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

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VITAMIN B₆

BACKGROUND

Vitamin B₆ comprises six compounds – pyridoxal, pyridoxine, pyridoxamine and their respective 5' phosphates (see table below). It acts as a coenzyme in the metabolism of amino acids, glycogen and sphingoid bases. The most common form in human tissue is the 5'-phosphate form of pyridoxal (PLP) most of which is found in muscle bound to phosphorylase. The second most common is the 5'-phosphate form of pyridoxamine (PMP). Plant foods contain primarily pyridoxine (PN) and its 5'-phosphate (PNP), sometimes in the form of a glucoside.

Absorption in the gut involves phosphatase-mediated hydrolysis and transport of the non-phosphorylated form to the mucosal cells. Quite large doses of PLP and PMP are well absorbed (Hamm et al 1979). PN glucoside is less well absorbed. Most of the absorbed non-phosphorylated vitamin B₆ goes to the liver where conversion to the phosphorylated form occurs. The major excretory product is 4-pyridoxic acid that accounts for about half the B₆ compounds in urine (Shultz & Leklem 1981).

FORMS AND EQUIVALENCE OF VITAMIN B₆ COMPOUNDS

	Units of measurement		
Pyridoxine (PN)	1 g = 5.9 mmol	1 mmol = 170 mg	Three naturally inter-convertible forms in the tissues
Pyridoxal (PL)	1 g = 6.0 mmol	1 mmol = 167 mg	
Pyridoxamine (PM)	1 g = 6.0 mmol	1 mmol = 168 mg	
Pyridoxal-5-phosphate (PLP)	1 g = 4.1 mmol	1 mmol = 247 mg	Principal active form
4-Pyridoxic acid (4-PA)	1 g = 5.5 mmol	1 mmol = 183 mg	Principal excretory form
Pyridoxine hydrochloride (PN.HCl)	1 g = 4.9 mmol	1 mmol = 206 mg	Usual form of supplements

Vitamin B₆ is found in a wide range of foods including organ meats, muscle meats, breakfast cereals, vegetables and fruits. Bioavailability is generally in the region of 75% in a mixed diet (Tarr et al 1981). It has been proposed that vitamin B₆ requirements may be increased at higher protein intake (Baker et al 1964, Hansen et al 1996a, Linkswiler 1978), although other studies have not shown this (Pannemans et al 1994). Nevertheless, protein intake is generally taken into consideration in setting requirements for vitamin B₆.

Clinical deficiency is rare. The symptoms of deficiency include seborrhoeic dermatitis (Mueller & Vilter 1950), microcytic anaemia (Snyderman et al 1953), convulsions (Bessey et al 1957, Coursin 1954) and depression and confusion (Hawkins & Barsky 1948).

Indicators used to assess requirements have ranged from measures of vitamin concentrations in plasma, blood cell or urine to functional measures such as erythrocyte aminotransferase saturation by pyridoxal 5'-phosphate or tryptophan metabolites. Most of these indicators change with dietary intake, but there is little information about what level would indicate a deficiency state. A review (Lui et al 1985) suggested that plasma PLP is probably the best single indicator as it reflects tissue stores.

RECOMMENDATIONS BY LIFE STAGE AND GENDER

<i>Infants</i>	AI	Vitamin B₆
0–6 months	0.1 mg/day	
7–12 months	0.3 mg/day	

Rationale: The AI for 0–6 months is calculated by multiplying the average intake of breast milk (0.78 L/day) by the average concentration of vitamin B₆ present in human milk (0.13 mg/L) based on the studies of West & Kirksey (1976). For 7–12 months, the AI was extrapolated from that of the younger infants using a metabolic weight ratio (FNB:IOM 1998).

<i>Children & adolescents</i>	EAR	RDI	Vitamin B₆
All			
1–3 yr	0.4 mg/day	0.5 mg/day	
4–8 yr	0.5 mg/day	0.6 mg/day	
Boys			
9–13 yr	0.8 mg/day	1.0 mg/day	
14–18 yr	1.1 mg/day	1.3 mg/day	
Girls			
9–13 yr	0.8 mg/day	1.0 mg/day	
14–18 yr	1.0 mg/day	1.2 mg/day	

Rationale: As there are few data on children and adolescents, the EARs were set based on the adult EARs adjusted for metabolic body weight and growth (FNB:IOM 1998). In the absence of information on the standard deviation of requirement, the RDI was set assuming a CV of 10% for the EAR.

<i>Adults</i>	EAR	RDI	Vitamin B₆
Men			
19–30 yr	1.1 mg/day	1.3 mg/day	
31–50 yr	1.1 mg/day	1.3 mg/day	
51–70 yr	1.4 mg/day	1.7 mg/day	
>70 yr	1.4 mg/day	1.7 mg/day	
Women			
19–30 yr	1.1 mg/day	1.3 mg/day	
31–50 yr	1.1 mg/day	1.3 mg/day	
51–70 yr	1.3 mg/day	1.5 mg/day	
>70 yr	1.3 mg/day	1.5 mg/day	

Rationale: Clinical deficiency is rarely seen at intakes below 0.5 mg/day, but various depletion-repletion studies suggest an average daily requirement of 1.1 mg/day in younger men for maintenance of tissue stores, although the range of study results was quite wide (Baker et al 1964, FNB:IOM 1998, Linkswiler 1978, Miller & Linkswiler 1967, Miller et al 1985, Selhub et al 1993, Yess et al 1964). For younger women, the average requirement seems to be similar (Brown et al 1975, FNB:IOM 1998, Hansen et al 1996a,b, 1997, Huang et al 1998, Kretsch et al 1995). The EAR appears to be higher for older people (Madigan et al 1998) and men have higher requirements than women. The increase due to age and gender appears to be about 0.2 to 0.3 mg of food vitamin B₆ per day. RDIs for all groups were set assuming a CV of 10% for the EAR.

Pregnancy	EAR	RDI	Vitamin B₆
14–18 yr	1.6 mg/day	1.9 mg/day	
19–30 yr	1.6 mg/day	1.9 mg/day	
31–50 yr	1.6 mg/day	1.9 mg/day	

Rationale: The EAR in pregnancy was based on additional requirements shown by studies of changes in plasma concentrations in pregnancy, fetal sequestration data and supplemental studies (Cleary et al 1975, Hamfelt & Tuvemo 1972, Contractor & Shane 1970, Shane & Contractor 1980, Lumeng et al 1976) that suggested that an additional allowance of 0.5 mg/day was justifiable. Because of the approximation of this figure, the adolescent EAR was set at the same level as that for older women. The RDI was set assuming a CV of 10% for the EAR.

Lactation	EAR	RDI	Vitamin B₆
14–18 yr	1.7 mg/day	2.0 mg/day	
19–30 yr	1.7 mg/day	2.0 mg/day	
31–50 yr	1.7 mg/day	2.0 mg/day	

Rationale: The vitamin B₆ in breast milk varies according to maternal vitamin B₆ levels. The amount of vitamin B₆ required to increase breast milk by a small increment is much higher than that increment. Accordingly, the additional requirement in lactation is higher than that suggested by the amount secreted in milk (Borschel et al 1986, West & Kirksey 1976). To ensure a breast milk vitamin B₆ concentration of 0.13 mg/L, five times that amount must be consumed in addition to the EAR of 1.1 mg for non-lactating women. Because of the approximation of the estimate, the adolescent EAR was set as for older women. The RDI is set assuming a CV of 10% for the EAR.

UPPER LEVEL OF INTAKE - VITAMIN B₆ AS PYRIDOXINE

Infants

0–12 months **Not possible to establish; source of intake should be breast milk, formula or food only**

Children and adolescents

1–3 yr **15 mg/day**
 4–8 yr **20 mg/day**
 9–13 yr **30 mg/day**
 14–18 yr **40 mg/day**

Adults 19+ yr

Men **50 mg/day**
 Women **50 mg/day**

Pregnancy

14–18 yr **40 mg/day**
 19–50 yr **50 mg/day**

Lactation

14–18 yr **40 mg/day**
 19–50 yr **50 mg/day**

Rationale: The ULs were set using results of studies involving long-term oral administration of pyridoxine at doses of less than 1g/day (Berger & Schaumburg 1984, Bernstein & Lobitz 1988, Dalton 1985, Dalton & Dalton 1987, Del Tredici et al 1985, FNB:IOM 1998, Parry & Bredesen 1985). A NOAEL of 200 mg/day was identified from the studies of Bernstein & Lobitz (1988) and Del Tredici et al (1985). These studies involved subjects who had generally been on the supplements for 5 to 6 months or less. The study of Dalton and Dalton (1987), however, suggested that symptoms might take substantially longer than this to appear. In this latter retrospective survey, subjects who reported symptoms had been on supplements for 2.9 years on average. Those reporting no symptoms had taken supplements for 1.9 years. Symptoms disappeared 6 months after cessation of supplements. Given these findings, a UF of 4 was used to derive the UL based on the limitations of the data involving pyridoxine doses of less than 500 mg/day (Berger & Schaumburg 1984, Parry & Bredesen 1985, Dalton 1985, Dalton & Dalton 1987, FNB:IOM 1998) and the limited duration of the studies. The UL for adults was thus set at 50 mg/day. The same figure was set for pregnancy and lactation as there is no evidence of teratogenicity at this level. The UL was set based on metabolic body size and growth considerations for all other ages and life stages except infancy. It was not possible to set a UL for infants, so intake is recommended in the form of food, milk or formula.

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