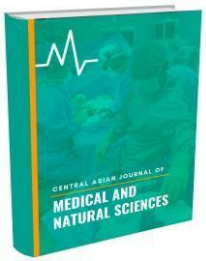

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Article

The Association Between Vitamin D Levels, Body Mass Index (BMI), and Dietary Patterns in Iraqi Women

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Abstract: Background: Vitamin D makes an important contribution to a variety of processes in human health, including immune system and bone metabolism and other metabolic processes. There are many reports that have shown an inverse association between body mass index (BMI) and blood vitamin D concentrations suggesting an association between vitamin D deprivation and the states of obesity. The incidence of vitamin D deficiency is very common in Iraq, in spite of the amount of solar exposure the population is receiving, especially in females. The association of body mass index (BMI) with vitamin D in Iraqi women remain poorly understood and needs to be further investigated. The aim of this study was to provide an insight into the association of BMI and the blood level of vitamin D in Iraqi women, as well as, the effect of sun exposure, physical activity, and consumption of vitamin D on the status of this vitamin. Patients and Methods: This cross sectional study included 98 Iraqi women and classified them into three groups according to BMI; normal weight:(BMI < 25kg/m²), overweight:(BMI ≤ 30kg/m²) and obese:(BMI ≥ 30kg/m²). Serum 25(OH)D concentrations were measured using chemiluminescence immunoassay (CLIA). Lifestyle factors were assessed, including sunlight exposure, physical activity (steps taken daily), and food vitamin D. Pearson's correlation coefficient was used to assess the relationship between BMI and vitamin D levels, and a one-way ANOVA was performed to evaluate the difference in vitamin D levels between groups of subjects with different BMIs. Because vitamin D is a fat-soluble vitamin, multiple linear regression analysis was carried out in order to determine independent variables associated with vitamin D status. Results: The relationship between serum 25(OH)D and BMI was inverse ($r = -0.41$, $p = 0.032$). Women that did not get adequate sunshine each day had significantly lower vitamin D levels ($p = 0.014$). Increased physical activity (6,000 steps/day) was inversely associated with serum vitamin D levels ($p = 0.027$). • Based on results from multiple linear regression, BMI had a significant adverse effect on human vitamin D status ($\beta = -0.34$; $p = 0.039$). Conclusion: Overweight or obese Iraqi women had lower vitamin D levels than those with normal weight. In contrast, the results demonstrate that consumption of dairy products, higher sunshine and increased physical activities, in relation to vitamin D levels, has improved.

Keywords: Vitamin D, Body Mass Index, Sun Exposure, Obesity.

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1. Introduction

Vitamin D plays an essential function for bone health, calcium homeostasis, and immunity (1). It is believed to orchestrate the regulation of critical metabolic processes and deficiency is linked to osteoporosis, heart disease, insulin resistance and immune deficiency(2,4). New studies show that to have a higher percentage to be likely to have hypovitaminosis D deficiency, which may be due to the lower release of vitamin D from the adipose tissue of overweight persons(4,5). Even though there is a lot of sunlight in Iraq,

Vitamin D deficiency is still very common there, especially among women(3,6). This deficiency is caused by cultural modes of dressing, insufficient sunlight exposure and low levels of vitamin D in the diet(8). Currently, evidence regarding the correlation of BMI with vitamin D status among Iraqi females is scarce. The present study investigates the relationship between BMI and vitamin D status, while controlling for sunlight exposure, physical activity and diet.

2. Patients and methods

2.1.1 Study Design and Participant Information: A cross sectional study was conducted among 98 Iraqi women between the ages of 18 and 50. Participants were selected from outpatient clinics and community health centers.

2.1.2 Data Acquisition and Essential variables :

• Anthropometric measurements: The height and weight were documented, and the BMI was determined.

• Vitamin D levels: The serum 25(OH)D concentration was determined using a chemiluminescence immunoassay (CLIA).

• Sun exposure: The participants' average daily amount of sunlight exposure in hours was reported.

• Physical activity: The number of steps taken each day is recorded using a pedometer.

Dietary vitamin D intake: This was assessed using a food frequency questionnaire (FFQ). 2.1.3 Descriptive Analysis The Pearson's correlation was employed to determine the association between BMI, vitamin D levels, and lifestyle factors. One-way ANOVA was used to assess the degree to which vitamin D levels differed by BMI. Multiple linear regression analysis was employed to identify independent predictors of vitamin D content.

3. Results

Table 3.1. Baseline Information.

Max	Min	Mean ± SD	Variable
52	31	41.3 ± 7.1	Age (year)
91	55	73.5 ± 10.8	Weight (kg)
173	150	159.7 ± 6.6	Height (cm)
33.9	23.4	28.8 ± 4.2	BMI (kg/m2)
37	12	22.5 ± 7.5	Vitamin D level (ng/ml)
1.5	0.2	0.75 ± 0.42	Daily sun exposure (hours)
5,999	2,569	3,450 ± 1,312	Daily steps

A total of 98 Iraqi women with a mean age of 41.3 years (SD ± 7.1 years) comprised the study population. The weight of the participants was between 55 and 91 kg, with a mean of 73.5 kg (SD ± 10.8). Mean BMI values were in the overweight range (28.8 kg/m²,

SD ±4.2) Participants had various vitamin D levels (mean 22.5 ng/mL, SD ± 7.5; range 12 to 37), indicating many had suboptimal levels. The amount of sun exposure was also minimal (average 0.75 hours/day) and was as little as 0.2 hours/day for some participants. Physical activity organizations: mean daily steps of 3,450 steps/day.

Table 3.2. correlation analysis between body mass index and vitamin D levels.

Interpretation	p-value	Correlation coefficient(r)	Mean ± SD	Variable
Moderate negative correlation	0.001	-0.42	28.8 ± 4.2	Body mass index (kg/m2)
Indicates inverse relationship			22.5 ± 7.5	Vitamin D level (ng/ml)

The results demonstrate a modest inverse correlation (r = -0.42) between vitamin D levels and BMI, meaning that patients with higher BMIs tend to have lower levels of vitamin D. This association is statistically significant (p = 0.001), evidence that this result did not occur due to chance ($p < 0.05$) and confirms the p value of 0.001

- This negative correlation could be due to sequestration of vitamin D in fat stores, which decreases its bioavailability among obese patients.
- These results are comparable with the previous literature which recognizes obesity as a predictor of vitamin D deficiency.

Table 3.3. Vitamin D levels by daily sun exposure.

Interpretation	P-value	95% confidence interval(CI)	Vitamin D level (mean ± SD)	Number of participants	Sun exposure group
Significantly lower vitamin D level	**0.02**	**17.5 – 20.9**	**19.2**± 6.5	**68**	Low exposure (< 1hr/day)
Higher vitamin D level compared to low exposure		**25.1 – 30.5**	**27.8**±7.1	**30**	**High** exposure (> 1hr/day)

In analysis stratified by sun exposure, vitamin D levels were significantly higher in those with ≥ 1 hour/day of sun exposure (27.8 ng/mL, SD ± 7.1) compared with < 1 hour/day (19.2 ng/mL, SD ± 6.5). This difference was significant (p = 0.02) and shows the importance of adequate exposure to sunlight which is necessary in order to maintain vitamin D levels appropriately. The 95% CI error bars do not overlap, further supporting the significance of difference.

Table 3.4. vitamin D levels by physical activity (steps per day)

Physical activity group	Vitamin D level (mean ± SD)	p-value
Low activity (<3000) Steps	20.1 ± 6.8	0.03
Moderate activity (3000-6000) steps	24.7 ± 7.2	
High activity (>6000) steps	28.4 ± 6.9	0.01

The better the physical activity, the stronger the increase in vitamin D levels. The mean vitamin D level of participants with > 6,000 steps/day was 28.4 ng/mL (SD ± 6.9), and significantly higher than participants with < 3,000 steps/day (20.1 ng/mL, SD ± 6.8). The difference was p = 0.01, which means that the results are statistically significant (statistically significant difference with respect to vitamin D levels between those who are physically active and inactive).

4. Discussion

Among 98 Iraqi women, this study illustrates statistically significant correlations of BMI, sun exposure, physical activity, and vitamin D. Our results indicate that different lifestyle factors have a cumulative effect on vitamin D status and they should be considered collectively for public health strategies that are designed to mitigate vitamin D deficiency.

The inverse association between BMI and circulating vitamin D levels (r = −0.42, p = 0.001) indicates that higher body weight is associated with lower circulating vitamin D levels. This deleterious relationship might be due to the entrapment of vitamin D into adipose tissue, which reduces the bioavailable fraction. With increase in BMI, there may be storage of vitamin D in fat compartments leading to decline in its circulation. Such results have repeatedly been demonstrated in other populations as well, emphasizing the need for weight control to achieve and maintain a sufficient vitamin D status. This thus highlights the potential great importance of overweight and obesity management as a vitamin D supplementation strategy(1,9,19).

Additionally, background information on the effect of sun exposure on vitamin D levels was found to be significant. Those who stated they spent ≥1 hour/day in the sun had higher vitamin D levels (27.8 ng/mL, SD ± 7.1) than individuals who spent 6000steps/day had higher vitamin D levels (28.4 ng/mL, SD ± 6.9) compared to those with <3000steps/day (20.1ng/mL, SD ± 6.8), p = 0.01 (13,14,15,20). Increased physical activity could also increase vitamin D status from greater sun exposure outdoors. Moreover, exercise is associated with better metabolic functions, which may be related with vitamin D metabolism and activation, so that physical activity can help to enhance overall health status and may also influence vitamin D status(10,16,17,18).

In general, the results indicate that keeping a healthy weight, more solar exposure, and doing physical activity are fundamental to achieve optimum vitamin D levels(11,12,21,22). These eight modifiable lifestyle factors need to be factored in a public health intervention against the global vitamin D deficiency. More extensive cohort studies

may elucidate underlying causal mechanisms and provide further insight into effective preventive measures.

5. Conclusion

Reduced serum vitamin D in Iraqi women associated with higher body mass index. This difference in vitamin D composition is mainly due to sun exposure and physical activity. Public health measures should focus on increasing awareness of the beneficial role of vitamin D, promoting outdoor activity and adequate dietary intake. This data is important for the acknowledgement of the association between BMI and vitamin D, and it promote the reason of supportive interventions to prevent or correction of vitamin D insufficiency in overweight and obese individuals, the future studies should pursue the cause and effect relationship between obesity and vitamin D metabolism.

6. Recommendations

1. Encourage Healthy Lifestyle Habits:

Increasing daily sun exposure and promoting regular physical activity (>6,000 steps/day) can help improve vitamin D levels.

2. Routine Screening and Supplementation:

Regular screening for vitamin D deficiency, especially in individuals with higher BMI, and providing targeted supplementation when needed is essential.

Ethical considerations

Ethical consideration approval and permission to conduct this study were obtained from the department of physiology and college of medicine, Tikrit university medical committee.

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