



Low Vitamin D in Tasmania

Key health messages for
doctors, nurses, pharmacists and
allied health professionals

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Contents

Overview	3
Why is vitamin D important?	4
Where do we obtain our vitamin D?	4
What is the best measure of vitamin D status?	4
What is the vitamin D status of the Tasmanian population?	5
Who is at risk of vitamin D deficiency?	5
How do you balance the risks and benefits of sun exposure to reduce the risk of vitamin D deficiency?	6
Who should be tested for vitamin D deficiency?	9
What are the benefits of vitamin D supplementation?	10
Are there any adverse effects of Vitamin D supplementation?	11
Management of Vitamin D Deficiency	11
Special Considerations	13
What vitamin D supplements are available in Tasmania?	14
References	16

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Members of the Vitamin D Scientific Advisory Group

Dr Roscoe Taylor, (Chair) Director of Public Health/Chief Health Officer DHHS
Dr Sean Beggs, Staff Specialist (Paediatrics), Royal Hobart Hospital (RHH)
Dr Rosalind Harrison, Senior Scientific Officer (Toxicology), DHHS
Dr Andrew Hodson, GP Caledonian Medical Centre
Prof Graeme Jones, Menzies Research Institute, Visiting Medical Specialist (Rheumatology), RHH
Ms Diane Mason, Cancer Council Tasmania
Mr Duncan McKenzie, Pharmacy Site Manager – South, RHH
Dr Venkateswaran Parameswaran, Medical Scientist in Charge (Endocrinology), RHH
Dr Alison Ratcliff, Staff Specialist (Infectious Diseases), RHH
Ms Jennifer Savenake, Senior Public Health Nutritionist, DHHS
Ms Jackie Slyp, CEO Arthritis Tasmania
Dr David Strong, Staff Specialist (Paediatrics), Launceston General Hospital (LGH)
Ms Erin Trainer, SunSmart Coordinator, Cancer Council Tasmania
Dr Ingrid van der Mei, Senior Research Fellow, Menzies Research Institute
Prof Alison Venn, Deputy Director, Menzies Research Institute
Prof Tania Winzenberg, Menzies Research Institute

Members of the Vitamin D Communication Advisory Group

Ms Jennifer Savenake, (Chair) Senior Public Health Nutritionist, DHHS
Ms Jenny Denholm, Manager Communications, Tasmanian Medicare Local
Mr Frank Noakes, Senior Communications Consultant, DHHS
Ms Pip Scholten, Tasmanian Medicare Local
Ms Deborah van Velzen, Policy Officer Multicultural Health, DHHS
Ms Erin Trainer, SunSmart Coordinator, Cancer Council

Secretariat

Ms Sophia Avery
Ms Caitlin Brain

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Low Vitamin D in Tasmania: Key health messages for doctors, nurses, pharmacists and allied health professionals

Overview

This document provides key health messages to assist doctors, nurses, pharmacists and allied health professionals in giving advice to people about vitamin D deficiency.

It outlines population groups at risk of having low vitamin D; sun exposure and vitamin D; and vitamin D screening and treatment.

Clinicians may recommend safe sun exposure that takes into consideration UV index and skin type as a key way to boost and maintain vitamin D levels.

Testing Recommendations

1. Routine testing of vitamin D levels in all patients is unnecessary and undesirable. Targeted testing for low serum 25(OH)D is recommended for groups with risk factors for moderate-severe vitamin D deficiency.
2. Testing 25(OH)D is recommended for the following groups
 - Patients with signs, symptoms or planned treatment of Vitamin D deficiency
 - Osteomalacia or rickets or osteoporosis or osteopenia
 - Unexplained proximal limb or muscle pain
 - Unexplained bone pain, unusual fractures or other evidence suggesting metabolic bone disease
 - Unexplained raised serum alkaline phosphatase, or low serum calcium or phosphate
 - People (all ages) with naturally dark skin (Fitzpatrick skin type V and VI)
 - People with chronic and severe lack of sun exposure eg – women who wear full body coverage clothing for religious or cultural reasons
 - Infants of mothers with demonstrated vitamin D deficiency
 - Pregnant women with risk factors for moderate-severe deficiency (at the first antenatal visit)
3. Consider testing the following groups at risk of moderate-severe vitamin D deficiency:
 - People (all ages) with conditions or medications affecting vitamin D metabolism
 - renal disease
 - end-stage liver disease
 - drugs that increase degradation such as rifampicin and enzyme-inducing antiepileptics: phenobarbitone, carbamazepine, phenytoin,
 - fat malabsorption syndromes e.g. cystic fibrosis, coeliac disease, inflammatory bowel disease
 - People (all ages) who spend most of their time indoors or who have limited exposure of their skin to sunlight for various reasons, which may be:
 - Chronic illness /hospitalisation
 - Complex disability – people with low mobility, who are frail or housebound, including people who are bed-ridden or chair bound
 - People who avoid sun exposure because they have had skin cancer, skin damage from the sun or are on photosensitising medications
 - Exclusively breast fed infants who fall into at least one of the risk categories above

Management Recommendations

4. For those with mild vitamin D deficiency (30-49nmol/L) who are not at risk of moderate-severe deficiency, safe sun exposure and dietary sources of vitamin D are recommended. Consider supplementation if clinically appropriate. There is some emerging evidence for improving vitamin D levels following weight loss in those who are overweight or obese.
5. For those with mild vitamin D deficiency (30-49nmol/L) and a risk of moderate-severe deficiency supplements and safe sun exposure (where applicable) are recommended.
6. Those with moderate-severe deficiency (<30nmol/L) require treatment with vitamin D supplements.

Low Vitamin D in Tasmania – key health messages for doctors, nurses, pharmacists and allied health professionals

Low vitamin D is an important public health issue and is common in Tasmania.

Why is vitamin D important?

Vitamin D maintains calcium and phosphate homeostasis, and optimises bone health and muscle function. Very low vitamin D causes bone and muscle pain and poor bone mineralization. This can result in *rickets* in children and *osteomalacia* in adults. Low vitamin D also contributes to *osteopenia* and *osteoporosis*.

Low vitamin D has also been linked to non-skeletal health outcomes such as multiple sclerosis, diabetes (type 1 and type 2), various types of cancers (particularly colon cancer), heart disease, all-cause mortality including cardiovascular mortality, worse outcomes in stroke, altered immunity and some auto-immune diseases. However, the presence of these links in observational studies does not prove that vitamin D supplementation will result in improvements in these outcomes. In fact, meta-analyses of the available data from current randomised controlled trials suggests that it is unlikely that vitamin D supplementation will reduce the risk of myocardial infarction or ischaemic heart disease, stroke or cerebrovascular disease or cancer by 15% or more. There are insufficient data to be certain of the effects of supplementation on mortality and this requires further research. Therefore, overall there is insufficient evidence to recommend supplementation for these outcomes in public policy at present.

Where do we obtain our vitamin D?

The major source of vitamin D in Australia is from exposure to the sun's ultraviolet-B (UVB) radiation.

Most Australians obtain less than 10 per cent of their daily vitamin D requirements from dietary sources (Nowson *et al.*, 2002). There are a few foods that are naturally good sources of vitamin D. Some foods have vitamin D added or are treated to increase the naturally occurring vitamin D. The main sources include:

- oily fish – salmon, sardines, tuna
- eggs
- butter / margarine
- UV exposed mushrooms

Vitamin D may be added to some commercial dairy, soy products and formulated drinks, but only a limited number are currently available on the market. Consumers should refer to the ingredient list to find out whether a product has been fortified with vitamin D.

Vitamin D is also available as a supplement. Cod liver oil capsules are not a suitable source of vitamin D as they also contain vitamin A which can be harmful if taken in large amounts.

What is the best measure of vitamin D status?

25-Hydroxyvitamin D [25(OH)D] is the main circulating form of vitamin D and its level in serum serves as an indicator of vitamin D status. The test result reflects the overall vitamin D status of the patient – this will include vitamin D produced cutaneously and that obtained from food and supplements.

Table 1 defines vitamin D status for adults and children. These cut-points are consistent with the position statements of the Australian New Zealand Bone and Mineral Society, Endocrine Society of Australia and Osteoporosis Australia (Nowson *et al.*, 2012; Paxton *et al.*, 2013).

The cut-points for vitamin D status provide guidance for clinicians only. Other factors need to be considered when determining treatment decisions and this is discussed under *Management of Vitamin D Deficiency*.

Table 1: Classification of vitamin D levels in adults and children

Vitamin D status	25(OH)D (nmol/L)
vitamin D adequacy	≥ 50
mild deficiency	30 - 49
moderate deficiency	12.5 – 29
severe deficiency	< 12.5

Working Group of the Australian and New Zealand Bone and Mineral Society, Endocrine Society of Australia and Osteoporosis Australia Position statement (Nowson *et al.*, 2012)

There is a general agreement in the scientific literature that levels under 30 nmol/L demonstrate deficiency of a severity that can lead to rickets in infants and children and osteomalacia in adults.

There is more uncertainty about the importance of correcting mild deficiency (levels between 30-49 nmol/L) because of limited evidence of improved health outcomes. The most convincing evidence supports the use of vitamin D in combination with calcium for reducing hip fracture in institutionalised older adults, with little evidence to support an effect in the community-dwelling individuals (Bolland *et al.*, 2014).

What is the vitamin D status of the Tasmanian population?

Around one third of Tasmanian adolescents and adults are vitamin D deficient (<50 nmol/L) in summer and up to two thirds are deficient in winter and spring (van der Mei *et al.*, 2012). In Tasmania, serum 25(OH)D levels are on average 30 nmol/L lower at the end of winter compared to the end of summer. It is unclear whether natural seasonal variation in vitamin D levels serves any biological purpose (Nowson *et al.*, 2012).

Even among the more sun seeking Tasmanian adults, approximately 45% were still vitamin D deficient in winter, suggesting that the combination of increased clothing and low ambient UV levels makes it difficult to achieve adequate vitamin D status (≥50 nmol/L) during the winter months.

The rate of vitamin D deficiency is much lower among younger children aged 7 -12 years (12% in winter), with no data available for children younger than 7 years. This low rate is likely due to primary school aged children playing outside all year round.

Overweight and obesity have also been linked to lower serum 25(OH)D levels and with 65% of the Tasmanian adult population being either overweight or obese, this raises concern over the number of individuals who may be affected by low vitamin D levels.

Who is at risk of vitamin D deficiency?

Groups at risk of mild vitamin D deficiency

- People who live in southern latitudes such as Tasmania, especially in winter when the ambient UV levels are low
- People who spend little time outdoors such as office workers and shift workers
- People with fair skin or those at risk of skin cancer who limit their sun exposure
- People who are overweight or obese

- People with a disability or chronic disease that may limit outdoor activity

Groups at risk of **moderate - severe** vitamin D deficiency

Table 2 shows groups at a particularly high risk of moderate - severe vitamin D deficiency and associated negative health outcomes.

Table 2: Groups at risk of moderate - severe vitamin D deficiency

<ul style="list-style-type: none"> • People (all ages) with naturally dark skin (Fitzpatrick Skin Types V/VI refer to Table 3) • People (all ages) with conditions or medications affecting vitamin D metabolism <ul style="list-style-type: none"> ○ renal disease ○ end-stage liver disease ○ drugs that increase degradation such as rifampicin and enzyme-inducing antiepileptics: phenobarbitone, carbamazepine, phenytoin ○ fat malabsorption syndromes e.g. cystic fibrosis, coeliac disease, inflammatory bowel disease • People (all ages) who spend most of their time indoors or who do not expose their skin to sunlight <ul style="list-style-type: none"> ○ Chronic illness / hospitalisation ○ Complex disability – people with low mobility, who are frail or housebound, including people who are bed-ridden or chair bound ○ People who avoid sun exposure because they have had skin cancer, skin damage from the sun or are on photosensitising medications ○ Full body coverage clothing for religious or cultural reasons • Infants of mothers with demonstrated vitamin D deficiency • Exclusively breast fed infants who fall into at least one of the risk categories above
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How do you balance the risks and benefits of sun exposure to reduce the risk of vitamin D deficiency?

For most people the main source of vitamin D is through skin exposure to sunlight. In Tasmania some sun exposure is recommended for vitamin D synthesis for the general population (all ages). Direct exposure to sunlight is required as UVB does not pass through glass.

There are many factors that affect UV radiation and vitamin D synthesis including season, time of day, cloud cover, pollution/smog, sunscreen, skin melanin content, amount of skin exposed, amount of time spent outside, age and obesity.

Advice on sun exposure requires balancing the risk of skin damage and skin cancer against the risk of vitamin D deficiency. The safe threshold level of UV exposure that allows for maximal vitamin D synthesis without increasing skin cancer risk is not known. For some people who are at particularly high risk of skin cancer, including those with a past history or who are immunosuppressed, supplements may be a more appropriate way to maintain vitamin D levels.

For the general population (including older adults) safe sun exposure includes consideration of:

- **Skin type** – All skin types can be damaged by too much UV. However dark skinned people (skin type V and VI) have a larger amount of melanin which provides a natural protection from UV but reduces vitamin D synthesis. People with dark skin may need 3-6 times more sun exposure than described for fair skinned people to achieve adequate vitamin D status. (Refer to Table 3 for Fitzpatrick skin type).

- **UV Index** – when the UV index is 3 and above most people will need to take sun protection measures (hat, sunscreen, sunglasses, clothing coverage and shade) if outside for longer than 10-15 minutes. When the UV index is below 3 it is generally safe to go outdoors without sun protection (unless outdoors for extended periods, in alpine areas or near highly reflective surfaces such as water and snow). This is usually early morning and early evening in summer and all day during winter. The UV index varies throughout the day and the year. Refer to Figure 1 for the mean maximum monthly UV index in Tasmania. For daily UV forecasts go to the following websites:
 - ARPANSA: http://www.arpansa.gov.au/uvindex/realtime/kin_rt.htm
 - Cancer Council Tasmania: <http://www.cancertas.org.au/healthy-living/sunsmart>
 - Bureau of Meteorology: <http://www.bom.gov.au/tas/uv/index.shtml>
- **Location** – sun protection should be used throughout the year when at high altitudes or near highly reflective surfaces such as snow or water, even in winter.

Physical activity outdoors should be encouraged. Being active outside may enable more skin to be exposed and thus increase vitamin D production and reduce the length of time required for vitamin D synthesis.

The use of solariums is not recommended to boost vitamin D levels because of the increased risk of skin cancer.

Table 3: How to identify Fitzpatrick skin type

Skin type	Degree of burning or tanning	Often associated with
I	Always burns, never tans (pale white skin)	freckles, red or fair hair, blue or green eyes
II	Burns easily, tans minimally (white skin)	light hair and blue or brown eyes
III	Burns moderately, tans uniformly (light brown skin)	brown hair and eyes
IV	Burns minimally, always tans well (moderate brown skin)	dark brown hair and eyes
V	Rarely burns, tans profusely (dark brown skin)	naturally black-brown skin, dark brown hair and eyes
VI	Never burns (deeply pigmented dark brown to black skin)	naturally black-brown skin, black-brown hair and eyes

The mean maximum monthly UV Index in Tasmania is generally high (6 or above) between mid-October and mid-March, it is generally moderate (3-5) from mid-March to mid-April and mid-September to mid-October, and generally low (below 3) from mid-April to mid-September (refer to Figure 1).

Figure 1: Mean maximum monthly UV Index in Tasmania

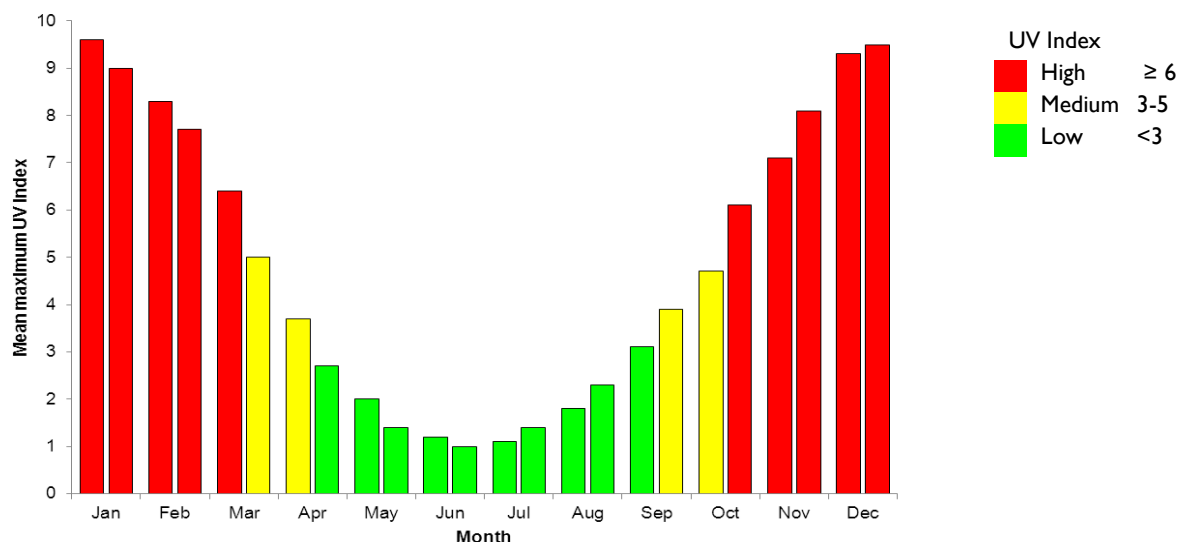


Table 4 provides guidance on the length of safe sun exposure to reduce the risk of vitamin D deficiency. These are a guide only and may not suit all people. For further information on safe sun exposure refer to Cancer Council Tasmania’s SunSmart webpage:

<http://www.cancertas.org.au/healthy-living/sunsmart>

Those at risk of moderate–severe vitamin D deficiency may also require vitamin D supplements.

Table 4: Safe sun exposure to reduce the risk of vitamin D deficiency

Mean maximum UV index / Months of year	Fair to olive skin (Fitzpatrick skin types I-IV) Higher risk of skin cancer	Naturally very dark skin (Fitzpatrick skin types V-VI) Higher risk of vitamin D deficiency
High mean maximum UV index (6 or above) mid-October to mid-March	<p>It is recommended for sun exposure to be:</p> <ul style="list-style-type: none"> Regular (1-2 times a day) Short (10-15 mins) Expose as much skin as practical <p>In particular, extra care should be taken between mid-October and mid-March if the UV is 9 or above as fair skinned people can burn within 15 minutes with no sun protection. Check UV regularly and exercise caution.</p> <p>Sun protection (hats, sunscreen, sunglasses, shade, cover up clothing) is recommended if outside for more than 10-15 minutes when the UV is 3 and above.</p> <p>Sunscreen may not be needed unless outside for more than 10-15 minutes but sunburn should be avoided.</p>	<p>It is recommended that sun exposure is 3-6 times more than that for fair to olive skin.</p> <p>It may not be possible to maintain vitamin D levels through sun exposure alone and supplementation may be required.</p> <p>It is not usually necessary for people with this type of skin to wear sunscreen. However wearing sunglasses and a hat is still recommended to protect the eyes.</p>
Moderate mean maximum UV index (3-5) mid-March to mid-April and mid-September to mid-October	<p>Regular safe sun exposure when the UV index is moderate can help reduce the seasonal decline in vitamin D levels over winter and help increase vitamin D levels following winter.</p> <p>It is recommended for sun exposure to be:</p> <ul style="list-style-type: none"> Regular (1-2 times a day) Short (10-15 mins) Expose as much skin as practical <p>Sun protection (hats, sunscreen, sunglasses, shade, cover up clothing) is recommended if outside for more than 10-15 minutes when the UV is 3 and above.</p> <p>Sunscreen may not be needed unless outside for more than 10-15 minutes but sunburn should be avoided.</p>	<p>It is recommended that sun exposure is 3-6 times more than that for fair to olive skin.</p> <p>It may not be possible to maintain vitamin D levels through sun exposure alone and supplementation may be required.</p> <p>It is not usually necessary for people with this type of skin to wear sunscreen. However wearing sunglasses is still recommended to protect the eyes.</p>

<p>Low mean maximum UV Index (below 3) mid-April to mid-September</p>	<p>It is difficult to produce adequate vitamin D during this period.</p> <p>Aim for sun exposure to be:</p> <ul style="list-style-type: none"> • Regular (midday best) • Longer (as much as practical) • Expose as much skin as practical <p>Sun protection is not be needed when the UV index is below 3 unless:</p> <ul style="list-style-type: none"> • in alpine regions or • near highly reflective surfaces such as snow or water or • outside for extended periods (most of the day) 	<p>It is recommended that sun exposure is 3-6 times more than that for fair to olive skin.</p> <p>It may not be possible to maintain vitamin D levels through sun exposure alone and supplementation may be required.</p> <p>Sun protection is not be necessary at this time of year, unless in alpine regions or highly reflective surface such as snow or water, where eyes need protecting.</p>
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Who should be tested for vitamin D deficiency?

There is inadequate evidence to recommend population-wide screening for vitamin D status in Australia and New Zealand, including a lack of high level evidence to support routine screening of pregnant women (Nowson *et al.*, 2012; Paxton *et al.*, 2013; Royal College of Pathologists of Australasia, 2013).

Targeted testing for low serum 25(OH)D is **recommended** for groups with risk factors for moderate-severe vitamin D deficiency as an appropriate case finding strategy (Royal College of Pathologists of Australasia, 2013)(refer to Table 5). This is particularly important for pregnant women due to the potential adverse effects of vitamin D deficiency on both maternal and foetal health.

Practice point:

Routine testing of vitamin D levels in all patients as a screening measure is unnecessary and undesirable. As with all clinical practice, there should be a purpose to assessing vitamin D status. Any testing should take place to identify those at risk of moderate to severe deficiency, as those patients are at an increased risk of disease resulting from the deficiency.

Among those at risk of moderate-severe vitamin D deficiency, **supplementation without testing** may be justified after considering the burden on the patient, the likelihood of adherence and the cost of testing.

Vitamin D testing **is appropriate** for adults and children presenting with clinical problems potentially associated with moderate to severe vitamin D deficiency. Management is then undertaken to correct a demonstrated moderate or severe deficiency in order to lower the patient's risk of conditions associated with that deficiency.

Testing is generally **not** indicated in populations at risk of **mild** deficiency. There are few data available on which to base recommendations regarding frequency of testing in the general population without clinical problems associated with vitamin D deficiency. There has been a large increase in the amount of testing in Australia in recent years, but little evidence for gain from this health care system cost (Bilinski *et al.*, 2012; Sattar *et al.*, 2012)¹.

Practice point:

Be aware of seasonal variation when interpreting results – in Tasmania serum levels of vitamin D are on average 30nmol/L lower at the end of winter when compared to summer

Retesting for monitoring purposes is discussed under *Management of Vitamin D Deficiency*.

¹ There has been a significant increase in requests for tests for vitamin D over the last decade but little evidence of population benefit. Over three million tests were requested in 2011-2012 at a cost to the Medicare Benefits Schedule (MBS) of \$126.9 million, or 5.7 per cent of the total MBS expenditure for that year. Some part of this growth has been due to increasing awareness and evidence of the clinical implications of low vitamin D. However, there are also indications of inappropriate diagnostic screening and overtesting (e.g. MBS data show some individuals have had more than 40 vitamin D tests performed in one year). The Australian Government has advised that a review of MBS reimbursement will be undertaken by the Medical Services Advisory Committee.

Table 5: Testing Recommendations for vitamin D deficiency

Testing Recommended:

- All persons presenting with clinical problems potentially associated with moderate-severe vitamin D deficiency:
 - osteomalacia, rickets, osteoporosis or osteopenia
 - unexplained proximal limb or muscle pain
 - unexplained bone pain, unusual fractures, or other evidence suggesting metabolic bone disease (consider specialist advice for people in this category)
 - unexplained raised serum alkaline phosphatase, or low serum calcium or phosphate
- People (all ages) with naturally dark skin (Fitzpatrick skin type V and VI)
- Chronic severe lack of sun exposure (refer to Table 2)
- Infants of mothers with demonstrated vitamin D deficiency
- Pregnant women with risk factors for moderate-severe vitamin D deficiency (refer to Table 2)

Consider testing:

- Apparently well people at risk of moderate-severe vitamin D deficiency (refer to Table 2); AND
- Where knowing the result will usefully improve clinical practice and patient wellbeing (Sattar *et al.*, 2012)
- Children or siblings of those with moderate-severe vitamin D deficiency

Testing not indicated

- Testing is not generally indicated in populations at risk of mild deficiency

What are the benefits of vitamin D supplementation?

Adults

Adults with moderate to severe deficiency are at higher risk of developing osteomalacia. One aim of supplementation in this group is to correct the vitamin D deficiency and hence prevent the development of osteomalacia.

The strongest evidence relating to the benefits of vitamin D supplementation relates to musculoskeletal outcomes in elderly populations (most commonly postmenopausal women), particularly falls and fractures. The evidence suggests that vitamin D supplementation is likely to provide the most benefit for people with moderate-severe deficiency (Winzenberg *et al.*, 2012) and/or the institutionalised elderly (Cameron *et al.*, 2010; Moyer, 2013)

There is consistent evidence that vitamin D supplementation, in combination with calcium, reduces the risk of falls and mortality in older women in institutional care (Bjelakovic G, 2011; Cameron *et al.*, 2010). Vitamin D supplements given without concomitant calcium supplementation are unlikely to prevent fractures (Avenell *et al.*, 2009). There is little evidence to support an effect of supplementation in the community-dwelling elderly (Bolland *et al.*, 2014).

Vitamin D supplementation with or without calcium has not been shown to reduce the incidence of cardiovascular disease, cancer, total fractures or hip fractures in people living in the community (Bolland *et al.*, 2014). There is no conclusive evidence on the effect of vitamin D supplementation for the general population (Ross *et al.*, 2011).

Infants

Infants and children with moderate to severe deficiency are at higher risk of developing rickets. One aim of supplementation in this group is to correct the vitamin D deficiency and hence prevent the occurrence of rickets.

A recent systematic review of vitamin D supplements for improving bone density in children suggested that vitamin D supplementation does not improve bone density in healthy children, however, a clinically important improvement might be achievable in vitamin D deficient children, although this has not yet been definitively proven (Winzenberg *et al.*, 2010).

Data from Randomised Control Trials addressing non-bone health outcomes in children are sparse and the risks and benefits of vitamin D supplementation in children remain unclear (Paxton *et al.*, 2013).

Are there any adverse effects of Vitamin D supplementation?

No safe upper level of 25(OH)D has been identified. There is some evidence of potential adverse effects (all-cause mortality, some cancers, cardiovascular risk, and fractures and falls) for serum 25(OH)D levels ranging from 75 to 120 nmol/L (Ross *et al.*, 2011). Although there is a lack of knowledge about the levels of vitamin D that could be harmful, serum 25(OH)D levels above 125 to 150 nmol/L should be avoided because the long term safety of such levels is unknown (Ross *et al.*, 2011). The balance of health risks and benefits of serum 25(OH)D levels in the range 50 to 150 nmol/L is largely undescribed (Ross *et al.*, 2011)

Vitamin D toxicity is considered to arise at serum 25(OH)D levels in excess of 500 nmol/L and presents with non-specific symptoms of anorexia, weight loss, polyuria, heart arrhythmias, fatigue, and soft tissue calcifications (Jones, 2008; Ross *et al.*, 2011). The main concerns of high serum 25(OH)D levels are hypercalcaemia and hypercalciuria, resulting in vascular and soft tissue calcification and renal insufficiency (Nowson *et al.*, 2012; Ross *et al.*, 2011). Although the threshold for toxicity in humans is not readily defined, doses below 10,000 IU per day are not associated with hypercalcaemia. Ross *et al.* (2011) noted that there are limited long term studies investigating the effects of vitamin D at intakes above 10,000 IU per day. However, doses greater than 50,000 IU per day for several weeks or months are likely to result in hypercalcaemia (Ross *et al.* 2011). Vitamin D toxicity can only be caused by excessive supplementation and not by prolonged exposure of the skin to sunlight (Nowson *et al.*, 2012; Paxton *et al.*, 2013)

Supplementation is generally not recommended when hypercalcaemia, hypervitaminosis D or renal osteodystrophy with hyperphosphatemia is present. Care should be taken when considering supplementation in the presence of atherosclerosis or cardiac function impairment, hypersensitivity to vitamin D, renal function impairment, or sarcoidosis.

Management of Vitamin D Deficiency

Options for managing vitamin D deficiency include lifestyle advice to improve levels of sun exposure and the use of vitamin D supplements.

The goal of managing vitamin D deficiency is to prevent disease, not simply to manage serum 25(OH)D levels.

Clinical judgement is required in assessing how best to manage vitamin D deficiency in a particular patient. This needs to take into account:

1. The severity of the deficiency
2. The potential impact of seasonality on vitamin D levels
3. The clinical context of the particular patient including:
 - a. The presence of contraindications or major barriers to increasing sun exposure;
 - b. The presence of risk factors for developing moderate to severe deficiency (refer to Table 2);
 - c. Likelihood of adherence to advice or supplements;

- d. The presence of diseases strongly associated with vitamin D deficiency such as rickets, osteomalacia and osteoporosis (see below).

Unless advice to increase sun exposure is contra-indicated, all patients with vitamin D deficiency should receive advice about appropriate sun exposure for their circumstances, taking into account their risk of skin cancer, skin type and any cultural or other circumstances affecting sun exposure behaviour.

Patients with moderate to severe vitamin D deficiency may not correct their vitamin D levels by improved levels of sun exposure alone and supplementation should be considered.

In patients with vitamin D deficiency who have clinical problems potentially associated with vitamin D deficiency, vitamin D supplementation should be considered regardless of the severity of their deficiency. These include conditions such as:

- Osteoporosis, osteopenia or rickets
- unexplained proximal limb or muscle pain
- unexplained bone pain, unusual fractures, or other evidence suggesting metabolic bone disease (consider specialist advice for people in this category)
- unexplained raised serum alkaline phosphatase, or low serum calcium or phosphate

In patients with mild deficiency, the decision whether to supplement or to rely on sun exposure alone to correct deficiency depends in part on the clinician's judgment as to the likelihood of the person proceeding to more severe deficiency. This may be affected by:

- a) The seasonality of serum vitamin D levels. If a person is mildly deficient in mid-autumn (from which time on serum vitamin D levels would be expected to drop further), they are at risk of their vitamin D levels dropping to moderate to severe levels over winter. Conversely, if they are mildly deficient in late winter to early spring, the deficiency may be correctable by increased sun exposure.
- b) The feasibility of the person being able to increase sun exposure to the extent needed to correct deficiency. For example, as people with naturally dark skin require much longer durations of sun exposure to produce adequate vitamin D, it may be difficult for such individuals to correct deficiency without the use of supplements. In other cases, cultural reasons may preclude the exposure of adequate skin or social circumstances e.g. residing in a nursing home, may make it difficult for adequate sun exposure to be obtained.

All sub-groups of the population at risk of moderate-severe deficiency may require supplementation if their serum 25OH(D) levels are <50 nmol/L.

It is not recommended to prescribe a single dose of more than 50,000 IU vitamin D for adults. Contraindications to high dose vitamin D include hypercalcaemia and kidney disease. (Chief Health Officer Victoria Australia., May 2010).

If vitamin D levels do not normalise, consideration should be given to possible underlying gastrointestinal disorders.

There is considerable inter-patient variation in the time needed for blood levels to plateau with supplementation. As it may take up to 2-5 months for serum 25(OH)D levels to plateau, retesting should not take place before 3 months (Nowson *et al.*, 2012; Royal College of Pathologists of Australasia, 2013). Thereafter, retesting should be performed as clinically indicated. For **neonates with moderate or severe deficiency**, retesting after one month is recommended.

Once a desirable target has been achieved, especially by the end of winter, no further testing is required unless risk factors change (Royal College of Pathologists of Australasia, 2013). Further retesting may be performed as clinically indicated for patients with risk factors for *moderate* to *severe*

deficiency. If there are concerns about adherence to treatment plans retesting annually may be indicated.

Dosage regimens for correcting vitamin D deficiency in adults are given in Table 6 (Nowson *et al.*, 2012)

Table 6: Recommended supplementation dosing regimens for adults with risk factors for moderate-severe deficiency

Vitamin D level nmol/L	High dose vitamin D3 ^{1,2}	Daily dose vitamin D3 ²	Maintenance ³
Mild, moderate or severe deficiency <50 nmol/L	50,000 IU/month for 3-6 months	3,000–5,000 IU/day for at least 6-12 weeks	Retest vitamin D level after 3 months. Maintenance dose (1,000-2,000 IU/day) once vitamin D levels have normalised.

¹Not readily available for use in Australia.

²Calcium intake of 1,000–1,300 mg per day is also recommended, preferably from calcium-rich foods.

³Target level for treatment \geq 50 nmol/L (Chief Health Officer Victoria Australia., May 2010)

Special Considerations:

Pregnant women

Although there is evidence of the benefits of vitamin D supplementation for pregnant women at risk of moderate-severe vitamin D deficiency, there is less evidence in the case of pregnant women at risk of mild deficiency. There may be health gains but further evidence is required before recommending routine supplementation (National Institute for Health and Clinical Excellence., 2008). Recommendations for pregnant women at risk of mild deficiency are consistent with those of other adults with mild deficiency.

Data on the optimal dose of vitamin D supplementation are lacking. There is inadequate evidence to support the use of high dose vitamin D during pregnancy or lactation.

Table 7 shows the recommended doses for pregnant women to correct vitamin D deficiency (Paxton *et al.*, 2013)

Table 7: Recommended supplementation dosing regimens for pregnant women with risk factors for moderate-severe deficiency

Vitamin D level nmol/L	Daily dose vitamin D3 ¹	Maintenance ²
30–49	1,000 IU/day	Retest vitamin D level at 28 weeks gestation
12.5–29	2,000 IU/day	
< 12.5	2,000 IU/day	

¹ Calcium intake of 1,000–1,300 mg per day is also recommended, preferably from calcium-rich foods.

² Target level for treatment \geq 50 nmol/L

Once levels reach \geq 50 nmol/L, continue a minimum of 600 IU daily throughout the remainder of pregnancy

Infants, children and adolescents

Young children with severe vitamin D deficiency, low calcium or low phosphate should be assessed by a paediatrician. There is inadequate evidence to support the use of high dose vitamin D in infants younger than 3 months old.

The Australian Dietary Guidelines recommend exclusive breastfeeding for around 6 months from birth. Despite the many other benefits of breastfeeding, breast milk is a poor source of vitamin D. Neonatal supplements may be indicated in infants of mothers at risk of moderate-severe vitamin D deficiency, if they are being exclusively breastfed.

Table 8 shows the recommended doses for infants, children and adolescents to correct vitamin D deficiency (Paxton *et al.*, 2013).

Table 8: Recommended supplementation dosing regimens for infants, children and adolescents

Age	Vitamin D level (nmol/L)	Dose vitamin D3	Maintenance
Preterm	mild deficiency 30 – 49	200 IU/kg/d maximum 400IU/day	200 IU/kg/d maximum 400 IU/day
	moderate deficiency 12.5 – 29 severe deficiency < 12.5	800 IU/d, retest after 1 month	200 IU/kg/d maximum 400 IU/day
< 3 months (term)	mild deficiency 30 – 49	400 IU/d for 3 months	400 IU/d
	moderate deficiency 12.5 – 29 severe deficiency < 12.5	1000 IU/d daily for 3 months, retest after 1 month	400 IU/d
3-12 months	mild deficiency 30 – 49	400 IU/d daily for 3 months	400 IU/d
	moderate deficiency 12.5 – 29 severe deficiency < 12.5	1000 IU/d daily for 3 months or 50,000 IU and retest after 1 month, consider repeating dose	400 IU/d
1-18 years	mild deficiency 30 – 49	1000-2000 IU daily for 3 months or 150,000 IU stat	400 IU/d or 150,000 IU at the start of autumn ^{1,2}
	moderate deficiency 12.5 – 29	1000-2000 IU daily for 6 months or 3000-4000 IU daily for 3 months or 150,000 IU stat and retest at 6 weeks	400 IU/d or 150,000 IU at the start of autumn ^{1,2}
	severe deficiency < 12.5	Treat as for moderate deficiency and consider referral to a paediatrician for assessment.	

¹The long-term safety of high dose intermittent treatment or other dosage regimens where vitamin D levels in excess of 100 nmol/L are attained is unknown in children and adolescents, though there is evidence that such levels may be detrimental for adults (Helzlsouer *et al.*, 2010; Winzenberg *et al.*, 2012).

²150 000 IU in autumn as a maintenance dose may not be sufficient to maintain adequate vitamin D levels in adolescents who have previously been deficient. More frequent dosing may be required (3-6 monthly) (Carnes *et al.*, 2012)

What vitamin D supplements are available in Tasmania?

The Australian Register of Therapeutic Goods (ARTG) at 1 October 2012 lists over 150 items as containing vitamin D.

Tablets/ Capsules

Of the vitamin D products listed on the ARTG, all single ingredient capsule or tablet formulations contain 1000 IU of vitamin D, mostly as cholecalciferol (vitamin D3). Combination multivitamin or calcium and vitamin D formulations contain between 200 and 1000 IU of vitamin D in each tablet/capsule. These products are widely and easily available over-the-counter from community pharmacies.

Liquid and Paediatric formulations

Vitamin D for children is commonly obtained from paediatric multivitamin oral liquids (e.g. Pentavite®) with a standard dose of the multivitamin preparation typically containing 400 IU of vitamin D.

There are some concentrated liquid formulations of vitamin D that have recently become available in Australia. These are commonly available over-the-counter from community pharmacies. The liquid formulations contain 1000 IU of vitamin D in volumes of between 0.2mL and 0.5mL, depending on the product.

Accessing high dose vitamin D

There are currently no TGA-registered high dose vitamin D products available in Australia. Some hospital and community pharmacies can supply or prepare high dose vitamin D capsules and liquid formulations on a non-PBS reimbursed prescription. High dose vitamin D products may be sourced directly from TGA-licensed pharmaceutical manufacturers; hospital pharmacies are able to obtain a contract with some manufacturers to obtain supplies directly. Other high dose products including injectable forms of vitamin D are accessible through the Special Access Scheme.

Vitamin D3 (cholecalciferol) is the preferred form over vitamin D2 (ergocalciferol), due to its superior bioavailability.

Note: 1 microgram (mcg) of Vitamin D3 equates to 40 international units (IU). As an example, a standard formulation that lists Vitamin D3 25 microgram, has 1,000 IU of Vitamin D.

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