Comparative analysis of vitamin D levels in younger and older populations in rural vs. urban areas of Amravati district: An epidemiological survey

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Abstract

Background Deficiency of the sunshine vitamin, vitamin D, is a major public health issue which affects people all over the world. Vitamin D deficiency was common among populations in the Amravati district of India, particularly among females, young adults in rural areas and the elderly. While many studies have focused on vitamin D levels in individuals, few have compared vitamin D status in younger and older as well rural and urban populations.

Methodology The present study was conducted in the pathology department of a tertiary health care centre serving both a rural and urban population. 481 adult patients were examined from Jun 2017 to May 2019, age 20 to 78, of both sexes.

Result We found that there was a high frequency of vitamin-D deficiency/inadequacy. The overall prevalence of vitamin D deficiency (<20 ng/ml of serum 25-Hydroxyvitamin D) was 40%. There was significantly more deficiency in urban than rural areas. However, we found no significant differences by age or sex.

Conclusion Vitamin-D deficiency is very common in India. The clinically identified cases, on the other hand, are just the tip of the iceberg. Given the numerous effects that this deficiency might produce, this hidden pandemic slows the country's development. Vitamin-D deficiency must be managed with care and attention. Vitamin-D supplementation is critical for these residents who are vitamin-D deficient. Food fortification should be explored as the best long-term public health measure to improve the vitamin D status of the entire population.

Keywords- Deficiency, Vitamin -D, insufficiency, vitamin D status, vitamin D deficiency
Introduction

Traditionally vitamin-D deficiency is widespread across the Indian subcontinent, with research some years ago finding very high prevalence rates in the general population, with more recent research indicating it is a continuing problem. In addition, the high prevalence of clinical and biological hypovitaminosis D in apparently healthy school children in India has been reported. Figure 1 provides data by research site for multiple other studies documenting vitamin D deficiency prevalences in the country. This is a paradox, since India has plenty of sunlight that is essential for the body to generate the vitamin in the skin when exposed to ultraviolet B rays.

Vitamin-D deficiency has been recorded in other tropical nations as well. Regardless, it is the most underdiagnosed dietary deficiency on the planet.

Vitamin D (25(OH)D) levels are classified into four categories, as summarized in Table 1. The ideal and safe range for serum 25(OH) D levels is 30–100 ng/mL because when blood 25(OH) D levels approach 30 ng/mL, intestinal calcium absorption peaks and PTH levels drop.

Table 1. Diagnostic cut-offs of levels for serum Vitamin D

<table>
<thead>
<tr>
<th>Vitamin D status</th>
<th>The serum level of Vitamin D in ng/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficiency</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Insufficiency</td>
<td>21-29</td>
</tr>
<tr>
<td>Sufficiency</td>
<td>&gt;30</td>
</tr>
<tr>
<td>Toxicity</td>
<td>&gt;150</td>
</tr>
</tbody>
</table>

Few studies have looked at the vitamin D status of rural Indians and none have done so in the state of Maharashtra. In the present study, vitamin-D status was assessed in patients attending an outpatient department (OPD) in a rural Indian hospital in the Amravati District.

Methodology

This hospital-based cross-sectional study was conducted at an out-patient pathology department of a tertiary health care centre Amravati, Maharashtra, India. After obtaining informed consent, demographic information was collected from Jun 2017 to May 2019 from consecutive adult patients along with 3 ml blood sample for vitamin-D analysis using electrochemiluminescence on cobaselecs E411 fully automated system. Vitamin-D levels were compared across various groups by using Mann–Whitney or Kruskal–Wallis tests, and multiple linear regression analysis was performed to identify the predictors of vitamin-D level.
Figure 1. State wise distribution of prevalence of vitamin D deficiency in India

Study area and Patients
This study was conducted with a convenience sample of patients assisted in a tertiary health care centre in. Because these data were gathered as part of routine patient services, approval was not needed except for publication, which was obtained.

Clinical Observation
Serum 25-hydroxyvitamin D [25(OH) D] levels were statistically analysed according to sex, age and region. Other factors associated with vitamin-D deficiency were also explored. The medical staff carefully checked the patients before entering information such as their age, into their medical records. Follow-up data was used to determine the key clinical outcomes.
Results
A total of 481 patients aged 20 to 80 years were included in the study; 293 (60.9%) were from urban and (188) 39.1% were from rural areas; 32.0% were male and 68.0% were female. The average age of the males was 48.9 ± 11.5 years and the females, 44.8 ± 11.2 years. Table 2 shows that there was no significant association between mean serum 25(OH)D and age group. Table 3 also finds no difference when serum values are grouped by diagnostic category. Table 4 shows that vitamin D levels are significantly higher among rural residents. The mean concentration of 25(OH)D was 42.6 ng/ml among rural residents compared to 29.6 ng/ml for urban. Table 5 shows that there was no significant difference in vitamin D diagnostic category by sex in this sample of adults. The mean concentration of 25(OH)D was 32.4 ng/ml among males and 35.9 among the females.

<table>
<thead>
<tr>
<th>Age Group (In Yrs.)</th>
<th>Vit D (Mean) (ng/mL)</th>
<th>F-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-40</td>
<td>30.9391</td>
<td>0.94</td>
<td>0.39 [NS]</td>
</tr>
<tr>
<td>41-60</td>
<td>35.2851</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61-80</td>
<td>42.0778</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Association between mean serum 25(OH)D and age

<table>
<thead>
<tr>
<th>Age Group (In yrs)</th>
<th>&lt;20</th>
<th>20-30</th>
<th>30-100</th>
<th>&gt;100</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
<td></td>
</tr>
<tr>
<td>20-40</td>
<td>42</td>
<td>24</td>
<td>26</td>
<td>7</td>
<td>0.24 [NS]</td>
</tr>
<tr>
<td>41-60</td>
<td>30</td>
<td>29</td>
<td>33</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>61-80</td>
<td>35</td>
<td>5</td>
<td>50</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Association between age group and serum Vit-D levels

Discussion
Contrary to popular belief, India has a high rate of vitamin-D deficiency. This may be attributed to, lack of sunshine exposure, skin pigmentation, application of sunscreen creams, Indian eating habits and a low intake of vitamin-D fortified foods. Though dietary intake of non-fortified foods cannot be expected to provide very much vitamin D, vegetarians, making up the majority of Indians, will on the whole receive less in the diet, though most Indian vegetarians consume dairy products and some consume eggs. Air pollution may play an important additional role in many areas of India, reducing the intensity of sunlight.
Table 4. Proportions of the sample in the Vit-D diagnostic categories by urban versus rural residency

<table>
<thead>
<tr>
<th>Region</th>
<th>Vit D Level (ng/mL)</th>
<th></th>
<th></th>
<th></th>
<th>P=value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;20</td>
<td>20-30</td>
<td>30-100</td>
<td>&gt;100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>116 (40)%</td>
<td>82 (28)%</td>
<td>78 (27)%</td>
<td>14 (5)%</td>
<td>&lt;0.001 [S]</td>
</tr>
<tr>
<td>Rural</td>
<td>50 (26)%</td>
<td>37 (19)%</td>
<td>77 (40)%</td>
<td>27 (14)%</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Proportions of the sample in the Vit-D diagnostic categories by sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Vit D Level (ng/mL)</th>
<th></th>
<th></th>
<th></th>
<th>P=value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;20</td>
<td>20-30</td>
<td>30-100</td>
<td>&gt;100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
<td>N(%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>47 (30%)</td>
<td>50 (32%)</td>
<td>48 (31%)</td>
<td>10 (6%)</td>
<td>0.49 [NS]</td>
</tr>
<tr>
<td>Female</td>
<td>122 (37%)</td>
<td>67 (21%)</td>
<td>108 (33%)</td>
<td>29 (9%)</td>
<td></td>
</tr>
</tbody>
</table>

Although we did not find differences in vitamin D status by age or sex, that of the urban population was significantly worse. Hashemipour et al.\textsuperscript{[26]} also found no significant variations between males and females in Tehran. However, other studies did find differences by age or sex\textsuperscript{[27-30]}.

The major limitation of this study was that it was a hospital-based. Thus it could have been a biased sample, resulting in an over- or under-estimate of the prevalence of vitamin D deficiency in the population of the district as a whole. In addition, this could have had some impact on the associations with sex, age, and residence that we tested for. Research on vitamin D deficiency will require more attention from researchers worldwide.

**Recommendations**

- The best way to solve this problem is to fortify foods with vitamin D. Vanaspati ghee (\textit{dalda}) in India is supplemented with 200 IU of vitamin D per 100 g. vitamin D fortification is also available in some brands of milk. However, this is clearly inadequate. Milk of any grade can be fortified. Vitamin D can be added to milk products such curd, yoghurt, and butter, as well as commercial oils. A wide range of commonly consumed foods, such as \textit{atta}, \textit{maida} and rice flour, could in theory be fortified. Foods fortified with vitamin D should be made widely available at a low cost and included in the public distribution system. To do this, a relevant research agenda must be implemented. The creation of a fortification programme then would require appropriate legislation followed by long-term political and administrative resolve and support.
Tackling pollution is also an important factor for vitamin D deficiency, because its prevalence is higher in polluted areas.\textsuperscript{[25]}

- Vitamin D deficiency is the most underdiagnosed and undertreated nutritional issue, so raising awareness through educational programmes is critical. Both doctors and the general public should be aware of its implications. To create, launch and sustain such a programme, sufficient time, money and effort are required.
- For the populations at greatest risk, such as pregnant women, breastfeeding women, children and the elderly, high-quality vitamin D supplements should be available at the PHC level.
- School-aged children can benefit from the following: education about the importance of adequate vitamin D levels and a healthy lifestyle; provision of vitamin D fortified foods at school lunches; and daily physical activity that ensures exposure to sunlight.
- Because mass screening is not possible, testing facilities for vitamin D levels should be made affordable and accessible to people at high risk of clinical vitamin D deficiency.
- The government should fund research organizations to examine and track the effects of supplementing programmes and fortification measures.

Conclusions
Vitamin-D deficiency is very common in India. The clinically identified cases, on the other hand, are just the tip of the iceberg. Given the numerous effects that this deficiency might produce, this hidden pandemic slows the country's development. Vitamin-D deficiency must be managed with care and attention. Vitamin-D supplementation is critical for these residents who are vitamin-D deficient. Compulsory fortification of some common food would be the lowest cost and most effective public health measure for prevention, indeed for ending this hidden epidemic.

Declarations
Availability of data and material – Data made available on request.
Competing interests – No authors showing any competing interest.
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Authors' contributions – 1. Dr. Ajay Daphale – Conceptualization, Methodology,
2. Dr. Amit Daphale – Reviewing of manuscript, data interpretation
3. Dr. Surita Daphale – Data interpretation, Methodology, writing of manuscript
4. Dr. Vaishali Thakare – Reviewing

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References


