

Vitamin D

Medical guide



Vitamin D is essential for calcium and phosphate homeostasis and important for optimal bone and muscle function. It is important for the development and maintenance of bone through assisting in the absorption of calcium from the intestine and also acts in the mineralisation of the bone. Vitamin D also contributes to muscle strength and a deficiency can impact on bone health and lead to an increase in falls and fractures in the elderly. Optimal levels of vitamin D are therefore important for general bone health, yet a range of studies have indicated surprising levels of vitamin D insufficiency in the population. Nearly a one-third of adults have vitamin D deficiency and this rate is even higher at the end of winter and in southern parts of Australia.¹

Adequate vitamin D levels

Vitamin D levels are measured in the serum through concentration of the major circulating metabolite 25(OH)D. The level of 25(OH)D recommended for adequate calcium homeostasis and bone and muscle function is at least 50 nmol/L at the end of winter. If you are testing for vitamin D at the end of summer, it is advisable to aim for at least 10-20 nmol/L higher (eg: 60-70 nmol/L) than the level recommended at the end of winter to allow for seasonal variations.

The recommended level of 25(OH)D for infants, children and adolescents for optimal bone health is also > 50 nmol/L.

Sunshine – UV requirements

Vitamin D is produced through the exposure of skin to ultraviolet B (UVB) radiation in sunlight. For most Australians sunshine is the main source of vitamin D. However the amount of sun exposure required will vary based on season, location, area of skin exposed and skin type.

In summer exposure times are limited:

- Time of day: At mid morning or at mid afternoon (just outside peak UV period).
- Fair skin requires only 5-10 minutes most days (depending on location).
- Darker skin requires 15-60 minutes most days (depending on location and dark skin type).

In winter longer exposure times may be needed:

- Time of day: Midday (with caution in the north of Australia).
- Fair skin requires 7-30 minutes most days (depending on location).
- Darker skin requires 20 minutes – 3 hours most days (depending on dark skin type and location).

Summary of sun exposure recommended for bone health

Skin type	Summer	Winter (depends on latitude)
Moderately fair skin		
How long?	5-10 minutes, most days	7-30 minutes (depending on latitude), most days
Body area exposed?	Arms exposed (or equivalent)	Arms exposed (or equivalent)
When?	At mid morning or at mid afternoon (at 10 am or at 2 pm standard time ie: 11 am or 3 pm daylight saving). Avoid peak UV times	Midday
Darker skin*		
How long?	15-60 minutes, most days	20 min – 3 hrs** (depending on latitude), most days
Body area exposed?	Arms exposed (or equivalent)	Arms exposed (or equivalent)
When?	At mid morning or at mid afternoon (at 10 am or at 2 pm standard time ie: 11 am or 3 pm daylight saving). Avoid peak UV times	Midday

Adapted from 'Vitamin D and health in adults in Australia and New Zealand: Position Statement 2012.'

Exposure times are a general guide only, and are based on averages which can vary depending on weather conditions, latitude and individual responses. Relevant only for times of day, seasons and skin type stated, and for exposure of arms or equivalent.

* 3-6 times longer exposure times required.

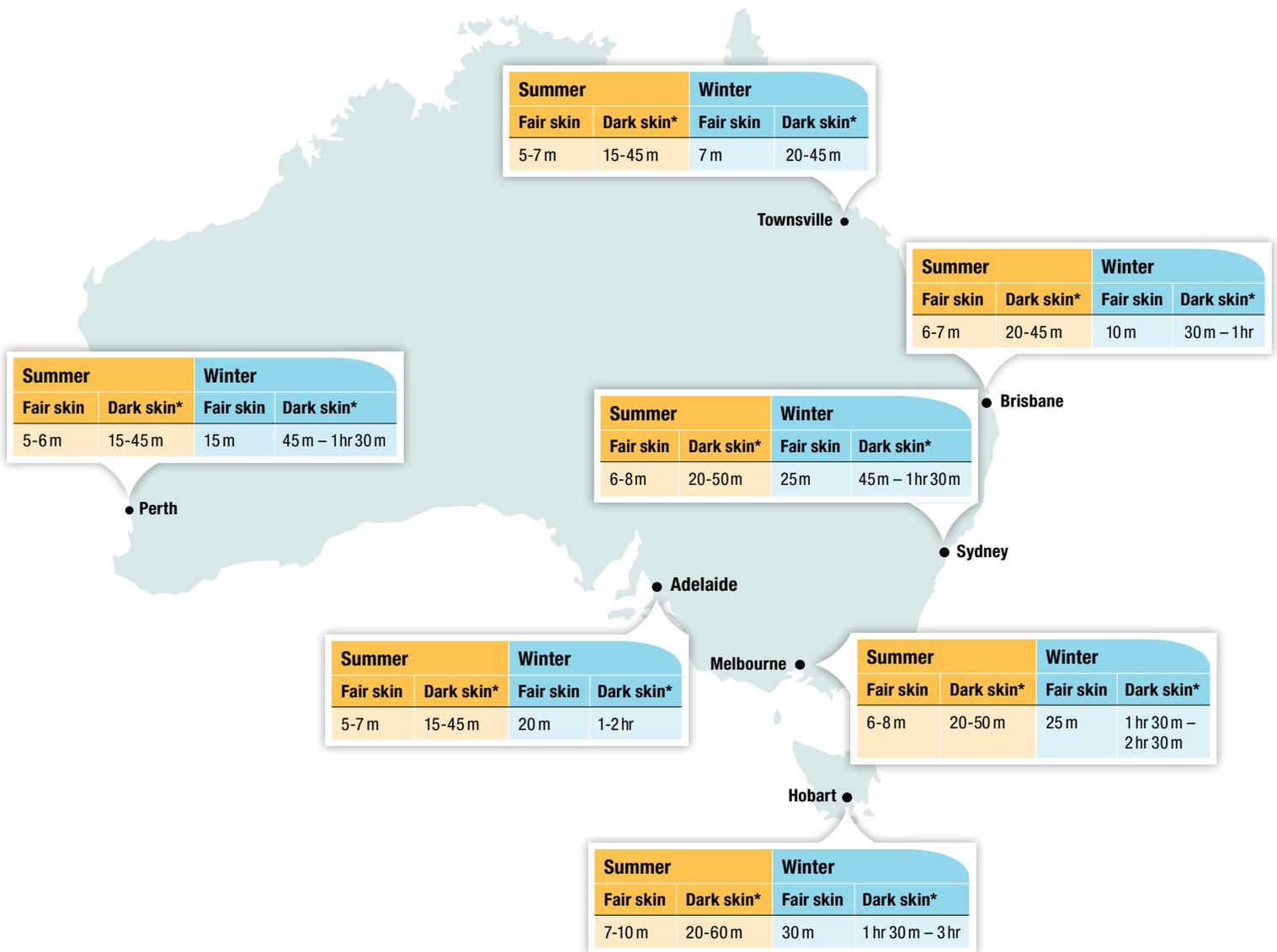
** Range varies due to latitude and darker skin type – greater exposure time is required with darker skin and more southerly latitudes.

Note: If adequate sun exposure is not possible, a supplement is advisable.

Recommended sun exposure for vitamin D based on location

Summer:	(December – January) At 10 am or at 2 pm (std time)^
Winter:	(July – August) at midday

- Exposure times: based on season, location, skin type
- Exposed area: arms or equivalent amount of skin surface
- Frequency: Most days
- Time of day. Summer: at 10am or at 2pm (std time)^
During winter: at midday



Source; Vitamin D and Health in adults in Australia and New Zealand: Position Statement 2012.

Times are a general guide only, based on averages which can vary depending on weather conditions and individual responses.

^ At 11 am or at 3 pm during Daylight Saving Time.

* Darker skin: 3-6 times longer exposure times are required based on dark skin type (and more southern latitudes).

Useful to know:

Less vitamin D is synthesised in winter, particularly at southern latitudes. There is minimal transmission of UVB radiation through normal clear windows, so sun exposure should be outdoors.

Groups at risk of vitamin D deficiency

Groups at risk of vitamin D deficiency are those affected by factors that reduce vitamin D synthesis (advancing age, chronic illness, darker skin type, covering clothing), a lack of exposure to sunlight, or other factors that affect storage or metabolism of vitamin D.

These groups include:

- Older people, particularly if housebound or those in institutional care.
- Naturally dark skinned people (pigment absorbs UV so longer exposure times are required).
- People who avoid sun exposure (eg: fair skinned people and those at risk of skin cancer).
- People who work indoors (such as office, factory and night shift workers).
- People who cover their skin for cultural or religious reasons.
- People with a disability or chronic disease.
- Obese people.
- Babies of vitamin D deficient mothers.

Deficiency and supplementation

Adequate vitamin D is considered to be > 50 nmol/L (at the end of winter).

In order to maintain an adequate vitamin D level at the end of winter it is necessary to have vitamin D levels 10-20 nmol/L higher at end of summer to allow for seasonal decrease.

Vitamin D deficiency can be mild, moderate or severe and has important consequences for bone health and muscle function. Mild vitamin D deficiency leads to increased parathyroid hormone secretion and high bone turnover, and may lead to reduced bone density. Moderate vitamin D deficiency

leads to reduced bone density, high bone turnover and increased risk of falls and hip fracture in older people. Severe vitamin D deficiency can lead to bone and muscle pains, weakness and fractures.

Deficiency can be easily rectified once detected. Vitamin D status should then be assessed in deficient patients 3 months after commencing treatment. It may take 3-5 months from commencing supplementation before the full improvement in serum 25(OH)D levels is seen.

Supplements – general recommendations

- To prevent deficiency in people who do not achieve target levels of sun exposure:
 - At least 600 IU per day for people under 70 years.
 - At least 800 IU per day for people over 70 years.
- Sun avoiders or people at high risk of vitamin D deficiency may require higher doses (eg: 1,000-2,000 IU).
- Vitamin D supplement of 1,000 IU per day (with adequate calcium intake) is required to reduce fracture risk in older people (65 years+).
- For severe deficiency 3,000-5,000 IU per day (6-12 weeks) followed by a lower maintenance dose 1,000-2,000 IU per day.

Note: Large annual doses of vitamin D are not recommended either to treat vitamin D deficiency or to prevent fractures.

Vitamin D supplements are currently available in the form of oral tablets, oral capsules, liquid, drops and preparations imported with permission or made by compounding chemists.

Vitamin D levels and age

Levels of circulating 25(OH)D decrease with age. This can be due to a variety of reasons, including a decline in the capacity to produce vitamin D due to thinning of the skin, a reduction in sunlight exposure, reduced dietary intake, decline in renal function, poor digestion, and reduced production or greater degradation of 25(OH)D.

Vitamin D and fracture reduction

Given alone, vitamin D generally does not prevent fractures, but when combined with adequate calcium intake has been shown to reduce fracture risk in older people.² As vitamin D and calcium deficiencies are common in older people, especially those who are housebound or in residential care, a calcium-vitamin D combination is recommended to reduce the risk of falls and fractures.³ Vitamin D is an independent predictor of falls in older people (levels < 60-70nmol/L have been associated with muscle weakness, impaired balance and accelerated loss in muscle mass, strength and physical function).^{4,5}

Supplement recommendations

Vitamin D status	Range	Recommended
Mild deficiency	30-49 nmol/L	Supplement of 1,000-2,000 IU per day
Moderate deficiency	12.5-29 nmol/L	3,000-5,000 IU per day (for 6-12 weeks) followed by maintenance dose of 1,000-2,000 IU per day
Severe deficiency	< 12.5 nmol/L	



Vitamin D in pregnancy

Recent studies have shown that low vitamin D (< 50 nmol/L) is common in pregnant women in Australia (studies have shown rates of 48% in Sydney, 35% in Canberra, 26% in rural Victoria).⁶ Given the prevalence of low vitamin D in pregnant women and the potential adverse effects on foetal bone health (and emerging evidence on other pregnancy outcomes), it is reasonable to check vitamin D status in all pregnant women with even one risk factor, and supplement where necessary to achieve maternal levels of > 50 nmol/L. Breast milk is a poor source of vitamin D and like other age groups, breast-fed infants are dependent on skin synthesis for their vitamin D stores.

Vitamin D and food

Average Australian dietary intake of vitamin D is very low, estimated at only 80-120 IU (2-3 µg). This is not sufficient to maintain normal vitamin D levels. Adequate vitamin D cannot be achieved through dietary means.

Foods containing vitamin D

Only a limited number of foods contain small amounts of vitamin D, including fatty fish (herring, mackerel), liver, eggs, and some fortified products (some milks, margarine). Vitamin D levels in food vary in concentration, due to production and season.

Fortification in food

Australia traditionally has a low rate of vitamin D fortification in food in comparison to countries such as the UK, Canada and USA (where the amount of sunshine is often insufficient to achieve adequate levels of vitamin D). In Australia, the range of products eligible for fortification and the level of fortification permitted is also less than in these countries. There is currently renewed debate in Australia around food fortification with vitamin D.

Currently, only margarines have mandatory fortification with small amounts of vitamin D.

It is also permitted for vitamin D to be added in limited amounts to dried milk, modified milk, cheese, yoghurt, dairy desserts, butter, soybean products and 'formulated supplementary food'.⁷ Mushrooms that have been exposed to UV radiation contain vitamin D2.

Australians are generally reliant on appropriate sun exposure to reach recommended levels of vitamin D, and may require supplements to reach adequate levels (> 50nmol/L at end of winter).

The benefits for optimal vitamin D levels for bone health are well known. Research on potential benefits of adequate vitamin D levels on other health outcomes is ongoing.



The Vitamin D fact sheet is based on the following Position Statement:

Nowson CA, McGrath JJ, Ebeling PR, Haikerwal A, Daly RM, Sanders KM, Seibel MJ, Mason RS. Working Group of the Australian and New Zealand Bone and Mineral Society, Endocrine Society of Australia and Osteoporosis Australia. Vitamin D and health in adults in Australia and New Zealand: a position statement. *Med J Australia* 2012;196:686-687.

Other references:

- 1 Daly RM, Gagnon C, Lu ZX, et al. Prevalence of vitamin D deficiency and its determinants in Australian adults aged 25 years and older: a national, population-based study. *Clin Endocrinol* 2012;77:26-35.
- 2 Abrahamsen B, Masud T, Avenell A, et al. Patient level pooled analysis of 68 500 patients from seven major vitamin D fracture trials in US and Europe. The DIPART (vitamin D Individual Patient Analysis of Randomized Trials) Group. *Brit Med J* 2010;340:b5463.
- 3 Nowson CA, McGrath JJ, Ebeling PR, et al. Vitamin D and health in adults in Australia and New Zealand: a position statement. *Med J Aust* 2012;196:1-7
- 4 Bischoff-Ferrari HA, Dietrich T, Orav EJ, et al. Higher 25-hydroxyvitamin D concentrations are associated with better lower-extremity function in both active and inactive persons aged > or = 60 y. *Am J Clin Nutr* 2004; 80:752-758.
- 5 Visser M, Deeg DJ, Lips P.. Low vitamin D and high parathyroid hormone levels as determinants of loss of muscle strength and muscle mass (sarcopenia): the Longitudinal Aging Study Amsterdam. *J Clin Endocrinol Metab* 2003;88:5766-5772.
- 6 Ebeling P, Daly R, English D, et al. Building healthy bones throughout life: an evidence-informed strategy to prevent osteoporosis in Australia. In press.
- 7 Food standards Australia New Zealand, Australia New Zealand food standards code, chapter 1, part 1.3 Substances added to food, standard 1.3.2 Vitamins and minerals, viewed 7 August 2012, <http://www.foodstandards.gov.au/foodstandards/foodstandardscode.cfm/>

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