



## Association between serum vitamin D levels and body mass index among women at reproductive age in urban areas

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### Abstract

**Introduction:** Globally, the deficiencies of vitamin D and the existence of high rates of obesity have become real problems for public health. Limited data exist on their relationship with each other among Iraqi women of reproductive age in urban settings. **Objective:** The purpose of the present study was to examine the association between serum vitamin D levels and BMI among women living in urban areas of Al-Diwaniyah, Iraq. **Methods:** The study involved 155 women between the ages of 15-49. All participants completed a questionnaire and all relevant anthropometric measurements were taken. Serum 25-hydroxyvitamin D [25(OH)D] levels were also determined. BMI classification was based on WHO standards. We used non-parametric tests and characteristic statistics, Chi-square tests, and correlation of Spearman's rank to compare the results from the sample and test hypotheses. **Results:** According to our data, 54.1% of the participants fell into either the overweight or obese class founded on body mass index (BMI). The average serum vitamin D level for all subjects was  $18.30 \pm$  (Sd=11.11 ng/mL) with 85.8% of the females having a serum level of vitamin D that was considered to be suboptimal. Significant correlation coefficients between BMI and serum levels of vitamin D were found to be inversely related ( $r = -0.241$ ,  $p=0.003$ ) but no statistically significant disparities were noted between groups in the analysis of BMI categories. **Conclusions:** Reproductive-age women living in the Al-Diwaniyah region are becoming increasingly likely to suffer from both vitamin D deficiency and

overweight/obesity. These results reveal a critical need for the establishment of effective public health policies that will address issues such as vitamin D screening, nutritional education, and weight management in urban female populations.

**Keywords:** Vitamin D. Obesity. BMI. Women.

### Introduction

Vitamin D is a fat-soluble, hormone-like vitamin that helps with the calcium balance in the body, metabolizing bones, immune system function and regulating your metabolism. It is formed mainly in the skin when UVB rays from the sun hit your skin. You can get vitamin D through food or supplements as well [1]. While vitamin D is made through exposure to sunlight, there are still areas where people do not get enough natural sunlight which creates a worldwide public health issue with Vitamin D deficiency, and this issue equally impacts women [2].

BMI is an anthropometric scale used for determining an individual's Body Mass Index (BMI) and for classifying each person into four categories; Underweight, Normal weight, Overweight and Obese [3]. Obesity is one of the largest global public health problems affecting almost all populations, but predominantly women, and is strongly linked to metabolic syndromes such as type 2 diabetes, insulin resistance, and menstrual problems [4].

Vitamin D is found in many different populations worldwide, but women and older adults have been reported to possess greater levels of vitamin D

deficiency [5]. The combination of vitamin D deficiency and excess body weight is a growing concern due to the additively negative effects on health and reproduction they produce, such as presenting an increased risk for polycystic ovary syndrome and metabolic syndrome [6-8].

Research has shown a biologically meaningful relationship to be an inversely proportional connection between a person's BMI and their concentration of 25-hydroxyvitamin D [25(OH)D] in their serum; the higher the amount of body fat (adiposity), the lower the amount of circulating 25(OH)D in the bloodstream [9]. Several mechanisms have been proposed through which obesity may alter the body's way of metabolizing vitamin D: 1) vitamin D being sequestered by adipose tissue; 2) volumetric dilution; and 3) vitamin D metabolism in obese people is altered [10]. Urban lifestyles for women, such as having decreased exposure to the outdoors, limited exposure to sunlight, leading sedentary lives, and wearing culturally appropriate clothing, have contributed to vitamin D deficiency in women [11,12].

Also, vitamin D levels are relatively low in the Middle-East countries, such as Iraq, despite the high availability of sunlight. This epidemic of obesity amongst women of reproductive age due to rapid urbanization, decreased physical activity, and dietary change to high calorie foods has been growing in frequency. However, there is little research amongst Iraqi women that establishes a relationship between body mass index and vitamin D levels.

The purpose of this study was to determine the partnership between levels of serum vitamin D and body mass index in reproductive-age women residing in urban areas of Al-Diwaniyah Governorate in Iraq.

## Materials and Methods

### Study Design

A descriptive correlational study design was used to evaluate the relationship between the body mass index (BMI) of reproductive-aged females and the level of vitamin D in their serum. This approach allowed researchers to assess both the direction and strength of the association between the two variables, but did not involve an experimental intervention.

### Study Setting and Population

The research took place inside urban communities in Al-Diwaniyah Governorate, Iraq. The target audience for this research study included all reproductive-aged women (15-49 years old) who live within an urban environment at the time of data collection.

## Inclusion Criteria and Exclusion Criteria

The study included participants who were women between the ages of 15 - 49 who lived in an urban area and voluntarily provided informed consent for all components of the research (including completing a questionnaire; having measurements taken of their height, weight; and providing a sample of blood). The following individuals did not meet inclusion criteria: pregnant/lactating women, people with chronic medical illnesses that can alter the metabolism of vitamin D (parathyroid disease, chronic gastrointestinal disease); autoimmune diseases; inflammatory bowel disease; people on a therapeutic dose of vitamin D; and people with gastrointestinal malabsorption disorders or lactose intolerance.

## Data Collection Tool

Data collection was performed through researcher-designed structured questionnaire based on previous literature reviews; this provided a model structure of sociodemographic features (including age category, marital status, level of education, occupation status, type of home, and monthly salary), patterns of sun exposure (including duration, area(s) exposed, and any sunscreen applied).

## Anthropometric Measurements

To ensure the accuracy of collected data, direct anthropometric measurements were made. Participants had their body weight recorded using a calibrated electronic scale with no shoes and minimal clothing. When measuring height, participants were vertically positioned in the Frankfort plane and two horizontal lines were created from each side of their body to the floor using a wall-mounted stature meter. Following these measurements, BMI (kg/m<sup>2</sup> ranking) could then be determined from weight divided by height and classified as per to the World Health Organization (WHO) into underweight, normal weight, overweight or obese.

## Biochemical Analysis

Blood samples taken from all subjects were obtained through venipuncture performed by a trained phlebotomist in adherence to standard laboratory protocols. To assess serum vitamin D levels, we measured serum 25-hydroxyvitamin D (25[OH]D) levels using standard photometric laboratory methods, and categorized results (ng/mL) according to well-established reference ranges for serum 25-hydroxyvitamin D concentration ranges as follows: vitamin D deficiency (<20 ng/mL), vitamin D suboptimal status (20-30 ng/mL), and vitamin D sufficiency (30-50 ng/mL) [13].

**Statistical Analysis**

SPSS software 27 was used for data entry and analysis. Study variables were summarized with descriptive statistics (continuous - minimum, maximum, mean & standard deviation; categorical - frequency and percentage). The normality of continuous variables was analyzed "Shapiro-Wilk Test" (The data were not normally distributed, (p < 0.05); so that, non-parametric tests were utilized). To assess the relationship between serum Vitamin D and BMI, the Spearman rank-order correlation coefficient was calculated. Chi-square tests were used to test for associations between categorical variables (e.g., BMI categories and Vitamin D status). In cases where >20% of the expected cell counts were < 5, the Fisher-Freeman-Halton Exact Test was performed to identify whether or not there was an association. A two-tailed p-value less than 0.05 was used as the threshold of statistical significance.

**Ethical Statement**

Ethical approval was attained from the Research Ethics Committee of "the College of Health and Medical Technologies, Al-Furat Al-Awsat Technical University" (No. jah5/35/5845,). Ethical clearance was also granted by the research ethics board at the institute involved in the study College of Health Sciences and Medical Technologies - Kufa. All participant had been given information about the study in writing and signed a consent form before participating. Throughout the study, confidentiality and anonymity of all participants were maintained, and all procedures followed the ethical principles for human subject research.

**Results**

A total of 155 participants were included in the study. The largest age group was 24–28 years (37.4%), followed by 18–24 years (25.2%), 28–32 years (22.6%), and 32–39 years (14.8%). Most participants lived in owned houses (76.1%), while 15.5% lived in shared housing and 8.4% in rented houses.

Regarding education, 36.8% held a diploma degree, 24.5% had a bachelor’s degree, 17.4% had completed secondary school, 12.9% had completed primary school, and 8.4% were literate without formal certification. More than half of the participants were single (58.1%), 39.4% were married, and 2.6% were divorced. In terms of occupation, 65.8% were employees, 22.6% were housewives, and 11.6% were students. The majority reported middle income (71.6%), whereas 23.9% had low income and 4.5% had high income. All these findings are presented in Table 1.

Table 1. Sociodemographic traits of the study population.

Age group	Frequency	Percent %
18 - 24	39	25.2
24 - 28	58	37.4
28 - 32	35	22.6
32 - 39	23	14.8
<b>Housing type</b>		
Owned	118	76.1
Rented	13	8.4
Shared	24	15.5
<b>Education</b>		
Literate (no certificate)	13	8.4
Primary school	20	12.9
Secondary school	27	17.4
Diploma	57	36.8
Bachelor’s degree	38	24.5
<b>BMI</b>		
Underweight	14	9.0
Healthy Weight	57	36.8
Overweight	38	24.5
Class 1 Obesity	32	20.6
Class 2 Obesity	14	9.0
<b>Marital status</b>		
Single	90	58.1
Married	61	39.4
Divorced	4	2.6
<b>Occupation</b>		
Housewife	35	22.6
Student	18	11.6
Employee	102	65.8
<b>Monthly income</b>		
Low income	37	23.9
Middle income	111	71.6
High income	7	4.5

Source: Own authorship.

Table 2 displays the various BMI patterns that ranged from 17.039 to 39.033, with a mean of 26.56478 and a standard deviation of 5.981919. Vitamin D levels measurements ranged from 4.200 to 53.625, with a mean value of 18.30104 and a standard deviation of 11.108271.

Table 2. Descriptive statistics

	Minimum m	Maximu	Mean	Std. Deviation
Vitamin D level	4.200	53.625	18.3010	11.10827
BMI	17.039	39.033	26.5647	5.981919

Source: Own authorship.

The study showed that 30.3% of the study population had severe deficiency, 32.3% had deficiency, 23.2% had insufficiency, and 14.2% had sufficient Vitamin D levels (Figure 1).

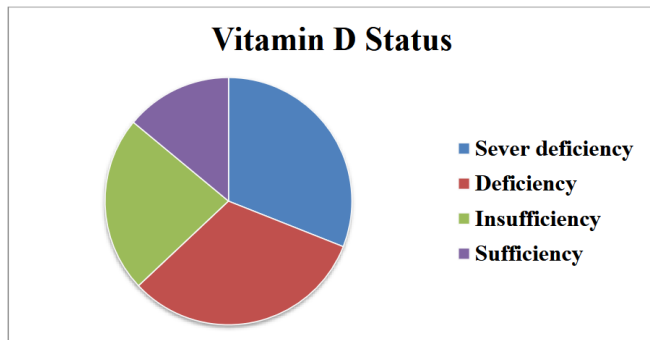


Figure 1. Dispersion of Vitamin D status among study participants. Source: Own authorship.

The normality of the data showed that the data did not have a normal distribution, as evidenced by statistically significant Shapiro–Wilk values for both body mass index ( $W(155) = 0.958, p < .001$ ) and Vitamin D level ( $W(155) = 0.927, p < .001$ ). Spearman’s correlation and nonparametric tests were used.

A weak but statistically significant negative correlation was identified between BMI and Vitamin D level ( $r = -0.241, p = 0.003$ ). This indicates that higher BMI values were related to with lower serum Vitamin D concentrations. Although the strength of the association was modest, BMI accounted for approximately 5.8% of the variability in Vitamin D levels, suggesting that additional factors likely contribute to Vitamin D status in this population.

When Vitamin D status was categorized as deficient/insufficient versus sufficient, no statistically significant associations were identified with any of the examined sociodemographic variables, include age group, occupation, educational level, marital status, type of dwelling, or monthly income ( $p > 0.05$  for all comparisons). Although small differences in the distribution of Vitamin D status were observed across different categories, these differences did not reach statistical significance, indicating that sociodemographic characteristics were not independently associated with Vitamin D sufficiency in this sample (Table 3).

Table 3. Collaboration between vitamin D status and Sociodemographic traits of the study population.

	Vitamin D levels		<i>p</i>
	Deficient / insufficient	sufficient	

Occupation			1.000*
Housewife	30 (85.7%)	5 (14.3%)	
Student	16 (88.9%)	2 (11.1%)	
Employee	87 (85.3%)	15 (14.7%)	
Age group			0.770*
18 – 24	32 (82.1%)	7 (17.9%)	
24 – 28	51 (87.9%)	7 (12.1%)	
28 – 32	31 (88.6%)	4 (11.4%)	
32 – 39	19 (82.6%)	4 (17.4%)	
Education level			0.356*
Literate (no certificate)	12 (92.3%)	1 (7.7%)	
Primary school	17 (85.0%)	3 (15.0%)	
Secondary school	20 (74.1%)	7 (25.9%)	
Diploma	49 (86.0%)	8 (14.0%)	
Bachelor’s degree	35 (92.1%)	3 (7.9%)	
Marital status			0.150*
Single	78 (86.7%)	12 (13.3%)	
Married	53 (86.9%)	8 (13.1%)	
Divorced	2 (50.0%)	2 (50.0%)	
Housing type			0.716*
Owned	100(84.7 %)	18 (15.3%)	
Rented	11 (84.6%)	2 (15.4%)	
Shared	22 (91.7%)	2 (8.3%)	
Monthly income			0.762
Low income	30 (81.1%)	7 (18.9%)	
Middle income	97 (87.4%)	14 (12.6%)	
High income	6 (85.7%)	1 (14.3%)	

Pearson Chi-squared and \*Fisher’s exact tests were performed for statistical analyses. Source: Own authorship.

Similarly, no significant associations were observed between Vitamin D status and BMI categories

( $p = 0.216$ ). When Vitamin D was further categorized into deficiency, insufficiency, and sufficiency across BMI groups, the differences had a trend toward statistical significance ( $p = 0.082$ ), with a higher proportion of deficiency among overweight and obese participants. In addition, no statistically significant associations were found between Vitamin D levels and sunlight exposure duration ( $p = 0.824$ ), body exposure pattern ( $p = 0.117$ ), or sunscreen use ( $p = 0.19$ ) (Table 4).

Table 4. Association between vitamin D status (Deficient& insufficient & sufficient) and BMI and sun exposure related behaviors.

	Vitamin D measurement			p
	Deficient	Insufficient	Sufficient	
<b>BMI</b>				0.082
Underweight	6 (42.9)	6 (42.9)	2 (14.3)	
Healthy Weight	30 (52.6)	15 (26.3)	12 (21.1)	
Overweight	28 (73.7)	5 (13.2)	5 (13.2)	
Obesity	33 (71.7)	10 (21.7)	3 (6.5)	
<b>Sun duration</b>				0.824*
<1 hour	44 (61.1)	17 (23.6)	11 (15.3)	
1_3 hours	39 (60.0)	17 (26.2)	9 (13.8)	
4_6 hours	11 (78.6)	2 (14.3)	1 (7.1)	
>6 hours	3 (75.0)	0 (0.0)	1 (25.0)	
<b>Body exposure</b>				0.117*
Fully covered	4 (80.0)	1 (20.0)	0(0.0)	
Face Exposure	13 (81.3)	3 (18.8)	0 (0.0)	
Face & Hands Exposure	79 (60.3)	30 (22.9)	22 (16.8)	
Face, Hands & Arms Exposure	1 (33.3)	2 (66.7)	0 (0.0)	
<b>Sunscreen use</b>				0.190
Always	39 (63.9)	10 (16.4)	12 (19.7)	
Sometimes	34 (56.7)	19 (31.7)	7 (11.7)	
Never	24 (70.6)	7 (20.6)	3 (8.8)	

Pearson Chi-squared and \*Fisher's exact tests were performed for statistical analyses. Source: Own authorship.

## Discussion

The present study evaluates the association between vitamin D level and body mass index among females in reproductive age. The study showed that a high percentage of the females who were included in this study have insufficient or deficient Vitamin D levels. Similarly, retrospective study conducted in Erbil, Kurdistan region of Iraq aimed to calculate the prevalence of Serum Vitamin D deficiency and determining risk factors associated with deficiency amongst patients in the study [14]. The study was conducted among 424 patients with different ages, sex, occupational categories and BMI classification. Their study showed that study population consisted of adults aged 30 years and above, 171 (40.3%) females and 253 (59.7%) males. The majority of the study population (51.9%) were Serum Vitamin D deficient, 27.6% were Serum Vitamin D insufficient and 20.5% had normal Vitamin D levels. Serum Vitamin D deficiency was seen more frequently among female gender, increased BMI and previous infection.

A statistically significant negative correlation was identified between Vitamin D level and BMI ( $r = -0.241$ ,  $P = 0.003$ ), which indicates that increases of BMI was associated with decreased of vitamin D level. This further supports the theory that increased amounts of adipose tissue can decrease bioavailability of Vitamin D either from being sequestered by fat tissue, or through volumetric dilution. Iftikhar [15] showed that there was a significant inverse relationship between BMI and serum Vitamin D levels, indicating that individuals with higher BMI tended to have lower circulating Vitamin D concentrations. These results are consistent with the present study. While the relationship between BMI categories group and vitamin D status did not reach statistical significance, the significant Spearman correlation confirms that there was an inverse linear relationship between adiposity and circulating Vitamin D concentration. Comparable findings were reported in United States, a study aimed to evaluate the association between BMI and vitamin D level amongst adults using nationally representative data. The study found that the obese people had significantly lower serum 25-hydroxyvitamin D concentrations compared to those with normal BMI [16]. Collectively, these findings support that higher BMI is associated with lower vitamin D level.

Regarding sociodemographic variables, there was no statistically significant associations between Vitamin D status and occupation ( $p = 1.000$ ), age group ( $p = 0.770$ ), education level ( $p = 0.356$ ), marital status ( $p = 0.150$ ), housing type ( $p = 0.716$ ) and monthly income ( $p = 0.762$ ). These findings suggest that Vitamin D deficiency in this population is widespread and not

confined to specific demographic categories. when compared these findings with other studies like a study was conducted in Babylon [17] that examined 240 adult patients (aged 20-89) with chronic conditions the study showed that there is No significant differences emerged by age groups, gender, income, education, or disease type, supporting lifestyle/environmental factors over demographics.

Present study shows no statistically significant association between Vitamin D level and sun exposure duration ( $p = 0.824$ ), body exposure pattern ( $p = 0.117$ ), or sunscreen use ( $p = 0.19$ ). The absence of a statistically significant association in present study could be attributed to limited variability in sun exposure patterns among participants. The majority of women reported similar clothing practices and relatively low levels of direct sun exposure, which may have reduced the statistical power to detect a significant difference. Furthermore, sun exposure was self-reported (rather than using an objective measure) which may introduce to recall bias. Therefore, the homogeneity of life style patterns in this urban population may have masked potential associations between sun exposure and serum vitamin D levels. Consistent with the present findings, a cross-sectional study conducted among housewives aged >18 from the outpatient department of a tertiary care hospital in Quetta [18]. The study showed that among of 151 housewives, 58.9% of them between age 18-30 had vitamin D deficiency.

The study found that 77.5% of housewives in the Vitamin D deficiency group spent 15 minutes or less outdoors versus 51.6% in the non-deficient group. Their study encouraged daily sun exposure and food items should be fortified with vitamin D. Recommendations for Vitamin D screening would be a good step, especially in Muslim housewives. In contrast, a study conducted in Libya [19] identified a significant association between sun exposure behaviours and vitamin D status among 287 patients, the majority of whom were females. who were attending three polyclinics in Benghazi. Data on participants' attitudes and behaviors related to sunlight, cultural and skin tone preference were collected using combination of interviews and questionnaires.

Also, the study found that Vitamin D deficiency proportion was 76.1%, insufficiency proportion was 15.2% and Vitamin D sufficiency was 8.7%, The sample consisted of a number of individuals who reported being exposed to the sun at its peak, (73.5%) reported being exposed between the hours of 10am and 4pm), while (74%) reported being exposed directly to sunlight for under fifteen minutes a day and

only (4.88%) reported having more than 2 hours of complete sun exposure. Of the sample of individuals (77%) reported always wearing some form of head covering (hat, scarf, etc.) when outside, but the majority of them were female. Only (10%) of the sample reported regularly using some type of sunscreen/product. Among males, (41%) reported using these products occasionally, whereas (61%) of the females do not use any type of sun protection at all. Finally, the majority of the sample would wear long-sleeved clothing (79.44%), and 85% would cover their legs.

The study contributed Culture, attitudes and sun exposure behavior as a major factor to high prevalence of Vitamin D deficiency. Circulating densities of 25(OH)D were considerably reduced in subjects with less sun exposure and in those displaying negative attitudes toward sunlight. The present study has several strengths, including laboratory-based measurement of serum Vitamin D levels and assessment of multiple demographic and lifestyle variables within a defined sample of 155 participants. However, the cross-sectional layout limits the ability to establish causality, and dietary intake, supplementation history, and seasonal variation were not evaluated.

In conclusion, the present study demonstrated a high prevalence of Vitamin D deficiency and insufficiency among the study population. A statistically significant inverse correlation was identified between BMI and Vitamin D level, indicating that higher BMI is associated with lower serum Vitamin D concentrations. Although no significant associations were found with sociodemographic or lifestyle variables, the findings support existing evidence that adiposity is an important factor influencing Vitamin D status. Further longitudinal studies are recommended to clarify causal mechanisms and to guide preventive and therapeutic strategies.

## Conclusion

The present study has shown a high prevalence of both vitamin D deficiency, as well as overweight and obesity among women of childbearing age in urban areas of Al-Diwaniyah Governorate. There was also a significant negative correlation between serum vitamin D and BMI. Greater BMI was linked with a decreased concentration of circulating vitamin D in the serum. Vitamin D deficiency occurred in all BMI categories, which suggests that lifestyle factors related to living in the city and a lack of effective sun exposure may be involved in the prevalence of vitamin D deficiency regardless of body weight. Thus, the results indicate that vitamin D deficiency and overweight and/or obesity represent two concurrent public health problems instead of two separate problems. To combat

these problems, prevention strategies will need to use an integrated approach, including routine screening for vitamin D, nutritional and lifestyle-based education, and weight management programs that are appropriate for reproductive-aged women. Additional longitudinal and population-based studies are necessary to further clarify cause and effect and help to support appropriate public health policies in Iraq.

## CRedit

**Authors' Contributions:** Aws Jabbar Al-awsy contributed to the practical section and the discussion section, in addition to the statistical analysis of the data and writing the research methodology and references. Riyadh Saad Atshan contributed to writing the introduction, the discussion section, and the abstract.

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## Ethical Approval

Ethical approval was attained from the Research Ethics Committee of "the College of Health and Medical Technologies, Al-Furat Al-Awsat Technical University" (No. jah5/35/5845,). Ethical clearance was also granted by the research ethics board at the institute involved in the study College of Health Sciences and Medical Technologies - Kufa. All participant had been given information about the study in writing and signed a consent form before participating. Throughout the study, confidentiality and anonymity of all participants were maintained, and all procedures followed the ethical principles for human subject research.

## Informed Consent

Informed consent was obtained from all participants, and all study procedures were fully explained prior to participation.

## Funding

Not applicable.

## Data Sharing Statement

Data used and analyzed during the current study are available from corresponding author upon reasonable request, and all data is stored in accordance with privacy and ethical guidelines.

## Conflict of Interest

The authors declare no competing interests.

## Similarity Check

It was applied by Ithenticate®.

## Application of Artificial Intelligence (AI)

Not applicable.

## Peer Review Process

It was performed.

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