Efficacy of high dose vitamin D supplementation in improving serum 25-hydroxyvitamin D among laboratory personnel working at the Nepal National Center for Rheumatic Diseases

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Abstract. Vitamin D deficiency is a highly prevalent condition worldwide. However, few studies have been conducted to examine the vitamin D status of laboratory personnel and the correlation between vitamin D deficiency and working conditions. The aim of the present study was to assess changes in serum 25-hydroxyvitamin D [25(OH)D] concentration with a weekly dose of oral cholecalciferol (60,000 IU) for two months. The prospective, open-label, interventional study was conducted from January 2016 to March 2016 at the National Centre for Rheumatic Diseases, Kathmandu, Nepal. The serum level of 25(OH)D in 19 healthy laboratory volunteers was measured at baseline and following the 2-month regimen with cholecalciferol supplement at 60,000 IU (1,500 µg)/week in oral tablet form. At baseline the mean serum 25(OH)D level was 10.31±7.78 ng/ml, which was increased following completion of the course of oral cholecalciferol to 59.78±14.74 ng/ml. This difference in the mean serum level of 25(OH)D compared with baseline was significant to P<0.001. These results indicate that vitamin D deficiency is prevalent among laboratory workers, and that high dose vitamin D3 (60,000 IU cholecalciferol) in tablet form may be effective in achieving sufficient serum 25(OH)D among laboratory personnel who tend to have lower baseline serum 25(OH)D. In conclusion, vitamin D deficiency may be common among laboratory workers, and guidelines should be formulated to implement vitamin D supplementation among laboratory personnel, as well as indoor workers, in Nepal.

Introduction

Vitamin D deficiency is a global health problem; an estimated 1 billion people across all ethnicities and age groups have deficient or inadequate levels of vitamin D worldwide (1). Vitamin D deficiency is mainly a result of reduced exposure to sunlight, which is essential for ultraviolet-B (UVB)-induced vitamin D production in the skin (2). Previous studies have indicated that vitamin D deficiency may be associated with increased incidence rates of cardiovascular disease, cancer, diabetes and cognitive impairment (3–6). It is considered that vitamin D deficiency is unlikely to occur in regions with adequate sunshine, and as such vitamin D deficiency may be overlooked in the neighboring countries of Nepal, including India and China (7,8). While different boundaries have been proposed to define vitamin D deficiency, Holick (9) defined vitamin D insufficiency as <30 ng/ml serum 25-hydroxyvitamin D [25(OH)D], and vitamin D deficiency as a serum 25(OH)D level <20 ng/ml. Vitamin D is considered the major sun-induced vitamin, and thus the traditional fashions in Nepal and India, religious or otherwise, may be responsible for vitamin D deficiency (8). In particular, indoor workers are probably unable to achieve normal serum levels of 25(OH) D from sun exposure alone. Though vitamin D3 is naturally present in small quantities in foodstuffs including oily fish, eggs and fortified foods, vitamin D supplementation is generally required to achieve the desired threshold concentration of serum 25(OH)D among deficient individuals (10).

There is no universally accepted threshold at which initiating vitamin D supplementation would achieve the greatest impact. Therapeutic strategies that aid adherence to treatment with the aim of providing long-term vitamin D supplement are of clinical interest. Similar to the trend in India (11), at present, it is common practice by physicians in Nepal to prescribe cholecalciferol at a dose of 60,000 IU/week for two months, then at 60,000 IU/month for six months for occult vitamin D deficiency. However, the short- and long-term effects on serum 25(OH)D levels in Nepalese individuals have not been systematically studied. Therefore, the present study reports on 19 healthy laboratory personnel working at the National Center for Rheumatic Diseases, Kathmandu, Nepal, with severe vitamin D deficiency who received oral
cholecalciferol at 60,000 IU/week for a duration of 2 months, with the aim of assessing changes in the serum concentration of 25(OH)D induced by cholecalciferol supplementation.

Materials and methods

Location. Kathmandu is the capital and largest metropolitan city of Nepal in terms of population, located centrally at an elevation of ~1,400 m (4,600 feet) above sea level in the Kathmandu Valley. At high altitude UVB travels over a shorter distance to the earth's surface and thus the skin is exposed to higher levels, enabling it to produce more vitamin D3; according to Holick et al (12), there is direct correlation of increased previtamin D3 production with increased altitude. Notably, they observed in the Indian city, Agra (169 m altitude), that there was a 5-fold decrease in previtamin D3 production compared with that at Mount Everest base camp (5,300 m altitude) (12).

Subjects. Between January 2016 and March 2016, a prospective open-label 2-month study was performed on 19 healthy laboratory volunteers (mean age 23.47±3.18 years) working at the National Center for Rheumatic Diseases. Serum 25(OH)D level was measured at baseline and after a 2-month regimen with oral cholecalciferol supplement at a dose of 60,000 IU (1,500 µg)/week (Cholirol-60K; Vega Pharmaceuticals Pvt., Ltd., Nepal) in tablet form. The majority of the volunteers (n=19) had insufficient sunlight exposure as they generally worked in the laboratory from 8 a.m. to 6 p.m.

Subjects included in the study were aged 18 years and older, working in the laboratory and available for follow-up after 2 months. Subjects excluded from the study were part time laboratory workers, not available for follow-up and/or taking vitamin D ≥400 IU/day prior to the study. All subjects were counseled to confirm the weekly intake of cholecalciferol and the 2-month follow-up after completion of treatment. Volunteers were advised to retain the same sun exposure pattern during the study period. Drug compliance was also assessed by counting empty sachets. As the study was a pilot, in the study. Participants ranged in age from 19 to 30 years (mean age 23.47±3.18 years), and there was a greater proportion of females (n=15, 79.0%) than males (n=4, 21.0%). At baseline, 17 subjects (89.4%) exhibited vitamin D deficiency, 1 (5.3%) exhibited insufficiency and 1 (5.3%) exhibited sufficiency. The mean 25(OH)D level of females was 10.15±8.45 ng/ml while the mean 25(OH)D level of males was 17.80±13.42 ng/ml.

Data collection. Vitamin D estimation was performed in the Diagno Labs Pvt., Ltd., Gurgaon, India using an ELISA kit provided by Roche Diagnostics GmbH (06506780160; Mannheim, Germany). Serum 25(OH)D levels were measured by electrochemiluminescence using a fully automated system (Cobas e411; Roche Diagnostics GmbH, Mannheim, Germany). Vitamin D deficiency, insufficiency and sufficiency was defined based on serum 25(OH)D concentrations of <20, 20-30 and 30-100 ng/ml, respectively (9).

Data analysis. Statistical analysis was performed using SPSS 20.0 software (IBM Corp., Armonk, NY, USA). Data are presented as means ± standard deviation. A dependent samples t-test was used to compare the means of serum 25(OH)D levels at baseline and after the 2-month regimen with oral cholecalciferol supplement. The statistical testing was two-tailed, and P<0.05 was considered to indicate statistical significance.

Results

Characteristics of study participants. As presented in Table I, relevant data were available for all 19 subjects included in the study. Participants ranged in age from 19 to 30 years (mean age 23.47±3.18 years), and there was a greater proportion of females (n=15, 79.0%) than males (n=4, 21.0%). At baseline, 17 subjects (89.4%) exhibited vitamin D deficiency, 1 (5.3%) exhibited insufficiency and 1 (5.3%) exhibited sufficiency. The mean 25(OH)D level of females was 10.15±8.45 ng/ml while the mean 25(OH)D level of males was 17.80±13.42 ng/ml.

Effect of oral cholecalciferol on serum 25(OH)D concentration. At baseline, the mean 25(OH)D level was 10.31±7.78 ng/ml with a minimum of 4 ng/ml and maximum of 37.6 ng/ml. Following completion of the course of oral cholecalciferol, the serum concentration of 25(OH)D in all volunteers was in the sufficient range (30-100 ng/ml). The mean serum level of 25(OH)D following the supplement course was 59.78±14.74 ng/ml, with a minimum of 42 ng/ml and maximum of 94.50 ng/ml (Fig. 1 and Table I). Notably, following the weekly supplement of cholecalciferol for two months, the increase in the mean serum level of 25(OH)D compared with baseline was significant to P<0.001 (Table II).

Discussion

Few studies have been conducted on oral vitamin D3 supplementation in Nepal. However, low levels of vitamin D have been associated with reduced health, particularly by contributing to increased risk of fractures, functional limitations and chronic diseases (3-5). To the best of our knowledge, the present study was the first prospective study in Nepal to evaluate the effect of high dose oral vitamin D3
Concluded that indoor occupations were minimal, which was the probable cause for their vitamin D levels (~8 a.m. to 6 p.m.), and thus their sunlight exposure was limited. This is similar to the findings of Gowda et al (25) and Garrett-Mayer et al (26). Notably, following the oral supplementation regimen, the present study observed an almost 5-fold increase in serum 25(OH)D level compared with that at baseline. This trend of a rise in serum 25(OH)D following 2 months of supplementation with cholecalciferol is similar to observations in Indian (11) and Caucasian (27) subjects. Additionally, findings of the present study demonstrated that supplementation with high dose vitamin D3 (60,000 IU/week cholecalciferol) restored serum levels to sufficient levels (>30 ng/ml) among laboratory personnel, even for those with lower baseline levels.

Although the US Endocrine Society Clinical Practice Guidelines (28) recommends 1,500-2,000 IU/day vitamin D for adults aged 19 years and over, there is currently no recommendation for vitamin D supplementation in Nepal. Thus, health policy-makers should formulate a uniform guideline for the supplementation of vitamin D in Nepal. Furthermore, health professionals working indoors and office workers should be educated on the benefits of vitamin D supplementation.

There were a number of limitations to the present study. Firstly, the majority of study subjects were women, and thus the results may not be generalizable to general populations. Secondly, the sample size was relatively small and there was a lack of consideration of exposure to sunlight, sunscreen application, clothing coverage, dietary information and other vitamin D supplementation, which may have influenced the change in serum 25(OH)D during the course of the study. Finally, the study was conducted during winter (January to March), and a previous study has demonstrated that individuals working at night and for longer hours may be vulnerable to deficits in vitamin D. As further factors to consider, Wacker et al (24) observed that vitamin D deficiency was associated with weather, time of day, altitude, air pollution and blockage of sunlight by high-rise buildings. Kathmandu is at high altitude, which may be beneficial for the skin regarding its production level of vitamin D3; however, being among the most polluted cities globally, the blockage of sunlight by air pollution may be a reason for deficits in vitamin D (18).

Few studies have indicated the effect of high dose vitamin D on serum 25(OH)D. However, in the present study, following the 2-month regimen of weekly oral cholecalciferol, the mean serum level of 25(OH)D was significantly increased. This is similar to the findings of Gowda et al (25) and Garrett-Mayer et al (26). Notably, following the oral supplementation regimen, the present study observed an almost 5-fold increase in serum 25(OH)D level compared with that at baseline. This trend of a rise in serum 25(OH)D following 2 months of supplementation with cholecalciferol is similar to observations in Indian (11) and Caucasian (27) subjects. Additionally, findings of the present study demonstrated that supplementation with high dose vitamin D3 (60,000 IU/week cholecalciferol) restored serum levels to sufficient levels (>30 ng/ml) among laboratory personnel, even for those with lower baseline levels.

Table II. Mean 25(OH)D levels of laboratory personnel at baseline and following cholecalciferol supplement therapy.

<table>
<thead>
<tr>
<th>Serum 25(OH)D level, ng/ml</th>
<th>Mean ± SD</th>
<th>P-value</th>
</tr>
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<tbody>
<tr>
<td>Baseline</td>
<td>10.31±7.78</td>
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<tr>
<td>After supplementation</td>
<td>59.78±14.74</td>
<td>&lt;0.001</td>
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Figure 1. Serum 25-hydroxyvitamin D levels of each participant (n=19) at baseline and following oral cholecalciferol supplementation (60,000 IU/week) for two months.

Consistent with previous studies (14-16), the results of the present study indicated that females had lower 25(OH)D levels than males. Traditional and religious clothing habits and lifestyle are considered to be responsible for vitamin D deficiency, particularly in women (17,18). In Nepal, the majority of individuals, particularly females, wear clothes that shield the majority of the skin from sunlight, due to religious beliefs and/or cosmetic concerns, which thus reduces the synthesis of vitamin D.

The major source of vitamin D in humans is sunlight. In the present study, at baseline, the majority of volunteers exhibited deficient 25(OH)D levels. Exposure to sunlight for ~20 min per day is considered to maintain sufficient levels of vitamin D (15,16). However, all participants in the present study worked in a laboratory during typical sunlight hours (~8 a.m. to 6 p.m.), and thus their sunlight exposure was minimal, which was the probable cause for their vitamin D deficiency, and is in accordance with previous studies (19,20). Roomi et al (18) concluded that indoor occupations were associated with hypovitaminosis D, and a later study on coal mine workers identified vitamin D deficiency and insufficiency among the participants (21). Furthermore, a study in Korea (22) demonstrated that occupational factors including shift work (shifts from 2 pm to midnight, 9 pm to 8 am the following day and 24-hour shifts) and office work were associated with an increased risk of vitamin D deficiency. Similarly, a British cohort study (23) indicated that individuals working at night and for longer hours may be vulnerable to deficits in vitamin D.

As further factors to consider, Wacker et al (24) observed that vitamin D deficiency was associated with weather, time of day, altitude, air pollution and blockage of sunlight by high-rise buildings. Kathmandu is at high altitude, which may be beneficial for the skin regarding its production level of vitamin D3; however, being among the most polluted cities globally, the blockage of sunlight by air pollution may be a reason for deficits in vitamin D (18).

Figure 1. Serum 25-hydroxyvitamin D levels of each participant (n=19) at baseline and following oral cholecalciferol supplementation (60,000 IU/week) for two months.
interventions that prevent vitamin D deficiency, and for the formulation of guidelines to implement vitamin D supplementation among indoor and office workers in Nepal.

In conclusion, to the best of our knowledge, the present study was the first to investigate vitamin D levels in laboratory personnel at baseline and following an oral supplementation regimen with cholecalciferol in Nepal. Vitamin D deficiency is an important but modifiable public health risk in Nepal, though often remains undiagnosed or insufficiently treated. Adequate sun exposure and vitamin D supplementation are key to achieving the vitamin D requirement of the body. The present findings highlight that vitamin D deficiency is common among laboratory workers. Further prospective studies with larger sample sizes are now required in this direction to examine the correlation between vitamin D deficiency and working conditions.

Acknowledgements

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References


