Association Between Vitamin D Deficiency and Higher Body Mass Index Among Women of Various Age Groups in Samawah City

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Abstract

Background: Vitamin D is not only classified as a vitamin but also functions as a hormone within the body. It belongs to a group of fat-soluble secosteroids known to enhance the absorption of calcium, magnesium, and phosphate in the intestines, thereby influencing various biological activities. The significance of vitamin D in maintaining human health cannot be overstated, as its deficiency has been linked to several disease conditions, including type 1 and type 2 diabetes, rheumatoid arthritis, chronic kidney diseases, cognitive dysfunction, and obesity. Objective: This study aims to assess the levels of vitamin D among women across different age groups in Samawah City. Method: A total of 315 women were included in this study and categorized into three groups based on age. Group A comprised 19.05% of women aged 18-25, with a mean age of 20.82 ± 2.43. Group B consisted of 62.22% of women aged 26-46, with a mean age of 33.31 ± 5.19. Lastly, Group C comprised 18.73% of women aged 47-60, with a mean age of 50.59 ± 3.01. Results: The study revealed that severe vitamin D deficiency was observed in 23.3%, 16.3%, and 15.3% of women in groups A, B, and C, respectively. Additionally, deficient levels of vitamin D were found in 40%, 41.3%, and 40.7% of women in groups A, B, and C, respectively. Meanwhile, insufficient levels of vitamin D were present in 26.7%, 27.6%, and 32.3% of women in groups A, B, and C, respectively. On the other hand, normal vitamin D levels were observed in 10%, 14.8%, and 11.7% of women in groups A, B, and C, respectively. Furthermore, the study revealed that 46.76% of women with vitamin D deficiency were classified as obese, 43.53% were considered overweight, and only 9.71% had an average weight. Conclusion: In conclusion, the study indicates that women with lower levels of vitamin D tend to have higher BMI values.

Keywords: Body Mass Index; Iraqi females; Overweight; Vitamin D Deficiency.

Significance | Body Mass Index; Iraqi females; Overweight; Vitamin D Deficiency.

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Introduction

Vitamin D, one of the most essential vitamins for human health, is a fat-soluble nutrient available in two primary forms: vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). Vitamin D2 is obtained from natural sources such as fish and cod liver, while vitamin D3 is synthesized in the skin from its precursor, 7-dehydrocholesterol, upon exposure to UV light (Park et al., 2018). Once ingested or synthesized, vitamin D undergoes conversion in the liver and kidneys to its active form, 1,25-dihydroxyvitamin D (1,25-(OH)2), which is crucial for calcium absorption in the gastrointestinal tract. This active form of vitamin D plays a pivotal role in maintaining optimal blood levels of calcium and phosphorus, which are necessary for numerous physiological functions including muscle contraction, enzyme activation, and

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blood clotting (Bouillon & Suda, 2014).

Beyond these well-known functions, vitamin D has been found to influence a range of biological activities such as insulin secretion, immune response modulation, and cellular proliferation and differentiation (Wolden-Kirk et al., 2012, Zainab et al. 2024, Anastasia et al. 2024, Walid et al. 2024). Consequently, vitamin D deficiency is linked to various health issues, including diabetes mellitus, autoimmune diseases, Crohn's disease, hypertension, and certain cancers. This deficiency is a widespread health problem affecting individuals of all ages across different regions and seasons, particularly during winter due to reduced sunlight exposure (Ahmed et al., 2023). Causes of vitamin D deficiency include inadequate dietary intake, limited sun exposure, chronic renal failure, and malabsorption syndromes (Kennel et al., 2010).

The American College of Cardiology classifies vitamin D levels as follows: sufficiency at serum levels ≥30 ng/mL, insufficiency at 21–29.9 ng/mL, deficiency at 10-20 ng/mL, and severe deficiency at <10 ng/mL (Holick et al., 2012). Given that sun exposure and dietary intake often fail to meet the body's vitamin D requirements, supplementation is usually necessary. The recommended daily dose of vitamin D is 600 IU, which is essential for normal muscle and bone function, while a dose of 1500–2000 IU per day is necessary to maintain levels above 30 ng/mL (Ahmed et al., 2021). Although extended sun exposure increases the risk of skin cancer, brief exposure of five to ten minutes two to three times weekly is considered sufficient (Beshna et al., 2012).

Recent research has highlighted a strong link between obesity and vitamin D deficiency. Obesity, now recognized as a significant risk factor for diseases such as diabetes and ischemic heart disease, is frequently associated with lower vitamin D levels (Gasmi et al., 2023). Body mass index (BMI), a common measure of obesity, is calculated by dividing an individual's weight in kilograms by their height in meters squared. According to the World Health Organization, BMI categories are defined as underweight (<18.5 kg/m²), normal (18.5-24.9 kg/m²), overweight (25-29.9 kg/m²), and obese (>30 kg/m²). High BMI is a known risk factor for chronic diseases like diabetes, hypertension, and cancer (Oniszczenko & Stanisławiak, 2019). This study aimed to measure vitamin D levels among groups of women in Samawah City and explore the correlation between vitamin D levels and body mass index.

Materials and Methods

Study design

This study included a total of 315 female participants who visited private laboratories in Samawah City, Iraq, between July 1, 2021, and September 1, 2023. Participants' medical histories and physical examinations were collected and recorded before they were tested for serum vitamin D levels. The exclusion criteria were as follows: pregnant or lactating women, individuals with hepatic or renal failure, users of vitamin D supplements, and females with missing BMI data or those younger than 18 years old.

The study participants were divided into three age groups: Group A: Females aged 18-25 years, Group B: Females aged 26-46 years, Group C: Females aged 47-60 years. Additionally, participants were classified based on their Body Mass Index (BMI).

This study was conducted in accordance with the ethical standards set forth by the relevant institutional and national research committees. Ethical approval was obtained from the appropriate ethics committee prior to the commencement of the study. Informed consent was obtained from all participants after explaining the purpose of the study, the procedures involved, and their right to withdraw at any time without any repercussions.

To ensure confidentiality, all personal information and medical data collected from participants were anonymized and securely stored. Only authorized personnel had access to the data, and it was used solely for the purposes of this research. The study adhered to the Declaration of Helsinki principles, ensuring respect for the participants, beneficence, and justice throughout the research process.

Participants were excluded from the study if they were pregnant or lactating, had hepatic or renal failure, used vitamin D supplements, had missing BMI data, or were younger than 18 years old. This was to ensure the integrity and accuracy of the study results.

The procedures for blood collection and vitamin D assay were performed in a manner that minimized discomfort and risk to the participants.

Blood Collection and Vitamin D Assay

Blood samples were collected from the participants at private laboratories in Samawah City. The samples were immediately placed into plain tubes and allowed to stand for 10 minutes to coagulate. Following this, the samples were centrifuged at 1600 rpm for 10 minutes to separate the serum. The serum levels of 25-OH Vitamin D were measured using the CLOBAS device.

Statistical Analysis

Data analysis was conducted using Excel 2016 and SPSS software (Version 24). Results were presented as mean ± standard deviation (SD), and the percentage values for each group were calculated. The significance of vitamin D deficiency was assessed using a one-sample t-test, with a significance level set at 0.05.

Results

Participant Demographics

The study population consisted of 315 female participants, divided into three age groups. Group A (18-25 years) comprised 19.05% of the participants with a mean age of 20.82 ± 2.43 years. Group B (26-46 years) was the largest group, making up 62.22% of the participants, with a mean age of 33.31 ± 5.19 years. Group C (47-60

Table 1. Baseline Age characteristics

Groups	N	Percentage	Mean age in years
Group A (18-25-year-old)	60	19.05 %	20.82 ± 2.43
Group B (26-46 years old)	196	62.22 %	33.31 ± 5.19
Group C (47-60 years old)	59	18.73 %	50.59 ± 3.01

Table 2. The results of the vitamin D of all groups

Groups	Severely deficient level	Deficient level	Insufficient level	Sufficient level
Group A (18-25-year-old)				
Prevalence	14	24	16	6
Percentage	23.3 %	40 %	26.7 %	10%
Mean	8.05±1.75	15.12±2.71	24.23±2.32	36.06±6.51
Group B (26 and 46 years old)				
Prevalence	32	81	54	29
Percentage	16.3 %	41.3 %	27.6 %	14.8 %
Mean	7.21±1.83	13.75±3.21	23.66±2.76	33.14±2.57
Group C (47-60 years old)				
Prevalence	9	24	19	7
Percentage	15.3 %	40.7 %	32.3 %	11.7 %
Mean	8.16±1.39	14.04±2.44	23.07±1.51	33.70±1.60

Table 3. The BMI value in participants females with vitamin D deficiency

BMI value	Prevalence	Percentage
Normal weight women	27	9.71 %
Overweight women	121	43.53 %
Obese women	130	46.76 %

Table 4. The BMI value in participants females with vitamin D deficiency in each group

Groups		BMI value	Prevalence	Percentage
Group A		Normal weight women	8 (54)	14.81 %
		Overweight women	25 (54)	46.3 %
		Obese women	21 (54)	38.89 %
Group B		Normal weight women	14 (167)	8.38 %
		Overweight women	83 (167)	49.7 %
		Obese women	70 (167)	41.92 %
Group C		Normal weight women	5 (52)	10 %
		Overweight women	13 (52)	25 %
		Obese women	39 (52)	75 %

years) included 18.73% of the participants with a mean age of 50.59 ± 3.01 years (see Table 1).

Vitamin D Levels by Age Group

Group A: Among the 60 females in this group, 14 (23.3%) exhibited severe vitamin D deficiency with a mean serum level of 8.05 ± 1.75 ng/ml. Vitamin D deficiency was observed in 24 females (40%) with a mean serum level of 15.12 ± 2.71 ng/ml. Insufficiency was noted in 16 females (26.7%) with a mean serum level of 24.23 ± 2.32 ng/ml, and only 6 females (10%) had sufficient vitamin D levels, with a mean of 36.06 ± 6.51 ng/ml (see Table 2).

Group B: In this group, consisting of 196 females, 32 (16.3%) had severe vitamin D deficiency with a mean level of 7.21 ± 1.83 ng/ml. Vitamin D deficiency was found in 81 females (41.3%) with a mean level of 13.75 ± 3.21 ng/ml. Insufficiency was observed in 54 females (27.6%) with a mean level of 23.66 ± 2.76 ng/ml, while 29 females (14.8%) had sufficient vitamin D levels, averaging 33.14 ± 2.57 ng/ml (see Table 2).

Group C: Out of the 59 females in this group, 9 (15.3%) showed severe deficiency with a mean vitamin D level of 8.16 ± 1.39 ng/ml. Vitamin D deficiency was present in 24 females (40.7%) with a mean level of 14.04 ± 2.44 ng/ml. Insufficiency was noted in 19 females (32.3%) with a mean level of 23.07 ± 1.51 ng/ml, and 7 females (11.7%) had sufficient levels, with a mean of 33.70 ± 1.60 ng/ml (see Table 2).

Correlation Between Vitamin D Levels and BMI

Among the 278 participants from groups A, B, and C who had vitamin D levels below 30 ng/ml, the study examined the correlation between vitamin D levels and BMI. Of these, 130 participants (46.76%) with vitamin D deficiency had a BMI greater than 30 kg/m², and 121 participants (43.53%) had a BMI between 25-29.9 kg/m². Only 27 participants (9.71%) with vitamin D deficiency had a normal weight (see Table 3). Table 4 provides a detailed breakdown of the prevalence and percentage of BMI values across groups A, B, and C.

Discussion

Vitamin D deficiency, particularly of cholecalciferol, is a prevalent health issue affecting approximately one billion people globally, with women being significantly impacted. Various factors contribute to the insufficient levels of vitamin D among women of different age groups, including lifestyle choices, physiological differences, and environmental conditions. The primary sources of vitamin D are sunlight exposure and a diet rich in vitamin D. Thus, inadequate sunlight exposure is a major cause of vitamin D deficiency, as the skin synthesizes vitamin D when exposed to UVB rays. Studies indicate that about 50% of populations in developing countries have insufficient levels of vitamin D (Amrein et al., 2020; Parva et al., 2018).

Several studies in different Iraqi cities have evaluated vitamin D deficiency levels. For example, a cross-sectional study in Duhok province included 1143 individuals and found that vitamin D deficiency is prevalent among younger adults and females, with the lowest levels observed in older adults (Mohammed et al., 2021). Another study focused on 300 elderly diabetic patients and revealed a significant correlation between vitamin D deficiency and diabetes mellitus (DM), showing that diabetic patients had lower vitamin D levels compared to non-diabetic patients (Jawad & Baiee, 2020). Additionally, a study in Basrah examined the impact of age, gender, and environmental factors on vitamin D levels, concluding that vitamin D deficiency is highly prevalent among women under 44 years old and unmarried women (Hussein et al., 2021).

In this study, participants were divided into three age groups. The majority of participants fell into Group B (26-46 years old), comprising 62.22% of the total sample, with a mean age of 33.31 ± 5.19 years. The results indicated a high prevalence of vitamin D deficiency across all age groups, with 40%, 41.3%, and 40.7% of participants in Groups A, B, and C, respectively, exhibiting deficiency. Only 10%, 14.8%, and 11.7% of participants in Groups A, B, and C, respectively, had sufficient vitamin D levels.

Several factors contribute to the high prevalence of vitamin D deficiency among women. Reduced sunlight exposure due to indoor occupational and household responsibilities, particularly as age increases, is a significant factor. Cultural practices such as wearing veils and sunglasses, and the use of sunscreen with high SPF, also limit UVB exposure, especially among younger women. These findings align with previous studies (Hantoosh et al., 2019; Sofihussein, 2023).

The study also explored the association between vitamin D deficiency and obesity. Among women with insufficient and deficient vitamin D levels, 43.53% were overweight, 46.7% were obese, and only 9.71% had a normal weight. The relationship between obesity and vitamin D deficiency is complex and multifactorial. Factors such as the sequestration of vitamin D by adipose tissue, volumetric dilution, and a sedentary lifestyle contribute to lower circulating levels of vitamin D in obese women. This study's results support the association between higher BMI values and lower vitamin D levels, consistent with previous research (Smotkin-Tangorra et al., 2007; Amrein et al., 2020; McKay et al., 2020; Quesada-Gomez et al., 2022; Al-Hussaniy et al., 2023).

This study highlights the widespread issue of vitamin D deficiency among women in Samawah City, with significant correlations to age and BMI. Addressing vitamin D deficiency requires a multifaceted approach, including promoting dietary intake of vitamin D-rich foods, encouraging safe sun exposure, and considering supplementation, particularly for those at higher risk of deficiency. Further research is needed to explore targeted interventions to improve vitamin D status in this population.

Conclusion

This study highlighted the significant prevalence of vitamin D deficiency among women in Samawah City, Iraq, with notable correlations to age and BMI. The data revealed that a substantial proportion of women across all age groups suffer from vitamin D deficiency, with the highest prevalence observed among those aged 26-46 years. Factors contributing to this deficiency include reduced sunlight exposure due to indoor activities, cultural practices, and higher BMI values. The association between obesity and lower vitamin D levels suggests that interventions should consider both nutritional and lifestyle modifications. Addressing vitamin D deficiency in this population necessitates a multifaceted approach, incorporating dietary improvements, safe sun exposure practices, and potential supplementation. Further research is essential to develop targeted strategies that effectively enhance vitamin D status among these women, ultimately improving their overall health and reducing the risk of associated conditions.

Author contributions

S.A.R. conceotualized, edited and reviewed the manuscript. S.A.R. performed the experiments, statistical analysis, wrote the manuscript.

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Competing financial interests

The authors have no conflict of interest.

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