SOCIODEMOGRAPHIC AND ANTHROPOMETRIC DETERMINANTS OF VITAMIN D LEVELS AMONG ADULTS WITH DIABETES

Abdul Jalil Khan[1], Afsheen Mahmood[2], Farida Ahmad[2], Zubia Shah[2], Riffat Sultana[2], Fatima Zulfiqar[2], Muhammad Irfan[3]

ABSTRACT
Vitamin D deficiency is now globally recognized as a public health concern, with deleterious effects on bone health, the function of the immune system, and the risk of chronic disease.

Objective: To find the Sociodemographic and Anthropometric Determinants of Vitamin D Levels Among Adults with Diabetes.

Materials and Methods: This cross-sectional study was conducted at Hayatabad Medical Complex, Peshawar. 208 known diabetic patients were recruited through non-probability convenience sampling. Patients' characteristics were recorded on a structured proforma.

Results: The Mean age of patients was 59.3 ± 8.3years. The mean BMI was 28.4 ± 4.7kg/m^2. Mean HbA1C levels were 9.7± 2.7%, and mean serum vitamin D was 23.2 ± 19.2 ng/ml. Multiple linear regression was carried out to analyze the relationship between serum vitamin D levels and the predictor variables: occupations, BMI, houses with open spaces, and rural-urban residency. Indoor workers had a non-significant negative association with vitamin D (Beta = - .011, p =0.90), housewives had a significant positive association (Beta = .273, p =0.006). Similarly, individuals belonging to urban areas showed a negative relationship (Beta = -.17, p =0.70); however, the association was non-significant. Those living in houses with open spaces had a positive association, though it was non-significant (Beta = .055, p =0.90). BMI showed a negative association, which was a non-significant effect (B = -.026, p = 0.78).

Conclusion: Outdoor work status emerged as a significant positive determinant of vitamin D levels, highlighting the beneficial role of sun exposure. In contrast, urban residency and BMI showed negative associations with vitamin D levels; however, these effects were statistically nonsignificant. Rural residency and houses with open spaces showed a positive association, but again, it was non-significant

Keywords: Vitamin D, BMI, Diabetes Mellitus, T2DM, Vitamin D deficiency, Glycated Hemoglobin A

INTRODUCTION

Vitamin D, among the fat-soluble vitamins, plays a critical role in maintaining several different aspects of human health. Apart from its known function in bone health, vitamin D has been recognized for its immunomodulatory, anti-inflammatory, and protective effects against a variety of diseases, such as cardiovascular, metabolic, immune, and inflammatory. (1-3).

[1] Institute of Family Medicine, Khyber Medical University, Peshawar
[2] Khyber Girls Medical College, Peshawar
[3] Hayatabad Medical Complex, Peshawar

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Address for Correspondence
Dr. Farida Ahmad,
Assistant Professor, Department of Physiology, Khyber Girls Medical College, Peshawar
faridaahmad397@gmail.com

At the same time, it has some crucial implications for cancer prevention and its key role as an immunomodulator in COVID-19 infections. (4, 5).

A systematic review encompassing South Asian countries showed vitamin D deficiency to be highly prevalent in Pakistan, followed by Bangladesh, India, and Nepal. It was also found that deficiency strikes females more than males(6). Although dietary sources contribute to vitamin D status, ultraviolet B-mediated radiation synthesis in the skin is the primary source for most individuals(7). Lifestyle variations, which include occupation and body composition and the presence of comorbidities, have been shown to affect serum vitamin D levels(8). It was noticed that individuals engaged in predominantly indoor occupations & activities and night shifts are twice as likely to be vitamin D deficient (9) . Occupational environments play a very crucial role in determining the amount of sun exposure a person receives and, subsequently, Vitamin D levels. People working outdoors, such as those in the field of agriculture, construction workers, and lifeguards, tend to have higher serum vitamin D levels compared to those working indoors, who usually spend the majority of daylight hours in confined or covered spaces with limited UVB exposure(10). Several studies have shown that even in regions with abundant sunlight, indoor occupations contribute to a high prevalence of suboptimal vitamin D levels(9). The implications for worker health are noteworthy, prompting recommendations for vitamin D screening and supplementation strategies in high-risk occupational groups.

In addition to occupational factors, BMI is a significant modulator of vitamin D status. Obesity is linked to lower serum vitamin D levels, a phenomenon attributed to the fat-soluble nature of the vitamin, which causes it to be deposited and sequestered in adipose tissue. This results in decreased bioavailability of vitamin D in obese individuals. This relationship is clinically important because low vitamin D levels in obese populations may increase the risk of metabolic disorders, impaired bone health, and other chronic conditions (11).
The combined effects of limited sun exposure and increased adiposity may heighten the risk of vitamin D deficiency. This interplay underscores the need for comprehensive strategies that address both lifestyle and metabolic factors when tackling vitamin D deficiency. Several studies have reported vitamin D status in various population subgroups, but few have examined this association within the diabetic population and its relation to BMI (8). Investigating this link in diabetics can help determine whether vitamin D status is a modifiable risk factor for glycemic control.

METHODS

This was a cross-sectional study conducted in the outpatient Department of Medicine at Hayatabad Medical Complex, Peshawar. Ethical approval was obtained from the IREB of Hayatabad Medical Complex, Peshawar (No: 77-N-2018, dated 09/29/2018). The study included diabetic patients presenting to the outpatient department who consented to participate.

The sample size was 208, calculated using OpenEpi software, based on a prevalence of 84% from a prior study, with a 95% confidence interval and a margin of error of 5%. This study employed a non-probability convenience sampling technique. Exclusion criteria included type-II diabetics taking vitamin D and calcium supplements, steroids, chemotherapeutic agents, anti-epileptics, Orlistat, and bisphosphonates. Patients with chronic kidney disease (eGFR < 60 mL/min), chronic liver disease, a history of rickets or osteomalacia, or those undergoing treatment for malabsorption syndrome, thyroid disorders, or parathyroid disorders were also excluded.

Demographic data were recorded on a questionnaire. Body mass index (BMI) was calculated following standard procedures by measuring weight in kilograms and dividing by the square of height in meters. Patients were instructed to remove their shoes and heavy clothing before measurement. Weight was measured using a German balance scale, 'Seca Model 762,' for all patients. Serum vitamin D and HbA1c levels were measured using standardized kits.

RESULTS

To identify the sociodemographic and anthropometric determinants of vitamin D status, we evaluated 208 diabetic patients. The mean body mass index (BMI) of participants was 28.4 ± 4.7 kg/m². The mean HbA1c level was 9.7 ± 2.7%, while the mean serum vitamin D level was 23.2 ± 19.2 ng/mL, and 54.8% had a vitamin D-deficient status. Other demographic characteristics of study participants are shown in Table 1.

Table 1: Demographic characteristics of study participants

Variable	Value
Age (years)	59.3 ± 8.3
Gender	
Female	76%
Male	24%
Housing Type	
Fully covered houses	18%
Houses with open spaces	82%
Occupation	
Laborers	20%
Housewives	69%
Others	11%
Residency	
Rural	64%
Urban	36%

A multiple linear regression analysis was performed to investigate the association between serum vitamin D levels and the predictor variables occupations, BMI, and rural-urban residency. In the correlation table, no value exceeded 0.7, confirming the absence of multicollinearity. The normal probability plot exhibited points generally following the line with only a few points not adhering to liners suggesting a linear relationship of the independent variable with the dependent variable. The standard residual ranged from -2.46 – 3.22. cook distance was 0.097 which is below the threshold of 1confirming there were no outliers. The model demonstrated a good overall fit, with an R-squared value of 0.143, indicating that approximately 14.3 % of the variance in vitamin D levels is explained by the predictor variables as shown in table 2

Table 2 Model Summary of Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.378[a]	.143	.108	.31146	.143	4.082	4	98	.004
a. Predictors: (Constant), urban, BMI, housewife , Houses with open space									
b. Dependent Variable: log10vitD									

The regression model was statistically significant (F = 4.082, p = 0.04), suggesting that the predictors collectively explain a significant proportion of the variance in Serum vitamin D levels.

Indoor workers showed a non-significant negative association with vitamin D (Beta = -0.011, p =0.90), while housewives had a significant positive association (Beta = .273, p =0.006). Similarly, individuals living in urban areas exhibited a negative relationship (Beta = -0.17, p =0.70); however, this association was not statistically significant. Those living in houses with open spaces had a positive association, but it was also non-significant (Beta = .055, p =0.90). BMI showed a negative association, which was not significant either (B = -0.026, p = 0.78).

Table 3. Regression coefficients for predictors of log10 serum vitamin D

Predictor	B	Std. Error	β	t	p-value
Constant	1.167	0.389	—	3.001	0.003
BMI	−0.002	0.007	−0.026	−0.269	0.789
House with open spaces	0.038	0.318	0.055	0.120	0.904
Housewife (ref: non-housewife)	0.196	0.070	0.273	2.793	0.006
Indoor occupation	−0.027	0.233	−0.011	−0.115	0.909
Urban residence (ref: rural)	−0.121	0.321	−0.172	−0.376	0.708

DISCUSSION

Our study explored the association between various demographic and lifestyle factors with vitamin D levels. The findings indicate that occupational and residential environments and BMI may influence vitamin D status.

Indoor workers exhibited a non-significant negative association with vitamin D levels, suggesting that indoor work environments might contribute to a lowering of vitamin D levels due to less sun exposure. In contrast, the outdoor working environment demonstrated a significant positive association with vitamin D, implying that spending more time in outdoor activities is beneficial for vitamin D synthesis. A systematic review by Sowah et al, demonstrated clear patterns in vitamin D status based on work environment. Indoor workers had significantly lower vitamin D levels compared to outdoor workers, with mean levels of 40.6 ± 13.3 nmol/L versus 66.7 ± 16.7 nmol/L, respectively. This difference translates to substantially higher deficiency rates, with 78% of indoor workers experiencing vitamin D deficiency compared to 48% of outdoor workers. Shift workers represent a particularly high-risk group, with vitamin D deficiency affecting 80% of this population and mean levels as low as 33.8 ± 10.0 nmol/L (13).The pattern is so pronounced that indoor working professionals are more prone to develop outright vitamin D deficiency, while outdoor workers are more likely to experience vitamin D insufficiency rather than complete deficiency (14).

Similarly, individuals from urban areas showed a negative association with vitamin D levels, though this relationship was not statistically significant. This aligns with previous literature indicating that urban dwellers may have limited sun exposure due to high-rise buildings, pollution, and indoor-centric lifestyles. Additionally, individuals living in houses with open spaces showed a positive but non-significant association (β = 0.060, p = 0.88), suggesting that access to outdoor areas might play a role in maintaining adequate vitamin D levels, but other confounding factors could be at play. Multiple studies across Pakistan reveal a clear pattern where urban populations experience significantly worse vitamin D status compared to their rural counterparts. The National Nutrition Survey 2018 showed vitamin D deficiency among women of reproductive age at 79.7%, with higher prevalence in urban areas (15). A comprehensive national survey found that vitamin D deficiency is widespread across all provinces (54.6-80.9%), but the situation is notably worse in urban areas with 72.5% deficiency in urban versus 64.3% in rural areas(16).the significant differences in vitamin D levels between rural and urban populations in Pakistan can be attributed to several interconnected cultural and lifestyle factors that are more prevalent in urban environments. Despite Pakistan's abundant sunlight throughout the year, urban populations experience higher deficiency rates due to behavioral and occupational patterns that limit sun exposure(17).Cultural factors play a major role in creating these rural-urban disparities. Heliophobic tendencies inherent in South Asian culture, combined with deliberate sun avoidance behavior and fear of tanning, are more commonly practiced in urban settings where social and beauty standards may be more strictly observed .Urban populations also tend to wear more covered clothing, which further reduces skin exposure to sunlight necessary for vitamin D synthesis (17).This contrasts with rural populations who often engage in outdoor agricultural work or activities that naturally provide more sunlight exposure throughout the day.

The indoor-focused lifestyle of urban areas extends beyond work environments to include recreational and social activities that predominantly occur indoors, further reducing opportunities for natural vitamin D synthesis. Rural populations, by contrast, maintain more outdoor-oriented daily routines that facilitate better vitamin D status despite facing similar cultural constraints regarding sun exposure and clothing practices (17).

BMI was found to have a negative, albeit non-significant, relationship with vitamin D levels ($\beta = -0.044$, $p = 0.78$). This is consistent with existing evidence that higher adiposity may reduce the bioavailability of vitamin D, possibly due to its sequestration in adipose tissue(8). Although our results did not reach statistical significance, they highlight a trend that aligns with previous research. A study has reported that 91% of the premenopausal females were vitamin D deficient (18). In another study, 24 % of the obese patients were vitamin D deficient (8). Serum vitamin D levels were considerably lower on average in overweight (>18.5-24.9 kg/m²) and obese (>30 kg/m²) females compared to those in the normal weight (18.5-24.9 kg/m²) and underweight (<18.49 kg/m²) categories. Serum vitamin D levels decreased by 0.61 nmol/l for every 1 kg/m² rise in BMI, according to univariate regression analysis for age and BMI. It also revealed that each one-year increase in age was associated with a 0.22 nmol/l decrease in serum vitamin D levels(11).

While some of our findings support established associations in the literature, the lack of statistical significance in certain variables suggests that larger sample sizes or more refined methodological approaches may be needed to better understand these relationships. Future studies should further investigate the impact of occupational settings, urbanization, and BMI on vitamin D levels while accounting for potential confounders such as dietary intake, genetic predisposition, and seasonal variations in sunlight exposure.

CONCLUSION

Outdoor work status emerged as a significant positive determinant of vitamin D levels, highlighting the beneficial role of sun exposure. In contrast, urban residency and BMI showed negative associations with vitamin D levels; however, these effects were statistically nonsignificant. Rural residency showed a positive association but again it was non-significant. Overall, the findings emphasize the importance of outdoor occupational exposure as a significant factor influencing serum vitamin D, while other variables may exert weaker or inconsistent effects that warrant further exploration in larger, more powered studies.

Authors contributions

Author Name	Contribution
Dr. Abdul Jalil Khan	Conception and design of the study, critical appraisal of the manuscript
Dr. Afsheen Mahmood	Conception and design of the study, data collection, critical appraisal of the manuscript
Dr. Farida Ahmad	Conception and design of the study, data analysis, manuscript preparation
Dr Zubia Shah	design of the study, critical appraisal of the manuscript
Dr Riffat Sultana	design of the study, critical appraisal of the manuscript,
Dr Fatima Zulfiqar	Data analysis, Preparation of the manuscript
Dr Muhammad Irfan	Data collection, critical appraisal of the manuscript

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