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ORIGINAL ARTICLE

Widespread vitamin D deficiency among Indian health care professionals

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Abstract
Summary Information on vitamin D status of Indian health care professionals is limited. Among 2,119 subjects studied, just 6 % were found to be sufficient in vitamin D status. There is urgent need of an integrated approach to detect and treat vitamin D deficiency among health care professionals to improve on-the-job productivity.
Introduction Vitamin D deficiency is prevalent worldwide. India has been reported to be one of the worst affected countries. Several single-center studies from India have shown high prevalence of vitamin D deficiency. Little is known regarding the vitamin D status of Indian health care professionals.
Aim This study aimed to determine prevalence of vitamin D deficiency among health care professionals in different regions of India.
Method In this cross-sectional, multicenter study, we enrolled 2,119 medical and paramedical personnel from 18 Indian cities. Blood samples were collected from December 2010 to March 2011 and analyzed in a central laboratory by radioimmunoassay. Vitamin D deficiency was defined as 25-hydroxyvitamin D [25(OH)D] <20 ng/mL or <50 nmol/L, insufficiency as 25(OH)D=20–30 ng/mL or 50–75 nmol/L, and sufficiency as 25(OH)D >30 ng/mL or >75 nmol/L.
Results Mean (±SD) age of subjects was 42.71± 6.8 years. Mean (±SD) 25(OH)D level was 14.35± 10.62 ng/mL (median 11.93 ng/mL). Seventy-nine percent of subjects were deficient, 15 % were insufficient, and just 6 % were sufficient in vitamin D status. No significant difference was found between vitamin D status in southern (25(OH)D=13.3±6.4 ng/mL) and northern (25(OH)D=14.4± 8.5 ng/mL) parts of India.

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Conclusion Our study confirms the high prevalence of vitamin D deficiency all across India in apparently healthy, middle-aged health care professionals.

Keywords Vitamin D · Health care professionals · Latitude · India

Introduction

Numerous reports have shown that a large proportion of people all over the world have insufficient levels of vitamin D [1]. An International Osteoporosis Foundation report on the global status of vitamin D nutrition highlights South Asia (especially India) as one of the most deficient regions [1]. Vitamin D deficiency is widespread in India among all age groups and both sexes, despite abundant sunshine [2–5]. This is due to factors such as skin pigmentation, clothing habits, and absence of vitamin D fortification [1–5]. Generally, health care professionals are more aware of the importance of vitamin D and thus are expected to take some action to avoid being deficient. Information regarding vitamin D status among health care professionals is limited. Such information is important because employee health status can significantly impact workplace productivity. Musculoskeletal effects of vitamin D deficiency that can result in impaired productivity may include nonspecific musculoskeletal pain [6, 7], low back pain [8, 9], impaired cognition [10], falls [11], and bone fractures [12]. Numerous studies in literature have demonstrated an association of vitamin D deficiency with various nonskeletal disorders like migraine/headache [13], respiratory disorders [14], allergic rhinitis [15], arthritis [16, 17], asthma [18, 19], cancer [20–22], depression [23, 24], diabetes [25], gestational diabetes [26], heart disease [27], and hypertension [13].

High prevalence of vitamin D deficiency and its importance for extraskeletal health benefits are generally underrecognized by the general population. Meanwhile, individuals engaged in medical profession, although expected to be more aware regarding vitamin D, often spend most of their time indoors and have miserable solar exposure. In view of limited information available, we decided to conduct this study with the aim to examine the prevalence of vitamin D deficiency among the medical and paramedical professionals in different regions of India.

Methods

Subjects

In this study, we enrolled 2,119 middle-aged subjects from Mumbai, Cochin, Bangalore, Chennai, Hyderabad, Aurangabad, Bhopal, Kolkata, Jaipur, Madurai, Ahmedabad, Chandigarh, Vapi, Lucknow, and Jodhpur. Subjects included were physicians and health care professionals attending educational programs in endocrinology. Subjects were included in the study after obtaining a written informed consent from them. Ethical clearance was obtained from the Institutional Ethics Committee, B.R.I.D.E, Karnal.

Biochemical analysis

A random venous blood sample was collected for estimation of serum 25(OH)D. The samples were collected between December 2010 and March 2011. The serum was separated in a refrigerated centrifuge at 4 °C for 20 min at 700×*g* and stored at −20 °C for further analysis and transported to the central lab in standardized conditions. 25(OH)D concentrations were measured by radioimmunoassay (DiaSorin, Stillwater, MN). The minimal detectable limit of 25(OH)D assay is 1.5 ng/mL. Vitamin D deficiency was defined as 25(OH)D) <20 ng/mL or <50 nmol/L, insufficiency as 25(OH)D=20–30 ng/mL or 50–75 nmol/L, and sufficiency as 25(OH)D >30 ng/mL or >75 nmol/L.

Statistical analysis

Data were expressed as mean±SD. Descriptive statistic analysis was performed using MS Excel. Student's *t* test was used to compare the difference in mean serum 25(OH)D level between men and women as well as between northern and southern subjects.

Results

Among the 2,119 participants, there were 1,516 men (72 %) and 603 (28 %) women. The mean±SD age of subjects was 42.71±6.8 years. Concentrations of serum 25(OH)D ranged from 1.5 to 119.7 ng/mL. The mean±SD concentration of serum 25(OH)D was 14.35±10.62 ng/mL (median 11.93 ng/mL). There was no significant difference between vitamin D levels of men (12.76±7.31 ng/mL) and women (13.84±8.84 ng/mL). All data were grouped according to vitamin D status and listed in Table 1.

Median serum 25(OH)D level of subjects in various regions of India is shown in Fig. 1. Vitamin D status of the subjects in different regions of India is shown graphically in Fig. 2.

We used latitude 18° N to divide the country in its central part into southern and northern parts. The mean level of 25(OH)D in five cities of southern part of India (Hyderabad, Chennai, Bangalore, Cochin, and Madurai) was 13.3±6.4 ng/mL (median 11.9, n=482) versus 14.4±

Table 1 Vitamin D status of subjects in various regions of India

City	*N*	Age (years)	Mean 25(OH)D (ng/mL)	Median 25(OH)D (ng/mL)	Vitamin D deficient, *N* (%)	Vitamin D insufficient, *N* (%)	Vitamin D sufficient, *N* (%)
Ahmedabad	54	42.1±9.9	17.6±1.3	12.4	35 (65)	11 (20)	8 (15)
Aurangabad	24	28.8±4.8	15.1±4.0	14.8	22 (92)	2 (8)	0 (0)
Bangalore	71	44.2±14.9	11.4±6.8	10.6	65 (92)	5 (7)	1 (1)
Bhopal	10	32.8±4.5	12.0±4.1	11.9	10 (100)	0 (0)	0 (0)
Chandigarh	55	49.3±11.9	12.7±12.3	7.6	44 (80)	3 (5)	8 (15)
Chennai	155	42.9±12.5	13.9±7.7	12.3	132 (85)	15 (10)	8 (5)
Cochin	103	53.8±13.9	16.3±6.8	15.9	34 (71)	13 (27)	1 (2)
Delhi	110	47.3±10.4	15.3±11.2	11.9	83 (76)	18 (16)	9 (8)
Hyderabad	101	44.3±14.0	13.2±2.3	10.6	86 (85)	11 (11)	4 (4)
Jaipur	36	46.3±11.7	9.9±8.3	7.7	34 (94)	1 (3)	1 (3)
Jodhpur	31	45.7±11.0	7.1±8.3	4.6	30 (97)	0 (0)	1 (3)
Kolkata	82	42.4±13.2	16.7±6.5	16.2	61 (74)	19 (24)	2 (2)
Lucknow	44	43.3±11.3	8.8±7.2	5.5	39 (89)	5 (11)	0 (0)
Madurai	52	49.2±11.8	11.6±8.1	9.9	46 (88)	3 (6)	3 (6)
Mumbai	1,087	41.0±12.0	14.4±10.8	11.6	845 (78)	178 (16)	64 (6)
Cuttack	30	47.4±10.6	22.0±12.7	19.0	16 (54)	7 (23)	7 (23)
Surat	39	41.5±11.0	22.1±18.7	18.6	21 (54)	10 (26)	7 (20)
Vapi	35	27.5±4.7	13.4±5.0	12.4	29 (83)	6 (17)	0 (0)

8.5 ng/mL (median 11.9, n=1,637) measured in 13 cities of northern part (Aurangabad, Bhopal, Kolkata, Jaipur, Ahmedabad, Chandigarh, Vapi, Lucknow, Mumbai, Jodhpur, Delhi, Cuttack, and Surat), p=NS.

Discussion

We have demonstrated a very high prevalence of vitamin D deficiency in apparently healthy, middle-aged Indian adults

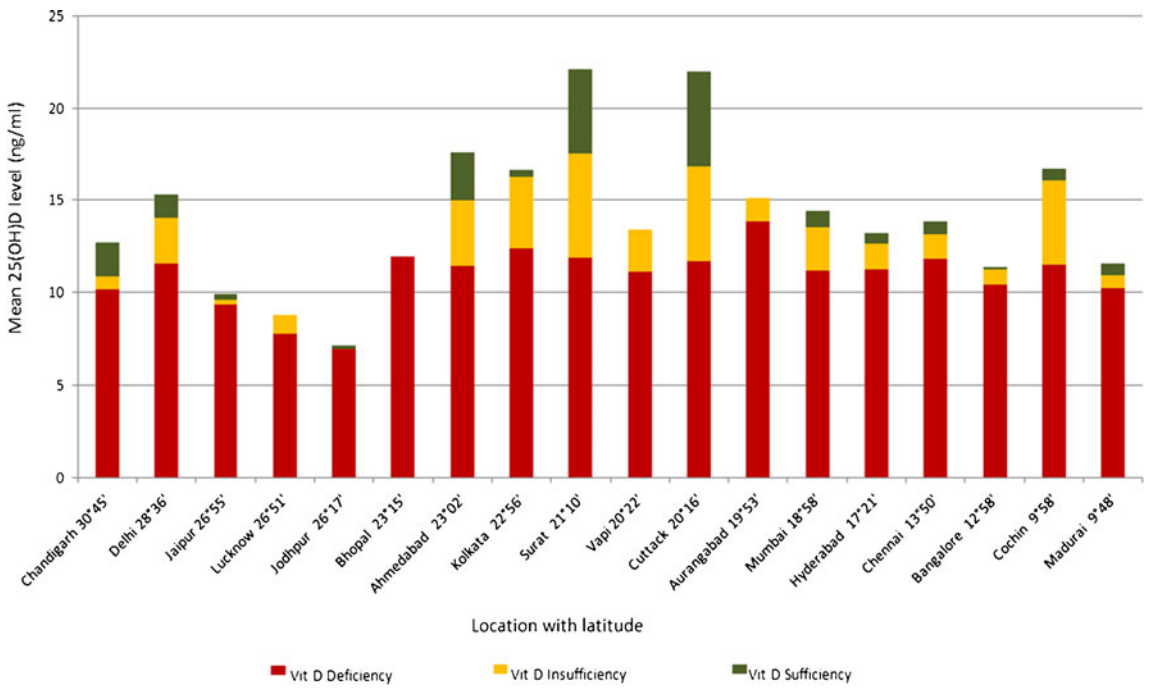

Fig. 1 Relative distribution of vitamin D level of subjects in various regions of India

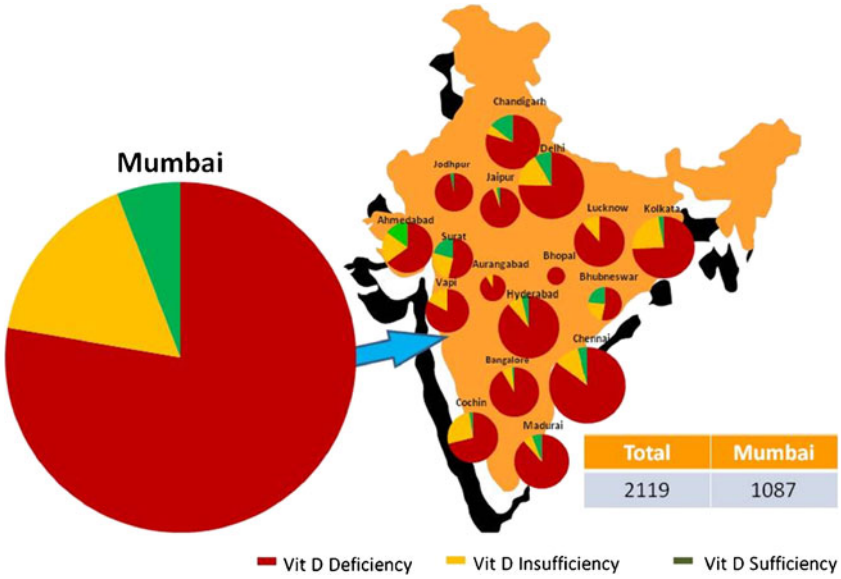

Fig. 2 Vitamin D status of subjects in various regions of India. Area of pie chart corresponds to the number of subjects investigated

engaged in health care services. In the current study, we found that 79 % of subjects were vitamin D deficient, 15 % had insufficient levels of 25(OH)D, and just 6 % of health professionals were adequate in vitamin D status. [1]. The study included a large number of volunteers recruited in southern and northern parts of India; mean concentration of 25(OH)D was 14.65± 10.32 ng/mL (median 11.93 ng/mL).

Our results correspond to some other studies from India which have reported vitamin D status among health care professionals. Goswami et al. [2] assessed vitamin D status in 123 healthy subjects residing in Delhi. Out of 123 subjects, the group comprising physicians and nurses (n=19) had significantly lower mean 25(OH)D level (7.98±3.49 nmol/L). Zargar et al. [5] found a very high prevalence (83 %) of vitamin D deficiency (defined as a serum 25(OH)D concentration of <50 nmol/L or 20 ng/mL) in apparently healthy middle-aged adults from Kashmir. In this study, between 70 and 100 % subjects in different groups were documented to have vitamin D deficiency. Among them, the prevalence of vitamin D deficiency in medical professionals was one of the highest (91.3 %).

Arya et al. [28] demonstrated vitamin D deficiency (defined as serum 25(OH)D concentration <15 ng/mL) in two thirds of healthy urban north Indian hospital staff. When a serum 25(OH)D level of 20 ng/mL was used as a cutoff, 78.3 % subjects were diagnosed to be vitamin D deficient/insufficient. Another study included 100 healthy adult women of reproductive age group from hospital staff and showed that all of them had vitamin D deficiency (25(OH)D <20 ng/mL) with a mean 25(OH)D level of 4.5±3.1 ng/mL [29]. Prior to this study, published data on vitamin D status, from various single-center studies, are available for a total of 234 health care professionals across India.

Only few other countries have reported their data on vitamin D status among health care professionals and have shown high prevalence of vitamin D deficiency among them. In a study examining the prevalence of vitamin D insufficiency in a group of free-living healthy young adults, consisting of mostly health care professionals (n=307), in Boston, Massachusetts, it was observed that 36 % of the subjects in age group of 18–29 years had vitamin D deficiency (defined as 25(OH)D level <20 ng/mL) at the end of winter [30]. High prevalence of vitamin D deficiency (87 %) (defined as 25(OH)D level <20 ng/mL) was found among 340 health care professionals studied in Qatar [31]. Mean serum 25(OH)D level in the study was 11.7 ng/mL, which is lower than that of our study. Another study by Jancin [32] involving 35 internal medicine house staff at Oregon Health Sciences University, Portland, revealed that 51.4 % of them were vitamin D deficient. A study conducted in health care professionals in Minnesota showed that nearly 30 % of the health care workers tested had serum 25-OH vitamin D levels lower than 20 ng/mL and additional 60 % had vitamin D levels <30 ng/mL [33].

The Indian subcontinent is situated between 8.4° N and 37.6° N latitude and has adequate sunshine throughout the year. Despite this fact, studies have shown widespread prevalence of hypovitaminosis D. This can be explained by skin pigmentation, traditional clothing, absence of vitamin D fortification, and air pollution [1]. Direct relation between vitamin D status and living in different latitudes has also been reported in literature [1]. Contrary to these results, we did not observe any effect of geographical location on the

prevalence of vitamin D deficiency. This may be because our study subjects belonged to a definite professional group with predominantly indoor activities and therefore lack of sunlight exposure.

Several major strengths distinguish the current study from previous ones. First, for the first time, vitamin D status has been estimated in such large number of health care professionals in India. Second, till now, only single-center studies have been conducted to assess vitamin D status in health care professionals. Ours is the only *multicenter study* conducted so far to evaluate vitamin D status among health care professionals. In fact, it is the first major multicenter study regarding vitamin D status from India. Third, we studied the effect of latitude on vitamin D status in subjects. Another important strength of the study is that blood samples collected in 15 different cities all over the country were analyzed in one laboratory. The limitation of the study includes lack of information on current medications including vitamin D supplements, concomitant diseases, and other factors that could possibly influence the results.

Awareness of vitamin D status in health care professionals is important. Health care professionals, who are aware of their own vitamin D status, are more likely to actively screen their patients for vitamin D deficiency. A study conducted in health care professionals in Minnesota concluded that low vitamin D status is associated with reduced employee work productivity [33]. Increasing levels of 25-OH vitamin D were associated with significantly improved on-the-job productivity in the study, with the best response at serum 25-OH vitamin D levels greater than 40 ng/mL [33]. The high prevalence of vitamin D deficiency in the present study points towards urgent need of an integrated approach to detect vitamin D deficiency among health care professionals and treat it appropriately. One such approach could be assessment of vitamin D status of all the hospital employees and its appropriate treatment at the time of employment and subsequently on a regular basis.

Conclusion

Our study confirms the high prevalence of vitamin D inadequacy all across the India. Vitamin D deficiency reaches its highest expression not only in vulnerable groups like children, the elderly, and pregnant women but also in middle-aged health care professionals. An integrated approach which includes vitamin D assessment and replenishment of health care professionals may signify a low-cost, high-return program to alleviate risk factors and health conditions that drive total employer health care costs.

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Conflicts of interest None.

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