

## Original Research Article

# Vitamin D deficiency, the urban epidemic: a cross-sectional study from Bhopal, India

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## ABSTRACT

**Background:** Vitamin D is a fat-soluble vitamin involved in the regulation of calcium homeostasis and bone health. Vitamin D deficiency results in abnormalities in calcium, phosphorous, and bone metabolism. We undertook a study in our part of the country to register the incidence of the deficiency in our community, and compared Urban and Rural communities to understand the cause of the deficiency.

**Methods:** This retrospective non-randomised cross-sectional study was carried out on asymptomatic patients undergoing blood tests due to various causes. 257 individuals consented to be part of the study and were divided into Urban (n=143) and Rural (n=114) groups. Incidence of Vitamin D deficiency, and various socio-behavioural parameters were compared.

**Results:** The prevalence of Vitamin D deficiency was 91.6% in the Urban population and 66.5% in the rural population, which is statistically significant ( $p < 0.00001$ ). This was observed despite the urban group having statistically better nutritional status and lower tobacco consumption.

**Conclusions:** Vitamin D deficiency is a widespread condition in community. Clinically diagnosed cases represent only the tip of the iceberg. This silent epidemic needs to be addressed with due attention and strong action.

**Keywords:** Bhopal, Vitamin D deficiency, Rural, Urban

## INTRODUCTION

Vitamin D is a fat-soluble vitamin involved in the regulation of calcium homeostasis and thus is essential for a healthy skeletal system. It is synthesized in vivo when UV rays from the Sun strike the skin and trigger vitamin D synthesis.<sup>1</sup> There are only few foods that naturally contain vitamin D or are fortified with it. The major source of vitamin D is exposure to natural sunlight, and thus the major cause of vitamin D deficiency is lack of sun exposure.<sup>2</sup> There is not yet any consensus on what constitutes vitamin D deficiency, with organisations

having various definitions, based on serum levels of 25-hydroxyvitamin D, or 25(OH)D. The Endocrine Society considers an individual Vitamin D deficient at less than 20 ng/ml, insufficient between 20-30 ng/ml and Vitamin D optimal at more than 30 ng/ml.<sup>1</sup> The Mayo Clinic considers a level less than 10 ng/ml severely deficient, 10-25 ng/ml mild to moderately deficient and 25-80 ng/ml optimal.<sup>3</sup> On the other hand, the American Association of Clinical Endocrinologists considers anything less than 30ng/ml deficient and 30-50 ng/ml optimal.<sup>4</sup>

Vitamin D deficiency results in derangement of calcium and phosphorous levels in the body which in turn affects bone metabolism. Severe and prolonged deficiency causes bone mineralization diseases- rickets in children and osteomalacia in adults. Vitamin D deficiency has been associated with falls, functional limitations, fractures, cancer, diabetes, cardiovascular disease, and depression. However, the U.S. Preventive Services Task Force notes that, “these associations are inconsistent and may vary by the cut point used to define low vitamin D levels.<sup>2</sup> Even when using a more conservative definition, many patients routinely encountered in clinical practice are still deficient in vitamin D.

The concern is that Vitamin D deficiency is often asymptomatic and goes undetected for long periods till it becomes severe. Severe or prolonged deficiency may cause the following symptoms:

Bone discomfort or pain in the lower back, pelvis, or lower extremities, Falls and impaired physical function, Muscle aches and proximal muscle weakness, Symmetric low back pain (in women).

Individuals with risk factors for vitamin D deficiency include patients with malnutrition, sedentary lifestyle including limited sun exposure, those who are obese or have dark skin. The elderly, with age  $\geq 65$ , gastrointestinal malabsorption due to various causes, liver disease or failure, renal insufficiency or patients on anticonvulsants or glucocorticoids are also prone to Vitamin D deficiency.<sup>5</sup>

Due to the high number of symptomatic patients showing up in Orthopaedic OPDs, it was likely that incidence of subclinical cases are quite high. This study was carried out in our part of the country to register the incidence of Vitamin D deficiency in asymptomatic individuals.

## METHODS

This non-randomised cross-sectional study was carried out on asymptomatic patients undergoing blood tests as part of Annual Physical examinations or as part of requirement to access Medical Insurance in Bhopal.

Thus, the test subjects included in the study were apparently healthy individuals. With Confidence level at 95%, Margin of Error 6%, and assuming a prevalence of 60% from previous studies, the required sample size was calculated to be 257. Results were accessed between Nov 2019 - Feb 2020 retrospectively, for blood tests done from Nov 2017- Nov 2019.

Records were accessed and a questionnaire was used for the interview. We screened a total of 426 subjects found eligible for the study, out of which 257 were recruited after excluding 169 subjects that could not be contacted, had incomplete data or did not provide consent.

**Study design:** Retrospective non-randomised cross sectional study.

**Study location:** Records were accessed and the study carried out at a private hospital in Bhopal.

**Study duration:** November 2017 to November 2019.

**Sample size:** 257 patients (Confidence interval 95%, margin of error 6%)

**Subjects and selection method:** The study subjects were recruited retrospectively from the computerized records. Patients were divided into Urban (Group A) and Rural (Group B) group as follows:

Group A (n=143 patients): people residing in the limits of Bhopal Municipal corporation were categorized as ‘Urban’;

Group B (n=114 patients): people residing outside the limits of the Corporation were categorized as ‘Rural’.

### Inclusion criteria

Asymptomatic individual who had undergone Blood sampling by Phlebotomy, with available computerized records for annual physical examination or insurance purpose. Aged between 18-70 years.

### Exclusion criteria

Children or adults  $>70$  years of age, Patients on Vitamin D supplementation, or treatment for Osteoporosis, History of fractures within the last 10 years, Patients with nephropathy with or without abnormal renal function test results, Patients with liver disease with a deranged Liver function test, Patients taking concurrent corticosteroids, anticonvulsants and/or hormone replacement therapy, Patients who are Wheel chair bound or bedridden, Patients with a history of drug or alcohol abuse, Pregnant women, Patients with genetic disorders or endocrinopathies.

### Procedure methodology

The records of eligible subjects for the study were obtained and the subjects were contacted. After written informed consent was obtained, a pre-tested questionnaire was used to collect the data of the recruited individuals retrospectively. The questionnaire elicited information regarding socio-demographic and behavioural characteristics such as age, gender, nationality, height, weight, and consanguineous marriage, physical activity, lifestyle habits like smoking and alcohol. Exposure to daylight, and work conditions were also assessed through the questionnaire. Clinical data and laboratory investigations such as Vitamin D levels, Vitamin B12 levels, Hemogram, and Renal and Liver function tests were obtained from computerized laboratory records.

25-Hydroxy Vitamin D levels were measured by direct competitive chemiluminescence immunoassay for quantitative determination of total 25 (OH) D in serum. The results were classified as either Deficient or Optimal as per the American Association of Clinical Endocrinologists. All biochemical assays of the included subjects were carried out by the same method, throughout the study period.

### Statistical analysis

Data was analyzed using SPSS version 20 (SPSS Inc., Chicago, IL). The categorical data was analysed using Pearson's Chi-square test. Continuous variables were compared by the Unpaired t test. The level  $P < 0.05$  was considered as significant.

## RESULTS

Of the 426 eligible for the study, informed written consent was obtained from 257 subjects to participate in

**Table 1: Social and demographic details of both groups, and significant differences between the groups.**

	Group A (Urban, n=143)	Group B (Rural, n=114)	Total (n=257)	P value (Group A vs Group B)
<b>Mean Age</b>	39.8 years	44.2 years	41.7 years	0.0004
<b>Marital status</b>				
Married	111 (77.6%)	107 (93.8%)	218 (84.8%)	0.000313
Unmarried	32 (22.3%)	7 (6.1%)	39 (15.2%)	
<b>Education</b>				
Illiterate	1	8 (7%)	8 (3.1%)	0.000112
Primary	27	40 (35.1%)	67 (26.1%)	
Secondary and above	115	66 (57.8%)	182 (70.8%)	
<b>Occupation</b>				
Sedentary job	65 (45.4%)	36 (31.5%)	101 (39.3%)	0.017267
Active job	19 (13.2%)	34 (29.8%)	53 (20.6%)	
Home maker	21 (14.7%)	27 (23.6%)	48 (18.6%)	
Student	30 (20.9%)	10 (8.7%)	40 (15.5%)	
Unemployed	8 (5.5%)	7 (6.1%)	15 (13.1%)	
<b>Tobacco consumption</b>				
Everyday	37 (25.8%)	51 (44.7%)	88 (34.2%)	0.002919
Sometimes	18 (12.5%)	16 (14%)	34 (13.2%)	
Never	88 (61.5%)	47 (41.22%)	135 (52.5%)	
<b>BMI</b>	23.4	22.7	23.1	0.0082
<b>Co-morbidity (DM/HTN)</b>				
Yes	35 (24.4%)	27 (23.7%)	62 (24.1%)	0.88289
No	108 (75.5%)	87 (76.3%)	195 (75.9%)	

The prevalence of Vitamin D deficiency was 91.6% in the Urban population, contrasting with 66.5% in the rural population (Figure 1).

Only 12 urban individuals had adequate 25-OH Vit D levels, an abysmal 8.3% of the group. The mean duration of sun exposure was 23.7 minutes in the Urban group in

the study. Laboratory reports of these individuals were accessed. The mean age of the study population was 41.7 years, with the urban population being younger with a mean of 39.8 years compared to 44.2 years of the rural population.

Table 1 shows the socio-demographic characteristics of Urban and Rural participants. The rural group was significantly older, and more were married.

The urban population was better educated and more had sedentary jobs compared to the rural population. 44.7% of the Rural group was regularly consuming tobacco in some form, compared to only 25.8% of the Urban group. The urban group had significantly better nutritional status as evaluated by the BMI.

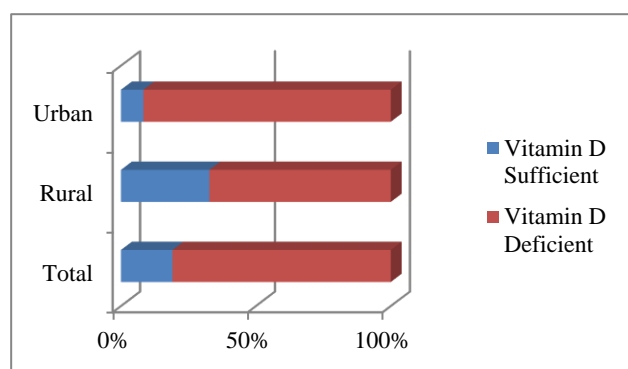
There was no statistical difference between the groups in terms of the comorbidities they suffered.

comparison to 56.1 min in the rural group. Table 2 lists the Vitamin D status, and mean Sun exposure.

The rural population had a higher sun exposure time which was found to be statistically significant and correlates well with serum Vitamin D levels in both groups.

**Table 2: Results, including p values.**

	Group A (Urban, n=143)	Group B (Rural, n=114)	Total (n=257)	P value (Group A vs Group B)
<b>Vitamin D</b>				
<b>Deficient</b>	131 (91.6%)	77 (66.5%)	208 (80.9%)	<0.00001
<b>Optimal</b>	12 (8.3%)	37 (32.4%)	49 (19.1%)	
<b>Mean Sun exposure duration/day</b>	23.7 min	56.1 min	38.1 min	<0.0001

**Figure 1: Vitamin D status in the urban and rural populations.**

## DISCUSSION

Vitamin D deficiency is prevalent worldwide, both in tropical and temperate climates. Nevertheless, it is the nutritional deficiency that is still under diagnosed and undertreated. Various studies have shown poor Vitamin D status irrespective of age, sex, and geography.<sup>7,8</sup> As there is no standard guideline followed all worldwide for classifying the Vitamin D status, studies have had different cutoff values for the deficiency. The vast majority of these studies used serum 25(OH) D level of <20 ng/ml as Vitamin D deficiency.

The community-based Indian studies of the past decade done on asymptomatic controls reported a prevalence ranging from 50% to 94%.<sup>9-19</sup>

These studies which included various age groups reflect the magnitude of the problem. High prevalence was seen throughout the country. Although the causes of Vitamin D deficiency hold no mystery, we have failed to prevent it to a large extent. India is bright and sunny, has a tropical climate with adequate sunshine. Most of the Indian population live in areas with adequate sunlight round the year, thus Vitamin D deficiency is counter-intuitive.

This might be due partly to the dark skin complexion, poor exposure to sunlight, popularity of sunscreens, vegetarian dietary habits and lower intake of Vitamin D fortified foods.<sup>20</sup> The high proportion of vegetarian diet among Indians means a lack of Vitamin D rich foods of

animal origin. All the above-mentioned factors can be a cause in urban population.

However, the rural population, who by the virtue of their occupation, active lifestyle and sufficient sunlight exposure might be expected to have adequate Vit D, too have been found deficient. This can be due to the high phytate and low calcium diet they consume, as postulated by Harinarayan et al.<sup>21</sup> Phytate rich diet is known to reduce the intestinal absorption of calcium. Hence, low dietary calcium increases the catabolism of 25(OH) D and increases the inactive metabolites with the resultant reduction in 25(OH)D concentrations.<sup>21,22</sup>

Urgent public health action is needed to rectify the situation. What can be done?

Vitamin D supplementation is easy, cost effective and can be done in the thousands of PHCs at a nominal cost. Six lakh IU given intramuscularly even at intervals of a couple of years are enough. High risk population including pregnant and lactating women, children, and elderly should be necessarily supplemented.

Awareness about Vitamin D deficiency is low, stays under diagnosed and undertreated. Both physicians and the public should be made aware of its implications.

Fortification of Food with Vitamin D. Oils, Dairy products can be good carriers for Vitamin D since it is a fat-soluble vitamin.

Revision of RDA for vitamin D school going children need education about a healthy lifestyle. Screen-time is to be reduced and children should be encouraged to play outside and gain valuable physical exercise and sunlight exposure. Vitamin D fortified foods, eggs and non-vegetarian fare should be considered in the mid-day meal program.

A minimum mandatory period of outdoor activity time prescribed in school can be an effective community-based step.

Laboratory tests for Vitamin D levels are prohibitively expensive and should be made affordable and accessible.

## Limitations

This is not a community-based study, was retrospective in nature and the groups were not well-matched, as is borne in the demographic data. The study also skews towards the more affluent part of the community, as participants afforded tests needed for routine annual tests or medical insurance. A more comprehensive, well matched and prospective study is needed to elucidate the true extent of the deficiency in the region.

## CONCLUSION

In India, Vitamin D deficiency is widespread. However, the clinically diagnosed cases represent only the tip of the iceberg. With the knowledge of the multiple consequences it can lead to, the gravity of the situation can be realized. This is a silent epidemic that may cause several potential morbidities across age group throughout the country. Vitamin D deficiency needs to be addressed with due attention and strong action.

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