Vitamin D Status and Supplementation in Elite Irish Athletes

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Background: A high prevalence of vitamin D insufficiency/deficiency, which may impact on health and training ability, is evident among athletes worldwide. This observational study investigated the vitamin D status of elite Irish athletes and determined the effect of wintertime supplementation on status. Methods: Serum 25-hydroxyvitamin D [25(OH)D], calcium, and plasma parathyroid hormone were analyzed in elite athletes in November 2010 (17 boxers, 33 paralympians) or March 2011 (34 Gaelic Athletic Association [GAA] players). A subset of boxers and paralympians (n = 27) were supplemented during the winter months with either 5,000 IU vitamin D3/d for 10–12 weeks or 50,000 IU on one or two occasions. Biochemical analysis was repeated following supplementation. Results: Median 25(OH)D of all athletes at baseline was 48.4 nmol/L. Vitamin D insufficiency/deficiency (serum 25(OH)D <50 nmol/L) was particularly evident among GAA players (94%) due to month of sampling. Wintertime supplementation (all doses) significantly increased 25(OH)D (median 62.8 nmol/L at baseline vs. 71.1 nmol/L in April or May; p = .001) and corrected any insufficiencies/deficiencies in this subset of athletes. In contrast, 25(OH)D significantly decreased in those that did not receive a vitamin D supplement, with 74% of athletes classed as vitamin D insufficient/deficient after winter, compared with only 35% at baseline. Conclusions: This study has highlighted a high prevalence of vitamin D insufficiency/deficiency among elite Irish athletes and demonstrated that wintertime vitamin D3 supplementation is an appropriate regimen to ensure vitamin D sufficiency in athletes during winter and early spring.

Keywords: cholecalciferol, paralympians, boxing, GAA

Aside from the classical role of vitamin D in calcium homeostasis and bone health, this fat-soluble vitamin has been implicated in many physiological processes that may adversely affect the health and training ability of an athlete. An inadequate vitamin D status has been associated with an increased risk of stress fracture, total body inflammation, infectious illness, impaired muscle function (Larson-Meyer & Willis, 2010; Willis et al., 2008), and increased risk of many noncommunicable diseases (Holick, 2005).

With the exception of oily fish, a rich source of vitamin D3 (cholecalciferol), few dietary sources of vitamin D are available in Ireland. Low vitamin D intakes have been reported for much of the Irish population (Barnes et al., 2006; Cashman et al., 2008, 2009; Hill et al., 2004), with sunlight exposure being the main source of the vitamin. Upon exposure of the skin to sunlight (UVB radiation; wavelength 290–310 nm), 7-dehydrocholesterol in the epidermis and dermis is converted to vitamin D3. Following cutaneous synthesis or dietary ingestion, vitamin D undergoes hydroxylation in the liver to 25-hydroxyvitamin D (25(OH)D), the status marker of the vitamin. In the kidney 25(OH)D is converted to 1,25-dihydroxyvitamin D, the biologically active hormone that plays a key role in calcium homeostasis, in conjunction with parathyroid hormone (PTH) and calcitonin (Lanham-New et al., 2011). In Ireland (latitude 51–56°N), UVB radiation from sunlight is of insufficient intensity to promote cutaneous vitamin D production for 6 months of the year, spanning October–March (Holick, 1994; Webb et al., 1988), and consequently, wintertime vitamin D insufficiency has been demonstrated among Irish adults (Barnes et al., 2006; Cashman et al., 2008, 2009). Taken together with the low dietary intakes reported among the Irish population, it is evident that vitamin D insufficiency, which is a 25(OH)D concentration of less than 50 nmol/L, is of concern and that supplementation may be warranted within this population.

A circulating 25(OH)D concentration less than 25 nmol/L (10 ng/ml) is used to define vitamin D deficiency (UK Department of Health, 1998), and while a serum 25(OH)D level of 50 nmol/L is believed necessary to maintain the classical skeletal effects of vitamin D (Institute of Medicine [IOM], 2011), recent evidence suggests that much higher concentrations (75–100 nmol/L) are needed for disease prevention, muscle strength, and opti-
A high prevalence of vitamin D insufficiency is evident in athletes worldwide with studies reporting 26–91% of athletes as having a 25(OH)D concentration of less than 50 nmol/L (Constantini et al., 2010; Close et al., 2012; Ducher et al., 2011; Bescós García & Guisado, 2011; Hamilton et al., 2010; Lehtonen-Veikoma et al., 1999; Lovell, 2008; Morton et al., 2012). Insufficiency is prevalent even at latitudes where cutaneous vitamin D production is unaffected by season (Constantini et al., 2010; Ducher et al., 2011; Hamilton et al., 2010; Lovell, 2008). Constantini et al. (2010) reported that the prevalence of vitamin D insufficiency in indoor Israeli athletes was almost double that of outdoor athletes, so it is plausible that this high prevalence of deficiency reported in athletes is a consequence of the long hours spent training indoors. Notwithstanding outdoor training time during peak sunlight and geographic location, skin color, adiposity, sunscreen use, and choice of athletic clothing will impact on the vitamin D status of athletes (Larson-Meyer & Willis, 2010).

Willis et al. (2008) recommend that athletes should aim to achieve a serum 25(OH)D of at least 75–80 nmol/L and that daily supplementation with 1000–2000 IU (25–50 μg) vitamin D may be required to achieve these levels. Higher doses given less frequently can also maintain optimal 25(OH)D levels (e.g., 50 000 IU vita-

The Irish Sports Council (2012) recommends against the use of sports supplements because it believes that a) a correct dietary and nutritional regimen will provide all the potential benefits of sports supplements, b) elite athletes are opening up the possibility of inadvertent positive doping tests, and c) it is inappropriate for any junior athlete to be taking supplements that could have an impact on their physical development. This stance is based on scientific evidence showing that a significant proportion of supplements available on the market are contaminated with substances which are on the WADA prohibited list (Geyer et al., 2008) and on the WADA strict liability rule.

To our knowledge no reports currently exist regarding the vitamin D status of Irish athletes; therefore, the aim of this study was to determine the vitamin D status of elite Irish athletes and to determine the effect of wintertime vitamin D3 supplementation on status in a subset of these athletes.

Methods

Subjects

Elite Irish athletes from three cohorts were invited to take part in this study: boxers from the Irish Amateur Boxing Association; paralympians from the Paralympic Council of Ireland and Gaelic Athletic Association (GAA) players from the Down County Board. Eligible subjects were athletes of at least 18 years of age, residing in Ireland (51–56°N), and who had provided a blood sample for previous consultancy purposes.

Ethics

Ethical approval was obtained from the University of Ulster research ethics committee. All written informed consent was provided retrospectively by athletes, in line with the Declaration of Helsinki, for the use of their data in this research.

Study Design

Baseline sampling was undertaken across different seasons of the year. Athletes from two cohorts (boxers and paralympians) were sampled in early November 2010, when vitamin D status is expected to be falling after peaking in late September (Hyppönen & Power, 2007). The GAA players were sampled at the end of winter (March 2011), the nadir for vitamin D status (Hyppönen & Power, 2007; Webb et al., 1988).

A subset of the boxers and paralympians, who had an insufficient/deficient vitamin D status at baseline (25(OH)D < 50 nmol/L), were offered oral supplementation over the winter months according to supplementation protocols devised by the athletes’ high performance teams. Paralympic athletes were offered 5,000 IU (125 μg) vitamin D3 daily for 10–12 weeks from January 2011. The team doctor outlined the rationale for supplementation and it was at the discretion of the athletes as to whether supplements were taken or not. Compliance was not assessed outside of 25(OH)D measurements in April or May. Boxers were offered 50,000 IU (1,250 μg) vitamin D3 on one or two occasions (at least 1 month apart) during the supplementation period. All boxers and paralympians were then sampled after the winter months in April or May 2011. All participants received an information sheet that contained background information on vitamin D, from diet and sunlight, and its purported beneficial effects for athletes.

Measures

Blood Collection. An 8-ml blood sample (4-ml serum and 4-ml EDTA plasma) was taken from each athlete at all available time points. These samples were stored on ice and separated within 3 hr of collection. Aliquots of serum and plasma were stored at –80°C until analysis.

Food Frequency Questionnaires (FFQ). Habitual dietary vitamin D (μg/d) and calcium (mg/d) intake from food sources were estimated from a subset of the boxers and paralympians at baseline using a validated FFQ (Collins, 2006). This 15-item questionnaire records information on the frequency of consumption of vitamin D and calcium-containing foods as well as...
estimates of typical portion sizes consumed, with the aid of a photographic food atlas (Ministry of Agriculture, Fisheries and Food, 1997).

The questionnaires were coded, entered into a self-designed spreadsheet independently by two researchers, and checked for agreement. Published values of the vitamin D and calcium content of foods per 100 g were used (Food Standards Agency, 2002), along with frequency of consumption and portion size estimates, to calculate habitual daily intakes of vitamin D and calcium.

**Biochemical Analysis.** Samples were analyzed for serum 25(OH)D and calcium concentrations at the University of Ulster and plasma PTH analyzed at Altnagelvin Area Hospital. Serum 25(OH)D was determined by ELISA; IDS Octeia 25-hydroxy vitamin D enzyme immunoassay (Immunodiagnostic Systems Limited, UK). The intra- and interassay coefficient of variation for this method was 3.9% and 4.6%, respectively. Total unadjusted calcium concentration was measured in serum using ILab Chemistry Systems (Instrumentation Laboratory Company, Lexington, MA USA). Plasma PTH concentration was analyzed using the ARCHITECT Intact PTH two-step sandwich assay (Abbott Diagnostics, Abbott Park, IL, USA).

**Statistical Analysis**

All statistical analysis was conducted using SPSS (version 19.0, SPSS Inc., Chicago, IL, USA), and significance was set at .05 throughout. The Kolmogorov-Smirnov statistic showed data did not follow a normal distribution, so square-root transformations were applied to achieve a more normal distribution. All continuous variables [25(OH)D, serum calcium, plasma PTH, mean daily intake of vitamin D, and calcium; excluding age] were transformed in the current study.

Descriptive statistics (median [25th, 75th percentiles], or n [%] where appropriate) were used to display the participant demographics at baseline. The distribution of vitamin D status according to established cut-offs was also described at baseline (sufficient: 25(OH)D ≥50 nmol/L, insufficient: 26–49 nmol/L and deficient: ≤25 nmol/L; Lips, 2004). Differences between groups were tested using one-way analysis of variance with Tukey post hoc tests, independent t tests or chi-squared tests, where appropriate. One-way analysis of covariance was also used at baseline to control for the seasonality of sampling.

Partial Pearson’s correlation coefficients were used to examine the relationship between the biochemical markers of vitamin D metabolism and dietary intake variables from the FFQ, after controlling for age and athletic group.

The effect of supplementation is presented graphically and was assessed using paired t tests and one-way analysis of covariance controlling for age, athletic group, baseline vitamin D intake, and status. Results are interpreted using the distribution of post-supplementation vitamin D status according to the established cut-offs used at baseline.

A total of 84 athletes were included in the current study. The demographics of the study population and baseline characteristics are shown in Table 1. With the exception of nine paralympic athletes, all athletes were male. However, there were no significant differences between the sexes in terms of any biochemical or dietary intake measure at baseline (data not shown). Age, vitamin D status and serum calcium concentrations were significantly different between the groups at baseline. Both vitamin D status and serum calcium concentrations were significantly lower

### Table 1 Participant Demographics and Baseline Measures

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total, (N = 84)</th>
<th>Boxers, (n = 17)</th>
<th>Paralympians, (n = 33)</th>
<th>GAA, (n = 34)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling month</td>
<td>November</td>
<td>November</td>
<td>March</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N (%) of men</td>
<td>75 (89)</td>
<td>17 (100)</td>
<td>24 (73)</td>
<td>34 (100)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age (years)</td>
<td>25 (22, 30)</td>
<td>20 (19, 23)a</td>
<td>32 (22, 39)b</td>
<td>26 (23, 28)c</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>25(OH)D (nmol/L)</td>
<td>48.4 (32.6, 64.0)</td>
<td>64.8 (49.1, 72.5)a</td>
<td>57.9 (48.9, 67.7)a</td>
<td>33.4 (28.8, 41.6)b</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>N (%) insufficient/deficient†</td>
<td>46 (55)</td>
<td>5 (29)</td>
<td>9 (27)</td>
<td>32 (94)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PTH (ng/L)</td>
<td>34.10 (25.20, 43.73)</td>
<td>31.60 (28.40, 40.20)</td>
<td>34.90 (20.60, 44.90)</td>
<td>37.90 (28.40, 43.65)</td>
<td>.462</td>
</tr>
<tr>
<td>Calcium (mmol/L)</td>
<td>2.46 (2.39, 2.53)</td>
<td>2.52 (2.47, 2.54)a</td>
<td>2.49 (2.40, 2.57)a</td>
<td>2.43 (2.36, 2.46)b</td>
<td>.001</td>
</tr>
<tr>
<td>Vitamin D intake (μg/d)‡</td>
<td>4.37 (2.52, 7.63)</td>
<td>3.64 (2.61, 6.20)</td>
<td>5.49 (2.46, 8.09)</td>
<td>~</td>
<td>.756</td>
</tr>
<tr>
<td>Calcium intake (mg/d)‡</td>
<td>958 (671, 1512)</td>
<td>1170 (807, 1709)</td>
<td>914 (507, 1474)</td>
<td>~</td>
<td>.214</td>
</tr>
</tbody>
</table>

**Note.** N (%) or median [25th, 75th percentiles], all such values; p for difference between groups (Chi-square, ANOVA, or independent t tests, p < .05). To convert μg to IU, multiply by 40. GAA = Gaelic Athletic Association; 25(OH)D = 25-hydroxyvitamin D; PTH = parathyroid hormone.

a,b,c Different superscript letters donate significant differences within the groups (p < .05, Tukey post hoc tests).

25(OH)D cut-offs: sufficient (≥50 nmol/L); insufficient (26–49 nmol/L); deficient (≤25 nmol/L).

‡Mean daily intakes measured using a validated FFQ, n = 41 (boxers, n = 15; paralympians, n = 26).
in the GAA athletes compared with the boxers and paralympians. However, after controlling for age, analysis of covariance indicated this significant difference in serum 25(OH)D and serum calcium concentrations between groups was accounted for by the different season of sampling (data not shown).

Mean daily vitamin D and calcium intake were significantly correlated at baseline after controlling for age and athletic group ($r = .561, p < .001$), however were not associated with circulating 25(OH)D, PTH or calcium concentrations (all $p > .05$). Of the athletes that completed a FFQ, 1 was taking a multivitamin and mineral supplement and 12 were taking a fish oil supplement; however brand information (and therefore vitamin D content) was not available to analyze these supplements as part of the FFQ.

A comparison of the baseline characteristics between the wheelchair-bound and more mobile paralympic athletes is shown in Table 2. At baseline, vitamin D and serum calcium concentrations of wheelchair-bound athletes were significantly lower, and a greater proportion were classified as vitamin D insufficient/deficient (25(OH)D ≤ 50 nmol/L), compared with their more mobile counterparts, without significantly affecting PTH concentrations. There were no significant differences in mean daily vitamin D or calcium intakes between the two groups of paralympians.

A total of 50 athletes were available for postsupplementation sampling (boxers: $n = 17$; paralympians: $n = 33$). Vitamin D status and PTH concentrations were available postsupplementation in all fifty, however, postsupplementation calcium concentrations were only available in 49 of these athletes (boxers: $n = 17$; paralympians: $n = 32$). Twenty seven of these 50 athletes were supplemented over the winter (12 paralympians with 5000 IU/day vitamin D$_3$ for 10–12 weeks and boxers with 50,000 IU once ($n = 5$) or twice ($n = 10$), with doses separated by at least 1 month during the supplementation period). Change in 25(OH)D from baseline was significantly different for all treatment groups in comparison with the control group (Table 3). As there was no significant difference in change in 25(OH)D between each of the supplementation protocols (Table 3), the effect of supplementation on 25(OH)D was considered combining data obtained from all supplementation protocols, compared with control (Figure 1). Paired $t$ tests showed a significant increase in 25(OH)D from baseline in the supplemented group, compared with a significant decrease in the control group. In analysis of covariance, a significant effect of treatment on postsupplementation 25(OH)D concentration remained after controlling for age, athletic group, baseline vitamin D intake, and status. Vitamin D supplementation significantly explained approximately 44% of the variance in postsupplementation vitamin D status ($p < .001$).

### Table 2 Comparison of Wheelchair-Bound and More Mobile Paralympic Athletes at Baseline

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Wheelchair-Bound, $(n = 12)$</th>
<th>More Mobile, $(n = 21)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>N° (%) of men</td>
<td>8 (67)</td>
<td>16 (76)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age (years)</td>
<td>35 (28, 40)</td>
<td>27 (22, 38)</td>
<td>.181</td>
</tr>
<tr>
<td>25(OH)D (nmol/L)</td>
<td>49.2 (31.6, 65.0)</td>
<td>62.9 (55.7, 67.7)</td>
<td>.032</td>
</tr>
<tr>
<td>N° (%) insufficient/deficient†</td>
<td>6 (50)</td>
<td>3 (14)</td>
<td>.027</td>
</tr>
<tr>
<td>PTH (ng/L)</td>
<td>37.60 (20.55, 44.15)</td>
<td>34.20 (20.60, 46.20)</td>
<td>.710</td>
</tr>
<tr>
<td>Calcium (mmol/L)</td>
<td>2.39 (2.34, 2.46)</td>
<td>2.54 (2.47, 2.59)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Vitamin D intake (μg/d)‡</td>
<td>5.47 (2.40, 7.50)</td>
<td>5.49 (2.51, 8.20)</td>
<td>.927</td>
</tr>
<tr>
<td>Calcium intake (mg/d)‡</td>
<td>1123 (836, 1550)</td>
<td>801 (457, 1418)</td>
<td>.195</td>
</tr>
</tbody>
</table>

Note. N° (%) or median (25th, 75th percentile), all such values; $p$ for difference between groups (Chi-square or independent $t$ tests, $p < .05$). To convert μg to IU, multiply by 40. 25(OH)D = 25-hydroxyvitamin D; PTH = parathyroid hormone.

†25(OH)D cut-offs: sufficient (≥50 nmol/L); insufficient (26–49 nmol/L); deficient (≤25 nmol/L).

‡Mean daily intakes measured using a validated FFQ, $n = 26$ (wheelchair-bound, $n = 10$; more mobile, $n = 16$).

### Table 3 Vitamin D Status by Supplementation Regime

<table>
<thead>
<tr>
<th>25(OH)D (nmol/L)</th>
<th>Control, $(n = 23)$</th>
<th>5,000 IU/day, $(n = 12)$</th>
<th>50,000 IU monthly, $(x1)$</th>
<th>50,000 IU monthly $(x2)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>57.9 (36.9, 72.2)</td>
<td>63.5 (55.6, 80.2)</td>
<td>44.1 (36.3, 48.3)</td>
<td>65.6 (60.7, 72.9)</td>
<td>.098</td>
</tr>
<tr>
<td>Postsupplementation</td>
<td>45.2 (33.7, 50.9)a</td>
<td>80.3 (55.8, 92.4)b</td>
<td>64.4 (63.2, 67.5) ab</td>
<td>73.7 (68.2, 88.4)b</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Change†</td>
<td>–11.9 (–20.9, –6.9)a</td>
<td>0.4 (–5.6, 31.5)b</td>
<td>19.6 (17.0, 29.5)b</td>
<td>9.4 (–1.8, 33.7)b</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note. Median (25th, 75th percentiles), all such values; $p$ for difference between groups (ANOVA, $p < .05$). 25(OH)D = 25-hydroxyvitamin D.

†Different superscript letters donate significant differences within groups ($p < .05$, Tukey post hoc tests).

Change from baseline (postsupplementation minus baseline).
At baseline, there was no significant difference in the proportion of athletes classified as vitamin D insufficient/deficient between the treatment groups (35% and 22% in the control and supplemented group, respectively; \( p = .324 \)). However, after supplementation, a significantly greater proportion of athletes in the control group were classed as vitamin D insufficient/deficient compared with those in the supplemented group (74% vs. 0%, \( p < .001 \)).

Serum calcium concentrations significantly decreased in both treatment groups, whereas no significant change in plasma PTH concentrations was apparent over time (data not shown). When analysis of covariance was repeated using calcium and PTH concentrations, there was no significant effect of treatment (data not shown).

**Discussion**

To our knowledge, this is the first study to investigate the vitamin D status of Irish athletes. Supporting previous findings among other athletic populations (Constantini et al., 2010; Close et al., 2012; Ducher et al., 2011; Bescós García & Guisado, 2011; Hamilton et al., 2010; Lehtonen-Veromaa et al., 1999; Lovell, 2008; Morton et al., 2012), a high prevalence of vitamin D insufficiency/deficiency was observed, with more than half of the total cohort having a baseline 25(OH)D concentration < 50 nmol/L. A high proportion (94%) of the GAA players, who were sampled at the end of winter, the nadir for vitamin D status, were classed as vitamin D insufficient/deficient. Similar findings have recently been observed among English Premier League professional soccer players with 65% of players being vitamin D insufficient in winter (Morton et al., 2012). Comparably, Close et al. (2012) reported 62% of UK professional athletes to be insufficient in winter. Vitamin D status in the GAA group is also comparable with that of Cashman et al. (2008), in a control group of healthy Irish adults sampled between February–April. Moreover, dietary intakes in both athletic groups assessed in the current study were similar to previous reports of low dietary vitamin D intakes among much of the Irish population (Barnes et al., 2006; Cashman et al., 2008, 2009; Hill et al., 2004). Dietary vitamin D intakes were not correlated with baseline serum 25(OH)D in the current study suggesting that sunlight...
was the main source of vitamin D for these athletes. It is possible, however, that supplements, which could not be analyzed for vitamin D content in this study, contributed significantly to the athletes’ vitamin D status. It is plausible that vitamin D insufficiency induced by insufficient sunlight exposure is exacerbated in athletes that spend large amounts of time training indoors. Although we did not assess sunlight exposure in the current study, time spent training indoors during the summer and early autumn likely affected vitamin D status in the boxers and paralympians at baseline (November). This is supported by Halliday et al. (2011), who recently reported that vitamin D status was significantly higher in college athletes in Wyoming (41.3°N) who participated in outdoor sports compared with those who participated in indoor sports in autumn.

To our knowledge, this is the first study to assess vitamin D status in elite paralympic athletes. Wheelchair-bound athletes had a significantly lower vitamin D status at baseline, with significantly more wheelchair athletes being classed as vitamin D insufficient/deficient in comparison with the more mobile paralympians. Dietary vitamin D intakes were similar between the two groups implicating reduced sunlight exposure as the probable cause. Although the paralympic athletes in the current study participated in both indoor and outdoor sports (athletics, soccer, Boccia and rowing), the wheelchair-bound athletes tended to spend more time indoors compared with their more mobile counterparts.

In the boxers and paralympians that were supplemented with vitamin D3 over the winter months, vitamin D status significantly increased postsupplementation, correcting any insufficiencies/deficiencies observed at baseline. The supplementation protocols used in this study are therefore effective in ensuring athletes are vitamin D sufficient with 25(OH)D concentrations approaching that considered optimal for athletes (75–80 nmol/L). Different supplementation regimes devised by the athletes’ high performance teams were used in the current study; 5,000 IU/d vitamin D3 is considered an adequate dose to maintain optimal vitamin D stores (Close et al., 2012; Larson-Meyer & Willis, 2010), and this dose has been administered to healthy men over a period of 20 weeks without significantly affecting serum calcium concentrations (Heaney, Davies, Chen, Holick & Barger-Lux, 2003). The alternative dose of 50,000 IU can be used to effectively treat vitamin D deficiency quickly (Larson-Meyer & Willis, 2010). The same dose of vitamin D3 has been administered to patients with metabolic bone disease every two weeks for up to 6 years as a maintenance dose to prevent recurrent vitamin D deficiency with no observed toxicity (Holick, 2011). This dose is within the recently revised tolerable upper limit of 4,000 IU/d specified by the Institute of Medicine (IOM, 2011). A recent systematic review and meta-analysis (Tripkovic et al., 2012) indicates that vitamin D3 is more efficacious at raising 25(OH)D concentrations compared with vitamin D2, therefore vitamin D3 may become the preferred choice of supplementation for athletes.

There are limited reports concerning vitamin D supplementation among athletes. Lovell (2008) observed that 15 out of 18 female elite Australian gymnasts had a serum 25(OH)D < 75 nmol/L (with 6 having 25(OH)D < 50 nmol/L). Furthermore, 13 gymnasts were found to have suffered from a bony stress injury within the previous 12 months. This study was conducted in Canberra (35.27°S), 2 months after the end of the Australian summer. It is thus likely that indoor training time in addition to skin cancer prevention advice to cover up arms and legs during lunch breaks impacted on the vitamin D status of these athletes. Following this study, all gymnasts in the Australian Institute of Sport female artistic gymnastics program with a circulating 25(OH)D concentration < 75 nmol/L were supplemented with 1,000 IU/d vitamin D3 (Lovell, 2008). A more recent study conducted at a latitude similar to the current study used a higher dose of vitamin D3, and similar to that used in the current study. In this small study of English professional soccer players, Close et al. (2012) demonstrated that supplementation with 5,000 IU/d vitamin D3 for 8 weeks significantly increased total serum 25(OH)D from baseline (mean ± SD = 29 ± 25 nmol/L), with all athletes achieving a vitamin D sufficient status following supplementation (mean ± SD = 103 ± 25 nmol/L). Furthermore significant increases in vertical jump height and 10-m sprint times were observed following supplementation, demonstrating for the first time that vitamin D3 supplementation improves musculoskeletal performance in athletes.

In contrast to the supplemented athletes, vitamin D status significantly decreased among athletes that did not receive a vitamin D3 supplement over winter in the current study. Furthermore, at the end of winter, levels of vitamin D insufficiency/deficiency within these athletes were more than double that of baseline. This finding highlights that wintertime supplementation may be required at higher latitudes, irrespective of status achieved over the summer months, to ensure sufficiency throughout the winter months. Indeed, among professional Spanish footballers (location 37°N), it has been suggested that a serum 25(OH)D concentration of approximately 122 nmol/L is necessary in mid-October to ensure serum 25(OH)D is greater than or equal to 75 nmol/L in early February (Galan et al., 2012). In the current study, only a single athlete achieved this status at baseline (November) further highlighting the need for wintertime supplementation among these athletes.

Conclusions

This is the first study demonstrating a high prevalence of vitamin D insufficiency/deficiency in elite Irish athletes, particularly after the winter months when cutaneous vitamin D3 synthesis is absent, and also in those with limited UV exposure (i.e., wheelchair-bound athletes). Food sources of vitamin D are limited and intake of vitamin D from dietary sources was inadequate to maintain status within the elite Irish athletes assessed.
in this study. Therefore in athletes residing at higher latitudes, supplementation with vitamin D₃ should be recommended over the winter months, as an effective regimen to ensure vitamin D sufficiency (25(OH)D > 50 nmol/L) is maintained. Based on our study findings the following practical recommendations can be made: a) rich dietary sources of vitamin D should be recommended to all athletes, b) elite athletes, residing at high latitudes, should be supplemented with vitamin D₃ over the winter months (October–March), and c) vitamin D₃ supplementation should account for baseline status and should be monitored by the medical/nutritional team, and d) the medical/nutrition team needs to take all steps and precautions to ensure that the vitamin D₃ supplement is tested and free from contamination.

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References


