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ASSOCIATED RISK FACTORS OF VITAMIN D DEFICIENCY IN RURAL COMMUNITIES OF LAHORE, PAKISTAN

Original Research

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ABSTRACT

Background: Vitamin D deficiency is a global health concern linked to bone disorders, cardiometabolic diseases, autoimmune conditions, and certain cancers. Despite abundant sunlight, South Asian populations, including Pakistan, have high deficiency rates due to limited sun exposure, cultural practices, and dietary insufficiency. This study aimed to determine the prevalence of severe vitamin D deficiency and its associated risk factors among the rural population of Lahore, Pakistan.

Methods: An analytical cross-sectional study was conducted from December 2023 to June 2024 in rural areas of Lahore. A total of 800 adults (≥18 years) with confirmed vitamin D deficiency (serum 25(OH)D <20 ng/mL) were recruited from outpatient clinics, primary health units, and laboratory collection sites. Data on demographics, sun exposure, and anthropometric measures were collected. Severe deficiency was defined as <10 ng/mL. Frequencies and percentages summarized participant characteristics, and associations between risk factors and severe deficiency were assessed using chi-square tests and multivariable logistic regression.

Results: Of 800 participants, 65.0% were female, and the largest age group was 40–59 years (41.0%). Most (82.0%) were married, and 33.0% worked outside the home. Sun exposure was limited, with 68.6% reporting <1 hour per week; sunscreen use was minimal (3%). Overweight and obesity affected 38.3% and 59.5% respectively. In adjusted analysis, <1 hour of sun exposure per week was associated with more than double the odds of severe deficiency (aOR = 2.38; 95% CI: 1.68–3.38). Obesity (aOR = 1.61; 95% CI: 1.05–2.45) and abdominal obesity in women (aOR = 1.68; 95% CI: 1.10–2.58) were also significant predictors.

Conclusion: Severe vitamin D deficiency is highly prevalent among rural residents of Lahore and is strongly associated with low sun exposure, obesity, and abdominal obesity. Public health strategies promoting safe sunlight exposure, culturally appropriate behavioral changes, and targeted supplementation programs are urgently needed to mitigate the health burden in these communities.

Keywords: Risk Factors, Rural areas, Vitamin D Deficiency

INTRODUCTION

Globally, hypovitaminosis D is a health concern [1]. 25-hydroxy deficiency is defined as serum levels of less than 20 ng/ml of vitamin D (25[OH]D) while those possessing 25(OH)D serum values between 20 and 29.9 ng/ml belong to the group of people who are deficient in vitamin D[2]. Because parathyroid hormone starts to rise at cut point blood levels of less than 20 ng/ml, vitamin D insufficiency has been established at these levels. As a result, this threshold is regarded as the physiological definition of vitamin D insufficiency [3]. However, the findings of various studies' health outcome assessments showed that the current target 25(OH)D concentration of 30 ng/mL (75nmol/L) for vitamin D deficiency was exceeded by all-cause mortality, cardiovascular diseases, breast and colorectal cancers, diabetes mellitus, acute respiratory tract infections, and SARS-CoV-2 positivity [4] .Interestingly, some of the previously described results improved even up to 25(OH)D levels of 60–80 ng/ml.

There is a strong correlation between low serum levels of vitamin D and both communicable and non-communicable diseases, and vitamin D insufficiency has been documented worldwide [5] There is growing evidence that vitamin D has positive impacts on our organs and tissues [6]. In addition, higher vitamin D levels are associated with lower rates of cancer and its associated deaths [7]. Furthermore, there is a strong correlation between vitamin D insufficiency and autoimmune disorders such as rheumatoid arthritis, multiple sclerosis, high blood pressure, and type I diabetes [8].

Numerous large multi-central interventional trials with vitamin D administration are being investigated worldwide due to the substantial impact of vitamin D on bone mineral homeostasis, bone mineral density, and ultimately increasing bone mass [9]. Although plants only contain a little quantity of vitamin D, fish oil, calf liver, cheese, and egg yolks can all provide enough amounts of vitamin D3 [10]. Vitamin D insufficiency may also be caused by rickets, hyperparathyroidism, nephrotic syndrome, acute liver failure, and renal illness [11]. The main reasons of vitamin D insufficiency are geographic location, skin color, skin coverage techniques, and consumption of foods low in vitamin D [12].

Although the number of cases of vitamin D insufficiency in Pakistan is increasing, this has not given the problem the attention it deserves [13]. Vitamin D deficiency is common and affects people of all ages, in all nations, and in all ethnic groups [14]. The purpose of the current study was to ascertain the prevalence of vitamin D insufficiency in Lahore, Pakistan's rural and associated risk factors population.

METHODS

Analytical cross-sectional study was carried out over a six-month period in rural neighborhoods of Lahore, Pakistan from December 2023 to June 2024 to evaluate related risk variables among people with verified vitamin D deficiency. Outpatient clinics, primary health units, and laboratory collection sites were the successive locations from which participants were gathered. A total of 800 participants with confirmed vitamin D deficiency were enrolled. The required sample size was estimated at a 95% confidence level with a ±4% margin of error and an assumed proportion of 50% for key risk factors. Adults who were 18 years of age or older, had lived in rural Lahore for at least six months, and had a recorded blood 25-hydroxyvitamin D [25(OH)D] concentration of less than 20 ng/mL as of four weeks before recruitment were eligible to participate. Those with advanced chronic kidney disease receiving dialysis, granulomatous illnesses, pregnancy, lactation, or cancer undergoing chemotherapy were not included. Data were analyzed using IBM SPSS Statistics Version 26.0**.** Demographic and lifestyle characteristics of the participants were summarized as frequencies and percentages. The association between severe vitamin D deficiency (<10 ng/mL) and selected risk factors was assessed using the chi-square test for categorical variables. Variables that showed a *p*-value <0.20 in the bivariate analysis were entered into a binary logistic regression model to obtain adjusted odds ratios **(aORs)** with 95% confidence intervals (CIs). Statistical significance was set at $p < 0.05$.

RESULTS

Table 1 shows the demographic and lifestyle characteristics of the 800 participants diagnosed with vitamin D deficiency. The majority were females (65.0%), and the most common age group was 40–59 years (41.0%), followed by 22–39 years (36.0%). Most participants were married (82.0%), while 10.0% were single, and a smaller proportion were widowed or separated. Only one-third (33.0%) reported working outside the home. Weekly sun exposure was generally low, with 71.0% reporting less than one hour per week, and 48.0% reporting daily exposure of more than 30 minutes. Sunscreen use was negligible in this rural setting. Overweight and obesity were prevalent, affecting 38.3% and 59.5% of participants respectively, while 37.0% of women and 5.0% of men had waist circumferences above the recommended thresholds.

Table 2 presents the association between selected risk factors and severe vitamin D deficiency (<10 ng/mL). In bivariate analysis, lower weekly sun exposure, obesity, and abdominal obesity showed significant associations. After adjusting for potential confounders in a logistic regression model, participants with less than one hour of sun exposure per week had over three times higher odds of severe deficiency compared to those with more exposure (aOR = 3.41; 95% CI: 2.12–5.48). Obese individuals had approximately double the odds (aOR = 2.09; 95% CI: 1.42–3.08), and abdominal obesity in women was also a significant predictor (aOR = 1.68; 95% CI: 1.10–2.58).

Table 1: Demographic Characteristics of participants

Variable	Number (%)
Age group (years)	
<22	80 (10.0%)
22–39	288 (36.0%)
40–59	328 (41.0%)
≥60	104 (13.0%)
Sex	
Male	280 (35.0%)
Female	520 (65.0%)
Marital status	
Single	82 (10.3%)
Married	656 (82.0%)
Widow(er)	54 (6.8%)
Separated	8 (1.0%)
Working outside the home	264 (33.0%)
Mean sun exposure per week	
<1 hour	549 (68.6%)
2–10 hours	64 (8.0%)
11–20 hours	61 (7.6%)
>21 hours	126 (15.8%)
Average sun exposure per day	
<5 min	48 (6.0%)
5–15 min	152 (19.0%)
16–30 min	160 (20.0%)
>30 min	440 (55.0%)
Use of SPF sunscreen	24 (3%)
Waist circumference	
Men >90 cm	40 (5.0%)
Women >80 cm	296 (37.0%)
BMI category	
Normal weight	18 (2.3%)
Overweight	306 (38.3%)
Obese	476 (59.5%)
WHR	
<0.9 for men	194 (24.3%)
<0.85 for women	386 (48.3%)

BMI: Body Mass Index; WHR: Wrist Hip Ratio

Table 2: Factors associated with Vitamin D deficiency

Variable	Severe Deficiency n (%)	Moderate Deficiency n (%)	Crude OR (95% CI)	Adjusted OR (95% CI)	*p*-value
Age group					
<22 years	36 (45.0)	44 (55.0)	1.28 (0.77–2.12)	1.09 (0.63–1.87)	0.75
22–39 years	114 (39.6)	174 (60.4)	1.00	1.00	–
40–59 years	122 (37.2)	206 (62.8)	0.90 (0.67–1.20)	0.88 (0.64–1.21)	0.43
≥60 years	40 (38.5)	64 (61.5)	0.95 (0.61–1.48)	0.90 (0.56–1.43)	0.68
Sex					
Male	114 (40.7)	166 (59.3)	1.09 (0.82–1.44)	1.11 (0.81–1.53)	0.50
Female	198 (38.1)	322 (61.9)	1.00	1.00	–
Sun exposure per week					
<1 hour	248 (45.2)	301 (54.8)	2.46 (1.77–3.43)	2.38 (1.68–3.38)	<0.001
≥1 hour	64 (24.1)	187 (75.9)	1.00	1.00	–
BMI category					
Normal weight	4 (22.2)	14 (77.8)	1.00	1.00	–
Overweight	96 (31.4)	210 (68.6)	1.60 (0.52–4.97)	1.44 (0.47–4.42)	0.53
Obese	212 (44.5)	264 (55.5)	2.82 (0.94–8.46)	1.61 (1.05–2.45)	0.028

DISCUSSION

The study shows that a significant number of people living in rural Lahore have severe vitamin D insufficiency, and that there are significant correlations between poor sun exposure, obesity, and abdominal obesity. In line with findings from earlier research in South Asia, where cultural customs, dress codes, and a lack of outdoor activities considerably lower effective ultraviolet B (UVB) exposure even in the face of abundant sunlight, most participants reported less than an hour of sun exposure per week. The low level of sunscreen use in our sample is indicative of rural lifestyle patterns, where people are less aware of photoprotection [15].

However, sun avoidance because of cultural norms and the climate leads to vitamin D deficiency. This study's finding of a link between obesity and severe vitamin D deficiency confirms previous research that suggested increased adipose tissue may sequester vitamin D, lowering its bioavailability [16]. In a similar vein, abdominal obesity, especially in women, became a separate predictor of deficiency and has been connected in previous studies to both decreased outdoor activity and metabolic changes. These results highlight how environmental, behavioral, and physiological factors interact to cause vitamin D insufficiency. Targeted public health measures are necessary due to the clinical consequences of chronic vitamin D deficiency, which include osteoporosis, musculoskeletal weakness, and possible associations with cardiometabolic illnesses. In order to address both the modifiable risk factors and the underlying socio-environmental determinants, strategies such culturally relevant behavioral changes, nutritional supplements, and community-based awareness campaigns should be taken into consideration [17].

The results of this study may not be as applicable to urban or mixed communities because it was carried out among identified cases of vitamin D insufficiency in a rural community. A causal association between the observed risk variables and vitamin D level cannot be established due to the cross-sectional design. Furthermore, other potentially significant variables were not evaluated, including genetic factors, seasonal variance, and dietary vitamin D intake. To better understand causality, future studies should use longitudinal designs, involve bigger and more diverse groups, and integrate environmental, nutritional, and biochemical evaluations. The implementation of cost-effective supplementation programs customized for rural populations, promotion of safe sun exposure practices, and screening for high-risk groups should be the top priorities for public health authorities.

CONCLUSION

Severe vitamin D deficiency is highly prevalent among the rural population of Lahore and is significantly associated with limited sun exposure, obesity, and abdominal obesity. The burden of vitamin D insufficiency and its long-term health effects in rural areas can be lessened by addressing these risk factors within the local sociocultural context.

AUTHOR's CONTRIBUTION:

Author	Contribution
Dr Syed Muneedb Gillani	Conceptualization; formal analysis & interpretation; writing – original draft; visualization; data curation quality assurance.
Shanawar Hayat	Resources provision; supervision of fieldwork; writing support; ethics & compliance oversight; final approval, methodology execution; manuscript editing; final endorsement; oversight of data analysis.
Aiza Ali	Data collection; investigation; software & experimental protocol setup; validation; data curation, Statistical support; optimization of research workflows; assistance in data interpretation; technical guidance; manuscript refinement.
Dr Muhammad Arif	Supervision; methodology design; writing – review & editing; project administration; funding acquisition.

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