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

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COPPER

BACKGROUND

Copper is a component of a number of metalloenzymes including diamine oxidase, monoamine oxidase, lysyl oxidase, ferroxidases, cytochrome *c* oxidase, dopamine beta monoxygenase, alpha-amidating monooxygenase and cupro/zinc superoxide dismutase.

Copper is widely distributed in foods with organ meats, seafood, nuts and seeds being major contributors. Wheat bran cereals and whole grain products are also good sources. Nearly two thirds of the body's copper is found in the skeleton and muscles but the liver is also important in maintaining plasma levels (Olivares & Uauy 1996, Turnlund et al 1998).

Copper is absorbed mainly in the small intestine although some absorption may also occur in the stomach. Absorption varies with copper intake, ranging from more than 50% at intakes below 1 mg/day to less than 20% for intakes above 5 mg/day (Turnlund 1998). The composition of the diet itself has little effect on bioavailability. However, very high levels of zinc or iron, generally taken as supplements, can affect absorption in adults and infants (Botash et al 1992, Lonnerdal & Hernell 1994, Morais et al 1994 Turnlund 1999). Excretion through bile is used to regulate copper balance. Urinary copper excretion is normally very low over a wide range of intakes.

Copper deficiency results in defects in connective tissue that lead to vascular and skeletal problems, and anaemia related to defective iron metabolism. It can also affect the central nervous system (Harris 1997, Turnlund 1999) and the immune and cardiovascular systems, notably in infants (Graham & Cordano 1969, Olivares & Uauy 1996, Turnlund, 1999). Frank copper deficiency is rare in humans but has been seen in certain circumstances in infants (Shaw 1992) and under conditions of total parenteral nutrition (Fujita et al 1989). Symptoms include normocytic, hyperchromic anaemia, leukopenia and neutropenia. Other studies have observed osteoporosis in copper-deficient infants and young children (Higuchi et al 1988) and heart beat irregularities (Milne 1998).

There is no single indicator for the assessment of requirements for copper in humans (FNB:IOM 2001). Serum copper, ceruloplasmin concentration, erythrocyte superoxide dismutase activity, platelet copper, cytochrome *c* oxidase activity, urinary copper, leucocyte copper concentration, lysyl oxidase activity, peptidyl glycine alpha-amidating mono-oxygenase activity, diamine oxidase activity, copper balance and factorial analysis have all been used, but they generally give inconsistent results.

1 mmol copper = 63.5 mg copper

RECOMMENDATIONS BY LIFE STAGE AND GENDER

Infants	**AI**	**Copper**
0–6 months	**0.20 mg/day**	
7–12 months	**0.22 mg/day**	

***Rationale*:** The AI for 0–6 months was calculated by multiplying the average intake of breast milk (0.78 L/day) by the average concentration of copper in breast milk, and rounding. The figure used for breast milk was 0.25 mg/L based on the studies of Biego et al (1998), Raiten et al (1998) and Rossipal & Krachler (1998) as outlined in the relevant FNB:IOM document (FNB:IOM 2001). The AI for 7–12 months was set by adding the average intake from human milk to a component for complementary foods. There are no data for copper intake of weaning foods in Australia or New Zealand. Data from the US NHANES survey (FNB:IOM 2001) showed that the median copper intake from weaning foods for children 7–12 months was 0.1 mg/day. At 7-12 months, human milk concentration is 0.20 mg/L or less, such that with a milk volume of 0.6 L, intake from milk is 0.12 mg/day. Thus, total intake is 0.22 mg/day.

Children & adolescents	AI	Copper
All		
1–3 yr	**0.7 mg/day**	
4–8 yr	**1.0 mg/day**	
Boys		
9–13 yr	**1.3 mg/day**	
14–18 yr	**1.5 mg/day**	
Girls		
9–13 yr	**1.1 mg/day**	
14–18 yr	**1.1 mg/day**	

***Rationale*:** As there are no data to set EARs, AIs for children were set using the median intakes from reanalyses using appropriate age-bands of the National Nutrition Surveys of Australia (ABS 1998) and New Zealand (MOH 1999, 2003) weighted on a population basis.

Adults	AI	Copper
Men		
19–30 yr	**1.7 mg/day**	
31–50 yr	**1.7 mg/day**	
51–70 yr	**1.7 mg/day**	
>70 yr	**1.7 mg/day**	
Women		
19–30 yr	**1.2 mg/day**	
31–50 yr	**1.2 mg/day**	
51–70 yr	**1.2 mg/day**	
>70 yr	**1.2 mg/day**	

***Rationale*:** It was felt that the small data sets – one in young men, one in men of mixed age and one in postmenopausal women – were insufficient to allow the setting of an EAR and an RDI. An AI was set based on median population intakes from the Australian (ABS 1998) and New Zealand (MOH 1999) National Dietary Surveys weighted on a population basis. As dietary data can underestimate intakes, the highest intake of the adult age groups for the men and women was used to set a figure for all adult males or females.

Pregnancy	AI	Copper
14–18 yr	**1.2 mg/day**	
19–30 yr	**1.3 mg/day**	
31–50 yr	**1.3 mg/day**	

***Rationale*:** There are no data on the needs for copper in pregnancy. Therefore an AI was derived based on the amounts of copper that must be accumulated during pregnancy to account for the fetus and products of pregnancy. Over the course of pregnancy, the additional requirement is about 0.067 mg absorbed copper/day (Widdowson & Dickerson, 1964) or 0.10 mg dietary copper/day. From the available data, it is not possible to assume that absorption efficiency increases in pregnancy to account for this; so 0.10 mg/day was added to the AI for non-pregnant, adolescent girls and women.

Lactation	AI	Copper
14–18 yr	**1.4 mg/day**	
19–30 yr	**1.5 mg/day**	
31–50 yr	**1.5 mg/day**	

***Rationale*:** There are no data to set an EAR for lactating women. The AI was set on the basis of the amount of copper required to replace copper secreted daily in human milk, equivalent to additional absorbed copper of 0.20 mg/day. At the level of the AI, copper bioavailability is about 65–75%, so an additional 0.30 mg/day copper needs to be consumed.

UPPER LEVEL OF INTAKE - COPPER

Infants	
0–12 months	**Not possible to establish. Source of intake should be milk, formula and food only**
Children and adolescents	
1–3 yr	**1 mg/day**
4–8 yr	**3 mg/day**
9–13 yr	**5 mg/day**
14–18 yr	**8 mg/day**
Adults+ 19 yr	
Men	**10 mg/day**
Women	**10 mg/day**
Pregnancy	
14–18 yr	**8 mg/day**
19–50 yr	**10 mg/day**
Lactation	
14–18 yr	**8 mg/day**
19–50 yr	**10 mg/day**

***Rationale*:** Human data relating to liver effects were used as the indicator outcome as described in FNB:IOM (2001). A NOAEL of 10 mg/day was identified from the work of Pratt et al (1985) who undertook a 12-week, double blind study in seven adults. Liver function tests were normal. A UF of 1 was applied, as there is no evidence from large international databases to indicate adverse effects at 10–12 mg copper/day in foods and because of the rarity of observed liver damage from copper exposure in humans with normal copper homeostasis. Thus, a UL of 10 mg/day from food and supplements was set for adults.

Given the lack of information, the ULs for children and adolescent were extrapolated from the adult figure on the basis of relative body weight, and rounded down. As there are no data about toxicity in pregnancy and lactation, the ULs for adolescent girls and adult women were also applied to the equivalent pregnant and lactating adolescent girls and women.

These ULs do not apply to individuals with Wilson's disease, Indian Childhood Cirrhosis or Idiopathic Copper Toxicosis.

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