

Association of Vitamin D Levels in Coal Miners: A Case–Control Study

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Abstract

Introduction: Coal miners working underground are likely to be at greater risk of developing Vitamin D deficiency due to reduced sunlight exposure. To date, only three studies have been reported, with no significant risk of Vitamin D deficiency among coal miners. None were conducted in the tropical region, where sunlight is ample. **Objective:** The present study estimated Vitamin D levels among underground coal miners in a tropical region and determined their associated factors. **Methods:** Serum calcium, 25-hydroxyvitamin D, and bone turnover markers among underground and surface workers were estimated in a matched case–control study. Binary logistic regression analysis was performed using case/control as the dependent variable to estimate odds ratios and 95% confidence intervals of variables which significantly ($P < 0.1$) differed among the cases and controls. **Results:** The mean Vitamin D level among both coal miners (22.12 ng/dl) and surface workers (23 ng/dl) were low. No significant difference was noted for all biochemical parameters after adjusting for other covariates except the parathyroid hormone (PTH), which was marginally higher among the surface workers. **Conclusions:** Even in the absence of statistically significant evidence of low Vitamin D level in underground workers compared to surface workers, there was indirect evidence (of differences in PTH) to indicate that Vitamin D level is lower in underground workers probably because of poor sunlight exposure.

Keywords: 25-hydroxyvitamin D, coal miners, parathormone

INTRODUCTION

Conventionally, though Vitamin D has been associated with bone health, recent evidence shows its role as a wonder molecule^[1] associated with many acute and chronic illnesses not only limited to metabolic, autoimmune, infectious, and cardiovascular diseases^[2] but also linked to several other diseases influencing over 200 genes.^[3] Despite ample sunlight in India, the prevalence of Vitamin D deficiency has been documented as a major health problem ranging between 50% and 90% in all age groups.^[4] Photosynthesis and bioavailability of Vitamin D are influenced by several factors ranging from the diet to variation in sun exposure due to latitude, season, time of day, atmospheric components, clothing, sunscreen use and skin pigmentation, as well as age, obesity, and the incidence of several chronic illnesses.^[5] Certain occupational groups are at greater risk^[6] as Vitamin D synthesis is highly dependent on sunlight, factors, and conditions associated with decreased time spent outdoors. Thus, working underground, as in the case of coal miners, a special occupational group, provide

an opportunity to understand the metabolism of Vitamin D in greater detail. They are expected to be associated with an increased risk of Vitamin D deficiency. However, to date, only three studies among coal miners have been reported in the published literature,^[6] reporting no significant risk of Vitamin D deficiency. Further, none of these studies has been conducted in the tropical region, where sunlight is plenty. Thus, we estimated Vitamin D level among underground coal miners and determined their associated factors in a case–control study.

METHODS

Participants and setting

Using the study methodology adopted by Sarikaya *et al.*,^[7]

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during June' 2015–May 2016, apparently healthy male coal miners working in the mines of Talcher, Odisha, working underground for at least 8 h/day for 6 days a week, who consented (informed, written) to participate, were recruited as cases, in a matched case–control study. Surface workers with similar physical activity matched for age and body mass index (BMI) were recruited as controls. To detect a difference of 20 ng/dl in 25-hydroxyvitamin D (25-OHD) Vitamin D levels with a power of 80%, α error of 5% and an expected dropout rate of 10%, 44 participants were recruited in each group.

Data were collected on age, height, weight, consumption of alcohol/cigarette, duration of work, and daily dietary intake of calcium (by recall method). Serum samples were collected for the measurement of creatinine, blood urea nitrogen, calcium, phosphate, and total alkaline phosphatase to be measured by spectrophotometer at the NSCH hospital laboratory. The parathyroid hormone (PTH) level was determined using a Chemiluminescence immunoassay (SRL diagnostics, Talcher) and (25-OHD) was measured using a competitive enzyme-linked immunosorbent assay (SRL diagnostics, Talcher).

Statistical analysis was performed using SPSS 20.0 version software (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as mean \pm standard deviation; comparison of continuous variables between two groups was made using Student's *t*-test, and comparison of proportions was carried out using the Chi-square test. A value of $P < 0.05$ is considered as statistically significant. Binary logistic regression analysis was performed using case/control as a dependent variable, and other variables which were significantly ($P < 0.1$) different among the cases and controls as independent variables.

Table 1: Characteristics of coal miners working underground and surface workers

	Underground workers ($n=44$), n (%)	Surface workers ($n = 44$), n (%)
Age (years)	45.68 \pm 10.35	49.48 \pm 8.66
Duration of working (years)*	16.70 \pm 10.19	20.95 \pm 8.27
Body mass index (kg/m ²)*	24.65 \pm 3.45	26.24 \pm 3.31
Smoking	12 (27.3)	5 (11.4)
Alcohol use*	14 (31.8)	5 (11.4)
Calcium intake		
Inadequate (<500 mg/day)	3 (6.8)	6 (13.6)
Moderate (500–1000 mg/day)	14 (31.8)	18 (40.9)
Adequate (>1000 mg/day)	27 (61.3)	20 (45.4)
Parathyroid hormone (pg/ml)	35.13 \pm 17.64	45.92 \pm 35.24
Calcium (mg/dl)	9.06 \pm 0.51	9.17 \pm 0.57
Alkaline phosphate (U/l)	99.84 \pm 45.85	119.59 \pm 75.81
25-hydroxyvitamin D (ng/dl)	22.12 \pm 11.58	23.00 \pm 17.73
Creatinine (mg/dl)	0.81 \pm 0.17	0.85 \pm 0.19
Blood urea nitrogen (mg/dl)	21.57 \pm 3.38	21.73 \pm 5.35
Phosphate (mg/dl)	4.10 \pm 1.31	4.00 \pm 1.44

*Significant

RESULTS

Table 1 outlines the baseline characteristics of the study population, including 44 underground workers and 44 surface workers of matched age, BMI, and duration of working years. Among the underground miners 27.3% (12) and 31.8% (14) were smokers and consumed alcohol, respectively and among surface workers the smokers 11.4% (5) and who consumed alcohol 5 (11.4%) were equal in number. The dietary pattern of miners revealed that calcium intake was adequate (8–10 mg/dl) among the majority of both underground workers 27 (61.3%) and surface workers 20 (45.4%). There was no significant difference in the various biochemical parameters. However, in the case of PTH, it was higher among the surface workers with a borderline significance level ($P < 0.07$).

The mean Vitamin D level among both coal miners (22.12 ng/dl) and surface workers (23 ng/dl) were low, and no statistical difference was noted. Furthermore, the proportion of workers having adequate Vitamin D was similar in both the groups (table not is shown). Further, as noted in Table 1, there were certain statistically significant differences in the background characteristics such as the duration of working and BMI among both the groups of workers. Using these significant variables ($P < 0.1$), a binary logistic regression analysis was carried out using case/control as the dependent variable; to check if these differences have contributed to the null difference in the Vitamin D level [Table 2].

It was observed that except for PTH, which was low among underground mining workers; there were no significant differences in other parameters among both the group of workers.

DISCUSSION

The plethora of published literature is available on the role of Vitamin D in health and disease. Still, gaps exist, especially in understanding its metabolism related to sunlight, especially among the occupational groups like coal mine workers. Due to reduced sunlight exposure among underground workers, it was hypothesized that they are likely to have reduced Vitamin D levels. However, akin to findings from other published literature (7–9), in the present study also, it was observed that there was no significant difference in the Vitamin D level between the coal miners and the surface workers. Furthermore, the proportion of participants having less than the desired level of Vitamin D was similar in both the group of workers. Shuster *et al.*^[8] compared the level of Vitamin D among coal miners and surface workers almost four decades ago. Initially it was evaluated in the summers and later assessment was repeated in the winters in order to observe the seasonal variations.^[9] and in both the cases, no significant difference was seen in Vitamin D levels between the coal miners and surface workers. Not only the effect of climate change but also the effect of shift duty was taken into consideration.

Table 2: Binary logistic regression analysis of factors attributing to the null difference in Vitamin D level among coal miners working underground and surface workers

	<i>B</i>	<i>SE</i>	<i>Wald</i>	<i>Df</i>	<i>Significant</i>	<i>OR</i>	<i>95% CI for OR</i>
Age	0.015	0.044	0.124	1	0.725	1.016	0.932 - 1.107
Duration of work	0.045	0.039	1.302	1	0.254	1.046	0.968 - 1.129
BMI	0.130	0.079	2.738	1	0.098	1.139	0.976 - 1.328
Smoking (reference: No)	-0.950	0.676	1.979	1	0.160	0.387	0.103 - 1.453
Alcohol (reference: No)	-1.026	0.659	2.422	1	0.120	0.358	0.098 - 1.305
Parathyroid hormone	0.022	0.011	3.831	1	0.050*	1.022	1.000 - 1.045
Vitamin D	0.020	0.018	1.245	1	0.265	1.020	0.985 - 1.055
Constant	-5.835	2.719	4.604	1	0.032	0.003	

*Statistically significant Nagelkerke $R^2 = 0.28$. SE: Standard error, CI: Confidence interval, OR: Odds ratio, BMI: Body mass index

Having observed no difference in the levels of Vitamin D between underground and surface workers, to explore, if it was due to a compensatory mechanism in the body metabolism, we did a binary logistic regression analysis using the group (whether case: underground worker or control: Surface worker) as dependent variable and all other variables that were significantly ($P < 0.1$) different between the groups of workers as independent variables [Table 2]. The results showed that the level of parathormone (PTH) significantly contributed to the model denoting the significant difference between underground and surface workers. Previous studies have documented a negative correlation between the levels of Vitamin D and PTH.^[7,10] The same was observed in our study, which was further evaluated independently among underground workers and surface workers separately showing a stronger negative correlation among surface workers (Pearson correlation: -0.380 , P : 0.011 as compared to the Underground (Pearson correlation: -0.154 , P : 0.317). Sahota *et al.*^[11] demonstrated the relationship between Vitamin D and parathormone, which is not a direct inverse relationship. A considerable proportion of patients with reduced Vitamin D level showed a blunted PTH response (value within the laboratory reference range) with disruption in the calcium homeostasis but protected against PTH-mediated bone loss. Only one-third of the patients showed secondary hyperparathyroidism, who maintained calcium homeostasis but at the cost of increased bone turnover. Previous studies (7–9) showing no difference in Vitamin D level among underground workers and surface workers might have been due to a compensatory mechanism, which requires further studies of higher order to establish a causal mechanism. At the same time, this highlights the need for close watch on the bone health of the underground workers.

This study had a few limitations. First, since this was a case-control study, it was unclear whether the working conditions were responsible for low Vitamin D level or PTH response. Second, the lack of information on exposure to sunlight (i.e. individual outdoor activity and sun exposure during work) and the amount of Vitamin D consumed by the participants limited the drawing of firm conclusions. Third, the survey was conducted over 11 months at random times from June to May, with the amount of sunlight exposure being influenced by the seasons, which may be important confounders.

CONCLUSIONS

Even in the absence of statistically significant evidence of low Vitamin D level in underground workers compared to surface workers, there was indirect evidence (PTH) to indicate that Vitamin D level is lower in underground workers probably because of poor sunlight exposure.

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Conflicts of interest

There are no conflicts of interest.

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