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Original Article

Vitamin D and Related Parameters in Sudanese Expatriates in Saudi Arabia

Adil A. A. Omer[1], Eltayeb A. E. Ali[2*], Omer Fadul[3]

[1]The Medical Subspecialties Center, Jeddah, Kingdom Saudi Arabia

[2]Chemistry Department, College of Science and Humanities-Dawadmi, Shaqra University,

[3]Department of Biochemistry and Molecular Biology, Faculty of Science and Technology, Al Neelain University, Khartoum, Sudan

***Correspondence author:** Prof. Eltayeb Ahmed Eltayeb Ali. Chemistry Department, College of Science and Humanities-Dawadmi, Shaqra University, Saudi Arabia. Email: tali@su.edu.sa

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Abstract

Background: Vitamin D deficiency is widespread in Middle Eastern populations despite abundant sunlight. Sudanese expatriates in Saudi Arabia may have additional risk due to clothing, indoor work, and dietary patterns. This study assessed vitamin D status and related biochemical markers, and examined sex-, age-, and lifestyle-related differences.

Methods: Cross-sectional analytic study of 304 Sudanese adults recruited at Jeddah Center (study group n=204; control group n=100). Demographic, and laboratory measures included 25(OH)vit-D, calcium, phosphorus, magnesium, ALKP, intact PTH, CRP, Hb and ESR. Associations were tested with appropriate parametric/nonparametric methods and Chi-square for categorical variables.

Results: Substantial vitamin D deficiency was observed, with significantly lower levels in the study group (12.1 ± 3.92 ng/ml) compared to controls (18.88 ± 7.20 ng/ml, $p < 0.001$). While males had slightly higher vitamin D levels than females, the difference was not statistically significant. Vitamin D showed a strong inverse correlation with PTH ($r = -0.655$) and ALKP ($r = -0.387$), and a positive correlation with calcium ($r = 0.225$). Sun exposure, physical activity, and fortified milk consumption were linked to higher levels, while sunscreen use, smoking, and fast-food intake were associated with lower levels.

Conclusions: Sudanese expatriates exhibit a high prevalence of hypovitaminosis D closely linked to modifiable lifestyle behaviors. Targeted public health interventions and gender-sensitive screening are necessary to address these deficiencies.

Keywords

Alkaline phosphatase, Calcium, Lifestyle, Parathyroid hormone, Sudanese expatriates, Vitamin D

Introduction

Vitamin D deficiency is a widespread public health issue globally, particularly in Middle Eastern populations despite abundant sunshine [1, 2]. Vitamin D plays a critical role in calcium metabolism, bone health, and immune modulation [3, 4]. Sudanese expatriates may experience unique environmental and lifestyle factors affecting vitamin D status, such as reduced sun exposure due to cultural clothing or indoor occupations [5, 6]. The role of vitamin D in extraskeletal health, including immune function and chronic disease prevention, is also increasingly recognized [7- 12].

Understanding the vitamin D status of Sudanese expatriates contributes to regional public health planning. Given their consistent exposure to similar environmental and occupational conditions, variations within this group reveal key insights into the impact of modifiable behaviors. This study, therefore, seeks to explore internal disparities among Sudanese residents in KSA that influence vitamin D levels, helping define priority areas for health policy reforms. The objective of this study is to compare vitamin D levels and associated biochemical markers between Sudanese residents in and a matched control group, evaluating demographic and lifestyle determinants that might affect these levels.

Materials and Methods

Study Design and Participants

This is a cross-sectional study involving 304 participants; of these, 204 were Sudanese individuals residing in Saudi Arabia and 100 were control subjects. The control group were mostly apparently healthy Sudanese co-patients living in KSA.. Exclusion criteria included known systemic diseases or vitamin D supplementation (13). Participants agreed to an informed consent for the purpose of this study.

Blood Sample Collection

Blood Samples were collected at The Medical Subspecialties Center, Jeddah, KSA, starting in September 2017 and continued for approximately six months. Five mL of venous blood were collected in dry tube from each subject with informed consent, allowed to clot and immediately centrifuged at 2000 r.p.m for 10 minutes and sera were stored at -20°C till analyzed using Liaison Analyzer and Vitros 350 Analyzer.

Biochemical and Hematological Analysis

Parameters analyzed included 25OH-vitamin D, calcium (Ca), phosphorus (PO4), magnesium (Mg), alkaline phosphatase (ALKP), parathyroid hormone (PTH), glucose, C-reactive protein (CRP), uric acid (UA), total cholesterol (TC), triglycerides (TG). In addition, hematological parameters such as hemoglobin (Hb) and erythrocyte sedimentation rate (ESR) were evaluated. Hb was assessed to explore anemia prevalence and sex-related hematological variations, while ESR was measured to investigate inflammatory status and its potential impact on vitamin D metabolism.

Statistical Analysis

Data was analyzed using SPSS version 20 (Chicago, IL, USA). The Kolmogorov–Smirnov test was used to assess the normality of continuous variables. For normally distributed data (e.g., age, height, weight, BMI, hemoglobin, vitamin D), results were expressed as mean ± standard deviation (SD) and comparisons were made using One-Way ANOVA for multiple groups. Post-hoc analyses were conducted using the Hochberg GT2 or Games-Howell test based on variance equality.

For non-normally distributed variables (e.g., phosphorus, magnesium, ALKP, PTH, CRP, ESR, glucose, TG, TC), data were summarized as median (min–max), and comparisons were made using the Kruskal–Wallis test for multiple groups and the Mann–Whitney U test for pairwise analysis.

Categorical variables were presented as frequencies and percentages, with differences tested using the Chi-square test or Fisher's exact test when appropriate.

Pearson correlation was used for normally distributed continuous variables, while Spearman correlation was applied for non-parametric correlations. A two-tailed p-value <0.05 was considered statistically significant.

Results

Comparison of Vitamin D levels in the two study groups:

The mean vitamin D concentration in the study group was 12 ± 3.92; while in the control group it was 18.88 ± 7.20; $p < 0.001$.**Vitamin D Status by Age, Gender and Biochemical Parameters**

Table 1 shows the effect of age on vitamin D levels in the two groups. There was no significant difference.

Table 1: Vitamin D level (in ng/ml) by Age.

Group	<50 Years (Median, Min-Max)	>50 Years (Median, Min-Max)	p-value
Study	12.9 (4–20)	13.2 (5.8–31.9)	0.14
Control	18 (5–31.9)	20 (6.7–32)	0.17

Table 2 shows the impact of lifestyle factors on vitamin D levels. All eight factors shown in Table 2 had significant impact on vitamin D levels. Participants with regular sun exposure, physical activity, or those consuming vitamin D-fortified milk had significantly higher median vitamin D levels. Conversely, individuals using sunscreen or wearing veils exhibited significantly lower levels. Smoking and fast-food consumption were also negatively correlated with vitamin D concentrations.

Table 2. Impact of Lifestyle Factors on Vitamin D Levels

Lifestyle Factor		Exposure	Median (Min-Max)	p-value
1	Sun exposure	Yes	16.0 (4.9–32)	<0.001*
		No	8.2 (4–16.35)	
2	Sunscreen	Yes	9.2 (4–20.5)	
		No	14.8 (4–32)	<0.001*
3	Wearing veil	Yes	12.0 (4–26)	
		No	17.5 (9–22)	0.015*
4	Consume Vitamin D fortified milk	Yes	15.7 (4.3–32)	<0.001*
		No	9.4 (4–20)	
5	Smoking	Yes	12.2 (4.9–25.8)	
		No	15.1 (4–32)	<0.001*
6	Fast food consumption	Yes	11.4 (4–25.3)	
		No	19.5 (4.3–32)	<0.001*
7	Physical exercise	Yes	16.6 (5.2–32)	<0.001*
		No	11.7 (4.3–31.2)	
8	History of rickets	Yes	9.0 (4.3–31.8)	
		No	14.3 (4.3–32)	0.012*
**p* value significant				

Table 3 shows correlation between vitamin D and individual biochemical parameters, the inverse relationships between vitamin D and PTH ($r = -0.655$) and ALKP ($r = -0.387$) support the endocrine feedback role of vitamin D in bone and mineral metabolism. The positive association with calcium ($r = 0.225$, $p < 0.001$) reinforces vitamin D's contribution to calcium absorption and homeostasis.

Table 3. Correlation Between Vitamin D and Individual Biochemical Parameters

Parameter	Spearman r	p-value
AGE	0.099	0.0825
Ca	0.225	0.0001*
Mg	0.068	0.2342
ALKP	-0.387	0.0*
PTH	-0.655	0.0*
GLU	0.053	0.3513

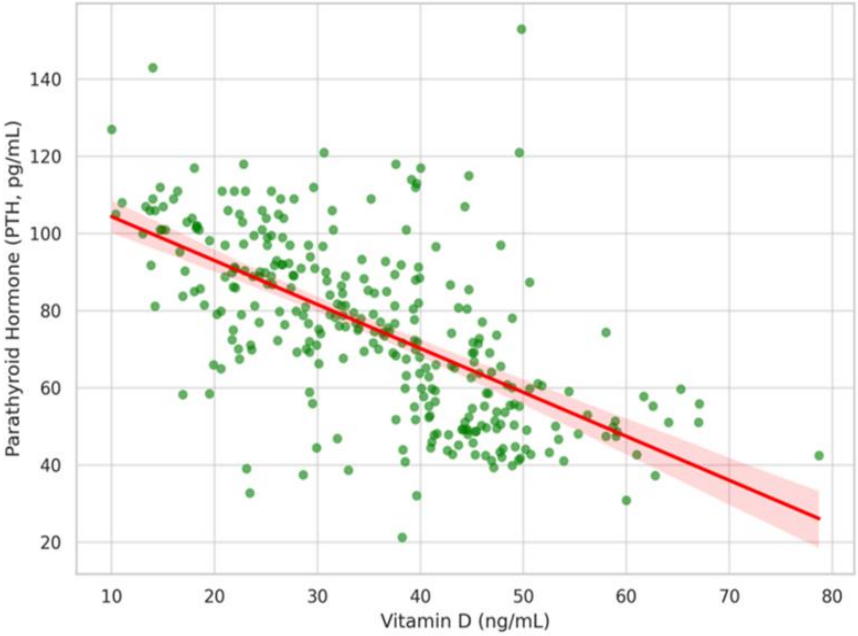

Figure 1: Correlation Between Vitamin D and Parathyroid

Vitamin D showed a strong inverse correlation with PTH (r = -0.655)

Hematological Parameters

Table 4 shows comparison between males and females in various hematological and biochemical parameters. Males had significantly higher hemoglobin levels compared to females across both groups (p<0.001). similarly, the ESR was significantly higher among females. These two findings are consistent with physiological norms between the two genders and may influence iron metabolism and overall health status. These variations should be considered when evaluating vitamin D levels and systemic health.

Table 4. Comparison of Key Parameters Between (Males = 33 and Females = 67) expressed as mean ± Standard Error Mean.

Parameter	Male	Female	P value
Age	43.58 ± 2.56	42.37 ± 1.71	
BMI	26.49 ± 0.81	27.54 ± 0.72	
Hb	15.08 ± 0.13	12.43 ± 0.08	<0.001
ESR	6.85 ± 0.93	12.72 ± 0.61	
VIT-D	13.91 ±0.064	12.57 ± 0.66	
Ca	2.35 ± 0.02	2.34 ± 0.01	
PO4	1.17 ± 0.02	1.18 ± 0.01	
Mg	0.79 ±0.01	0.79 ± 0.01	
ALKP	76.82 ±2.79	79.78 ± 2.27	
PTH	76.48 ±3.62	78.52 ±2.82	
UA	308.76 ±15.48	256.04 ± 6.80	
CRP	71.09 ±1.76	57.43 ±1.40	
GLU	5.52 ± 0.07	5.52 ± 0.056	
TC	4.29 ±0.09	4.44 ± 0.07	
Tg	1.28 ± 0.04	3.74 ±2.36	

Discussion:

Analysis of vitamin D status across sex and age revealed notable patterns. While both males and females demonstrated insufficient vitamin D levels, males generally exhibited slightly higher mean values than females though the differences were not statistically significant. Regarding age, individuals over 50 years tended to have higher vitamin D levels across both groups, though again, the differences were not statistically significant. This suggests that younger participants may be more affected by lifestyle limitations such as indoor occupations and reduced sun exposure, while older adults may benefit from greater awareness or medical interventions such as supplements [14 - 17].

These results are consistent with observations in the MENA region, where younger adults often engage in more indoor work and are less likely to be supplemented or screened for deficiencies [1, 5]. The biochemical findings strongly support the endocrine role of vitamin D. The significant negative correlation with PTH (r = -0.655) and ALKP (r = -0.387) highlights the physiological feedback mechanism where low vitamin D triggers PTH secretion to maintain mineral homeostasis. The strong inverse relationship with ALKP further confirms the role of vitamin D in skeletal homeostasis. These findings are aligned with Bouillon et al. (2019), Holick (2021), and other seminal works [18 - 21], confirming the physiological relevance of vitamin D status in regulating critical biochemical markers.

Lifestyle behaviors demonstrated significant impact on serum vitamin D levels . Participants reporting regular sun exposure, physical activity, and consumption of vitamin D-rich milk showed significantly higher serum vitamin D levels, whereas sunscreen use, wearing veils, smoking, and fast-food consumption were associated with lower values. These associations underscore the modifiable nature of vitamin D deficiency and suggest feasible public health targets [22 - 24].

Moreover, the study has brought attention to a relatively underexplored subgroup—Sudanese expatriates—highlighting a pressing need for population-specific studies. The results contribute to the growing global concern that vitamin D insufficiency may be a silent epidemic affecting both skeletal and extraskeletal health [25, 26].

In light of these findings, tailored interventions are recommended. These include health education campaigns, fortification programs, and regular screening for high-risk groups. Further longitudinal research would be beneficial to explore causal relationships and the long-term effects of correcting hypovitaminosis D in this population.

Sudanese individuals living in KSA show significant hypovitaminosis D and altered biochemical profiles compared between Sudanese subgroups living in KSA. Public health measures should focus on modifiable factors like nutrition and sun exposure habits to mitigate deficiency [27 - 29]. Overall, the study supports the urgent need for health education campaigns, targeted supplementation, and policy actions to improve vitamin D status among Sudanese populations living abroad.

Conclusion:

This study provides evidence that Sudanese expatriates in Saudi Arabia suffer from significant vitamin D deficiency. Despite the region's abundant sunlight, cultural and lifestyle factors—such as indoor work, clothing choices, and dietary habits—prevent adequate vitamin D synthesis. The clear correlations between vitamin D and markers like PTH and ALKP confirm the systemic impact of this deficiency on bone and mineral metabolism.

Recommendations:

Launching campaigns to promote safe sun exposure and the health benefits of vitamin D; encouraging the consumption of vitamin D-fortified foods and milk; integrating vitamin D testing into routine health check-ups, especially for high-risk groups such as those with limited sun exposure; implementing targeted supplementation programs for individuals with identified clinical deficiencies and conducting longitudinal studies to track the long-term health outcomes of these interventions in the expatriate population.

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Conflict of Interest Declaration:

The authors confirm that there are no conflicts of interest related to this manuscript, as per the signed declaration submitted.

Ethical Approval:

The study received ethical clearance from the relevant institutional committee. Informed consent was obtained from all participants, and confidentiality was maintained throughout, as documented in the attached ethical approval letter.

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