such as newspapers and radio. During the submission period, workshops will be held in Australia and New Zealand with health professional, food industry and end users, which will include consideration of optimal methods for dissemination, including electronic access.

After submissions are received the working party will meet in to consider the submissions and amend the document as necessary. The document will then be technically edited and independently reviewed assessing it against the NHMRC criteria for guideline development.

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Note: All the FNB:IOM Dietary Reference Intake publications can be accessed on line through the website of the National Academy Press at http://www.nap.edu

NUTRIENT REFERENCE VALUES

ENERGY

Infants and children (1-2 years) EERs

Table 1. Estimated Energy Requirements (EER) of infants and young children

Age (months)	Reference weight Boys	Girls	EER (kJ/day) Boys	Girls
1	4.4	4.2	2000	1800
2	5.3	4.9	2400	2100
3	6.0	5.5	2400	2200
4	6.7	6.1	2400	2200
5	7.3	6.7	2500	2300
6	7.9	7.2	2700	2500
7	8.4	7.7	2800	2500
8	8.9	8.1	3000	2700
9	9.3	8.5	3100	2800
10	9.7	8.9	3300	3000
11	10.0	9.2	3400	3100
12	10.3	9.5	3500	3200
15	11.1	10.3	3800	3500
18	11.7	11.0	4000	3800
21	12.2	11.6	4200	4000
24	12.7	12.1	4400	4200

(Adapted from FNB:IOM, 2002; Reference weights from Kuczmarski et al, 2000)

Children and adolescents EERs

Table 2. Estimated Energy Requirements for children, adolescents (MJ/day)
(using BMR predicted from weight, height and age)

Age yrs	Reference weight kg*	Reference height m	BMR** kJ/day	PAL 1.2*** Bed rest	PAL 1.4*** Very sedentary	PAL 1.6*** Light	PAL 1.8*** Moderate	PAL 2.0*** Heavy	PAL 2.2*** Vigorous
Boys									
3	14.3	0.95	3430	4200	4880	5570	6250	6940	7620
4	16.2	1.02	3620	4430	5150	5880	6600	7330	8050
5	18.4	1.09	3840	4690	5460	6230	6990	7760	8530
6	20.7	1.15	4060	4960	5770	6580	7390	8210	9020
7	23.1	1.22	4300	5240	6100	6960	7820	8680	9530
8	25.6	1.28	4530	5520	6430	7340	8240	9150	10060
9	28.6	1.34	4810	5880	6840	7800	8770	9730	10690
10	31.9	1.39	5120	6250	7280	8300	9330	10350	11380
11	35.9	1.44	5420	6610	7700	8780	9.870	10950	12040
12	40.5	1.49	5770	7020	8180	9330	10480	11640	12790
13	45.6	1.56	6150	7490	8720	9950	11180	12410	13640
14	51.0	1.64	6570	7980	9300	10610	11920	13240	14550
15	56.3	1.70	6960	8460	9850	11240	12640	14030	15420
16	60.9	1.74	7300	8860	10320	11780	13240	14700	16160
17	64.6	1.75	7550	9170	10680	12190	13700	15210	16720
18	67.2	1.76	7740	9390	10940	12480	14030	15580	17130
Girls									
3	13.9	0.94	3180	3900	4530	5170	5800	6440	7070
4	15.8	1.01	3360	4120	4790	5460	6130	6800	7470
5	17.9	1.08	3560	4350	5060	5. 70	6480	7200	7910
6	20.2	1.15	3770	4600	5360	6110	6860	7620	8370
7	22.8	1.21	3990	4870	5670	6470	7270	8070	8870
8	25.6	1.28	4240	5170	6020	6860	7710	8560	9410
9	29.0	1.33	4510	5520	6420	7320	8230	9130	10030
10	32.9	1.38	4680	5720	6650	7590	8520	9460	10390
11	37.2	1.44	4940	6040	7030	8020	9000	9990	10980
12	41.6	1.51	5230	6390	7430	8480	9530	10570	11620
13	45.8	1.57	5500	6700	7800	8900	10000	11100	12200
14	49.4	1.60	5680	6920	8060	9200	10330	11470	12610
15	52.0	1.62	5810	7080	8240	9410	10570	11730	12890
16	53.9	1.63	5900	7180	8360	9540	10720	11900	13080
17	55.1	1.63	5940	7230	8420	9610	10800	11990	13170
18	56.2	1.63	5980	7280	8480	9670	10870	12060	13260

* *reference weights from Kuczmarski et al, 2000 (see also FNB:IOM, 2002)*

** estimated using Schofield, 1985 equations for weight, height and age group 3-10, 10-18.

*** PALs (Physical Activity Levels) incorporate relevant growth factor for age

Adults EERs

Table 3. Estimated energy requirements of adult using predicted BMR x PAL

Age group yrs	BMI=22.0		BMR kJ/d Males	Physical activity level (PAL) Males MJ/day						BMR kJ/d Female	Physical activity level (PAL) Females MJ/day					
	Ht m	Wt kg		1.2	1.4	1.6	1.8	2.0	2.2		1.2	1.4	1.6	1.8	2.0	2.2
19-30	1.5	49.5	–	–	–	–	–	–	–	5105	6.1	7.1	8.2	9.2	10.2	11.2
	1.6	56.3	6443	7.7	9.0	10.3	11.6	12.9	14.2	5527	6.6	7.7	8.8	9.9	11.1	12.2
	1.7	63.6	6903	8.3	9.7	11.0	12.4	13.8	15.2	5979	7.2	8.4	9.6	10.8	12.0	13.2
	1.8	71.3	7388	8.9	10.3	11.8	13.3	14.8	16.3	6457	7.7	9.0	10.3	11.6	12.9	14.2
	1.9	79.4	7898	9.5	11.1	12.6	14.2	15.8	17.4	6959	8.4	9.7	11.1	12.5	13.9	15.3
	2.0	88.0	8440	10.1	11.8	13.5	15.2	16.9	18.6	–	–	–	–	–	–	–
31-70	1.5	49.5	–	–	–	–	–	–	–	5221	6.3	7.3	8.4	9.4	10.4	11.5
	1.6	56.3	6355	7.6	8.9	10.2	11.4	12.7	14.0	5452	6.5	7.6	8.7	9.8	10.9	12.0
	1.7	63.6	6706	8.0	9.4	10.7	12.1	13.4	14.8	5700	6.8	8.0	9.1	10.3	11.4	12.5
	1.8	71.3	7075	8.5	9.9	11.3	12.7	14.2	15.6	5962	7.2	8.3	9.5	10.7	11.9	13.1
	1.9	79.4	7464	9.0	10.4	11.9	13.4	14.9	16.4	6238	7.5	8.7	10.0	11.2	12.5	13.7
	2.0	88.0	7877	9.5	11.0	12.6	14.2	15.8	17.3	–	–	–	–	–	–	–
>70	1.5	49.5	–	–	–	–	–	–	–	4636	5.6	6.5	7.4	8.3	9.3	10.2
	1.6	56.3	5218	6.3	7.3	8.3	9.4	10.4	11.5	4894	5.9	6.9	7.8	8.8	9.8	10.8
	1.7	63.6	5575	6.7	7.8	8.9	10.0	11.2	12.3	5172	6.2	7.2	8.3	9.3	10.3	11.4
	1.8	71.3	5953	7.1	8.3	9.5	10.7	11.9	13.1	5464	6.6	7.7	8.7	9.8	10.9	12.0
	1.9	79.4	6350	7.6	8.9	10.2	11.4	12.7	14.0	5772	6.9	8.1	9.2	10.4	11.5	12.7
	2.0	88.0	6771	8.1	9.5	10.8	12.2	13.5	14.9	–	–	–	–	–	–	–

BMI of 22.0 is approximately the mid point of the WHO (1998) healthy weight range (18.5–24.9)
Physical activity level (PAL) of 1.2 (bed rest) to 2.2 (very active or heavy occupational work).
Activity levels consistent with good health are PAL 1.75 and above
Activity levels below PAL 1.4 are not compatible with moving around freely or earning a living.
Activity levels above PAL 2.5 are difficult to maintain for long periods.

Pregnancy EER (all ages)

1st trimester	**No additional requirement**
2nd trimester	**Additional 1400 kJ/day**
3rd trimester	**Additional 1900 kJ/day**

Lactation EER **Additional 2000 -2100 kJ/day**

Upper Intake Limit **Not possible to set**

SUMMARY TABLES OF
ESTIMATED ENERGY REQUREMENTS (EER)
ESTIMATED AVERAGE REQUIREMENTS (EARs),
RECOMMENDED DIETARY INTAKES (RDIs),
ADEQUATE INTAKES (AIs) AND
UPPER INTAKE LIMITS (UILs)
FOR MACRO AND MICRONUTRENTS

Table 4 Nutrient Reference Values for Australia and New Zealand: Macronutrients and water

Age/gender group		Energy* Mj/day	Protein g/day			Dietary fats† Linolenic (n6) g/d		Dietary fats† α –linolenic (n3) g/d		Dietary fats† VLC n3 (DHA/EPA/DPA) mg/d		Carbohydrate g/d		Dietary Fibre g/day		Total Water‡ (fluids) L/d	
		EER	*AI*	*UIL*		*AI*	*UIL*	*AI*	*UIL*	*AI*	*UIL*	*AI*	*UIL*	*AI*	*UIL*	*AI*	*UIL*
Infants **	**0-6 mo.**	1.8 - 2.7	10	BM		4.4	BM	0.5†	BM	-		60	BM	NP	NP	0.7 (0.7)	NP
	7-12 mo.	2.5 - 3.5	14	B/F		4.6	B/F	0.5†	B/F	-		95	B/F	NP	NP	0.8 (0.6)	NP
			EAR	*RDI*	*UIL*	*AI*	*UIL*	*AI*	*UIL*	*AI*	*UIL*			*AI*	*UIL*	*AI*	*UIL*
Children	**1-3 years**	3.2 - 5.5	12	14	NP	5	NP	0.5	NP	40	3000	NONE SET		12	NP	1.4 (1.0)	NP
	4-8 years	5.5 - 7.4	16	20	NP	8	NP	0.8	NP	55	3000	FOR OTHER		16	NP	1.6 (1.2)	NP
Boys	**9-13 years**	7.8 - 10.0	31	40	NP	10	NP	1.0	NP	70	3000	AGES		21	NP	2.2 (1.6)	NP
	14-18 years	10.6 - 12.5	49	65	NP	12	NP	1.2	NP	125	3000			23	NP	2.7 (1.9)	NP
Girls	**9-13 years**	7.3 - 8.9	24	35	NP	8	NP	0.8	NP	70	3000			17	NP	1.9 (1.4)	NP
	14-18 years	9.2 - 9.7	35	45	NP	8	NP	0.8	NP	85	3000			18	NP	2.2 (1.4)	NP
Men	**19-30 years**	10.3 - 13.5	52	64	NP	13	NP	1.3	NP	190	3000			25	NP	3.4 (2.6)	NP
	31-50 years	10.2 - 12.6	52	64	NP	13	NP	1.3	NP	190	3000			25	NP	3.4 (2.6)	NP
	51-70 years	10.2 - 12.6	52	64	NP	13	NP	1.3	NP	190	3000			25	NP	3.4 (2.6)	NP
	>70 years	8.3 - 10.8	52	64	NP	13	NP	1.3	NP	190	3000			25	NP	3.4 (2.6)	NP
Women	**19-30 years**	8.2 - 11.1	37	46	NP	8	NP	0.8	NP	90	3000			20	NP	2.8 (2.1)	NP
	31-50 years	8.4 - 10.0	37	46	NP	8	NP	0.8	NP	90	3000			20	NP	2.8 (2.1)	NP
	51-70 years	8.4 - 10.0	37	46	NP	8	NP	0.8	NP	90	3000			20	NP	2.8 (2.1)	NP
	>70 years	7.4 - 9.2	37	46	NP	8	NP	0.8	NP	90	3000			20	NP	2.8 (2.1)	NP
Pregnant	**14-18 years**	2nd trimest	47 #	58 #	NP	10	NP	1.0	NP	110	3000			20	NP	2.4 (1.8)	NP
	19-30 years	+1.4MJ	49 #	60 #	NP	10	NP	1.0	NP	115	3000			22	NP	3.1 (2.3)	NP
	31-50 years	3rd trimest + 1.9MJ	49 #	60 #	NP	10	NP	1.0	NP	115	3000			22	NP	3.1 (2.3)	NP
Lactating	**14-18 years**		51	63	NP	12	NP	1.2	NP	140	3000			22	NP	3.5 (2.6)	NP
	19-30 years	+ 2.0-2.1MJ	54	67	NP	12	NP	1.2	NP	145	3000			24	NP	3.5 (2.6)	NP
	31-50 years		54	67	NP	12	NP	1.2	NP	145	3000			24	NP	3.5 (2.6)	NP

*EAR Estimated Average Requirement; RDI Recommended Dietary Intake; AI Adequate Intake; UIL Upper Intake Limit * Energy needs are dependent on body size and activity: ** AI recommendations for infants are based on amounts in breast milk: # in 2nd and 3rd trimesters only; † Recommendation for total n6 and total n3; total fat AI also set at 30-31g/day for infants;‡ total water includes water from foods as well as fluids: BM = amount normally received from breast milk of healthy women: B/F amount in breast milk and food: NP = Not Possible to set (may be insufficient evidence or no clear level for adverse effects).*

Table 5. Nutrient Reference Values for Australia and New Zealand: B Vitamins

Age group/gender		Thiamine mg/day			Riboflavin mg/day			Niacin * mg/d niacin equivalents			Vitamin B6 mg/day			Vitamin B12 µg/day			Folate (folate equivs) mg/day			Panto-thenate mg/day		Biotin µg/day	
		AI		***UIL***	***AI***		***UIL***	***AI***		***UIL***	***AI***		***UIL #***	***AI***		***UIL***	***AI***		***UIL#***	***AI***	***UIL***	***AI***	***UIL***
Infants **	**0-6 mo.**	**0.2**		NP	**0.3**		**BM**	**2**		**BM**	**0.1**		**BM**	**0.4**		**BM**	**65**		**BM**	**1.7**	**BM**	**5**	**BM**
	7-12 mo.	**0.3**		**NP**	**0.4**		**B/F**	**4**		**B/F**	**0.3**		**B/F**	**0.5**		**B/F**	**80**		**B/F**	**2.2**	**B/F**	**6**	**B/F**
		EAR	***RDI***	***UIL***	***EAR***	***RDI***	***UIL***	***EAR***	***RDI***	***UIL***	***EAR***	***RDI***	***UIL***	***EAR***	***RDI***	***UIL***	***EAR***	***RDI***	***UIL***	***AI***	***UIL***	***AI***	***UIL***
Children	**1-3 yrs**	0.4	0.5	NP	0.4	0.5	NP	5	6	10	0.4	0.5	30	0.7	0.9	NP	120	150	300	3.5	NP	8	NP
	4-8 yrs	0.5	0.6	NP	0.5	0.6	NP	6	8	15	0.5	0.6	40	1.0	1.2	NP	160	200	400	4	NP	12	NP
Boys	**9-13 yrs**	0.7	0.9	NP	0.8	0.9	NP	9	12	20	0.8	1.0	60	1.5	1.8	NP	250	300	600	5	NP	20	NP
	14-18 yrs	1.0	1.2	NP	1.1	1.3	NP	12	16	30	1.1	1.3	80	2.0	2.4	NP	330	400	800	6	NP	30	NP
Girls	**9-13 yrs**	0.7	0.9	NP	0.8	0.9	NP	9	12	20	0.8	1.0	60	1.5	1.8	NP	250	300	600	4	NP	20	NP
	14-18 yrs	0.9	1.0	NP	0.9	1.0	NP	11	14	30	1.0	1.2	80	2.0	2.4	NP	330	400	800	4	NP	25	NP
Men	**19-30 yrs**	1.0	1.2	NP	1.1	1.3	NP	12	16	35	1.1	1.3	100	2.0	2.4	NP	320	400	1000	6	NP	30	NP
	31-50 yrs	1.0	1.2	NP	1.1	1.3	NP	12	16	35	1.1	1.3	100	2.0	2.4	NP	320	400	1000	6	NP	30	NP
	51-70 yrs	1.0	1.2	NP	1.1	1.3	NP	12	16	35	1.4	1.7	100	2.0	2.4	NP	320	400	1000	6	NP	30	NP
	>70 yrs	1.0	1.2	NP	1.3	1.6	NP	12	16	35	1.4	1.7	100	2.0	2.4	NP	320	400	1000	6	NP	30	NP
Women	**19-30 yrs**	0.9	1.1	NP	0.9	1.1	NP	11	14	35	1.1	1.3	100	2.0	2.4	NP	320	400	1000	4	NP	25	NP
	31-50 yrs	0.9	1.1	NP	0.9	1.1	NP	11	14	35	1.1	1.3	100	2.0	2.4	NP	320	400	1000	4	NP	25	NP
	51-70 yrs	0.9	1.1	NP	0.9	1.1	NP	11	14	35	1.3	1.5	100	2.0	2.4	NP	320	400	1000	4	NP	25	NP
	>70 yrs	0.9	1.1	NP	1.1	1.3	NP	11	14	35	1.3	1.5	100	2.0	2.4	NP	320	400	1000	4	NP	25	NP
Pregnant	**14-18 yrs**	1.2	1.4	NP	1.2	1.4	NP	14	18	30	1.6	1.9	80	2.2	2.6	NP	520	600	800	5	NP	30	NP
	19-30 yrs	1.2	1.4	NP	1.2	1.4	NP	14	18	35	1.6	1.9	100	2.2	2.6	NP	520	600	1000	5	NP	30	NP
	31-50 yrs	1.2	1.4	NP	1.2	1.4	NP	14	18	35	1.6	1.9	100	2.2	2.6	NP	520	600	1000	5	NP	30	NP
Lactating	**14-18 yrs**	1.2	1.4	NP	1.3	1.6	NP	13	17	30	1.7	2.0	80	2.4	2.8	NP	450	500	800	6	NP	35	NP
	19-30 yrs	1.2	1.4	NP	1.3	1.6	NP	13	17	35	1.7	2.0	100	2.4	2.8	NP	450	500	1000	6	NP	35	NP
	31-50 yrs	1.2	1.4	NP	1.3	1.6	NP	13	17	35	1.7	2.0	100	2.4	2.8	NP	450	500	1000	6	NP	35	NP

EAR Estimated Average Requirement; RDI Recommended Dietary Intake; AI Adequate Intake; UIL Upper Intake Limit

**UIL for niacin is for nicotinic acid. For supplemental nicotinamide UIL is 1000mg/day for men and 850mg a day for non-pregnant, women. There is insufficient data to set upper limits for nicotinamide in pregnancy and lactation, or for children and adolescents. ** All infant AIs are based on estimates based on breast milk concentrations in healthy women and average volumes; # forVit B6 UIL set for pyridoxine; for folate UIL is for intake from fortified foods and supplements as dietary folate equivalents. BM = amount normally received from breast milk of healthy women: B/F amount in breast milk and food: NP = Not Possible to set (may be insufficient evidence or no clear level for adverse effects).*

Table 6. Nutrient Reference Values for Australia and New Zealand: Vitamins A, C, D. E and K and Choline

Age group/gender		**Vitamin A (retinol equivalents) µg/day**			**Vitamin C mg/day**			**Vitamin D µg/day**		**Vitamin E (α-tocopherol equivalents #) mg/day**		**Vitamin K µg/day**		**Choline mg/day**	
		AI		**UIL**	**AI**		**UIL***	**AI**	**UIL**	**AI**	**UIL**	**AI**	**UIL**	**AI**	**UIL**
Infants	**0-6 mo.**	250 (as retinol)		600	25		BM	5	BM	4	BM	2	BM	125	BM
	7-12 mo.	430		600	30		B/F	5	B/F	5	B/F	2.5	B/F	150	B/F
		EAR	**RDI**	**UIL**	**EAR**	**RDI**	**UIL**	**AI**	**UIL**	**AI**	**UIL**	**AI**	**UIL**	**AI**	**UIL**
Children	**1-3 yrs**	210	300	600	25	35	NP	5	NP	5	70	25	NP	200	1000
	4-8 yrs	275	400	900	25	35	NP	5	NP	6	100	35	NP	250	1000
Boys	**9-13 yrs**	445	600	1700	28	40	NP	5	NP	9	180	45	NP	375	1000
	14-18 yrs	630	900	2800	28	40	NP	5	NP	10	250	55	NP	550	3000
Girls	**9-13 yrs**	420	600	1700	28	40	NP	5	NP	8	180	45	NP	375	1000
	14-18 yrs	485	700	2800	28	40	NP	5	NP	8	250	55	NP	400	3000
Men	**19-30 yrs**	625	900	3000	30	45	NP	5	NP	10	300	70	NP	550	3500
	31-50 yrs	625	900	3000	30	45	NP	5	NP	10	300	70	NP	550	3500
	51-70 yrs	625	900	3000	30	45	NP	10	NP	10	300	70	NP	550	3500
	>70 yrs	625	900	3000	30	45	NP	15	NP	10	300	70	NP	550	3500
Women	**19-30 yrs**	500	700	3000	30	45	NP	5	NP	7	300	60	NP	475	3500
	31-50 yrs	500	700	3000	30	45	NP	5	NP	7	300	60	NP	475	3500
	51-70 yrs	500	700	3000	30	45	NP	10	NP	7	300	60	NP	475	3500
	>70 yrs	500	700	3000	30	45	NP	15	NP	7	300	60	NP	475	3500
Pregnant	**14-18 yrs**	530	700	2800	38	55	NP	5	NP	7	300	60	NP	420	3000
	19-30 yrs	550	800	3000	40	60	NP	5	NP	7	300	60	NP	450	3500
	31-50 yrs	550	800	3000	40	60	NP	5	NP	7	300	60	NP	450	3500
	14-18 yrs	780	1100	2800	58	80	NP	5	NP	12	300	60	NP	525	3000
Lactating	**19-30 yrs**	800	1110	3000	60	85	NP	5	NP	11	300	60	NP	550	3500
	31-50 yrs	800	1110	3000	60	85	NP	5	NP	11	300	60	NP	550	3500

EAR Estimated Average Requirement; RDI Recommended Dietary Intake; AI Adequate Intake; UIL Upper Intake Limit
** Not possible to establish an UIL for Vitamin C at present but 1000 mg/day would be a prudent limit.*
 # One α-tocopherol equivalent is equal to 1 mg RRR α- (or d-α-) tocopherol; 2mg β-tocopherol; 10mg γ tocopherol and 3mg α-tocotrienol. The relevant figure for synthetic all-rac- α –tocopherols (dl-α-tocopherol) is 14 mg.

Table 7. Nutrient Reference Values for Australia and New Zealand: Minerals (EARs and RDIs)

Age/gender group		Calcium* mg/day			Phosphorus mg/day			Zinc mg/day			Iron mg/day		
		AI		*UIL*	*AI*		*UIL*	*AI*		*UIL*	*AI*		*UIL*
Infants	**0-6 mo.**	210		BM	100		BM	2		4	0.27		20
	7-12 mo.	270		B/F	275		B/F	2.5	3.0	5	6.9	11.0	20
		EAR	*RDI*	*UIL*	*EAR*	*RDI*	*UIL*	*EAR*	*RDI*	*UIL*	*EAR*	*RDI*	*UIL*
Children	**1-3 yrs**	360	500	2500	380	460	3000	2.5	3	7	4.1	9	20
	4-8 yrs	520	700	2500	405	500	3000	3	4	12	4.1	10	40
Boys	**9-13 yrs**	800/ 1050	1000/ 1300	2500	1055	1250	4000	5.2	6	25	5.9	8	40
	14-18 yrs	1050	1300	2500	1055	1250	4000	10.5	13	35	7.7	11	45
Girls	**9-13 yrs**	800/ 1050	1000/ 1300	2500	1055	1250	4000	5.2	6	25	5.7	8	40
	14-18 yrs	1050	1300	2500	1055	1250	4000	5.9	7	35	7.9	15	45
Men	**19-30 yrs**	840	1000	2500	580	1000	4000	11.7	14	40	6	8	45
	31-50 yrs	840	1000	2500	580	1000	4000	11.7	14	40	6	8	45
	51-70 yrs	840	1000	2500	580	1000	4000	11.7	14	40	6	8	45
	>70 yrs	1100	1300	2500	580	1000	3000	11.7	14	40	6	8	45
Women	**19-30 yrs**	840	1000	2500	580	1000	4000	6.5	8	35	8	18	45
	31-50 yrs	840	1000	2500	580	1000	4000	6.5	8	35	8	18	45
	51-70 yrs	1100	1300	2500	580	1000	4000	6.5	8	35	5	8	45
	>70 yrs	1100	1300	2500	580	1000	3000	6.5	8	35	5	8	45
Pregnant	**14-18 yrs**	1050	1300	2500	1055	1250	3500	8.3	10	35	23	27	45
	19-30 yrs	840	1000	2500	580	1000	3500	8.9	11	40	22	27	45
	31-50 yrs	840	1000	2500	580	1000	3500	8.9	11	40	22	27	45
Lactating	**14-18 yrs**	1050	1300	2500	1055	1250	4000	9.1	11	35	7	10	45
	19-30 yrs	840	1000	2500	580	1000	4000	9.7	12	40	6.5	9	45
	31-50 yrs	840	1000	2500	580	1000	4000	9.7	12	40	6.5	9	45

EAR Estimated Average Requirement; RDI Recommended Dietary Intake; AI Adequate Intake; UIL Upper Intake Limit
** For calcium, because of growth needs, there are separate recommendations for children aged 9-11 years and 12-13 yrs*
For zinc and iron there are EARs and RDIs for older infants

Table 8. Nutrient Reference Values for Australia and New Zealand: Minerals (EARs and RDIs contd)

Age/gender group		**Magnesium mg/day**			**Iodine µg/day**			**Selenium µg/day**			**Molybdenum µg/day**		
		AI		***UIL#***	***AI***		***UIL***	***AI***		***UIL***	***AI***		***UIL***
Infants	**0-6 mo.**	30		BM	90		BM	12		45	2		BM
	7-12 mo.	75		B/F	110		B/F	15		60	3		B/F
		EAR	***RDI***	***UIL***	***EAR***	***RDI***	***UIL***	***EAR***	***RDI***	***UIL***	***EAR***	***RDI***	***UIL***
Children	**1-3 yrs**	65	80	65	65	90	200	20	25	90	13	17	300
	4-8 yrs	110	130	110	65	90	300	25	30	150	17	22	600
Boys	**9-13 yrs**	200	240	350	73	120	600	40	50	280	26	34	1100
	14-18 yrs	340	410	350	95	150	900	55	65	400	33	43	1700
Girls	**9-13 yrs**	200	240	350	73	120	600	40	50	280	26	34	1100
	14-18 yrs	300	360	350	95	150	900	55	65	400	33	43	1700
Men	**19-30 yrs**	330	400	350	100	150	1100	55	65	400	34	45	2000
	31-50 yrs	350	420	350	100	150	1100	55	65	400	34	45	2000
	51-70 yrs	350	420	350	100	150	1100	55	65	400	34	45	2000
	>70 yrs	350	420	350	100	150	1100	55	65	400	34	45	2000
Women	**19-30 yrs**	255	310	350	100	150	1100	45	55	400	34	45	2000
	31-50 yrs	265	320	350	100	150	1100	45	55	400	34	45	2000
	51-70 yrs	265	320	350	100	150	1100	45	55	400	34	45	2000
	>70 yrs	265	320	350	100	150	1100	45	55	400	34	45	2000
Pregnant	**14-18 yrs**	335	400	350	160	220	900	47	57	400	40	50	1700
	19-30 yrs	290	350	350	160	220	1100	47	57	400	40	50	2000
	31-50 yrs	300	360	350	160	220	1110	47	57	400	40	50	2000
Lactating	**14-18 yrs**	300	360	350	190	270	900	55	65	400	35	50	1700
	19-30 yrs	255	310	350	190	270	1100	55	65	400	36	50	2000
	31-50 yrs	265	320	350	190	270	1100	55	65	400	36	50	2000

EAR Estimated Average Requirement; RDI Recommended Dietary Intake; AI Adequate Intake; UIL Upper Intake Limit # UIL magnesium is for supplemental magnesium

Table 9. Nutrient Reference Values for Australia and New Zealand: Minerals (Adequate Intakes)

Age/gender group		Copper mg/day		Chromium µg/day		Manganese mg/day		Fluoride mg/day		Sodium mg/day *		Potassium mg/day	
		AI	UIL	AI	UIL	AI	UIL	AI	UIL	AI	UIL	AI	UIL#
Infants	**0-6 mo.**	0.20	BM	0.2	NP	0.003	BM	0.01	0.7	120	700	400	NP
	7-12 mo.	0.22	B/F	5.5	NP	0.6	B/F	0.5	0.9	170	1000	700	NP
Children	**1-3 yrs**	0.7	1	11	NP	2.0	2	0.7	1.3	200-400	1400	3000	NP
	4-8 yrs	1.0	3	15	NP	2.5	3	1	2.2	300-600	1600	3700	NP
Boys	**9-13 yrs**	1.3	5	25	NP	3.0	6	2	10	400-800	1400	4400	NP
	14-18 yrs	1.5	8	35	NP	3.5	9	3	10	460-920	1600	4700	NP
Girls	**9-13 yrs**	1.1	5	21	NP	2.5	6	2	10	400-800	1600	4400	NP
	14-18 yrs	1.1	8	24	NP	3.0	9	3	10	460-920	1600	4700	NP
Men	**19-30 yrs**	1.7	10	35	NP	5.5	11	4	10	460-920	1600	4700	NP
	31-50 yrs	1.7	10	35	NP	5.5	11	4	10	460-920	1600	4700	NP
	51-70 yrs	1.7	1	35	NP	5.5	11	4	10	460-920	1600	4700	NP
	>70 yrs	1.7	10	35	NP	5.5	11	4	10	460-920	1600	4700	NP
Women	**19-30 yrs**	1.2	10	25	NP	5.0	11	3	10	460-920	1600	4700	NP
	31-50 yrs	1.2	10	25	NP	5.0	11	3	10	460-920	1600	4700	NP
	51-70 yrs	1.2	10	25	NP	5.0	11	3	10	460-920	1600	4700	NP
	>70 yrs	1.2	10	25	NP	5.0	11	3	10	460-920	1600	4700	NP
Pregnant	**14-18 yrs**	1.2	8	30	NP	5.0	9	3	10	460-920	1600	4700	NP
	19-30 yrs	1.3	10	30	NP	5.0	11	3	10	460-920	1600	4700	NP
	31-50 yrs	1.3	10	30	NP	5.0	11	3	10	460-920	1600	4700	NP
	14-18 yrs	1.4	8	45	NP	5.0	9	3	10	460-920	1600	4700	NP
Lactating	**19-30 yrs**	1.5	10	45	NP	5.0	11	3	10	460-920	1600	4700	NP
	31-50 yrs	1.5	10	45	NP	5.0	11	3	10	460-920	1600	4700	NP

EAR Estimated Average Requirement; RDI Recommended Dietary Intake; AI Adequate Intake; UIL Upper Intake Limit

 # for potassium, supplements should be taken only under medical supervision

** 460 –920 mg/day for sodium is equivalent to 20-40 mmol/day; 1600mg/day sodium is equivalent to 70mmol/day*

*** 4700mg/day of potassium is equivalent to 120 mmol/day*

OPTIMISING DIETS FOR LOWERING CHRONIC DISEASE RISK

Although Nutrient Reference Values are determined on the basis of needs for sustenance and avoidance of deficiency disease, it is obviously most beneficial if nutrient intakes are also compatible with intakes that may reduce chronic disease risk.

Optimising of the diet for chronic disease risk involves, a consideration of the balance, and types of macronutrients (protein, fats, carbohydrates) in the context of energy balance and consideration of the role of higher than RDI intakes of certain micronutrients

Whilst there is an extensive and growing data base related to diet and chronic disease risk in humans, the population methodologies generally employed have a number of limitations when trying to identify a specific level of intake that is optimal for reduced chronic disease risk.

THE BALANCE OF MACRONUTRIENTS AND CHRONIC DISEASE RISK

The macronutrients (proteins, fats and carbohydrates), unlike the micronutrients, all contribute to dietary energy intake. Alcohol can also contribute to dietary energy. The effect of alcohol on health outcomes has been reviewed elsewhere and will not be revisited here except to say that recommendations for alcohol intake are for intakes to be below about 5% of dietary energy (NHMRC 1999, 2003). For a given energy intake, increases in the proportion of one macronutrient necessarily involves a decrease in the proportion of one, or more, of the other macronutrients. Thus, for example, a high fat diet is usually relatively low in carbohydrate and vice versa and a high protein diet is relatively low in carbohydrate and/or fat.

There is a growing body of evidence that a major imbalance in the relative proportions of macronutrients, can increase risk of chronic disease and may adversely affect micronutrient intake. However, the form of fat (eg saturated, polyunsaturated or monounsaturated or specific fatty acids) or carbohydrate (eg starches or sugars; high or low glycaemic) is also a major consideration in determining the optimal balance in terms of chronic disease risk. This has not always been given enough consideration in study design or interpretation.

There appears to be quite a wide range of relative intakes of proteins, carbohydrates and fats that are acceptable in terms of chronic disease risk. The risk of chronic disease (as well as the risk of inadequate micronutrient intake) may increase outside these limits but often data in free-living populations are limited at these extremes of intake. The Food and Nutrition Board of the Institute of Medicine in constructing the US:Canadian Dietary Reference Intakes (FNB:IOM, 2002) called this range the *Acceptable Macronutrient Distribution Range* (AMDR). In their document, they extensively reviewed the current evidence, in terms of outcomes such as body weight maintenance, obesity, coronary heart disease and LDL oxidation, stroke, Type 2 diabetes, hyperinsulinaemia and glucose tolerance, metabolic syndrome, cancer osteoporosis, renal failure, renal stones, inflammatory disorders and risk of nutrient inadequacy in adults, as well as some of these outcomes, plus birth weight and growth, in relation to children. Much of the evidence is based on epidemiological studies with clinical endpoints but these studies generally show associations rather than causality and are often confounded by other factors that can affect chronic disease outcome.

Randomised controlled trials, which provide the most conclusive evidence of causality, are often lacking in relationship to optimising macronutrient profile. Because of their interrelatedness, studies of individual macronutrients are also particularly prone to confounding by the other necessary changes to the diet (ie either the energy content changes in the "control" group and/or the proportion of other macronutrients). For example, in assessing the effects of a high carbohydrate diet on a specific endpoint, the test diet, of necessity, must be relatively low in fat and/or protein and/or vary in its energy content. If a benefit or adverse effect is seen, it is not immediately clear what is responsible for the outcome observed.

Given these limitations, an expert review of the evidence base described in the US:Canadian DRI review, together with consideration of papers that have been published since, and dietary modelling to assess the effects of changes in macronutrients on micronutrients, was used to develop "Acceptable Macronutrient Distribution Ranges" for use with adults in Australia and New Zealand. It is important to remember that these recommendations are population recommendations for otherwise healthy people and it is assumed that usual dietary intake will be at a level to maintain current body weight (ie these are not necessarily recommendations for optimal weight loss diets or for treatment or management of existing chronic disease conditions).

Dietary modelling involved two approaches. Firstly, an assessment was undertaken of daily diets reported in the National Nutrition Survey for Australia (ABS,1995) in relation to macronutrient profile, energy intake and Estimated Average Requirements (or a proportion of the AIs) for all nutrients except sodium, fluoride, biotin, selenium, choline, chromium, iodine and molybdenum, for which reliable analytical food data were not available For modelling purposes, Vitamin D was also excluded as much of this can be accessed through the action of sunlight on skin. For those nutrients where an AI was set, a value of 83% AI was used in modelling as this gave a rough equivalence to the relativity between the EAR and RDI (*ie* it is 2CV below the AI assuming a CV of 10%, as used to derive RDIs where the variability in requirements is unknown). The second approach used linear programming to assess whether it was possible to design diets which conformed to the EAR/AIs as outlined above, for varying macronutrient and total energy intake profiles.

Where an RDI or AI has already been set for one of the macronutrients (eg for protein or selected fatty acids), this has generally been used as the bottom end of the AMDR range for that nutrient, unless dietary modelling showed this to be problematical.

Table 10. Summary of nutrient recommendations for macronutrients to reduce chronic disease risk whilst still ensuring adequate micronutrient status

Acceptable Macronutrient Distribution Ranges

Nutrient	Lower end of recommended intake range	Upper end of recommended intake range	Comments
Protein	14% energy	25% energy	On average, only 10% of energy is required to cover physiological needs but this level is insufficient to allow for estimated average requirements for micronutrients when consuming foods commonly eaten in Australia and New Zealand. Intakes in some highly active communities (eg hunter-gatherers arctic, pastoralists)are as high as 30% with no apparent adverse health but no predominantly sedentary, western societies have intakes at this level from which to assess potential adverse outcomes. Thus a prudent upper intake level of 25% of energy has been set.
Total Fat	20% of energy	35% of energy	The lower end of the range is determined by the amount required to sustain body weight and to allow for intakes of estimated average requirements of micronutrients. Some communities, notably some Asian groups do have average fat intakes below this level but they are often smaller in stature and their overall nutrient status is not always known. The upper level was set in relation to risk of obesity and cardiovascular disease, bearing in mid that high fat diets are often high in saturated fat, a known risk factor for heart disease, and are also often energy dense increasing a propensity to over-consumption of energy. Saturated fats should be limited to no more than 10% energy.
Linoleic acid (n-6 fats)	As per relevant age/gender. AI Equates to 4-5% dietary energy	90th centile of population dietary intake: equates to 10% dietary energy	Based on intakes to help optimise chronic disease risk, notably coronary heart disease. There is some animal-based evidence that intakes up to 15% could be acceptable but human evidence is limited. 10% as energy equates to about the 90th centile of current population intakes
α- linolenic acid (n3 fat)	As per relevant age/gender. AI; Equates to 0.4-0.5% dietary energy	90th centile of population intake: equates to 1% dietary energy	Based on intakes to help optimise chronic disease risk, notably coronary heart disease
VLC ω3 fats (DHA:EPA:DPA)	As per relevant age/gender AI Men 190mg/d Women 90mg/d	Men 610mg/d Women 430mg/d	Upper end of range based on 90th percentile of current intakes
Carbohydrate	45% energy (predominantly from low energy density, low glycaemic index food sources)	66% energy (predominantly from low energy density, low glycaemic index food sources)	The upper bound carbohydrate recommendations were set so as to accommodate the essential requirements for fat (20%) and protein (14%). It is of importance to note that the type of carbohydrates consumed are of paramount importance in relation to their health effects.

THE EFFECT OF HIGHER THAN RDI INTAKES OF MICRONUTRIENTS ON CHRONIC DISEAE RISK

With the provisos outlined above about the nature of the evidence in mind, there are some indications in the scientific literature, that a range of nutrients could have benefits in chronic disease etiology at levels above the RDI or AI. This is discussed in detail in the publications of the Food and Nutrition Board: Institute of Medicine as part of the reviews of the US:Canadian Dietary Reference Intakes notably those published in 1998, 2000 and 2002. It is not the purpose of this NRV review to revisit this extensive database of studies, but to acknowledge its existence and its complimentarity to the NRV recommendations, and to summarise key findings from some of these studies and the intervention trials.

The nutrients for which higher than RDI/AI intakes have been linked to benefits for chronic disease risk include the antioxidant vitamins such as vitamin C, vitamin E and vitamin A (primarily its precursor, β-carotene) as well as selenium and nutrients such as folate, omega 3 fats and dietary fibre. These nutrients have been assessed in relation to heart disease and cancer as well as degenerative eye diseases such as cataract formation or macular degeneration, and conditions like Alzheimers or cognitive decline.

The balance and type of macronutrients in the diet have also been studied extensively. The role of the various types of carbohydrates (starches, sugars, high vs low-glycaemic carbohydrates, resistant starch, dietary fibres), fats (saturated, polyunsaturated, monounsaturated) and protein (animal, plant-based) have been variously assessed in relation to risk of conditions such as coronary heart disease, certain cancers, diabetes or insulin sensitivity and risk of obesity.

Table 11. Summary of nutrient recommendations to reduce chronic disease risk whilst still ensuring adequate micronutrient status – micronutrients and dietary fibre

Nutrient	Lower end of recommended dietary intake range from food	Upper end of recommended dietary intake range from food	Comments
Vitamin A	As per relevant age/gender EAR / RDI	90th centile of population intake *Vitamin A* Men 1500 µg/day Women 1220 µg/day *β-carotene* Men 5800 µg/day Women 5000 µg/day.	Equivalent to the 90th centile of intake in the Australian/New Zealand population; to be attained through increasing intakes of foods such as red-yellow vegetables and fruits, dairy foods and oils.
Vitamin C	As per relevant Age/gender EAR/RDI	Men 220g/day Women 190g/day	Equivalent to the 90th centile of intake in the Australian/New Zealand population; to be attained through increasing intakes of foods such as vegetables, legumes, and fruits.
Vitamin E	As per relevant age/gender AI	Men 19mg/day Women 14mg/day	Equivalent to the 90th centile of intake in the Australian/New Zealand population; to be attained through increasing intakes of foods such as poly or monounsaturated fats and oils, some vegetables; meat, poultry and fish, and to lesser degree cereals and dairy foods.
Selenium	As per relevant age/gender EAR/RDI	No specific figure can be set. There is some evidence of potential benefit for certain cancers but adverse effects for others.	There are no available population intake data for Australia and New Zealand is a known low selenium area thus recommendations based on percentiles of population intakes are inappropriate
Dietary Fibre	As per relevant age/gender AI	Men 38g/day Women 28g/day	Upper level at 90th percentile of intake for reduction in coronary heart disease risk. Intake should be from increased consumption of vegetables, fruits and wholegrain cereals which would also increase micronutrient intake.