The following is an extract from:

Nutrient Reference Values for Australia and New Zealand
Including Recommended Dietary Intakes

VERSION 1.2

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Australian Government
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2006 Nutrient Reference Values

These guidelines were endorsed by the Chief Executive Officer (CEO) of the National Health and Medical Research Council (NHMRC) on 9 September 2005, under Section 7(1)(a) of the National Health and Medical Research Council Act 1992. In endorsing these guidelines the NHMRC considers that they meet the NHMRC standard for clinical practice guidelines.

2017 Update: Sodium

Updates to the guideline recommendations for sodium for adults were approved by the Chief Executive Officer of the National Health and Medical Research Council (NHMRC) on 13 July 2017, under Section 14A of the National Health and Medical Research Council Act 1992. In approving these guidelines the NHMRC considers that they meet the NHMRC standard for clinical practice guidelines. Approval of the guideline recommendations will be reviewed for currency after five years.

NHMRC is satisfied that the guideline recommendations are systematically derived, based on the identification and synthesis of the best available scientific evidence, and developed for health professionals practising in an Australian health care setting.

NHMRC publications contact:
Email: nhmrc.publications@nhmrc.gov.au Internet:
http://www.nhmrc.gov.au or www.nrv.gov.au
Phone: (02) 6217 9000

SODIUM (*UPDATED 2017*)

AMENDMENT TYPE	AMENDMENT DETAIL	DATE UPDATED	VERSION NUMBER
Revision of sodium NRVs as follows: • SDT for adults • UL for adults Amendments to the resources across the NRV suite have been made to reflect the latest scientific evidence and recommendations.	NHMRC approved the revised NRV recommendations for sodium on 13 July 2017 under section 14A of the NHMRC act 1992. The supporting material including the Methodological Framework, any literature reviews and evidence summaries are authored by the Australian Government Department of Health (formerly the Department of Health and Ageing) and the New Zealand Ministry of Health. The Executive Summary and full report are available in PDF from the NHMRC Guidelines and Publications Page.	September 2017	1.2

UPDATE 1.1 REVISION OF SODIUM (2017)

The sodium SDT and UL were approved by the Chief Executive Officer of the National Health and Medical Research Council on 13 July 2017, under Section 14A of the National Health and Medical Research Council Act 1992.

The SDT is the daily average intake of a nutrient that may help in the prevention of chronic disease. As indicated by the definition, an SDT is a target for a population average. In this case 'average' refers to the median intake of the population.

The UL is defined as the highest average intake likely to pose no risk in the general population. As intake increases above the UL, the risk of adverse effects increases.

Sodium was identified as a priority for review given the relationship between sodium intake and blood pressure. Hypertension (high blood pressure) is a significant risk factor for cardiovascular disease, a major cause of premature death in the Australian and New Zealand populations. Given these pressing public health concerns, the review focused on the SDT and UL for adults because of their potential to impact public health.

There is convincing evidence that as sodium intake increases, blood pressure increases. Indeed, Australia and New Zealand have pursued public health policy initiatives to reduce intakes of sodium because most people consume excessive amounts. A desirable target for the population (SDT) falls within a diet that meets nutritional requirements whilst reducing current excess sodium intakes. The SDT also takes into account the current food supply.

The 2017 SDT is based on analysis of data indicating that if population sodium intake levels were to reduce from the current average of about 3600mg/day to 2000mg/day, reductions in average population blood pressure could be achieved. It also aligns well with dietary modelling underpinning the Australian Dietary Guidelines to support nutritional adequacy of the whole diet, and with current WHO recommendations. Using the new Methodological Framework for the Review of NRVs, the value of the SDT for sodium was revised from 1600 mg/day to 2000mg/day. The new target of 2000mg/day is more realistic as it represents a total diet that meets all nutritional requirements, given the current food supply.

For the review of the UL, an analysis of data (currently available between 1200 and 3300mg) failed to determine an identifiable point at which the relationship between higher sodium intakes and higher blood pressure did not occur. This means that increased sodium intake was associated with increased blood pressure at all measured levels of intake. Thus, the UL was revised from the 2006 UL of 2,300 mg/day to 'not determined' reflecting the inability to identify a single point below which there is low risk. The position of 'not determined' is also aligned with the current positions of international authorities (IOM, WHO, EFSA). The previous 2006 UL (2300mg/day) was based on early interpretations of very limited data, which have now been surpassed by methodological advances and a much larger amount of data.

The evidence for the sodium-blood pressure relationship continues to support the current public health activities aimed at reducing sodium intake in the population. The SDT provides a target for these activities. Further information can be found in the *Optimising Diets for Lowering Chronic Disease Risk* section of this report.

The supporting material including the 2017 technical report systematic literature review and evidence summaries, statistical analyses and dietary modelling can be found on the NHMRC Guidelines and Publications Page.

The UL for infants and children, and the AI for all ages and pregnancy and lactation were not reviewed and remain as per the 2006 NRVs for Australia and New Zealand. This publication has been revised to incorporate the 2017 SDT and UL for adults.

BACKGROUND

Sodium is a nutrient that is ubiquitous in the food supply and plays an essential role in human physiology. Excess sodium intakes have been associated with increased chronic disease risk, and in particular high blood pressure (NHMRC 2013). A comprehensive overview of the physiological role of sodium in the human body is provided in the Institute of Medicine's Dietary Reference Values document (FNB:IOM 2005). Briefly, sodium is the primary cation in human extracellular fluid. It has an essential role in the maintenance of key physiological activities such as extracellular fluid volume and cellular membrane potential (FNB:IOM 2013). Sodium balance is maintained through a range of physiological systems and hormones such as the renin-angiotensin-aldosterone hormone system, the sympathetic nervous system, atrial natriuretic peptide, the kallikrein-kinin system and other factors that regulate renal and medullary blood flow (NHMRC 2006). In the absence of a situation where excessive sweating may be occurring, urinary sodium excretion in humans is approximately equivalent to intake (FNB:IOM 2005). Thus urinary sodium excretion is often used as a biomarker of intake.

Sodium is largely consumed as sodium chloride, or 'salt'. Sodium may also be found in food additives such as sodium phosphate, sodium bicarbonate and sodium benzoate, however these contribute much less to total sodium intakes than dietary salt. Approximately 90% of the total sodium intake is excreted in the urine, therefore studies utilise the 24hr urinary sodium measure as indication of sodium intake (He et al 2014).

Accurate estimations of dietary sodium intake are of particular importance given the potential negative health effects of excess dietary sodium. The relationship between high sodium intakes and elevated blood pressure has been established both in clinical trial research and large observational studies (Suckling et al 2012; Sacks et al 2001; Elliott et al 1996). Elevated blood pressure is an established risk factor for the development of adverse health outcomes such as stroke (Willmot et al 2004), myocardial infarction (Psaty et al 2001), and chronic kidney disease (Jafar et al 2003). Thus sodium intake is recognised as being of key public health importance. There may also be some value in considering effects of sodium intake on other heart disease risk factors, such as cholesterol levels.

The prevalence of hypertension in the community is well established. In the 2008/09 New Zealand Adult Nutrition Survey, 15% of adults 15 years and older reported taking medication to lower blood pressure, and 31% could be defined as having hypertension (McLean et al 2013)[1]. The 2011-12 Australian Health Survey reported that 21.5% of individuals aged 18 years and older had measured blood pressure greater than 140/90 mmHg. However, this was based only on measurement at the interview and excluded those with normotension who were managing their condition via medication (Dickinson et al 2014).

The 2011-12 Australian Health Survey analysed the proportion of sodium that comes from the diet, excluding salt added by consumers at the table and in food preparation (ABS 2014). For the population aged 2 years and older, cereals and cereal products and cereal based product and dishes contribute 43% of dietary sodium, 8% is contributed by milk products and dishes and 6% from processed meat. Although 1.9% of dietary sodium came from snack foods, including potato crisps, this varied by age from 4.8% among those aged 4-8 years to less than 1% in those aged over 50 years (ABS 2014). Similar figures have also been reported among an assessment

1 Updated data from the 2015/16 New Zealand Health Survey can be found on the New Zealand Ministry of Health website at www.health.govt.nz

of Australian Indigenous children and non-Indigenous children living in rural NSW (n=215), with 19-21% of sodium in the diet from bread, 14-16% from processed meat, 7-9% from take-away foods, 5.5-7.5% from potato crisps (Gwynn et al 2012).

In New Zealand breads, cereals, and processed meats are likely to contribute most to sodium intake from processed food. Several analyses from previous New Zealand based surveys suggest that for all age groups bread made the greatest contribution to sodium intake from processed foods (at approximately 35-43%) (Thomson 2009). Processed meats, sauces, breakfast cereals and baked products are also likely to be important sources of dietary sodium (MoH 2003). Other foods that are likely to contribute significantly to dietary sodium intake in New Zealand include takeaways, dairy products, cereals and pasta, biscuits and cake and meat and meat products (NZFSA 2005).

Since these analyses were undertaken the sodium content of bread has been reduced (Gorton et al 2010), however the effect of this on contribution to sodium intake has not been formally evaluated. Further reductions in the sodium content of discretionary and processed foods will greatly assist in reducing the average sodium intake at a population level.

1 mmol sodium = 23 mg sodium 1 gram of sodium chloride (salt) contains 390 mg (17 mmol) of sodium

RECOMMENDATIONS BY LIFE STAGE AND GENDER

INFANTS

Age		AI
0–6 months	**120 mg/day**	**(5.2 mmol)**
7–12 months	**170 mg/day**	**(7.4 mmol)**

Rationale: The AIs for infants were not reviewed in the 2017 update. The AI for 0-6 months was calculated by multiplying together the average intake of breast milk (0.78 L/day) and the average concentration of sodium of 160 mg/L from the studies of Dewey & Lonnerdal (1983), Gross et al (1980), Keenan et al (1982), Lemons et al (1982), Morriss et al (1986) and Picciano et al (1981). The AI for 7-12 months was extrapolated from that for 0-6 months from a consideration of metabolic body weights and relative energy requirements.

CHILDREN & ADOLESCENTS

Age		AI
All		
1–3 yr	**200–400 mg/day**	**(9–17 mmol)**
4–8 yr	**300–600 mg/day**	**(13–26 mmol)**
9–13 yr	**400–800 mg/day**	**(17–34 mmol)**
14–18 yr	**460–920 mg/day**	**(20–40 mmol)**

Rationale: The AIs for children and adolescents were not reviewed in the 2017 update. There are not enough dose-response data to set an EAR for children and adolescents, so AIs have been set. There is no reason to expect that the sodium requirement of children ages 1 to 18 years would be fundamentally different from that of adults, given that maturation of kidneys is similar in normal children by 12 months of age (Seikaly & Arant 1992). The AIs for children and adolescents were derived from adult AIs based on relative energy intake.

ADULTS

Age		AI	
Men	**460-920 mg/day**		**(20-40 mmol)**
Women	**460-920 mg/day**		**(20-40 mmol)**

Rationale: The AIs for adults were not reviewed in the 2017 update. As there are insufficient data from dose-response trials, an EAR could not be established, and thus a RDI could not be derived. An AI for adults for sodium was set at 460-920 mg/day (20-40 mmol/day) to ensure that basic requirements are met and to allow for adequate intakes of other nutrients. This AI may not apply to highly active individuals, such as endurance athletes or those undertaking highly physical work in hot conditions, who lose large amounts of sweat on a daily basis.

PREGNANCY

Age		AI	
14–18 yr	**460-920 mg/day**		**(20-40 mmol)**
19–30 yr	**460-920 mg/day**		**(20-40 mmol)**
31–50 yr	**460-920 mg/day**		**(20-40 mmol)**

Rationale: The AIs for pregnancy were not reviewed in the 2017 update. During pregnancy there is a small increase in extracellular fluid, but as the AI for women was set generously, there should be no additional requirement in pregnancy.

LACTATION

Age		AI	
14–18 yr	**460-920 mg/day**		**(20-40 mmol)**
19–30 yr	**460-920 mg/day**		**(20-40 mmol)**
31–50 yr	**460-920 mg/day**		**(20-40 mmol)**

Rationale: The AIs for lactation were not reviewed in the 2017 update. In lactation, there is a small increase in maternal extracellular fluids and some sodium is excreted in breast milk. However, these additional requirements are well within the additional margin added to the adult AI so there are no additional requirements.

SUGGESTED DIETARY TARGET

ADULTS*

Age	SDT	
Men 18+ years	**2,000 mg/day**	**(86 mmol)**
Women 18+ years	**2,000 mg/day**	**(86 mmol)**

*The sodium SDTs for adults 18+ years were updated in 2017.

Rationale: The purpose of the SDT for sodium is to assist in the prevention of chronic disease risk at a population level, in this case by addressing the relationship between sodium intake and high blood pressure.

The meta-analysis informing the 2017 NRV review showed a reduction of 2 mm Hg in systolic blood pressure (when corrected to the Australia and New Zealand population) when mean sodium excretion was lowered from about 3500 mg/day to 2100 mg/day. This would lead to an SDT of an intake that is equivalent to an excretion of 2100 mg/day.

The recommended SDT in this report was rounded to 2000 mg/day to reflect the lack of precision in the change in the dose relationship at exactly 2100 mg. The 2000 mg value is also consistent with international recommendations including the 2012 WHO guideline for sodium consumption which recommends less than 2000 mg/day for adults. The SDT of 2000mg/day is realistic as it represents a total diet that meets all nutritional requirements, given the current food supply. The current average sodium intake of the Australia and New Zealand population is about 3600mg/day (almost double the SDT). Evidence shows that reducing the average sodium intake at a population level would also support a reduction in blood pressure when averaged across the population. Further information can be found in the *Optimising Diets for Lowering Chronic Disease Risk* section of this report.

UPPER LEVEL OF INTAKE

INFANTS, CHILDREN AND ADOLESCENTS

The 2006 ULs for infants, children and adolescents remain in place until reviewed.

Age	UL	
Infants		
0–12 months	**Not possible to establish. Source of intake should be through breast milk, formula and food only.**	
Children and adolescents		
1–3 yr	**1,000 mg/day**	**(43 mmol)**
4–8 yr	**1,400 mg/day**	**(60 mmol)**
9–13 yr	**2,000 mg/day**	**(86 mmol)**
14–18 yr*	**2,300 mg/day**	**(100 mmol)**

* Note: the 2006 UL for 14 - 18 years, including for pregnancy and lactation, remains until the UL for infants, children and adolescents are reviewed. The 2017 UL for adults of 'not determined' is for adults 18+ years. It is recognised that currently there is overlap in the UL recommendations for 18 year olds. The UL for 18 year olds should be taken as the 2017 UL for adults as this is more up-to-date.

Rationale: The UL for infants and children were not reviewed in the 2017 update. The rationale in this section applies to the 2006 review of the UL.

The adverse effects of higher levels of sodium intake on blood pressure provide the scientific rationale for setting the 2006 UL. It was also recognised then that because the relationship between sodium intake and blood pressure is progressive and continuous, it is difficult to set a UL precisely.

The 2006 UL was based on a number of considerations. These included population studies available at the time showing low levels of hypertension (less than 2%) and no other observed adverse effects in communities with intakes below the level of 2,300mg/day (100mmol/day). Experimental studies were also considered. The main study cited at the time was the DASH-sodium trial that showed an additional systolic blood pressure reduction of 4.6 mmHg ($p < 0.001$) at intakes of 1,500 mg/day (65 mmol/day) compared to 2,500 mg/day (107 mmol/day) in people on the control diet. In this study, decreasing sodium intake by approximately 920 mg/day (40 mmol/day) caused a greater lowering of blood pressure when the starting sodium intake was at the intermediate level than when it was at a higher intake similar to the Australian/New Zealand average of about 6g/day of salt/ sodium chloride. The 2006 review considered 2,300 mg/day (100 mmol) to represent the No Observed Adverse Effect Level (NOAEL).

A UF of 1 was applied as, by definition, there is no convincing evidence of harm in the general population at levels of intake of 100 mmol or less. The 2006 review found that there were no data to suggest increased susceptibility in pregnancy or lactation, so the UL was set at the same level as for adult women (this rationale has also been applied as an interim position in the 2017 review (see below)).

The 2006 UL for infants could not be established because of insufficient data documenting the adverse effects of chronic over-consumption of sodium in this age group. The 2006 UL for children was extrapolated from the adult 2006 UL on an energy intake basis as numerous observational studies have documented that blood pressure tracks with age from childhood into the adult years (Bao et al 1995, Dekkers et al 2002, Gillman et al 1993, Van Lenthe et al 1994).

ADULTS

The sodium ULs for adults 18+ years were updated in 2017.

Age	**UL**
Adults 18 + yr	
Men	**Not determined**
Women	**Not determined**
Pregnancy	
18 + yr	**Not determined**
Lactation	
18 + yr	**Not determined**

Rationale: The purpose of a UL is to provide information on the level of intake above which the risk of an adverse effect increases. The UL is used in risk assessment, involving actual estimated intakes of population groups.

The 2017 NRV review (with an extensive analysis of a larger amount of data than that available for the 2006 NRV review) found a linear relationship, with no breakpoints, between reduction in sodium intake and reduction in systolic blood pressure across the range of sodium excretion levels tested in the trials. The relationship between dietary sodium and systolic blood pressure was related to the size of the reduction in sodium excretion in each study and this relationship did not vary across the range of 1200-3300 mg/day in the data examined. The 2006 NRV report set the UL for sodium based on two studies (Sacks et al 2001, Macgregor et al 1989), but further studies and developments in methodology have expanded the range of inputs. When the whole body of evidence was examined in the analysis conducted for the 2017 review, it was noted that the attenuating effect at higher intakes observed in the DASH study (Sacks et al 2001) which informed the setting of the UL in 2006 did not exist. Therefore no point in the range of 1200 to 3300 mg/day conforms to the

definition of the UL (as the point above which an adverse effect is identifiable) and so it was not possible to identify the NOAEL across the range of 1200-3300 mg/day.

In this situation where it is accepted that there is an effect, but a NOAEL cannot be determined, a UL cannot be set. The systematic literature review confirmed the presence of strong evidence that decreasing intakes of sodium decreases systolic blood pressure. As part of this review, the quality of evidence assessment (GRADE) was determined as 'high' for both hypertensive and normotensive participants, analysed separately. Thus the analysis showed it was not possible to identify an intake where the change in systolic blood pressure shifts from non-existent to present (or from weaker to stronger). It was therefore not possible to define a UL based on the dose-response relationship between sodium and systolic blood pressure observed.

The 2017 interim position on the UL for lactation and pregnancy is 'not determined' aligning with the recommendation of 'not determined' for adults. This position is based on the 2006 rationale that there was 'no data to suggest increased susceptibility in pregnancy or lactation, so the UL was set at the same level as for adult women'. It is recognised that this is an interim position and requires further analysis in a future review of the sodium NRVs.

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