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Absence of vitamin D deficiency among common outdoor workers in Delhi

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Abstract

Background: There is reservation about accepting the notion of widespread vitamin D deficiency (VDD) in sunny countries because information base is largely urban indoors, and the cut-off serum 25(OH)D > 75.0 nmol/L to define sufficiency is perceived as high.

Objective: We assessed the vitamin D status of subjects engaged in six types of outdoor jobs with freedom to seek shade, when needed.

Design: Descriptive observational study.

Subjects and methods: A total of 573 outdoors, (hawkers, n = 144; auto-rickshaw drivers, n = 113; manual rickshaw pullers, n = 49; fuel-station attendants, n = 84; gardeners, n = 96; traffic police personnel, n = 87) were assessed for serum 25(OH)D, iPTH and total calcium during summer and winter. Bank employees were indoor controls (n = 72). Serum 25(OH)D was defined as sufficient if ≥50.0 nmol/L and deficient when <30.0 nmol/L, as per 'Institute of Medicine'.

Results: Mean serum 25(OH)D of 573 outdoors was 44.8 ± 19.6 nmol/L and showed a physiological inverse relation with iPTH ($P < 0.001$). 77.5% of the outdoors did not have VDD. Hawkers, gardeners, fuel-station attendants and rickshaw pullers had sufficient or near sufficient serum 25(OH)D. The mean serum 25(OH)D (30.6 ± 23.2 nmol/L) of indoors though lower by 12.7 nmol/L than outdoors was above the cut-off of VDD. Proportions with supranormal iPTH were comparable between outdoors and indoors (14.0% vs 20.8%). Despite winter dip, the mean serum 25(OH)D (31.2 ± 14.3 nmol/l) of outdoors was not deficient.

Conclusions: Vitamin D deficiency is not universal. Most urban outdoor workers do not have VDD.

KEYWORDS

25(OH)D, outdoor workers, vitamin D

Pramila Dharmshaktu and Soma Saha contributed equally and are the joint first authors.

1 | INTRODUCTION

Vitamin D deficiency (VDD) is common in countries with cold climate and also in regions with plenty of sunshine as in India, Africa and Middle Eastern countries.[1-3] A systematic study from our centre in the year 2000 revealed a high prevalence of VDD among physicians.[1] Similar VDD was also reported in school children, teachers in Delhi and subjects from other parts of India.[4-7] Dark skin complexion, limited sun exposure and culture of wearing full body covering attire are the major contributory factors for VDD in sunny countries.[1,7,8] With reports suggesting pandemic of VDD, fortification of food with vitamin D is in offing in several countries.[9,10] However, there is a hesitation in accepting the notion of widespread VDD in sunny countries because information base is predominantly from urban indoors with paucity of data from outdoor population.[6,11-13] Besides, serum 25(OH)D level of >75.0 nmol/L to define vitamin D sufficiency is perceived as being rather high leading to an overestimate of prevalence of VDD.[14,15]

Interestingly, our recent study showed normal vitamin D status in outdoor construction workers of Delhi.[16] Absence of VDD in the construction workers was explained by compulsory long hours of sun exposure. However, this study suggested likelihood of good vitamin D status among outdoors working under sun with freedom to seek shade off and on as per their need. It is important to assess the vitamin D status of people working outdoors in order to focus the strategies for tackling VDD in urban cities. If the outdoor workers do not show gross VDD, vitamin D supplementation should be offered to indoor workers only with VDD, and not to all population. The aim of this study was to assess the spectrum of vitamin D status of outdoor workers engaged in different jobs in the urban areas of sunny region and its seasonal variation.

2 | MATERIAL AND METHODS

The study was carried during 2016-18, at the All India Institute of Medical Sciences (AIIMS), Delhi (latitude 28.70°N; longitude 77.11°E). The six groups of outdoor workers were selected based on the variation in their jobs: (a) hawkers or street vendors on pavements around AIIMS, (b) attendants from five fuel stations around AIIMS, (c) drivers of auto rickshaws plying in Delhi, (d) manual rickshaw pullers from a central market near AIIMS, (e) traffic police personnel in Delhi, and (f) gardeners from two plantation nurseries of central Delhi. Only those subjects who had been working for at least past six months in their respective outdoor jobs at Delhi were considered eligible to participate. They were initially investigated during summer, that is in June to September, 2016, when sunshine was available for most of the day with temperatures surging to 40°C. Seasonal variation of vitamin D status was assessed for subjects who had serum 25(OH)D levels ≥50 nmol/L during summer. Re-assessment was carried out during winter, that is January to March 2017. Subjects with use of calcium or vitamin D supplements during past six months were excluded. Those with any chronic illness during this period were also excluded.

Multiple visits were made by the authors to contact hawkers and pavement vendors. They were contacted individually to explain the aim of the study, requested to participate and advised to visit next day after overnight fasting to the Department of Endocrinology at AIIMS for investigations. Auto-rickshaw drivers and manual rickshaw pullers were contacted through their union leaders. The leaders motivated their fellow members to participate in this study. traffic police personnel, gardeners and fuel-station attendants were recruited after permission from their supervisors. These workers were requested to come after overnight fasting for investigations at a prefixed date. To facilitate fasting, camps were arranged at their work place and breakfast was served between 8:00 and 9:00 hours. Blood glucose was also measured using point of care glucometer device.

The controls were employees of a national bank located in the premises of the AIIMS and its nearby branches. These employees worked indoors from 9.30 AM to 5.00 PM and were recruited with the outdoor workers during summer months. All the subjects in the outdoor and indoor groups were interviewed individually about the details of their work schedule, clothes worn and pattern of daily sunlight exposure. Body surface area exposed to sunshine was assessed by the rule of nine.[17] The daily dietary intake of calories, carbohydrate, protein, fat, calcium and phytin phosphorus (phytin-P) was assessed by a trained dietician using a semi-quantitative food frequency questionnaire recording information on food groups and 40 food items commonly consumed by Indians.[18,19]

2.1 | Biochemical estimations

Ten ml of blood was drawn for biochemical investigations, and aliquots of the serum were stored at −20°C.[15] Serum total calcium, inorganic phosphorus, alkaline phosphatase and albumin were measured by Cobas-c111 analyzer (Roche; normal, 2.02-2.60 mmol/L, 0.81-1.45 mmol/L and 40-129 IU/L, 35-52 g/L, respectively). All the assays were performed in batches, and their intra- and inter-assay coefficients of variation were 3.5%-5.0%. Serum 25(OH)D and iPTH were measured by chemiluminescence assay using DiaSorin LIAISON® (DiaSorin, Inc). The measuring range for serum 25(OH)D was 10.0-374.4 nmol/L, with inter- and intra-assay CV of 4.8%-7.7% and 4.2%-7.7%, and 100% cross-reactivity with $25(OH)D_2$ and $25(OH)D_3$. Serum 25(OH)D and iPTH assays were performed in the Department of Cardiac Biochemistry. The laboratory had participating in the Randox International quality Assessment Scheme (RIQAS, https://www.randox.com/riqas-external-quality-assessment), since 2014 for external quality assessment.[20,21] The laboratory had acceptable performance in the RIQAS with 'Standard Deviation Index' of <0.60 (limit <2.0) during the study tenure. The measuring range for serum iPTH was 3.0-1900 ng/L with normal median (2.5th to 97.5th) of 34.0 (14.5-87.1) ng/L. Vitamin D status was defined as per the report of 'Institute of Medicine committee' with serum 25(OH)D ≥ 50 nmol/L considered as sufficient, <50 nmol/L as insufficient, and values <30 nmol/L as vitamin D deficient.[14]

TABLE 1 Study characteristics of outdoor and indoor workers

Characteristics	Outdoor (n = 573)	Indoor (n = 72)	*P*-value
Age (y)	39.4 ± 12.9	42.9 ± 12.9	0.03
BMI (kg/m^2)	23.5 ± 3.9	24.7 ± 3.8	0.01
Serum total Ca (mmol/L)	2.36 ± 0.12	2.40 ± 0.10	<0.001
Albumin-adjusted total Ca (mmol/L)	2.30 ± 0.10	2.35 ± 0.08	0.003
Serum inorganic phosphorus (mmol/L)	1.08 ± 0.18	1.07 ± 0.17	0.71
Serum albumin (g/L)	43.0 ± 3.7	43.2 ± 2.3	0.6
Serum alkaline phosphatase (IU/L)	88 ± 28	86 ± 27	0.54
Serum 25(OH)D (nmol/L)	44.8 ± 19.6	30.6 ± 23.2	<0.001
≥30.0 nmol/L, n (%)	444 (77.5)	26 (36.1)	<0.001
≥50.0 nmol/L, n (%)	192 (33.5)	13 (18.1)	0.008
Serum iPTH (ng/L)	55.7 ± 30.2	63.6 ± 33.2	0.03
≤87.1 ng/L, n (%)	493 (86.0)	57 (79.2)	
>87.1 ng/L, n (%)	80 (14.0)	15 (20.8)	0.16
Body surface area exposed (%)	12.9 ± 7.2	9.7 ± 3.7	<0.001
Dietary calories (kcal/d)	2085 ± 524	1850 ± 424	<0.001
Dietary calcium (mg/d)	818 ± 513	685 ± 423	0.03
Dietary phosphorus (mg/d)	1572 ± 509	1369 ± 421	0.001
Dietary phytin phosphorus (mg/d)	149 ± 99	136 ± 68	0.29
Dietary carbohydrate (g/d)	310 ± 82	276 ± 62	<0.001
Dietary protein (g/d)	70 ± 25	60 ± 20	<0.001

The study was carried out in accordance with the tenets of the Declaration of Helsinki. The Ethics Committee of AIIMS, Delhi, approved the protocol. Written informed consent was obtained from all the subjects.

2.2 | Sample size and statistical analysis

Sample size was based on the vitamin D status of male construction workers in the previous study.[16] With 14.8% prevalence of serum 25(OH)D < 50.0 nmol/L in construction workers and assuming a similar vitamin D status among the outdoors of the present study, a total of 539 subjects were required to estimate prevalence of VDD at 3% absolute error margin in a two-sided 95% confidence interval.

3 | RESULTS

A total of 605 outdoor workers were contacted (hawkers/pavement vendors, n = 152; auto-rickshaw drivers, n = 113; manual rickshaw pullers, n = 49; fuel-station attendants, n = 104; gardeners, n = 98; traffic police personnel, n = 89). In view of the limited number of females among outdoor workers, results are reported only for males (n = 573). Accordingly, only male indoor subjects were recruited as comparative controls (n = 73). The body surface area exposed was higher in the outdoor than in the indoor group ($P < 0.001$, Table 1).

3.1 | The vitamin D status of outdoor subjects and their comparison with indoor groups

The clinical and biochemical features of the outdoor and indoor workers are listed in Table 1. The mean age and BMI of all the 573 outdoor subjects were 39.4 ± 12.9 years and 23.5 ± 3.9 kg/m^2, respectively. Their daily dietary intake of calorie, protein, carbohydrate and calcium was 2085 ± 524 kcal, 70 ± 25 g, 310 ± 82 g and 818 ± 513 mg, respectively (Table 1). The mean serum 25(OH)D of the outdoors as a group was 44.8 ± 19.6 nmol/L and showed a physiological inverse relation with iPTH ($r = -0.21$, $P < 0.001$). 77.5% of the outdoors did not have VDD.

In comparison with outdoor workers, indoors had significantly lower mean serum 25(OH)D levels with 63.9% having serum 25(OH)D < 30.0 nmol/L ($P < 0.001$). Only 18.1% of the indoors had serum 25(OH)D ≥ 50.0 nmol/L ($P = 0.008$). The mean serum 25(OH)D was lower among indoors by 12.7 nmol/L than the outdoors ($P < 0.001$). The mean age and BMI of outdoors were significantly less than that of the indoors. In view of significant differences in the mean age and BMI between the outdoor and indoor groups, a regression analysis was carried out to assess the significance of difference in the mean serum 25(OH)D level between the two groups. The 25(OH)D levels were significantly higher among the outdoors even after adjustment of age and BMI differences ($P < 0.001$). The mean serum iPTH was higher in indoors than the outdoors and also showed an inverse relationship with serum 25(OH)D ($r = -0.28$, $P = 0.02$).

TABLE 2 Baseline characteristics of six different groups of outdoor workers

Parameter	Hawkers/pavement vendors (n = 144)	Fuel-station attendants (n = 84)	auto-rickshaw drivers (n = 113)	Gardeners (n = 96)	traffic police personnel (n = 87)	Rickshaw pullers (n = 49)	Indoors (n = 72)	*P* value
Age (y)	33.7 ± 12.7[b,c,d,f]	34.0 ± 10.6[g,h,i]	44.4 ± 10.8[n]	46.9 ± 12.1[q]	42.8 ± 12.2[s]	34.3 ± 9.9[u]	42.9 ± 12.9	<0.05
BMI (kg/m^2)	23.2 ± 4.0[b,d,e]	22.4 ± 3.4[g,l,k]	25.3 ± 4.1[l,n]	22.7 ± 3.8[p]	25.1 ± 3.1[s]	21.1 ± 2.7[u]	24.7 ± 3.8	<0.01
Serum total Ca (mmol/L)	2.36 ± 0.11[d]	2.33 ± 0.11[g,i,k]	2.36 ± 0.11[m]	2.33 ± 0.12[p,r]	2.43 ± 0.12[s]	2.33 ± 0.09	2.41 ± 0.10	<0.05
Serum albumin-adjusted Ca (mmol/L)	2.30 ± 0.13[b,d,f]	2.30 ± 0.10[g,i,k]	2.25 ± 0.08[l,m,n]	2.33 ± 0.08[p]	2.38 ± 0.10[s]	2.30 ± 0.08	2.35 ± 0.08	<0.05
Serum phosphate (mmol/L)	1.09 ± 0.18	1.13 ± 0.16	1.06 ± 0.17	1.09 ± 0.17	1.05 ± 0.21	1.06 ± 0.18	1.07 ± 0.17	<0.05
Serum albumin (g/L)	43.5 ± 4.3[a,b,c,d]	41.7 ± 2.4[g,i,k]	45.9 ± 3.3[m]	40.9 ± 2.9[q,r]	42.9 ± 2.7	41.3 ± 1.9	43.2 ± 2.3	<0.05
Serum ALP (IU/L)	87 ± 25	82 ± 23[g]	98 ± 29[m,n,o]	88 ± 31	84 ± 28	80 ± 27	86 ± 27	<0.05
Serum 25(OH)D nmol/L	49.7 ± 20.1[b,d,f]	45.3 ± 18.1[g,k]	36.4 ± 17.9[l]	51.4 ± 23.6[p,r]	39.4 ± 15.2	45.5 ± 13.3[u]	30.6 ± 23.2	<0.05
Median (IQR)	47.2(34.9-61.3)	42.7(30.6-57.4)	34.4(25.0-44.9)	46.2(35.4-63.4)	38.4(30.5-46.9)	43.7(37.7-54.2)	24.2(13.3-40.9)	
≥30.0 nmol/L, n (%)	124 (86.1)	65 (77.4)	69 (61.1)	78 (81.3)	66 (75.9)	42 (85.7)	26 (36.1)	<0.001
≥50.0 nmol/L, n (%)	67 (46.5)	31 (36.9)	18 (15.9)	45 (46.9)	15 (17.2)	16 (32.7)	13 (18.1)	<0.001
Serum iPTH (ng/L)	60.3 ± 33.0[d]	62.7 ± 29.6[i,j]	63.6 ± 34.5[m,n]	53.5 ± 25.7[p]	39.2 ± 19.5[t]	45.7 ± 21.3[u]	63.6 ± 33.2	<0.01
≤87.1 ng/L, n (%)	115 (79.9)	69 (82.1)	92 (81.4)	85 (88.5)	85 (97.7)	47 (95.9)	57 (79.2)	
>87.1 ng/L, n (%)	29 (20.1)	15 (17.9)	21 (18.6)	11 (11.5)	2 (2.3)	2 (4.1)	15 (20.8)	
Body surface exposed (%)	15.6 ± 7.8[a,b,c,d]	12.7 ± 3.8[h,i,j]	10.5 ± 3.7[k]	9.1 ± 3.6[q]	9.2 ± 3.6[s]	23.4 ± 10.8[e,u]	9.7 ± 3.7[f]	<0.05
Dietary Calories (kcal/d)	2016 ± 505[a,c]	2242 ± 598[g,k]	1913 ± 409[l]	2256 ± 612[r]	2088 ± 473[t]	2047 ± 401[u]	1850 ± 424	<0.05
Dietary Ca (mg/d)	665 ± 448[c,d,e]	771 ± 349[h,i,j]	762 ± 428[l,m,n]	1055 ± 570[p,q,r]	1124 ± 588[s,t]	468 ± 3778[u]	685 ± 423	<0.01
Dietary Phosphorus (mg/d)	1462 ± 447[a,c,d]	1639 ± 490[g,j,k]	1438 ± 369[l,m]	1802 ± 584[q,r]	1782 ± 543[s,t]	1245 ± 406	1369 ± 421	<0.05

Note: Inter-group differences are indicated by superscripts: a: hawkers vs fuel-station attendants; b: hawkers vs auto-rickshaw drivers, c: hawkers vs gardeners, d: hawkers vs traffic police personnel; e: hawkers vs rickshaw pullers; f: hawkers vs indoors; g: fuel-station attendants vs auto-rickshaw drivers; h: fuel-station attendants vs gardeners; i: fuel-station attendants vs traffic police personnel; j: fuel-station attendants vs rickshaw pullers; k: fuel-station attendants vs indoors; i: auto-rickshaw drivers vs gardeners; m: auto-rickshaw drivers vs traffic police personnel; n: auto-rickshaw drivers vs rickshaw pullers, o: auto-rickshaw drivers vs indoors; p: gardeners vs traffic police personnel; q: gardeners vs rickshaw pullers; r: gardeners vs indoors; s: traffic police personnel vs rickshaw pullers; t: traffic police personnel vs indoors; u: rickshaw pullers vs indoors.

The mean dietary calcium intake was significantly lower among indoors than the outdoors ($P = 0.03$). Although the mean serum inorganic phosphorus and alkaline phosphatase values were comparable between the outdoor and indoor groups, the mean serum total calcium was higher in indoors (Table 1).

3.2 | Vitamin D status of outdoors according to their different types of jobs

Table 2 lists the demographic characteristics, vitamin D status and related parameters in six types of outdoor jobs. The mean serum 25(OH)D was ≥30.0 nmol/L in all the six types of outdoor jobs with the highest levels in the gardeners (51.4 ± 23.6 nmol/L). The mean serum 25(OH)D was near sufficient range in the hawkers/pavement vendors (49.7 ± 20.1 nmol/L), rickshaw pullers (45.5 ± 13.3 nmol/L) and fuel-station attendants (45.3 ± 18.1 nmol/L). In contrast, the mean 25(OH)D level in traffic police personnel and auto-rickshaw drivers were comparable to that of the indoors. The mean serum iPTH was normal in all the six outdoor groups. Interestingly, auto-rickshaw drivers with the lowest mean 25(OH)D values had the highest mean serum iPTH levels (Table 2). Despite having serum 25(OH)D comparable to that of auto-rickshaw drivers, traffic police personnel had lowest mean PTH levels, highest mean serum total calcium levels and dietary calcium intake among all study groups (Table 2).

3.3 | Seasonal variation

A total of 192 outdoor subjects had serum 25(OH)D values ≥50.0 nmol/L during summer (Table 3). Eighty-four of them could be contacted during winters (hawkers/pavement workers, n = 21; gardeners, n = 29; petrol pump attendants, n = 23; auto-rickshaw drivers, n = 4; and traffic police personnel, n = 7). The mean serum 25(OH)D levels in these outdoors decreased significantly (70.2 ± 18.5 to 31.2 ± 14.3 nmol/L, $P < 0.001$). However, mean serum iPTH levels did not change significantly (49.3 ± 21.7 to 52.3 ± 28.6 ng/L, $P = 0.68$).

TABLE 3 Seasonal variation in 84 outdoor workers

Parameter	Summer	Winter	P value
Serum total Ca (mmol/L)	2.34 ± 0.11	2.31 ± 0.07	0.03
Serum albumin-adjusted Ca (mmol/L)	2.30 ± 0.10	2.30 ± 0.05	0.15
Serum inorganic PO4 (mmol/L)	1.11 ± 0.18	1.08 ± 0.17	0.31
Serum albumin (g/L)	41.8 ± 3.4	41.2 ± 2.1	0.08
Serum alkaline phosphatase (IU/L)	79 ± 24	88 ± 26	<0.001
Serum 25(OH)D (nmol/L)	70.2 ± 18.5	31.2 ± 14.3	<0.001
Serum iPTH (ng/L)	49.3 ± 21.7	52.3 ± 28.6	0.68

Though mean serum total calcium showed a fall of 0.03 mmol/L ($P = 0.03$) in winter, the albumin-adjusted serum total calcium did not change significantly in winter (2.30 ± 0.10 to 2.30 ± 0.05 mmol/L, $P = 0.15$).

4 | DISCUSSION

The ability to achieve good vitamin D status under prolonged hours of direct sunshine exposure has been shown by several investigators. The examples include farmers of Nebraska, coastal guards, field workers in Florida, and countries with plenty sunshine as Hawaii, Israel and Australia, where serum 25(OH)D ranged from 75 to 160 nmol/L.[22-27] The vitamin D status of traditional hunters in Tanzanian, Caribbeans and Indian construction workers too ranged from 75 to 115 nmol/L.[16,28,29]

The current study showed that most outdoor workers under indirect and less harsh sun exposure with freedom to seek shade were also free from VDD. The absence of VDD was observed in all the six groups of workers, irrespective of type of their outdoor jobs. In fact, the mean 25(OH)D levels were sufficient or near sufficient in gardeners, pavement vendors/hawkers, rickshaw pullers and fuel-station attendants. The mean serum 25(OH)D of auto-rickshaw drivers and traffic police personnel was also above the cut-off of VDD, but could not reach near sufficiency and can be explained by their pattern of sun exposure. Although auto-rickshaw drivers were plying for several hours, they were mostly seated under roof of their vehicle. Similarly, policemen stood under shade, wore cap and were intermittently out for tackling traffic rules offenders. These observations highlight that though indirect sun exposure can prevent VDD, for vitamin D sufficiency outdoors workers need to have direct sun exposure. The observation of near normal serum 25(OH)D of 50.0 nmol/L is common in southern India that receives more sunlight than north India.[30-32] Present study indicates that it is possible to have normal serum 25(OH)D naturally in outdoor workers of northern Indian region. When the opportunity to expose under the sun was missed as in the auto-rickshaw drivers and traffic police personnel, the serum 25(OH)D could not reach near sufficiency, that is 50 nmol/L, though levels were above the cut-off of VDD.

Not unexpectedly, the mean serum 25(OH)D of indoors was lower by 12.7 nmol/L than the outdoors. However, mean 25(OH)D values were still above 30.0 nmol/L, indicating absence of VDD in noteworthy fraction in summer. The higher mean serum 25(OH)D levels among indoors in the present study in comparison with values of 25.0 nmol/L in the previous studies[13,20] could be explained by several ways. The realization of the importance of sunshine exposure among urban indoors in improving vitamin D status during the last two decades and/or inadvertent use of vitamin D supplements among indoors might explain their improved vitamin D status. Similar improvement in vitamin D status was observed recently by Sowah et al[33] among healthcare professionals.

Present study observed a winter dip in the vitamin D status among outdoor subjects who were vitamin D sufficient during summer. Multiple factors like lack of available sun exposure, covered body surface area and increasing smog over Delhi due to construction or burning of agricultural crop stubbles in the states near Delhi could be the reasons for decline in serum 25(OH)D levels in winter. Interestingly, its functional effect on serum total calcium was negligible. Though mean serum total calcium showed a fall of 0.03 mmol/L (P = 0.03) during winter, the albumin-adjusted serum total calcium showed no significant change with season (2.30 ± 0.10 to 2.30 ± 0.05 mmol/L, P = 0.15). The mean serum 25(OH)D of 31.2 ± 14.3 nmol/l in winter indicated that several outdoor workers had serum 25(OH)D values below <30 nmol/L. However, despite this low value, they had normal mean serum iPTH and were clinically well and performing physically demanding jobs that required a good skeletal health. This brings the focus on the level of serum 25(OH)D actually needed for good skeletal health and also questions the relevance of term 'vitamin D insufficiency'. Subjects can be simply categorized as 'Vitamin D deficient' or 'non-deficient' using 'IOM' cut-off of 30 nmol/L, doing away with the category 'vitamin D insufficiency'.

Meta-analysis of studies assessing effect of vitamin D supplementation in apparently healthy subjects has not shown any remarkable effect on various functional outcomes.[34,35] In fact, two randomized control trials from our centre showed no significant improvement in muscle strength despite significantly improved vitamin D status after six months of cholecalciferol supplementation.[13,20] In this context, the present study does not show any functional impact of low serum 25(OH)D among indoors other than borderline raised serum PTH. There is possibility that a higher serum PTH among indoors, albeit within the range of normality, might be a fruitful bioadaptive response leading to increased calcium reabsorption in the renal tubules. The higher serum PTH among indoors could theoretically explain the paradox of higher mean serum calcium among indoors despite lower serum 25(OH)D in comparison with outdoors as observed in the present study and also in the previous study on outdoor construction workers in Delhi.[16]

The practice of advising vitamin D supplementation to the urban indoors in presence of the sufficient dietary calcium intake is questionable. The basis of this question and its answer is best exemplified with serum PTH value of traffic policemen group who also had sufficient dietary calcium intake. This group had lowest serum PTH values despite having lowest mean serum 25(OH)D among all outdoor groups.

Currently, vitamin D-fortified milk is being marketed (~250 IU/pack of 500 mL) in Delhi. However, whether this fortification is needed for indoors with sufficient calcium intake or for healthy outdoors needs to be debated in light of the current study. Unnecessary vitamin D supplementation could be associated with risks of hypercalcemia and hypercalciuria and so should be avoided. It would be preferable to depend on sun exposure to achieve vitamin D sufficiency particularly among the subjects with outdoor jobs.

To conclude, the present study indicates that vitamin D status of the majority of the urban outdoors and sizable number of the indoor population was not deficient as per the cut-off suggested by IOM. With complete freedom to move in and out of the shade as per the demand of the work and comfort of the body, the common outdoor workers showed sufficient or near sufficient serum 25(OH)D levels. Thus, contrary to the popular perception, VDD is not universal in urban population and majority of outdoors achieved vitamin D sufficiency by just following their day-to-day schedule. It is important to adopt a conservative view on fortification of food with vitamin D in countries with ample of sunshine due to the possibility of hypercalcemia and renal stone.

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CONFLICT OF INTEREST

The authors have nothing to disclose, and there is no conflict of interest.

AUTHORS CONTRIBUTION

Prof Ravinder Goswami designed and guided the study. Dr Soma Saha, Dr Pramila Dharmshaktu*, Parmita Kar and Dr Ravinder Goswami collected the data. Dr Vishnubhatla Sreenivas performed the statistical analysis. Dr Lakshmy Ramakrishnan supervised the vitamin D and PTH assays. All the authors have contributed in writing of the manuscript.

DATA ACCESSIBILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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