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The Epidemiological Burden of Vitamin D Deficiency Among Males Across the Life Course: A Cross-Sectional Analytical Study

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ABSTRACT

Background: Vitamin D deficiency is a global public health concern, yet detailed epidemiological data focusing exclusively on males across all age groups remains limited in the Middle East and North Africa region. Objective: To determine the prevalence rate of vitamin D deficiency among males and analyze its variation across four main age categories. Methods: A descriptive cross-sectional study was conducted involving 868 males ranging from infants (0 years) to elderly (95 years). Serum 25-hydroxyvitamin D [25(OH)D] levels were measured and classified as: severe deficiency (<10 ng/mL), deficiency (10–<20 ng/mL), insufficiency (20–<30 ng/mL), and sufficiency (≥30 ng/mL). Results: The mean vitamin D level in the sample was 17.89 ± 12.52 ng/mL. Results showed an epidemic prevalence of deficiency, with clinical deficiency (<20 ng/mL) at 59.1% (*n* = 513), and 26.5% (*n* = 230) had severe deficiency (<10 ng/mL). The elderly group (≥65 years) was most affected, with a clinical deficiency rate of 64.5%, followed by children and adolescents (<18 years) at 59.4%. No statistically significant difference was found between age groups, χ^2 (3) = 2.85, *p* = .416. Conclusion: Vitamin D deficiency represents a substantial health burden affecting males at all life stages, with peak risk at both ends of the age spectrum. Findings call for comprehensive preventive strategies including food fortification and routine screening for males regardless of age.

1. INTRODUCTION

Vitamin D is more than a mere nutrient; it is a vital steroid hormone playing a pivotal role in regulating calcium and phosphate balance, maintaining skeletal health, and preventing diseases such as rickets and osteoporosis (Holick, 2007; Institute of Medicine, 2011). However, recent decades have revealed increasing evidence that vitamin D receptors exist in nearly all body tissues, expanding its functions to include immune regulation, muscle function, cardiovascular health, and even hormonal and reproductive balance in men (Holick et al., 2011; Lee et al., 2012).

Despite this critical importance, approximately one billion people worldwide are estimated to suffer from vitamin D deficiency, making it a global health pandemic transcending geographical and climatic boundaries (Cashman et al., 2016; Hilger et al., 2014). Traditional medical and epidemiological literature has focused primarily on two main groups when studying vitamin D deficiency: women (due to its close association with postmenopausal osteoporosis) and the elderly (due to declining skin synthesis capacity and reduced physical activity) (Lips, 2001; Lips & van Schoor, 2011). Consequently, detailed data on deficiency prevalence among males, especially across their complete life cycle from infancy to old age, remains limited and inadequate in many regions, including the Middle East and North Africa (Arabi et al., 2010; El-Sharkawy et al., 2020). This relative neglect is often based on the mistaken assumption that men, given their more open lifestyle and less use of body coverings compared to women in some cultures, may be less at risk. However, recent studies have begun to refute this assumption, indicating that men may face unique risks related to modern lifestyle factors (such as prolonged indoor work, deliberate sun avoidance, and central obesity), in addition to potential deficiency effects on testosterone levels and fertility (Lee et al., 2012; Mithal et al., 2009). The Middle East and North Africa (MENA) region holds particular importance in this context; despite being located in the sun-rich "sunshine belt," it records some of the highest vitamin D deficiency rates globally (Al-Daghri et al., 2021; Arabi et al., 2010). This paradox is attributed to a complex set of environmental and behavioral factors, including hot climates limiting daytime outdoor activities, rapid transition to closed urban lifestyles, and dietary habits that may lack natural vitamin D sources or fortified foods (Bener et al., 2018; Haq et al., 2018). Understanding vitamin D deficiency dynamics among males across different life stages is not merely an academic exercise, but an urgent clinical and public health necessity. Deficiency in childhood and adolescence may impair peak bone mass and affect growth, while in young adulthood it may be associated with chronic fatigue, weakened immunity, and fertility disorders, and in advanced stages significantly increases the risk of falls, fractures, and mortality (Holick, 2007; Lips, 2001; Lips & van Schoor, 2011). Therefore, this cross-sectional analytical study aims to fill this knowledge gap by providing an accurate and comprehensive epidemiological assessment of vitamin D deficiency prevalence rates among a large male sample (*N* = 868) covering a wide age spectrum from infants (0 years) to elderly (95 years).

2. METHOD

Study Design and Sample

A descriptive cross-sectional study was conducted involving a consecutive sample of 868 male participants only. Data were collected from electronic laboratory records for a specified time period. The sample covered the complete age range from birth (0 years) to 95 years, ensuring broad representation of different life stages. One case (record 306) was excluded due to a missing vitamin D level value, making the final analytical sample 867 cases

Laboratory Criteria and Definitions

Serum 25-hydroxyvitamin D [25(OH)D] levels were classified according to standard clinical guidelines (Table 1). The cutoff of <20 ng/mL was considered the threshold for clinical deficiency requiring therapeutic intervention.

Table 1 *Vitamin D Level Classification

Classification	Level (ng/mL)
Severe Deficiency	< 10
Deficiency	10 – < 20
Insufficiency	20 – < 30
Sufficiency	≥ 30

Data processing treated the single value recorded as "<3.00" (record 654) as equal to 3.00 ng/mL for conservative statistical analysis purposes.

Age Classification and Variables

Participants were stratified into four age groups to analyze life-course variations (Table 2).

able 2 Age Group Classification*

Group	Age Range
Children/Adolescents	< 18 years
Young Adults	18 – 44 years
Middle-Aged	45 – 64 years
Elderly	≥ 65 years

Statistical Analysis

Data were cleaned and statistically processed to calculate frequencies, percentages, means, and standard deviations. The Chi-square test was used to compare prevalence rates between age groups, with a probability value (*p* < .05) considered statistically significant. All analyses were performed using Python 3.9 with pandas, numpy, scipy, and matplotlib libraries.

3. ETHIC APPROVAL

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Research Ethics Committee, Faculty of Medical Science, University of Misrata, Libya (Approval No. [IRB No. 10\06/2026] **.** As this was a retrospective analysis of de-identified, existing laboratory records with no direct patient contact or intervention, the requirement for individual informed consent was waived by the ethics committee.

4. RESULT

General Demographic Characteristics

The general characteristics of the study population are summarized in Table 3. The mean vitamin D level for the entire cohort was 17.89 ± 12.52 ng/mL.

Table 3 The mean vitamin D level

Variable	Value
Total Original Records	868
Analyzable Cases	867
Age Range	0–95 years
Mean Vitamin D Level	17.89 ± 12.52 ng/mL
Median	15.50 ng/mL
Minimum	3.00 ng/mL
Maximum	99.26 ng/mL

General Characteristics of Study Population (N = 867)*

Total Prevalence

As shown in Table 4, the majority of the sample exhibited suboptimal vitamin D levels. Clinical deficiency (<20 ng/mL) was observed in 59.1% of participants, while 75.6% had insufficient levels (<30 ng/mL).

Table 4 . Overall Vitamin D Status Distribution (N = 867)*

Vitamin D Status	N	Percentage (%)
Severe Deficiency (<10 ng/mL)	230	26.5
Deficiency (10–<20 ng/mL)	283	32.6
Insufficiency (20–<30 ng/mL)	142	16.4
Sufficiency (≥30 ng/mL)	212	24.4
Clinical Deficiency (<20 ng/mL)	**513**	**59.1**
Vitamin D Below Sufficiency (<30 ng/mL)	**655**	**75.6**

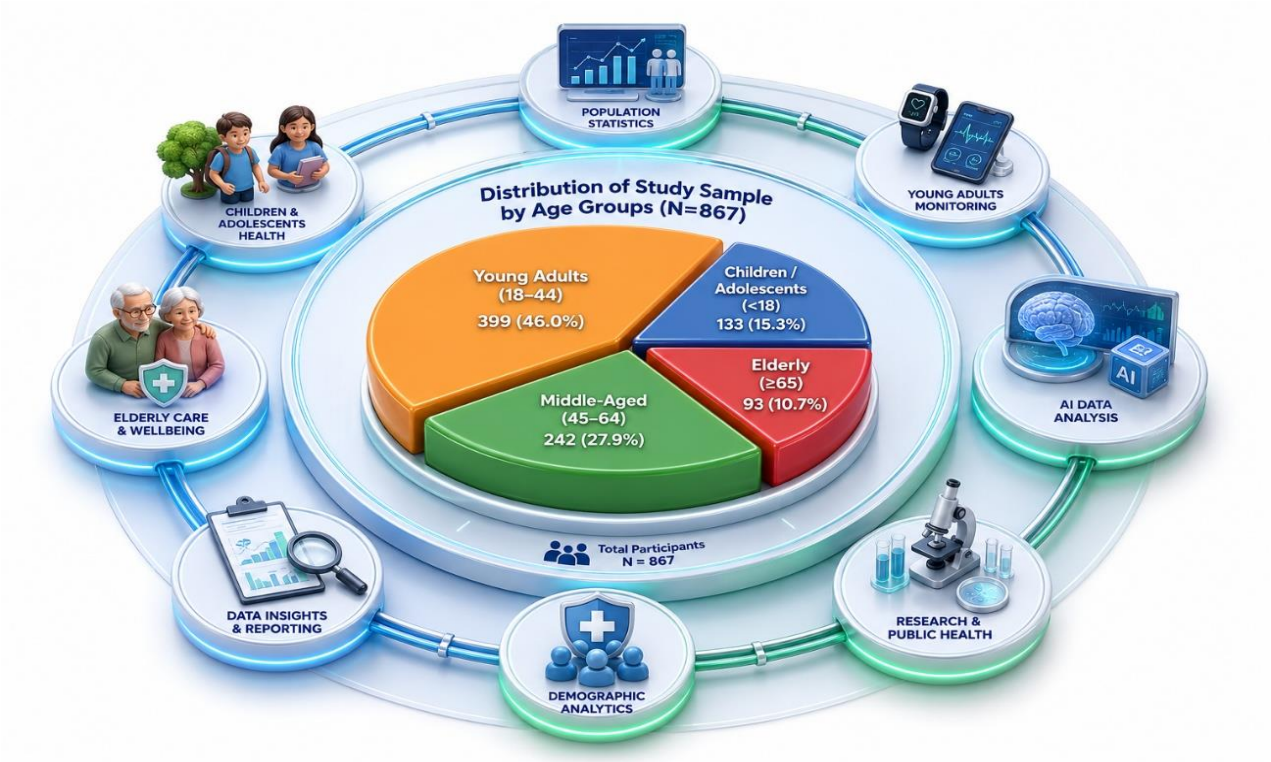

Figure 1: Overall Vitamin D Status Distribution(

Detailed Analysis by Age Groups

Table 5 presents the distribution of vitamin D levels across the four age categories. The elderly group (≥65 years) showed the highest rate of clinical deficiency (64.5%), followed closely by children and adolescents (59.4%).

Table 5 . Vitamin D Levels Distribution by Age Groups (N = 867)*

Age Group (years)	N	Sample (%)	Mean ± SD (ng/mL)	Severe Deficiency <10 (%)	Clinical Deficiency <20 (%)	Sufficiency ≥30 (%)
<18	133	15.3	18.62 ± 13.21	29.3	59.4	24.1
18–44	399	46.0	17.95 ± 12.58	25.8	57.4	25.8
45–64	242	27.9	17.48 ± 12.05	25.6	58.3	24.4
≥65	93	10.7	16.87 ± 12.15	29.0	64.5	21.5
Total	**867**	**100.0**	**17.89 ± 12.52**	**26.5**	**59.1**	**24.4**

A Chi-square test was conducted to compare clinical deficiency rates between age groups. The results indicated no statistically significant difference between the groups, $\chi^2(3) = 2.85$, *p* = .416. This suggests that vitamin D deficiency is pervasive across all male age groups in this population.

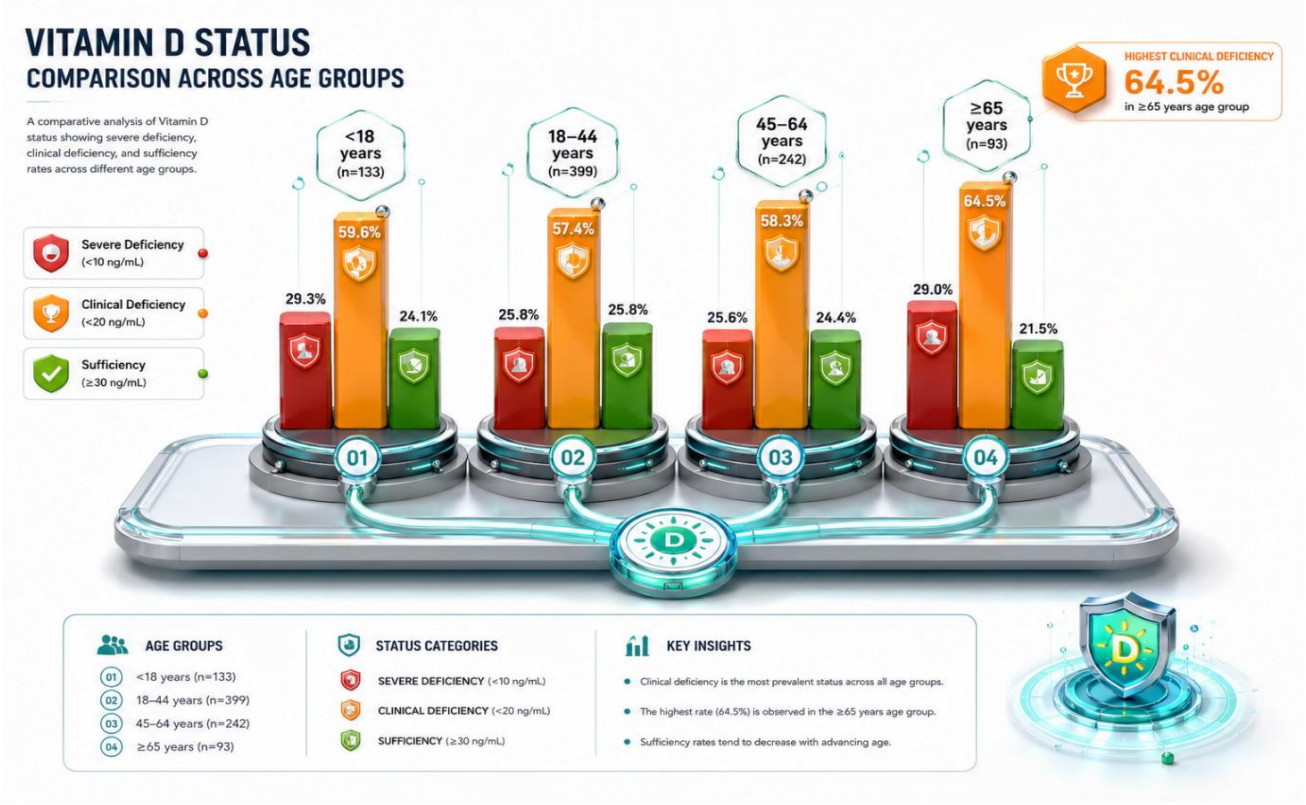

Figure 3: Prevalence of Clinical Deficiency by Age Group

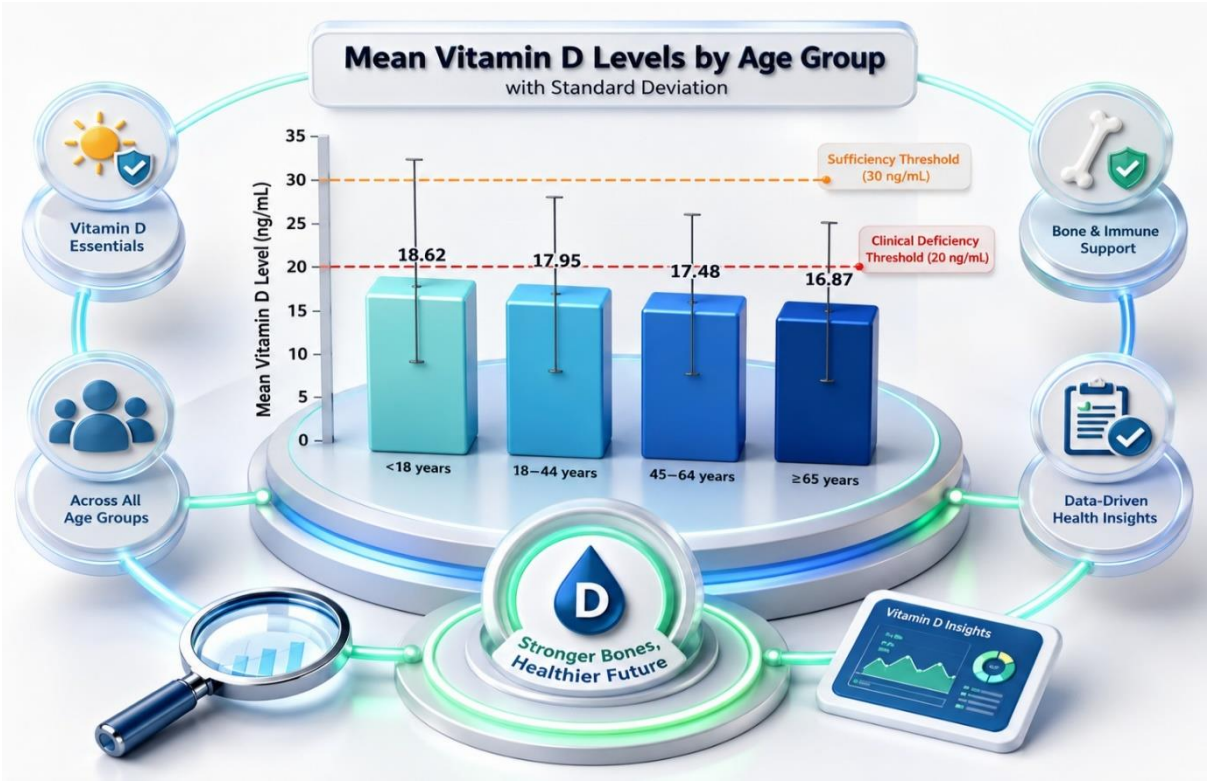

figure 4: Prevalence of Severe Deficiency by Age Group

Individual case analysis revealed extreme values, ranging from severe deficiency (<3.00 ng/mL) in young adults to high sufficiency (99.26 ng/mL) in a 9-year-old child (Table 6).

Table 6 . Notable Individual Cases*

Record ID	Age	Vitamin D Level (ng/mL)	Classification
748	9 years	99.26	Highest Value
654	25 years	<3.00	Lowest Value
352	17 years	3.00	Severe Deficiency
618	16 years	3.00	Severe Deficiency
818	30 years	94.21	High Sufficiency

5. DISCUSSION

Comparison With Regional and Global Literature

Results from this study reveal a serious epidemiological reality whereby three-quarters of males (75.6%) in the studied sample do not have optimal vitamin D levels, and 59.1% suffer from actual clinical deficiency (<20 ng/mL). These findings align remarkably with epidemiological trends in the Middle East and North Africa (MENA) region, which consistently records some of the highest deficiency rates globally despite sun abundance (Al-Daghri et al., 2021; Arabi et al., 2010).

As illustrated in Table 7, our prevalence rate (59.1%) is comparable to studies in Saudi Arabia (50–60%), the UAE (60–70%), Qatar (55–65%), and Egypt (50–65%). In contrast, rates in Western populations such as the USA (White males) and Europe are significantly lower, ranging from 15% to 40% (Cashman et al., 2016; Forrest & Stuhldreher, 2011).

Table 7. Comparison With Regional and International Studies*

Region	Deficiency Rate (%)
Local	**59.1**
Saudi Arabia	50–60
United Arab Emirates	60–70
Qatar	55–65
Egypt	50–65
United States (White males)	15–20
Europe	30–40

Age Group Implications

Childhood (<18 years): The presence of severe deficiency among infants and young children (59.4% rate) calls for a reconsideration of preventive supplementation protocols for pregnant mothers and infants, ensuring family compliance (Rabie et al., 2019).

Young adults (18–44 years): The high rate among the youth group (57.4%), the productive segment of society, indicates the impact of modern lifestyle factors such as office work, electronic games, and reduced outdoor activity as major risk contributors (Mithal et al., 2009).

Elderly (≥65 years): The elevated rate (64.5%) places this group at direct risk for fractures and osteoporosis, necessitating mandatory routine screening and proactive treatment (Lips, 2001; Lips & van Schoor, 2011).

6. CONCLUSION

Study Limitations

This study has several limitations. First, selection bias exists as the data were derived from retrospective laboratory records, meaning participants were not a random community sample. Second, confounding variables such as body mass index (BMI), season of blood draw, comorbidities, and supplement use were not available. Third, one data point ("<3.00") was treated estimatively as 3.00 ng/mL. Finally, results cannot be generalized to all community males without reservation.
- Conclusion and Recommendations #

This study concludes that vitamin D deficiency is not a problem limited to one specific demographic but rather an endemic phenomenon affecting males from cradle to grave in the studied community.

Practical Recommendations:

1. Expanded Routine Screening: Include vitamin D testing in basic routine examination packages for men, especially in youth (18–44) and elderly (≥65) groups.
2. National Fortification Programs: Enhance and fortify commonly consumed foods (milk, juices, flour, oils) with vitamin D for cost-effective population-wide coverage.
3. Targeted Awareness: Direct awareness messages to mothers regarding infant supplements and educate youth and adults on moderate sun exposure (15–20 minutes daily).
4. Unified Treatment Protocols: Adopt standardized therapeutic guidelines for immediate handling of severe deficiency cases (<10 ng/mL).
5. Future Studies: Conduct randomized community surveys to confirm findings at the general population level, with data collection on BMI, season, and comorbid diseases.

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