VITAMIN D AND THE ATHLETE

CONSIDERATIONS FOR THE PRACTITIONER

Written by Bruce Hamilton, Qatar

Vitamin D is a steroid hormone that has previously been given little attention, partially as a result of its inappropriate naming in the early 20th century as a ‘vitamin’. This title, and the previously held belief that Vitamin D deficiency was a condition limited to the elderly, has belittled the important role that Vitamin D plays in both bone and general health. In recent years, increasing awareness of the prevalence of Vitamin D deficiency in otherwise healthy young individuals has led to increased research into the impact of Vitamin D. The result of this increased interest has been remarkable as it is now recognised that along with Vitamin D being involved in the maintenance of body calcium levels and therefore good bone health, Vitamin D deficiency is now also known to be associated with a wide range of medical conditions. In recent years there has been renewed interest in the impact of both sub-optimal and supra-optimal levels of Vitamin D on athletic performance.

This article will briefly review the role of Vitamin D and outline the relevant clinical considerations for the practitioner in sports medicine.

VITAMIN D METABOLISM

Vitamin D is a steroid, formed initially in the skin as Vitamin D3 (cholecalciferol) from pre-vitamin D3, under the influence of UVB rays from the sun. Vitamin D3 is transported to the liver and metabolised to 25-hydroxy-cholecalciferol [25(OH)D] which is subsequently converted to the active form of Vitamin D, 1,25-dihydroxycholecalciferol [1,25(OH)$_2$D] in the kidney. This final metabolic step in the production of active Vitamin D is tightly regulated by parathyroid hormone and blood levels of both calcium and phosphorus (Figure 1). While the majority of Vitamin D is formed in the skin from sunlight exposure, smaller amounts are also found in the diet. 1,25(OH)$_2$D receptors are now known to be present in most organ systems in the body, suggesting that Vitamin D can have a widespread effect and making this an interesting area for research. Clinically we measure 25(OH)D levels as they are both more stable than 1,25(OH)$_2$D and are found in greater quantities, thereby best reflecting the body’s true Vitamin D status.

THE FUNCTION OF VITAMIN D

Vitamin D plays an important role in maintaining serum levels of calcium and phosphorus through its actions in the intestine, kidney and bone. Vitamin D will maintain blood calcium levels via increasing absorption of calcium in the intestine and increasing release of calcium from the bones. It achieves this in the same manner as other steroid hormones, through stimulating protein synthesis in the cells of these organs, thereby facilitating calcium flux. The most recognised manifestation of Vitamin D deficiency are those effects noted in the bone. In children, both today and in the smog-filled skies...
of the 17th century, this results in ‘rickets’; in adults, it results in low bone mineral density or osteomalacia. In athletes, an association between Vitamin D deficiency and stress fractures and has been previously highlighted. For a long time, this was thought to be the principle function and impact of Vitamin D, but the recognition that Vitamin D receptors are found in most organs, including skeletal muscle, has increased awareness of the broader impact that Vitamin D may have. Chronic diseases now felt to have a potential association with Vitamin D deficiency include bowel cancer, diabetes, multiple sclerosis and high blood pressure to name but a few.

Authors have recently speculated, on the basis of research performed in the mid-20th century, that sub-optimal Vitamin D levels may negatively impact upon performance. I will discuss this further in the following section. But first let’s address the question of: How common is Vitamin D deficiency?

Figure 1: Main steps in the production of Vitamin D in the skin, liver and kidneys.
There remains controversy as to both the optimal 25(OH)D levels in the blood and the daily requirement. Traditionally Vitamin D deficiency has been recognised as being very common in the elderly and infirm who have had limited sunlight exposure. Similarly, Vitamin D deficiency has been well-described in those countries of high latitude (e.g. Scandinavia), since the effective UVB rays available at higher latitudes are markedly reduced (conversely, the UVB exposure in the equatorial regions is much greater). More recently, Vitamin D deficiency and insufficiency have been recognised in young people throughout the world, including those regions of high sunlight hours. Surprisingly, in countries as diverse as Australia and Finland, Vitamin D deficiency has been recognised in significant proportions of their athletic populations. Even in Qatar, a Middle Eastern country with high levels of accessible sunlight hours, our athlete screening programme has identified an endemic level of Vitamin D deficiency in male athletes. In one study, 93% of male Qatari footballers were found to have either deficient or insufficient Vitamin D levels. This is believed to result predominantly from sun avoidance due to the extreme heat for much of the year. Further research into this and other intrinsic factors in the Middle East is required.

**10 Key Points On Vitamin D And The Athlete**

1. When monitoring Vitamin D we measure 25(OH)D
2. Vitamin D is critical in the maintenance of serum calcium levels through its action on the bone, bowel and kidney
3. Many people suspect that Vitamin D deficiency may impact upon performance, but the scientific evidence to support this is lacking
4. Oral supplementation is often all that is required to correct 25(OH)D levels
5. Vitamin D deficiency is known to be associated with a number of chronic medical conditions
6. Athletes at risk of Vitamin D deficiency should be regularly monitored
7. Vitamin D insufficiency and deficiency is common in athletes
8. The active form of Vitamin D is 1,25(OH)₂D
9. Further research is necessary to evaluate the impact of Vitamin D on all organ systems in the body, including the muscular system
10. Dark skin, indoor sports activity, high latitudes and sun avoiding behaviour may all increase the risk of Vitamin D deficiency

**Vitamin D Deficiency**

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**Vitamin D AND PERFORMANCE**

In 2009 a research paper was published highlighting the potential impact of Vitamin D deficiency on the performance of athletes. This research highlighted historical studies (which had limitations) which illustrated how Vitamin D may indeed impact upon performance. This was combined with a summary of the current understanding of Vitamin D action to emphasise the importance of adequate Vitamin D intake to athletic performance. Unfortunately, as this research highlights, to date there is little substantiated evidence (using modern techniques) that Vitamin D can have a clinically relevant impact on the performance of exercise. However, the work of Cannell et al. had the effect of stimulating interest in this potentially important area.

In Qatar, given the high incidence of Vitamin D deficiency, we are interested in the potential impact of that deficiency on both health and athletic performance. Since the identification of Vitamin D receptors in skeletal muscle in 2001, one postulated means by which Vitamin D deficiency may impact on performance is via impeding optimal muscle function. In support of this, it is well-recognised that elderly patients suffering from osteomalacia may have an associated muscle weakness. Furthermore, it has been shown that Vitamin D deficiency may result in a reduction in the number and size of Type II (fast twitch) muscle fibres in the elderly population, which can be reversed with correction of the Vitamin D status. Finally, the impact of the Vitamin D receptor has been investigated and it has been shown that:

1. Mice devoid of Vitamin D receptors in their skeletal muscle have muscles 20% smaller than their ‘normal’ siblings.
2. The number of Vitamin D receptors found in skeletal muscle may decrease with age.
3. Genetic variation in the structure of the receptor has been shown to be associated with different functional outcomes.

Given these findings, it is surprising that there are very few studies assessing the impact of Vitamin D deficiency on skeletal muscle function in young, otherwise healthy individuals, let alone athletes. One such study performed on Lebanese adolescent...
deficiency may result in a reduction in the number and size of Type II (fast twitch) muscle fibres

girls showed no improvement in grip strength with improving Vitamin D levels, while in a study on young women in Britain, Vitamin D levels were found to correlate positively with jump height, jump velocity and power. If it is true that Vitamin D may impact upon muscle function, this will have profound implications for both response to training, risk of injury and recovery from injury. Specifically, if muscle function is impaired by Vitamin D deficiency, the response to training may be impaired, the risk of overuse-type injury may be elevated and the recovery from injury may be delayed. We are exploring the impact that Vitamin D may have on isokinetic function of the lower limb in football players in Qatar but it remains unclear whether there is a significant effect. However, given the widespread potential effects of Vitamin D deficiency, it is recommended that athletes in areas of endemic deficiency closely monitor their 25(OH)D concentrations with a view to optimising their status.

VITAMIN D REQUIREMENTS

As previously mentioned, exactly what constitutes adequate or optimal 25(OH)D levels remains controversial. Typically however, we recommend the maintenance of 25(OH)D levels over 30 ng/ml (Table 1). There is no significant data to suggest that levels greater than this endow greater benefits. Internationally recommended daily intakes of Vitamin D are in the range of 500 – 1000 IU/day, but the recent literature suggests that these intakes may not be adequate. Maintenance of Vitamin D levels is most easily achieved with appropriate sunlight exposure, balanced against the risk of sun-burn and skin cancer. Achieving adequate sunlight exposure can be difficult under the following conditions:

1. In very hot countries (such as Qatar).
2. In countries where the cultural practices are to remain covered.
3. In individuals with dark skin (less UVB

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<tr>
<th>Concentration</th>
<th>Status</th>
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<tbody>
<tr>
<td>&gt;30 ng/ml</td>
<td>Sufficiency</td>
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<tr>
<td>20-30 ng/ml</td>
<td>Insufficiency</td>
</tr>
<tr>
<td>10-20 ng/ml</td>
<td>Deficiency</td>
</tr>
<tr>
<td>&lt;10 ng/ml</td>
<td>Severe deficiency</td>
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Table 1: Serum 25(OH)D concentrations and Vitamin D status.
And elite athletes of all sporting codes are clear that this is an area that physicians even without a high level of evidence it is 100 whether this suspicion is correct or not, coming years, further research may show appear a worthwhile objective. Over the (as some authors suspect), then it would be encouraged to achieve optimisation of dietary Vitamin D by eating oily fish, egg yolk, fortified cereals and some yeast products which all provide small but beneficial amounts of Vitamin D. In many countries, including Qatar, some milk, butter, margarine and other foods are fortified with Vitamin D to provide additional small amounts of Vitamin D. In individuals with documented Vitamin D deficiency, appropriate sunlight exposure, dietary intake and supplementation should be recommended. Supplementation can take many forms, but typically we recommend a course of Vitamin D3, 2000 IU/day for 8 weeks.

IMPLICATIONS FOR TEAM DOCTORS AND ATHLETES

While we now recognise that athletes are not immune from being Vitamin D deficient, it remains unclear exactly what the impact of that may be on the otherwise fit and healthy individual. We do know however, that injury and illness are major limitations to achieving excellence in sport, and if simply maintaining an adequate Vitamin D level may reduce the risk of either (as some authors suspect), then it would appear a worthwhile objective. Over the coming years, further research may show whether this suspicion is correct or not, but even without a high level of evidence it is clear that this is an area that physicians and elite athletes of all sporting codes are now taking seriously. Given that testing for 25(OH)D is simple and readily available in most centres, we recommend at least annual evaluation of athletes’ 25(OH)D status. In the Middle East, we have recognised a seasonal variation in 25(OH)D concentrations which, in contrast to most other parts of the world, results in peak concentrations of Vitamin D at the end of the winter. This reflects the increased sunlight exposure by athletes when the temperature is more manageable throughout the winter months. Hence, it may be reasonable to assess Vitamin D at the end of winter (when levels are expected to be highest in the Middle East) and again at the end of summer (when levels may be expected to be lowest). Routine supplementation of athletes with Vitamin D without a confirmed diagnosis remains controversial. As outlined above, appropriate sunlight exposure and a rounded diet is often adequate to maintain appropriate Vitamin D levels. Furthermore, the risk of contamination of Vitamin D supplements is always a consideration when dealing with elite athletes, and any supplements used must be of pharmaceutical grade to ensure no risk of sustaining an adverse analytical finding in an anti-doping test.

SUMMARY

Vitamin D is an inappropriately named endogenously produced steroid hormone whose metabolic impact on the body is yet to be fully elucidated. Increasingly, an association between Vitamin D deficiency and many chronic diseases is being established and the true incidence of Vitamin D deficiency is being recognised. Athletes are not exempt from either Vitamin D deficiency or the problems associated with Vitamin D deficiency. However, it remains to be determined if Vitamin D levels are relevant to physical performance. We recommend that in regions and sports where sunlight exposure may be limited that athletes undergo monitoring of Vitamin D levels and, when necessary, undergo education and supplementation in order to maintain optimal Vitamin D levels in the blood.

References


Bruce Hamilton M.B., Ch.B.
Chief of Sports Medicine
Aspetar – Qatar Orthopaedic Sports Medicine Hospital
Doha, Qatar
Contact: bruce.hamilton@aspetar.com