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Serum 25-Hydroxyvitamin D Status Among Adults Attending Medical Laboratories in Tarhuna, Libya: A Cross-Sectional Study

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Abstract

Background: Vitamin D deficiency remains common in the Middle East and North Africa despite abundant sunlight. Local data from Libya are limited.

Objective: To assess serum 25-hydroxyvitamin D [25(OH)D] status among adults attending local medical laboratory settings in Tarhuna, Libya, and examine its association with gender and self-reported chronic disease.

Methods: A cross-sectional descriptive-analytical study was conducted among 85 adults aged ≥18 years recruited via convenience sampling in medical laboratory settings between January 2024 and June 2024. Demographic and chronic disease data were collected using a structured questionnaire. Serum 25(OH)D was measured by chemiluminescence immunoassay. Vitamin D status was categorized as severe deficiency (<10 ng/mL), deficiency (10–<20 ng/mL), insufficiency (20–<30 ng/mL), or normal/sufficient (30–100 ng/mL). Data were analyzed using IBM SPSS Statistics version 27. The chi-square test assessed the association between chronic disease status and vitamin D category, and an independent-samples two-tailed *t*-test compared mean concentrations by gender

.**Results:** Mean age was 43.12 ± 15.30 years; 50 (58.8%) participants were female and 35 (41.2%) were male. Mean serum 25(OH)D was 17.87 ± 13.69 ng/mL (range, 1.6–70.0). Severe deficiency occurred in 30 (35.3%) participants and deficiency in 33 (38.8%), giving an overall prevalence of concentrations <20 ng/mL of 74.1%. Vitamin D category was significantly associated with chronic disease status ($\chi^2(3) = 35.426$, $p < 0.001$). Mean 25(OH)D was numerically higher in males than in females (20.94 ± 13.28 vs. 15.73 ± 13.70 ng/mL), but this difference did not reach statistical significance in a two-tailed comparison ($p = 0.08$).

Conclusion: Low vitamin D status was highly prevalent among laboratory-attending adults in Tarhuna, particularly among participants reporting chronic disease. Although females showed lower average concentrations than males, the difference was not statistically significant. Larger, population-based multicenter Libyan studies incorporating seasonal, behavioral, nutritional, and clinical variables are warranted.

Keywords: Vitamin D deficiency; 25-hydroxyvitamin D; serum vitamin D; gender; chronic disease; Tarhuna; Libya.

1-Introduction

Vitamin D is essential for calcium and phosphate homeostasis and skeletal mineralization. Serum 25-hydroxyvitamin D [25(OH)D] is the principal circulating marker used to assess vitamin D status. Low 25(OH)D concentrations have been associated with skeletal disorders and, observationally, with several chronic conditions; however, these associations do not establish causality (Holick, 2007; Autier *et al.*, 2014; Bouillon *et al.*, 2019, 2022).

Vitamin D deficiency remains prevalent in the Middle East and North Africa despite high solar availability. Limited effective sun exposure, indoor lifestyles, clothing practices, dietary patterns, obesity, and limited food fortification may contribute to this paradox (Bassil *et al.*, 2013; Chakhtoura *et al.*, 2018). Studies from Libya also indicate a substantial burden of low vitamin D, but available evidence remains geographically limited (Elzouki *et al.*, 2020).

Gender and chronic disease status may be associated with vitamin D concentrations. Women may have lower levels because of differences in outdoor exposure, clothing, diet, body composition, or physical activity, while chronic illness may be accompanied by reduced mobility, altered diet, or changes in vitamin D metabolism. Therefore, this study assessed serum 25(OH)D status among adults attending medical laboratory settings in Tarhuna, Libya, and examined its association with gender and self-reported chronic disease.

2- Materials and Methods

Study design and participants

A cross-sectional descriptive-analytical study was conducted among adults in Tarhuna, Libya. A convenience sample of eighty-five (85) participants aged ≥18 years who underwent serum vitamin D testing in local medical laboratory settings between January 2024 and June 2024 was included. Eligibility required complete demographic information and a documented serum 25(OH)D result. Participants were excluded if demographic or laboratory information was incomplete or if they reported vitamin D supplementation during the preceding three months, severe liver disease, or chronic kidney disease.

Data collection

Demographic and clinical information was obtained using a structured questionnaire. Variables included age, gender, and self-reported chronic disease status, classified as present or absent.

Laboratory measurement

Approximately 5 mL of venous blood was collected using standard aseptic procedures into plain tubes. After clotting, samples were centrifuged at 3000 rpm for 10 minutes. Serum 25(OH)D was measured by chemiluminescence immunoassay according to the manufacturer's instructions and routine laboratory quality-control procedures. Results were expressed in ng/mL.

Table 1: Serum 25-hydroxyvitamin D [25(OH)D] reference ranges and status categories

Vitamin D category	Serum 25(OH)D
Severe deficiency	<10 ng/mL
Deficiency	10 to <20 ng/mL
Insufficiency	20 to <30 ng/mL
Normal/sufficient	30–100 ng/mL

For descriptive analysis, severe deficiency and deficiency were also combined as serum 25(OH)D <20 ng/mL.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 27. Continuous variables are presented as mean ± standard deviation (SD), minimum, and maximum; categorical variables are presented as frequencies and percentages. Pearson's chi-square test was used to assess the association between chronic disease status and vitamin D category. An independent-samples two-tailed t-test was used to compare mean serum 25(OH)D concentrations between males and females. A two-sided $p < 0.05$ was considered statistically significant.

Ethical considerations

Verbal informed consent was obtained from all participants before blood collection. Participant information was kept confidential and recorded using non-identifying codes in accordance with the ethical principles of the Declaration of Helsinki.

3- Results

Participant characteristics

The study included 85 participants with a mean age of 43.12 ± 15.30 years (range, 19–90). Females accounted for 50 (58.8%) participants and males for 35 (41.2%). Chronic disease was reported by 38 (44.7%) participants.

Table 2: Demographic and clinical characteristics of the study participants

Characteristic	Value
Age, mean ± SD (years)	43.12 ± 15.30
Age range (years)	19–90
Male, n (%)	35 (41.2)
Female, n (%)	50 (58.8)
Chronic disease: Yes, n (%)	38 (44.7)
Chronic disease: No, n (%)	47 (55.3)

Serum 25(OH)D concentrations

Mean serum 25(OH)D concentration was 17.87 ± 13.69 ng/mL, with values ranging from 1.6 to 70.0 ng/mL.

Table 3: Serum 25-hydroxyvitamin D [25(OH)D] concentrations among the study population

Variable	Value
Sample size	85
Mean serum 25(OH)D ± SD (ng/mL)	17.87 ± 13.69
Minimum (ng/mL)	1.6
Maximum (ng/mL)	70.0

Distribution of vitamin D status

Severe deficiency was present in 30 (35.3%) participants and deficiency in 33 (38.8%). Overall, 63 (74.1%) participants had serum 25(OH)D <20 ng/mL. Insufficiency and normal/sufficient concentrations were each observed in 11 (12.9%) participants.

Table 4: Distribution of vitamin D status categories among the study participants

Vitamin D category	n	%
Severe deficiency (<10 ng/mL)	30	35.3
Deficiency (10 to <20 ng/mL)	33	38.8
Insufficiency (20 to <30 ng/mL)	11	12.9
Normal/sufficient (30–100 ng/mL)	11	12.9
Deficiency or severe deficiency (<20 ng/mL)	63	74.1

Association with chronic disease

Vitamin D category differed significantly according to chronic disease status ($\chi^2(3) = 35.426$, $p < 0.001$). Among participants reporting chronic disease, 26/38 (68.4%) had severe deficiency compared with 4/47 (8.5%) among those without chronic disease.

Table 5: Association between chronic disease status and vitamin D categories

Chronic disease	Severe deficiency n (%)	Deficiency n (%)	Insufficiency n (%)	Normal n (%)	Total
Yes	26 (68.4)	10 (26.3)	1 (2.6)	1 (2.6)	38
No	4 (8.5)	23 (48.9)	10 (21.3)	10 (21.3)	47

Comparison by gender

Males had a numerically higher mean serum 25(OH)D concentration than females (20.94 ± 13.28 vs. 15.73 ± 13.70 ng/mL; mean difference 5.21 ng/mL); however, this difference was not statistically significant under a two-tailed independent-samples t-test ($p = 0.08$).

Table 6: Comparison of mean serum 25(OH)D concentrations between male and female participants

Gender	n	Mean ± SD (ng/mL)	Mean difference	*p*-value (two-tailed)
Male	35	20.94 ± 13.28	5.21	**0.08**
Female	50	15.73 ± 13.70		

4- Discussion

This investigation provides valuable laboratory-based insight into serum 25(OH)D status among adults presenting to diagnostic medical laboratories in Tarhuna, Libya. The observed overall mean serum 25(OH)D concentration of 17.87 ± 13.69 ng/mL, coupled with a 74.1% combined prevalence of deficiency and severe deficiency (<20 ng/mL), demonstrates a heavy metabolic burden of suboptimal vitamin D status within this clinical cohort.

In terms of overall prevalence, our findings align closely with previously reported epidemiological patterns across the Middle East and North Africa (MENA) region (Bassil *et al.,* 2013; Chakhtoura *et al.*, 2018), as well as local observational data reported from western Libya (Elzouki *et al.*, 2020). Despite the abundant solar radiation characteristic of Libya's geographical location, cutaneous vitamin D synthesis is frequently compromised by modern indoor lifestyles, high body mass, traditional covering attire, and inadequate dietary fortification (Bassil *et al.*, 2013). This high rate of inadequacy also mirrors broader international patterns; large-scale population observations across European cohorts similarly demonstrate that vitamin D deficiency remains a widespread clinical concern despite variable latitudes and healthcare infrastructures (Cashman *et al.*, 2016).

Regarding gender comparison, our study noted a numerically higher mean serum 25(OH)D concentration in males compared to females (20.94 ± 13.28 vs. 15.73 ± 13.70 ng/mL). However, two-tailed independent-samples testing revealed that this numerical margin did not achieve statistical significance ($p = 0.08$). This outcome partially contrasts with the dominant literature in the MENA region and Libya, where numerous studies report significantly lower serum 25(OH)D levels in women and establish gender as a primary determinant (Bassil *et al.*, 2013; Chakhtoura *et al.*, 2018; Elzouki *et al.*, 2020). Those investigations frequently attribute female vulnerability to greater skin coverage, higher adiposity, and restricted outdoor physical activity. In contrast, the absence of a statistically significant gender disparity in our dataset suggests that within this specific clinical laboratory sample, both sexes share overlapping environmental, behavioral, or dietary exposure constraints. Furthermore, this discrepancy may be attributable to statistical power limitations related to sample size rather than a true biological equilibrium between genders.

A major finding of this study is the striking association identified between self-reported chronic disease and poorer vitamin D status (chi-square(3) = 35.426, $p < 0.001$). Participants with chronic medical conditions exhibited a markedly higher rate of severe deficiency (<10 ng/mL) than those without chronic disease (68.4% vs. 8.5%). This result agrees strongly with established clinical literature documenting high rates of hypovitaminosis D among patient cohorts suffering from metabolic, cardiovascular, and autoimmune disorders (Autier *et al.,* 2014; Bouillon *et al.*, 2022). Nevertheless, the cross-sectional design of our study precludes establishing temporal sequence or direct causality. While chronic pathology may impair physical mobility, alter sun exposure habits, or disrupt hepatic hydroxylase activity, low vitamin D levels could concurrently exacerbate systemic inflammatory pathways and skeletal fragility (Holick, 2007; Bouillon *et al.*, 2019).

From an operational and clinical decision-making standpoint, these results reinforce the clinical necessity of targeted risk evaluation over unselected mass screening. Recent international consensus recommendations emphasize prioritizing biochemical 25(OH)D testing for high-risk clinical populations,

particularly individuals presenting with multi-system chronic conditions (Giustina *et al.*, 2020). When deficiency is confirmed, therapeutic correction should follow structured, evidence-based management algorithms to ensure physiological restoration while avoiding unmonitored high-dose regimens (Pilz *et al.,* 2019). Additionally, potential inter-assay variability across commercial immunoassay platforms must be taken into account when evaluating single-point 25(OH)D measurements or comparing regional data across different clinical laboratories (Binkley *et al.,* 2004; Sempos & Binkley, 2020).

5- Strengths and Limitations

A strength of this study is that it provides laboratory-based vitamin D data from Tarhuna, where published local evidence is limited. However, several key limitations must be noted. First, the selection of participants attending local medical laboratory settings introduces inevitable selection bias, as individuals presenting for diagnostic testing are more likely to have clinical symptoms or underlying health concerns, which likely overestimates the true prevalence of deficiency compared to the general healthy population of Tarhuna. Second, the study relied on a relatively small convenience sample (n = 85) without an initial sample size calculation, which may have limited the statistical power to detect gender differences. Third, the cross-sectional design precludes causal inferences, and chronic disease status was self-reported without detailed diagnostic breakdown or duration. Finally, critical determinants of vitamin D levels—such as seasonal variations, body mass index (BMI), sunlight exposure duration, dietary intake, and socio-economic indicators—were not quantified. Assay variations should also be considered when making comparisons with other studies .

6- Conclusion

Vitamin D deficiency was highly prevalent among laboratory-attending adults in Tarhuna, Libya, with nearly three-quarters demonstrating serum 25(OH)D concentrations below 20 ng/mL. While lower numerical mean concentrations were noted in females compared to males, this difference was not statistically significant. A strong association was identified between poorer vitamin D status and self-reported chronic disease. Given the clinical nature and sampling constraints of this study, findings cannot be extrapolated to the general population of Tarhuna. Future research should focus on prospective, representative population-based samples incorporating seasonal, nutritional, and clinical variables to establish true population prevalence and risk factors across Libya.

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