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

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MOLYBDENUM

BACKGROUND

Molybdenum acts as a cofactor for the enzymes sulphite oxidase, xanthine oxidase and aldehyde oxidase. These enzymes are involved in catabolism of sulphur amino acids and heterocyclic compounds including purines and pyridines. No clear deficiency syndrome has been seen in animals even with major reductions in molybdoenzymes. Molybdenum is absorbed very efficiently over a wide range of intakes by passive transport and urinary excretion reflects intake (Turnlund et al 1995a,b).

Molybdenum is found in plant foods and reflects the soil content in which they grow. Legumes are major contributors of molybdenum in the western diet, as are grain products and nuts (Pennington & Jones 1987, Tsongas et al 1980). Animal foods, fruits and vegetables are low in molybdenum. Little is known about bioavailability from various foods. There are no data for Australia or New Zealand either for dietary or supplemental intake. One US study reports dietary intakes from 120–240 µg/day, averaging 180 µg/day (Tsongas et al 1980). The US Total Diet study showed dietary intakes of 76 µg/day for women and 109 µg/day men (Pennington & Jones 1987).

Deficiency has not been seen in otherwise healthy people. Evidence of essentiality relates to a specific genetic defect that prevents the synthesis of sulphite oxidase and can lead to severe neurological damage and to the demonstration of amino acid intolerance in a long-term parenterally fed patient where molybdenum was omitted from the feed (Abrumrad et al 1981, Johnson 1993). There is some limited and inconclusive epidemiological data that low intakes may be associated with increased incidence of oesophageal cancer (WHO 1996).

Plasma, serum or urinary concentrations of molybdenum or indicators can be used to assess requirements, as plasma levels are generally low and difficult to measure, and urinary measures alone do not reflect status. Molybdenum balance studies are therefore used to establish homeostasis and changes in body stores. Two such studies have been done in men (Turnlund et al 1995a,b), and one in pre-adolescent girls (Engel et al 1967).

1 mmol molybdenum = 96 mg molybdenum

RECOMMENDATIONS BY LIFE STAGE AND GENDER

Infants	**AI**	**Molybdenum**
0–6 months	**2 µg/day (0.3µg/kg/day)**	
7–12 months	**3 µg/day (0.3µg/kg/day)**	

***Rationale*:** The AI for infants 0–6 months was based on the average volume of breast milk (0.78 L/day) and the average concentration of molybdenum in breast milk of 2 µg/L (Anderson 1992, Aqulio et al 1996, Biego et al 1998, Bougle et al 1988, FNB:IOM 2001, Krachler et al 1998, Rossipal & Krachler 1998). The AI for older infants was extrapolated using a body weight ratio from the AI for younger infants. Cow's milk contains more molybdenum (50 µg/L) than human milk, as does soy milk, but there are no data on bioavailability in cow's milk or infant formula.

Children & adolescents	EAR	RDI	Molybdenum
All			
1–3 yr	**13 µg/day**	**17 µg/day**	
4–8 yr	**17 µg/day**	**22 µg/day**	
Boys			
9–13 yr	**26 µg/day**	**34 µg/day**	
14–18 yr	**33 µg/day**	**43 µg/day**	
Girls			
9–13 yr	**26 µg/day**	**34 µg/day**	
14–18 yr	**33 µg/day**	**43 µg/day**	

***Rationale*:** There are no specific age-related data on which to base EARs for children and adolescents. The EARs are extrapolated from adult EARs on a metabolic body weight basis allowing for growth needs (FNB:IOM 2001). For this and all other age and gender groups, RDIs were set as the EAR plus twice the CVs, which were set at 15%.

Adults	EAR	RDI	Molybdenum
Men			
19–50 yr	**34 µg/day**	**45 µg/day**	
51–70 yr	**34 µg/day**	**45 µg/day**	
>70 yr	**34 µg/day**	**45 µg/day**	
Women			
19–50 yr	**34 µg/day**	**45 µg/day**	
51–70 yr	**34 µg/day**	**45 µg/day**	
>70 yr	**34 µg/day**	**45 µg/day**	

***Rationale*:** The adult EAR is based on the results of controlled balance studies in young men (Turnlund et al 1995a,b, FNB:IOM 2001) using an average bioavailability of 75%. As there are no data for older men and women, the same EAR was set for these groups. As the number of available studies was limited and subject numbers were low, RDIs were derived assuming a CV of 15% for the EAR.

Pregnancy	EAR	RDI	Molybdenum
14–18 yr	**40 µg/day**	**50 µg/day**	
19–30 yr	**40 µg/day**	**50 µg/day**	
31–50 yr	**40 µg/day**	**50 µg/day**	

***Rationale*:** There are no direct data for needs in pregnancy. The EAR was determined by extrapolating from the requirements for adolescent and adult women on a body weight basis, assuming an average additional 16 kg weight. The RDI was set using a CV of 15% for the EAR and rounding to the nearest 10 µg.

Lactation	EAR	RDI	Molybdenum
14–18 yr	**35 µg/day**	**50 µg/day**	
19–30 yr	**36 µg/day**	**50 µg/day**	
31–50 yr	**36 µg/day**	**50 µg/day**	

***Rationale*:** The EARs were based on that of the non-pregnant, non-lactating women plus the molybdenum intake required to replace molybdenum secreted in human milk. The RDI was set using a CV of 15% for the EAR and rounding to the nearest 10 µg.

UPPER LEVEL OF INTAKE - MOLYBDENUM

Infants	
0–12 months	**Not possible to estimate**
Children and adolescents	
1–3 yr	**300 µg/day**
4–8 yr	**600 µg/day**
9–13 yr	**1,100 µg/day**
14–18 yr	**1,700 µg/day**
Adults 19+ yr	
Men	**2,000 µg/day**
Women	**2,000 µg/day**
Pregnancy	
14–18 yr	**1,700 µg/day**
19–50 yr	**2,000 µg/day**
Lactation	
14–18 yr	**1,700 µg/day**
19–50 yr	**2,000 µg/day**

***Rationale*:** Toxic effects seen in animals have included decreased haemoglobin concentration, depression of growth, mild renal failure, diuresis and proteinuria, histological changes in kidney and liver and body weight loss. Other effects included impaired copper utilisation, prolonged oestrus cycle, failure to breed, decreased gestational weight gain, deaths in litters and adverse effects on embryogenesis (FNB:IOM 2001).

There are limited toxicity data in humans. The relevance to the general population of data on the effects of tetrathiomolybdate treatment on copper metabolism in subjects with Wilson's disease, a condition in which copper accumulates in the body (Brewer 2003, Goodman et al 2004), is unclear. The limited toxicity data may relate in part to the rapid excretion of molybdenum in urine, particularly at higher intake levels. One study of supplemental intakes up to 1.5 mg/day in humans showed no adverse effects on copper utilisation (Turnlund & Keyes 2000). There are limited and inconclusive data to suggest that high molybdenum intakes may be associated with increased dental caries.

Because of the limited human data, ULs were set on the basis of the most sensitive indicator in animals – the effect of molybdenum on reproduction and fetal development in rats and mice. These studies indicated a NOAEL of 0.9 mg/kg/day (Fungwe et al 1990). A UF of 30 was applied for extrapolation from animal to human data and for intraspecies differences to give a UL of 30 µg/kg/day for humans.

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