

## Article

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## Comparison of Serum Vitamin D Level between Outdoor and Indoor Working Professionals and Its Correlation with Serum Parathyroid Hormone Level

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### Abstract

**Background:** Parathyroid hormone (PTH) is functionally linked to vitamin D for calcium homeostasis in our body. **Objective:** To compare serum vitamin D level between outdoor and indoor working professionals of Dhaka city, Bangladesh, and observe its correlation with serum PTH level. **Methods:** This cross-sectional, analytical study was conducted in the Department of Biochemistry, Dhaka Medical College, Dhaka, Bangladesh, from July 2018 to June 2019. A total of 101 indoor and outdoor professional workers of both sexes working in different sectors living in Dhaka city participated in this study. They were divided into two groups – outdoor workers (n=35) and indoor workers (n=66). Estimations of both serum vitamin D<sub>3</sub> and PTH were estimated by using chemiluminescence microparticle immunoassay method. Statistical analysis was done by students unpaired t tests and Pearson correlation coefficient test. **Results:** Among outdoor workers, mostly hailed from Traffic Police Services (83%) and the rest (17%) were street hawkers. Indoor workers were recruited from the hospital – nurses (32%), doctors (27%), administrative employees (21%), hospital ward assistants (12%) and medical technicians (8%). Sufficient and insufficient levels of serum D<sub>3</sub> were observed more in outdoor professional workers than indoor (P<0.05) whereas deficient levels of serum D<sub>3</sub> was found more in indoor workers than outdoor workers (P<0.001). Mean serum vitamin D<sub>3</sub> level was found significantly

( $P < 0.001$ ) higher in outdoor workers than that of indoor workers ( $19.35 \pm 5.67 \text{ ng/ml}$  vs.  $14.17 \pm 4.18 \text{ ng/ml}$ ) but mean serum PTH level was not significantly different ( $P > 0.05$ ) in outdoor workers than that of indoor workers ( $42.35 \pm 18.27$  vs.  $37.78 \pm 17.54$ ); Moreover, there was no significant correlation between serum vitamin D and parathyroid hormone levels in both outdoor ( $r = +0.290$ ;  $p > 0.05$ ) and indoor ( $r = -0.206$ ;  $p > 0.05$ ) groups. **Conclusion:** Our data concluded that indoor working professionals were more prone to develop vitamin D deficiency although outdoor working professionals may be affected with vitamin D insufficiency. In addition, there may be no relationship between serum vitamin D and parathyroid hormone levels even in D deficient indoor workers.

**Keywords:** Serum vitamin D, 5-hydroxycholecalciferol( $D_3$ ), parathyroid hormone, calcium metabolism, outdoor and indoor professionals

### Introduction

Since vitamin D is widely known and classified as a vitamin for ages but recent evidence indicated that it can be produced in skin with the help of ultraviolet radiation from sunlight, which is a violation to the definition of a vitamin.<sup>1</sup> Hence, vitamin D is now recognized as a prohormone, which on subsequent activation through liver and kidney converted to its active form 1,25-dihydroxycholecalciferol and which functions like a hormone to mediate several endocrine effects to the distant sites from where it is produced.<sup>1,2</sup> The serum level of 25-hydroxycholecalciferol or vitamin  $D_3$  is generally considered as the best marker of a subject's vitamin D status, due to its ease of measurement, long half-life, and correlation with known vitamin D effects.<sup>3,4</sup> Vitamin D deficiency is a common disorder that is found in all age groups and in both genders. It is highly prevalent in various parts of the world including South Asian countries like Bangladesh.<sup>5,6</sup> Worldwide, many countries reported very high prevalence of low vitamin D status. 25(OH)D levels  $< 30 \text{ nmol/L}$  (or  $12 \text{ ng/ml}$ ) in  $> 20\%$  of the population are common in India, Tunisia, Pakistan, and Afghanistan. For

example, it has been estimated that 490 million individuals are vitamin D deficient in India.<sup>7,8</sup> Parathyroid hormone (PTH) is intricately linked to the physiological roles played by vitamin D. Membrane-bound calcium-sensing receptors in the parathyroid glands, continuously monitor the serum calcium levels.<sup>9</sup> When hypocalcemia sets in, these calcium-sensing receptors are activated, and they signal the parathyroid glands to release PTH, which in turn increases the conversion of 25-hydroxycholecalciferol(vitamin  $D_3$ ) to the active form 1,25-dihydroxycholecalciferol in the kidney. Thus, PTH works in synergy with vitamin D to regulate the serum calcium levels. Thus, calcium homeostasis is maintained by the parathyroid hormone and vitamin D.<sup>9-11</sup>

As we know that vitamin D synthesis is highly dependent on sunlight, factors and conditions causing lower time spent in outdoor activities, consumption of an imbalanced diet and low-quality (nutrient-poor) food, more covering clothing style, less skin exposure to sunlight and widespread use of sun block can be expected to adversely impact vitamin D status in humans.<sup>12-14</sup> Furthermore, in many big cities, air pollution and blockage of sunlight by high-rise buildings also

contribute to vitamin D deficiency.<sup>15</sup> Our study place, Dhaka city, is not an exception to this. No previous published data reported about the vitamin D status in working professionals engaged in indoor job in Dhaka city. So this study has been designed to compare the vitamin D status between indoor and outdoor working professionals to find out if there is any deficiency or insufficiency present or not. As parathyroid hormone and vitamin D are regulating factor of plasma calcium level it is important to find out whether there is any relationship between serum vitamin D levels and PTH even in D deficient subjects. We proposed this study to compare serum vitamin D level between outdoor and indoor working professionals of Dhaka city in Bangladesh and to observe its correlation with serum parathyroid hormone level.

## Methods

### *Study design, setting*

This cross-sectional, analytical study was conducted in the Department of Biochemistry, Dhaka Medical College, Dhaka, Bangladesh, from July 2018 to June 2019.

### *Study Participants*

A total of 101 apparently healthy subjects working in different sectors living in Dhaka city participated in this study. They were divided in to two group (indoor and outdoor working professional) according to the period of exposure to sunlight during their professional working hour. Among the outdoor workers, traffic police and street hawkers were selected. Nurses, doctors, administrative officials, medical technicians were enrolled as indoor workers.

### *Sampling*

All subjects were enrolled by purposive sampling from the National Institute of Cardiovascular Diseases (NICVD) and Traffic Police Division (Dhaka West), Dhaka Metropolitan Police.

### *Inclusion criteria*

Apparently healthy individual, aged between 18 and 60 years both male and female was selected for the study after a preliminary scrutiny.

### *Exclusion criteria*

Subjects with history of systemic disease e.g., diabetes mellitus, chronic kidney or liver disease, endocrine disorder, bone disease, etc. or pregnancy were excluded

### *Data collection procedure*

After recruiting according to selection criteria, the purpose and procedure of the study was explained in details and an informed written consent was taken from each study subject. Initial evaluation of them were done by taking history and clinical examination and data were recorded in the preformed data collection sheet. Anthropometric variables were measured and 5 ml of venous blood samples were collected to estimate the serum vitamin D, PTH and calcium level. Level of serum vitamin D, PTH and calcium was estimated by chemiluminescent microparticle immunoassay method (Access 2 Immunoassay System of Backman Coulter Inc., USA). We used widely accepted cut-off values for levels of D<sub>3</sub>, as stratified according to the classification of the Endocrine Society's Clinical Guidelines: deficiency (<20 ng/ml), insufficiency (20–29 ng/ml) and sufficiency (≥30 ng/ml).<sup>3</sup>

### *Statistical analysis*

Continuous variables were expressed as mean±SD and compared between groups by unpaired student's t-test. Categorical variables were compared using Fisher's exact test. Correlation was done by Pearson's correlation coefficient test. Level of significance was defined as P value <0.05 at 95% confidence interval. Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 24.0 for windows.

## Results

The mean age of the study participants of both indoor and outdoor workers was not significantly different and ranging between 25 and 52 years. The frequency of gender in both outdoor and indoor groups are presented in table I. Frequency of subjects with sufficient and insufficient levels of serum D<sub>3</sub> were found significantly higher in outdoor workers than indoor working professional (P<0.05). In contrast, subjects with deficient levels of serum D<sub>3</sub> was found more in indoor working subjects than outdoor workers (P<0.001) (Table II). Again mean Serum vitamin D<sub>3</sub> level was found significantly (P<0.001) higher in outdoor workers than that of indoor workers Serum PTH level showed higher trend in outdoor workers, however, the difference was not statistically significant (P>0.05) (Table III). No significant correlation was observed between serum vitamin D and parathyroid hormone levels in both outdoor (P>0.05) and indoor (P>0.05) groups (Figure 1).

**Table I:** Demographic characteristics of the study participants

Variables	Outdoor workers (n=35)	Indoor workers (n=66)
<b>Age (mean ±SD)</b>	38.72±6.88	
<b>Gender (No.%)</b>		
Male	27 (77%)	37 (56%)
Female)	8 (23%)	29 (44%)
<b>Occupation (No.%)</b>		
Traffic Police	-	29 (83%)
Street Hawker	-	6 (17%)
Nurse	-	21 (32%)
Doctor	-	18 (27%)
Administrative Employee	-	14 (21%)
Ward Assistant	-	8 (12%)
Medical Technician	-	5 (8%)

**Table II:** Serum vitamin D<sub>3</sub> levels in outdoor and indoor working study participants(N=101)

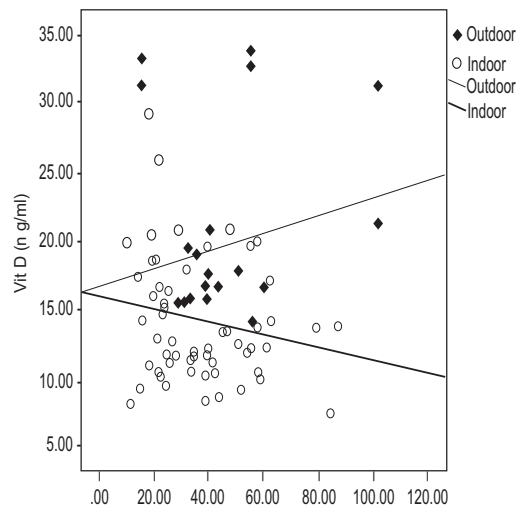
Serum Vitamin D <sub>3</sub>	Outdoor (n=35)	Indoor (n=66)	P value
	no.(%)	no.(%)	
Sufficient	5 (14.3)	0 (0.0)	<0.05
Insufficient	30 (85.7)	38 (57.6)	<0.05
Deficient	0 (0.0)	28 (42.4)	<0.001

P value reached from Fisher's Exact test; Cut point for sufficient- >30ng insufficient- 20-29ng deficient-<20ng

**Table III:** Serum D<sub>3</sub> and parathyroid hormone levels of outdoor and indoor study participants (N=101)

Variables	Outdoor (n=35)	Indoor (n=66)	P value
Serum D <sub>3</sub> (ng/ml)	19.35±5.67 (13.94-33.67)	14.17±4.18 (7.50-29.14)	<0.001
Serum PTH (pg/ml)	42.35±18.27 (15.40-101.70)	37.78±17.54 (9.90-87.10)	>0.05

Data expressed as mean±SD Values in the parentheses indicate range. P value reached from unpaired Student's t-test;



**Figure 1:** Correlation between serum vitamin D and parathyroid hormone levels in both outdoor and indoor study participants (r= +0.290; p=0.091 vs. r= -0.206; p=0.100)

## Discussion

Although no consensus on an optimal level of vitamin D<sub>3</sub> has been reached, vitamin D deficiency is defined by most experts as a level of <20 ng/ml (or 50 nmol/L),<sup>3,16-18</sup> as we took the same as our cut-off value for this study. Outdoor life is an important determinant of vitamin D status and may explain the reverse gradient of serum vitamin D.<sup>13</sup> In our study we found that vitamin D deficiency is more prevalent in indoor workers compared to outdoor workers. Sowah et al.<sup>12</sup> found 75% were deficient and 90% were insufficient among indoor workers, while 48% were deficient and 75% were insufficient among outdoor cases. Divakar et al.<sup>19</sup> estimated that the prevalence of vitamin D deficiency was 2.16 times and 2.25 times higher in office and workshop workers, respectively, compared to control room workers. According to Kawashima et al.<sup>20</sup>, the indoor athletes showed a significantly higher rate of vitamin D deficiency than the outdoor athletes (90.5% vs. 18.5%). Those results are similar to our findings.

We also observed a higher level of vitamin D but PTH in professionals who work outdoor in comparison to who work indoor but PTH was similar. Similar results were observed by Kawashima et al.<sup>20</sup>, on male athletes, as they reported that the serum D<sub>3</sub> levels of indoor athletes were significantly lower than those of outdoor athletes (15.3±3.3 ng/ml vs. 24.9±4.5 ng/ml;). According to Maruyama-Nagao, Sakuraba & Suzuki,<sup>21</sup> the serum vitamin D<sub>3</sub> concentration showed a seasonal oscillation, with a nadir in March (indoor, 19±4.0 ng/ml; outdoor, 32±2.7 ng/ml) and a peak in September (indoor, 32±6.6 ng/ml; outdoor, 39±5.7 ng/ml), as they studied on female athletes. Dharmshaktu et al.<sup>22</sup> compared vitamin D levels between outdoor and indoor subjects (44.8±19.6 nmol/L vs. 30.6±23.2 nmol/L). Those findings are in congruence with our study findings. In contrast, Daugaard et al.<sup>23</sup> reported that outdoor worker had similar vitamin D<sub>3</sub> concentrations but 7.5% lower PTH

concentration compared to indoor workers, while Aydin et al.<sup>24</sup> showed that gender and indoor/outdoor sports participation showed no statistically significant outcomes on vitamin D levels. However, winter season had a negative effect on vitamin D levels.

In the present study, we did not find significant correlation between serum vitamin D and parathyroid hormone levels in both outdoor and indoor groups of working professionals which contrasts similar studies. However, Kuchuk et al.<sup>25</sup> studied on 1319 elderly Dutch people, Okajaki et al.<sup>26</sup> studied on 107 Japanese subjects and Saliba et al.<sup>27</sup> studied on 172 Israeli people and all those studies reported a significant negative correlation between serum concentrations of 25(OH)D and PTH, there was no specific threshold though.

Since optimal precautions were taken in every step of this study, limitations still exist. We had a relatively small sample size and that was collected only from Dhaka city; the outdoor study subjects were selected only from two professions. Hence, the study findings might not be generalizable to the whole of the country. Another important issue is the cut-off levels for determining serum vitamin D<sub>3</sub> based on the lack of standardized physiological cut-off points to define deficiency and insufficiency as well as the use of different cut-off points by various authors for statistical analysis of deficiency and insufficiency in varied population groups.<sup>9</sup>

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## Conclusion

Our data concluded that indoor working professionals may develop vitamin D deficiency although outdoor working professionals may be affected with vitamin insufficiency. In addition, there may be no relationship between serum vitamin D and PTH levels even in indoor professionals.

The findings of the study are expected to contribute to the information pool for further studies on determining the threshold of vitamin

D levels sufficient to keep the parathyroid hormone level at a range that will prevent bone loss as well as setting guidelines to supplement vitamin D and suggest workplace policies and wellness programme for different professionals to expose them to optimal sunlight.

### Conflict of interest

The authors declare no conflict of interest.

### Ethical approval

The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka, Bangladesh.

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