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Vitamin D Deficiency among Female Students in the University of Kerbala and its Association with Body Mass Index and Other Factors

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ABSTRACT

Background: Vitamin D deficiency is common among Iraqi females and has been linked to various diseases. Although associated with lower weight, there is no evidence that it causes weight gain in young females.
Objectives: To determine the prevalence of Vitamin D deficiency among female university students and explore its association with obesity, sun exposure, dietary habits, and physical activity.
Materials and methods: A cross-sectional study was conducted at the University of Kerbala (April–May 2024) on 200 female students. Serum 25-hydroxyvitamin D was measured, and data were analysed using nonparametric tests and Spearman's correlation, with significance set at a P-value < 0.05.
Results: Serum 25-hydroxyvitamin D levels indicated sufficiency in 22.5% and deficiency in 64% of participants. The mean body mass index (BMI) of students was 25.38 ± 5.60 kg/m^2. Vitamin D levels differed significantly across colleges (P-value = 0.036), with engineering students showing the lowest values. No association was found between vitamin D and BMI (P-value > 0.05). However, sun exposure and a healthy diet were positively correlated with higher vitamin D levels (P-value $<$ 0.05).
Conclusion: Over 60% of participants had vitamin D deficiency. No significant correlation was found between high BMI and vitamin D status. Implementing educational programs promoting outdoor activity, sun exposure, and a vitamin D-rich diet is recommended.
Keywords: Vitamin D deficiency; Obesity; Female university students; Body mass index.

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INTRODUCTION

Vitamin D is an essential vitamin for the body that plays a crucial role in calcium metabolism. It is thought to be a hormone that functions through nuclear receptors found in various bodily regions, including the immune system, kidneys, intestines, brain, and bone. Vitamin D deficiency is linked to multiple human conditions and illnesses, such as diabetes, cancer, cardiovascular, respiratory, musculoskeletal, and autoimmune diseases [1, 2].

The causes of vitamin D deficiency include geographic latitude and altitude, air pollution, inadequate consumption of vitamin D-rich items, restriction of solar exposure (poor sun exposure owing to religious beliefs), having diseases, including kidney or liver diseases, using some medications, and malabsorption of vitamin D [3–5].

Vitamin D insufficiency tends to be clinically silent, especially in adults. At the same time, symptoms might include weariness, persistent musculoskeletal pain, and a feeling of heaviness in the legs, primarily in the proximal limb muscles. The pain may be hyperaesthetic. Unmineralized collagen matrix, or osteomalacia, may present with symptoms resembling fibromyalgia. Although physical examination findings are often nonspecific, marked tenderness on pressure over the tibia or sternum can be a valuable clinical clue. Vitamin D plays a central role in the management of metabolic bone disease, in the prevention of falls and fractures, and in the treatment

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of secondary hyperparathyroidism [2, 6].

A low vitamin D plasma level typically results in decreased intestinal calcium absorption and a lower plasma calcium level, which in turn causes bone resorption and decreases bone mineral density. However, compared to underweight individuals, obese subjects had higher bone mineral density (BMD), cortical thicknesses, and cortical tissue mineral densities [6, 7].

Although there is considerable literature demonstrating the association between low body mass index (BMI) and vitamin D, there is no evidence that a lack of vitamin D causes high BMI, especially among young females [8, 9].

Obesity is a progressively increasing risk factor worldwide and is linked to many noncommunicable diseases, and represents a burden on people, and the health system. The high BMI is correlated with a low concentration of 25-hydroxyvitamin D and a high concentration of parathyroid hormone in adults [10]. The low serum 25(OH) D levels seen in obese individuals have been explained by several theories, such as increased whole-body clearance of vitamin D during inflammation linked to high BMI, catabolism of vitamin D by the 24-hydroxylase enzyme in adipose tissue, or sequestration of vitamin D by adipose tissue [11, 12]. However, other studies reported no or weak correlation with BMI [13, 14]. The mechanism of action that leads to the deposition of vitamin D in adipose tissue and the limited response to administration of supplements is still unknown. The association between elevated body fat levels and vitamin D concentrations is biologically plausible because vitamin D regulates adipogenesis [15, 16]. Females in Iraq are considered at increased risk of vitamin D deficiency due to limited sun exposure, particularly in religious cities such as Kerbala, where most women cover their bodies and hair. This study aimed to determine the prevalence of vitamin D deficiency among female university students, examine its correlation with BMI, and identify other associated factors.

MATERIALS AND METHODS

An analytic cross-sectional study was conducted at the University of Kerbala between April and May 2024. The study included 200 female students from three colleges, randomly selected from the seven colleges in the Hey-Al-Moadhafin campus. The University of Kerbala, located in the city center, comprises 17 colleges with approximately 23,000 students, most of whom offer four-year study programs. Then, on a random approach, a class was selected, and after that, all female students in that class were approached. The required sample size was calculated using the following formula for estimating a single population proportion: *n=d2Z2.p.(1-p)* in which Z=1.96 (corresponding to 95% confidence level), *p*=0.70, estimated prevalence of vitamin D deficiency among young females in Iraq, based on recent studies such as Al-Zarooni et al., 2022 [17], *d=0.06* (desired margin of error). The sample size should be 224. However, due to logistical and time constraints during the data collection period (April–May 2024), we were able to enrol 200 participants, which still provides 80% power to detect a moderate correlation (r=0.2) between vitamin D and BMI at $\alpha = 0.05$, according to power analysis (G*Power 3.1). We acknowledge that this is slightly below the ideal sample size. Still, given the high prevalence of deficiency and strong effect sizes observed (e.g., college differences, sun exposure), the study remains adequately powered for primary outcomes.

Ethical approval was obtained from the Medical Research Bioethical Committee, College of Medicine, University of Kerbala (Registration No. 24-17, dated March 25, 2024). Female undergraduate students who consented to participate in the study and gave a blood sample were eligible for the study. Those who took vitamin D supplements within the last 6 months were excluded from the study.

After explaining the study objective and getting the written consent, each individual filled out a questionnaire containing demographic information like age, weight, height, residential status, lifestyle characteristics such as exposure to the sun, dietary habits, physical activity, and fatigue. A blood sample for vitamin D was also taken from each participant by an independent laboratory female assistant, two mL from the cubital area after sterilization of the selected area with alcohol. Blood samples were collected at the University of Kerbala campus. The blood samples were transported to Al-Amal General Hospital Laboratory for analysis. Serum 25-hydroxyvitamin D levels were measured using the I-Chroma II reader device, a fluorescence-based immunometric analyzer with specific kits (Icromax Vit D Neo, Boditech Med, South Korea). All procedures followed standard operating protocols and were conducted by certified technicians. This device permits a quantitative and fast evaluation. It thus allows for categorization as to whether the vitamin D status of the student may be considered as either deficient with serum 25(OH)D <20 ng/mL, insufficient with 25(OH)D range of 20-30 ng/mL, or sufficient with serum 25(OH)D >30 ng/mL [18]. Participants' height was measured using a measuring tape, and body weight was recorded with a weighing scale. Later, the BMI in kg/m^2 was estimated and calculated by dividing the (weight/height^2) formula in Microsoft Excel. According to the World Health Organization (WHO) classification system, participants were classified into underweight (less than 18.5, normal weight (18.5 to 24.9, overweight (25 to 29.9, and obesity classes (30 and above [19]. A 10-item dietary habits questionnaire was administered using a 4-point Likert-type scale [20]. A modified version of a previously validated dietary habits questionnaire, Naja et al. [21, 22], adapted to suit local dietary patterns, was scored for each item (from 0-3), giving the Total Dietary Habits Score, which ranged from 0 to 30, as follows: Questions related to dietary intake given value of 3 to Always, 2 to Sometimes, 1 to Rarely, and 0 to Never. At the same time, a reverse score was given to questions related to bad dietary habits (value of 0 to Always, and 1 to Sometimes, value of 2 to Rarely, and value of 3 to Never). For stimulant beverage intake, scores were assigned as follows: 3 for ≥4 cups, 2 for 3 cups, 1 for 2 cups, and 0 for 1 cup. For water intake, a score of 3 was given for >8 glasses, 2 for 6-8 glasses, 1 for 3-5 glasses, and 0 for <3 glasses [23].

The data from the present study were analysed using the Statistical Package for the Social Sciences (SPSS) version 24.0 for Windows (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as frequencies and percentages for qualitative variables, and as mean ± standard deviation (SD) for quantitative variables, using appropriate tables and graphs. Abnormal distributions were determined using the Kolmogorov-Smirnov test, and the median and mean ranks were expressed for non-normally distributed variables. Possible association for abnormally distributed variables was determined through the use of the Mann-Whitney test to compare the means between two groups, or the Kruskal-Walli's test to compare the means among three or more groups, and Spearman's rank correlation coefficient to examine correlation between two continuous variables. Significance level was

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considered when the P-value < 0.05.

RESULTS

The 200 female students illustrated a mean age of 21.99 ± 1.99 years and a mean BMI of 25.38 ± 5.60 (kg/m^2). More than half of the study females (54%) reported high economic status, 90% were single, 64.5% came from an urban region, and smoking was reported by only 2 (1%) of them, as described in Table 1.

Based on BMI categories, 29.5% of them were overweight and 16.5% were obese, as shown in Figure 1.

In relation to physical activity, more than half of the study participants (54.5%) reported that they "Rarely" 78 (39%) engaged in walking, "Outdoor, and 122 (61%) reported engaging in physical activity. While the sun exposure "One hour" 149 (74.5%) was reported by the study participants, as shown in Table 2.

Regarding symptoms of vitamin D deficiency, the results showed that physical pain was reported by 81% of study females, while 96% of study participants indicated that they experienced fatigue and tiredness at least sometimes. The majority (80%) of students have a regular menstrual cycle. The study revealed that 76 participants (38%) reported that they always or sometimes use dietary supplements of vitamin D, whereas 124 participants (62%) reported that they never or rarely use nutritional supplements of vitamin D. A Previous vitamin D test was reported by 101 (50.5%) participants (Table 3).

Around two-thirds of the participants had vitamin D deficiency (Figure 2)

The study revealed that 83.5% of the study participants reported that they always or sometimes consumed fruits and vegetables, followed by meat, legumes, milk, and fish (73.5%, 73.5%, 73% and 68.5% respectively).

Table 1. Demographic and clinical characteristics of the 200 studied participants. BMI: Body Mass Index, ID: Iraqi Dinar.

Variables	Categories	Total Number(%)
College	Nursing	120 (60)
	Applied Sciences	60 (30)
	Engineering	20 (10)
Class	First	62 (31)
	Second	7 (3.5)
	Third	32 (16)
	Fourth	99 (49.5)
Age (years)	mean ± SD	21.99 ± 1.99
BMI (kg/m^2)	mean ± SD	25.38 ± 5.60
Marital status	Single	180 (90)
	Married	20 (10)
Residence	Urban	129 (64.5)
	Rural	71 (35.5)
Economic status	High (>1.5 million ID)	108 (54)
	Medium (0.5-1.5 million ID)	88 (44)
	Low (<0.5 million ID)	4 (2)
Chronic diseases	Yes	9 (4.5)
	No	191 (95.5)
Smoking	Yes	2 (1)
	No	198 (99)

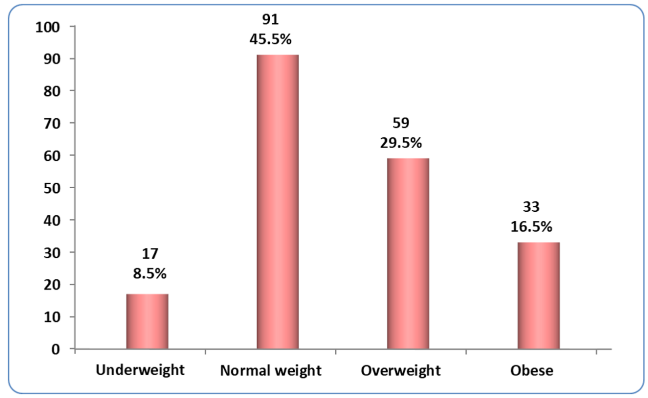

Figure 1. Body mass index categories among female study participants.

Table 2. Physical activity and sun exposure among 200 studied participants.

Variables	Categories	Total Number(%)
Walking	Always	24 (12)
	Sometimes	67 (33.5)
	Rarely	78 (39)
	Never	31 (15.5)
Intensity of physical activity(n=169)	Light	70 (41)
	Moderate	97 (58)
	Intense	2 (1)
Types of physical activity	Outdoor activity	122 (61)
	Indoor activity	78 (39)
Duration of sun exposure per day	< One hour	8 (4)
	One hour	149 (74.5)
	> One hour	43 (21.5)
	mean ± SD	1.25 ± 0.66

Regarding the association between the socio-demographic characteristics and Vitamin D levels among study participants, a statistically significant difference was found across the three colleges (P-value = 0.036), i.e., participants from the Engineering College revealed significantly lower levels of vitamin D than those from the Nursing and Applied Sciences colleges. No statistically significant associations were found between vitamin D levels and... menstrual cycle (p-value > 0.05 for all). Similarly, no significant difference was observed across academic classes (P-value = 0.063). as illustrated in Table 4.

The outdoor activity demonstrated a significantly higher level of vitamin D compared to indoor activity (P-value = 0.015). The study showed a significant positive correlation between vitamin D level and duration of sun exposure (Spearman's rank correlation coefficient = 0.141), indicating that the longer the duration of sun exposure, the higher the vitamin D level, as illustrated in Table 5.

A history of previous vitamin D testing showed a highly significant association with higher vitamin D levels (P-value < 0.001), as shown in Table 6.

Table 3. Symptoms of vitamin D deficiency and supplements among 200 studied participants.

Variables	Categories	Total Number(%)
Physical pain	No pain	38 (19)
	Simple	68 (34)
	Moderate	80 (40)
	Severe	14 (7)
Fatigue and tiredness	Always	58 (29)
	Sometimes	134 (67)
	Never	8 (4)
Menstrual cycle	Regular	160 (80)
	Irregular	40 (20)
Use of dietary supplements of vitamin D	Always	38 (19)
	Sometimes	38 (19)
	Rarely	30 (15)
	Never	94 (47)
Previous vitamin D test	Yes	99 (49.5)
	No	101 (50.5)

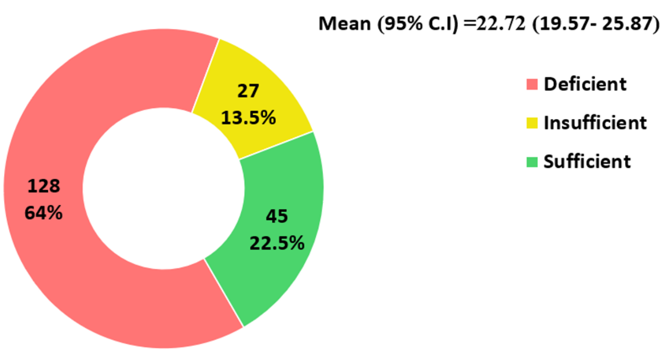

Figure 2. Vitamin D status among the 200 female students studied.

DISCUSSION

Vitamin D deficiency has attracted growing global attention over the past two decades due to its widespread prevalence and impact on health. Even the general public is concerned that it is being over investigated by many. The current study highlights the burden of vitamin D deficiency, revealing that 64% of participants had insufficient levels. This high prevalence is consistent with findings from regions with similar circumstances, where rates exceed 70% [17, 24]. The deficiency is associated with multiple risk factors, including limited sun exposure, inadequate dietary intake, and low physical activity. Moreover, some of these factors are closely linked to the rising prevalence of high BMI, both in the Middle East and globally.

However, no discernible correlations were found between vitamin D levels and BMI. The current study's findings, which show no significant correlation between BMI and vitamin D status, are against some earlier research, particularly in Western countries, where obesity has been more frequently linked to decreased vitamin D levels [1, 7, 13]. The results of various studies that discussed the relation between BMI and vitamin D status were similar. However, there was no relationship between BMI and vitamin D levels, which is being advocated by a meta-analysis and systematic review by Pereira-Santos et al. [9], which concluded that though obesity is linked to lower levels of vitamin D, the relationship is weak, with the possible underlying mechanisms still under discussion. The widely accepted "sequestration hypothesis" postulates the storage of vitamin D in adipose tissue and thus its reduced bioavailability in obese people. Vitamin D status may not be appropriately predicted. Likewise, the results of a study by Oommen et al. [25], conducted in Iran, indicated a weak positive correlation between BMI and vitamin D levels in adult females. The correlation between sun exposure and vitamin D levels is a long-standing one, and this study merely upholds the view that insufficient sun exposure is a major cause of vitamin D deficiency, affecting more than two-thirds of the samples. This study is coherent with what happens in the rest of the world, especially in areas with cultural or environmental factors that limit sun exposure [13, 26]; however, they said that exposure to the sun for 1 hour or more. However, almost all of their body is covered, and probably only a small part of their body, including the face and palms of their hands, is exposed to the sun.

The study found no significant association between water intake and vitamin D levels, consistent with previous literature indicating that water consumption does not affect vitamin D status. In general, water intake is not regarded as a significant determinant of vitamin D, which primarily depends on ultraviolet irradiation from sunlight, dietary sources, and supplementation. Although limited research has examined the role of hydration in vitamin D metabolism, the present study reinforces the prevailing view that water intake does not significantly influence vitamin D levels [27].

The present study found no significant association between menstrual status and vitamin D levels. However, hormonal changes have been reported to influence vitamin D metabolism and may contribute to cyclic variations in vitamin D levels. For instance, Harmon et al. [28]. Highlighted the role of oestrogen in regulating vitamin D metabolism, suggesting that menstrual irregularities or hormonal imbalances could potentially alter vitamin D status in females. This association warrants further investigation, particularly in younger women, as hormonal fluctuations during menstruation may impact vitamin D absorption and metabolism.

Our study in Kerbela revealed a clear correlation between dietary patterns in women of academic age and vitamin D deficiency. This finding is consistent with previous research, suggesting that inadequate intake of vitamin D–rich foods such as eggs, fatty fish, and fortified dairy products contributes to the high prevalence of deficiency in this population. Unhealthy dietary habits and irregular eating patterns among academic females may further limit adequate vitamin D intake. These results highlight the importance of promoting healthy dietary practices to improve eating behaviours and prevent health problems related to vitamin D deficiency among students in Kerbela [21, 22, 29].

The high prevalence of vitamin D deficiency reported in this study is representative of global trends, especially in populations with limited sun exposure or dietary intake of vitamin D. Isa et. al. [24] reported that vitamin D deficiency remains a widespread and growing issue", particularly in those regions where cultural practices, for example, the donning of clothes that limit sun exposure, or lifestyles of indoor living, hold as predominant factors. These findings align with studies from the Middle East and South Asia. The rates are similar because the low sun exposure and dietary habits do

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Table 4. Relationship of the sociodemographic characteristics and vitamin D level among the 200 female students studied. BMI: Body mass index, ID: Iraqi dinar*.

Characteristics	Categories	Vitamin D (ng/mL)		P-value
		Median	Mean Rank	
College	Nursing	15.00	103.50	0.036*
	Applied Sciences	18.15	105.01	
	Engineering	10.15	68.98	
Class	First	12.25	86.20	0.063
	Second	19.60	113.00	
	Third	24.60	118.36	
	Fourth	15.00	102.80	
Age (years)	Spearman's rank correlation coefficient		0.082	0.247
BMI (kg/m^2)	Spearman's rank correlation coefficient		–0.031	0.674
Marital status	Single	15.00	99.77	0.591
	Married	15.95	107.10	
Residence	Urban	15.60	103.71	0.290
	Rural	12.70	94.67	
Economic status	High (>1.5 million ID)	16.40	103.65	0.675
	Medium (0.5–1.5 million ID)	13.55	96.41	
	Low (<0.5 million ID)	16.15	105.25	

* Significant P-value of less than 0.05. The Mann-Whitney test, Kruskal-Walli's test, or Spearman's correlation was used for variables with abnormally distributed data.

Table 5. Association of physical activity and sun exposure with vitamin D level among 200 study participants*.

Characteristics	Categories	Vitamin D (ng/mL)		P-value
		Median	Mean Rank	
Walking	Always/ Sometimes	13.90	96.88	0.420*
	Never/ Rarely	17.50	103.52	
Types of physical activity	Outdoor activity	17.00	111.10	0.001*
	Indoor activity	10.45	83.92	
Duration of sun exposure	Spearman's correlation coefficient		0.141	0.046*

* Significant P value of less than 0.05. The Mann-Whitney test or Spearman's correlation was used for variables with abnormally distributed data.

Table 6. Association of symptoms of vitamin D deficiency and previous vitamin D test among 200 study participants.

Characteristics	Categories	Vitamin D (ng/mL)		P-value
		Median	Mean Rank	
Physical pain	No or simple pain	16.80	107.06	0.089
	Moderate or severe	14.75	93.11	
Menstrual cycle	Regular	15.70	103.38	0.159
	Irregular	12.40	88.96	
Use of dietary supplements of vitamin D	Always / Sometimes	15.25	109.46	0.086
	Never / Rarely	15.00	86.51	
Previous vitamin D test	Yes	21.00	119.77	<0.001
	No	10.70	81.61	

not emphasize to the same vitamin D-rich foods [21, 22].

Physical complaints were, however, common among the participants (93% reported feeling fatigued sometimes). The study found no significant correlation between fatigue and vitamin D levels. This finding contrasts with another research, such as that by Hiranai et al. [30], which concluded that fatigue can be the presenting complaint for vitamin D deficiency, but is not pathognomonic. Other factors that may contribute to fatigue, rather than vitamin D status, include stress levels, sleep quality, and an individual's overall lifestyle.

This study has several limitations. Small sample size is a recognized limitation to the current research. This study did not assess inflammatory markers. Clothing type and the extent of skin exposure to sunlight were not measured. Although sun exposure duration was recorded, the total body surface area exposed, a factor critical for vitamin D synthesis, was not evaluated. Additionally, geographical and seasonal variations may have influenced the findings, as data were collected only during April and May, without accounting for variation across different seasons. Nevertheless, this period is typically characterized by sunny and hot weather.

CONCLUSION

Vitamin D deficiency was prevalent among students, with under a quarter having sufficient levels. Although vitamin D levels were not associated with BMI, they showed a significant relationship with physical activity, sun exposure, prior testing, and healthier dietary habits. These findings highlight the need for educational programs focused on promoting outdoor activities, adequate sun exposure, and dietary intake of vitamin D to improve students' status.

ETHICAL DECLARATIONS

Acknowledgments

I would like to express great thanks to all female students participating in this research.

Ethics Approval and Consent to Participate

Ethical approval for the study conduct was obtained from the Medical Research Bioethical Committee in College of Medicine, University of Kerbala in their document registration numbered 24-17 issued in 25-3-2024. Informed consent was obtained from each participant.

Consent for Publication

Not applicable.

Availability of Data and Material

Data generated during this study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that there is no conflict of interest.

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Authors' Contributions

H.K, A.A , A.M. and Z.M structured the concept; H.K, A.A and Z.M. structured the methodology and chose the materials; H.K and Z.M conducted the data collection; H.K and Z.M did the analysis and interpretation of data; H.K and Z.M wrote the literature search; H.K and Z.M. conducted manuscript writing; H.K , A.A and Z.M. conducted critical Reviews. All the authors read and approved the final version of the manuscript.

REFERENCES

[1] M. A. Majid, W. N. Hassan, and A. F. Ridha. Prevalence of 25-hydroxyvitamin d (vitamin D) deficiency in a group of infertile women from baghdad city. *Biochemistry Research International*, 2023.

[2] N. F. Maroufi et al. Association between vitamin D deficiency and prevalence of metabolic syndrome in female population: a systematic review. *Horm Mol Biol Clin Investig*, 41(4), 2020.

[3] M. M. Shady, M. M. Youssef, M. A. Shehata, E. M. El-Din, and H. A. ElMalt. Association of serum 25-hydroxyvitamin D with life style and dietary factors in egyptian prepubescent children. *Open Access Maced J Med Sci*, 3(1):80–84, 2015.

[4] A. R. Martineau et al. Vitamin D supplementation to prevent acute respiratory tract infections: systematic review and meta-analysis of individual participant data. *BMJ*, 356:i6583, 2017.

[5] M. Abdelsalam et al. Prevalence and associated factors of vitamin D deficiency in high altitude region in saudi arabia: Three-year retrospective study. *Int J Gen Med*, 16:2961–2970, 2023.

[6] R. Vieth. Vitamin D supplementation: cholecalciferol, calcifediol, and calcitriol. *Eur J Clin Nutr*, 74(11):1493–1497, 2020.

[7] L. Vranić, I. Mikolašević, and S. Milić. Vitamin D deficiency: Consequence or cause of obesity? *Medicina*, 55(9), 2019.

[8] A. Svedlund, C. Pettersson, B. Tubic, P. Magnusson, and D. Swolin-Eide. Vitamin D status in young swedish women with anorexia nervosa during intensive weight gain therapy. *Eur J Nutr*, 56(6):2061–2067, 2017.

[9] M. Pereira-Santos, P. R. Costa, A. M. Assis, C. A. Santos, and D. B. Santos. Obesity and vitamin D deficiency: a systematic review and meta-analysis. *Obes Rev*, 16(4):341–349, 2015.

[10] C. M. Lenders et al. Relation of body fat indexes to vitamin D status and deficiency among obese adolescents. *Am J Clin Nutr*, 90(3):459–467, 2009.

[11] P. Boonchaya-anant, M. F. Holick, and C. M. Apovian. Serum 25-hydroxyvitamin D levels and metabolic health status in extremely obese individuals. *Obesity*, 22(12):2539–2543, 2014.

[12] M. Sosa Henríquez and M. J. Gómez de Tejada Romero. Cholecalciferol or calcifediol in the management of vitamin D deficiency. *Nutrients*, 12(6), 2020.

[13] G. J. Salih and S. Abdul Sahib. Prevalence and associated risk factors of vitamin D deficiency among female adolescents in sulaimaniyah, iraq. *Journal of Contemporary Medical Sciences*, 10(5), 2024.

[14] Annis Lorensia, Raphael V. Suryadinata, and Ida A. Inu. Comparison of vitamin D status and physical activity related to obesity among tertiary education students. *Journal of Applied Pharmaceutical Science*, 12(04):108–118, 2022.

[15] L. F. de Oliveira, L. G. de Azevedo, J. da Mota Santana, L. P. C. de Sales, and M. Pereira-Santos. Obesity and overweight decreases the effect of vitamin D supplementation in adults. *Rev Endocr Metab Disord*, 21(1):67–76, 2020.

[16] N. R. Parva et al. Prevalence of vitamin D deficiency and associated risk factors in the us population (2011-2012). *Cureus*, 10(6):e2741, 2018.

http://doi.org/10.33091/amj.2025.160056.2238

[17] A. A. R. Al Zarooni, N. Nagelkerke, F. I. Al Marzouqi, and S. H. Al Darmaki. Risk factors for vitamin D deficiency in Abu Dhabi Emirati population. *PLoS One*, 17(2):e0264064, 2022.

[18] Institute of Medicine (US) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium. *Dietary Reference Intakes for Calcium and Vitamin D*. National Academies Press (US), 2011.

[19] World Health Organization. Obesity: Preventing and managing the global epidemic. report of a WHO consultation. (894):i–xii, 1–253, 2000.

[20] R. Likert. A technique for the measurement of attitudes. *Archives of Psychology*, 22(140):5–55, 1932.

[21] A. F. Alharbi et al. Association between serum vitamin D levels and body mass index status. *Cureus*, 15(10):e46927, 2023.

[22] F. Naja et al. The bahraini food based dietary guidelines: a holistic perspective to health and wellbeing. *Front Public Health*, 11:1182075, 2023.

[23] J. Robinson. Likert scale. In A. C. Michalos, editor, *Encyclopedia of Quality of Life and Well-Being Research*. 2014, pages = 3620–3621, publisher = Springer.

[24] Z. Md Isa, N. R. Mohd Nordin, M. H. Mahmud, and S. Hashim. An update on vitamin D deficiency status in malaysia. *Nutrients*, 14(3), 2022.

[25] A. Oommen and I. H. Al-Zahrani. Association of obesity with vitamin D deficiency and the clinical implications. *Int J Res Med Sci*, 3(11):3262–3265, 2017.

[26] A. Elwafa, A. Hawad, and S. Mrami. The Prevalence of Vitamin D Deficiency among Students of Faculty of Engineering and Technical Sciences in Brack Al-Shatti. *Wadi Alshatti Univ J Pure Appl Sci*, 2(1):84–89, 2024.

[27] S. A. Quraishi and C. A. Camargo. Vitamin D in acute stress and critical illness. *Curr Opin Clin Nutr Metab Care*, 15(6):625–634, 2012.

[28] Q. E. Harmon et al. Vitamin D and reproductive hormones across the menstrual cycle. *Hum Reprod*, 35(2):413–423, 2020.

[29] Y. Zhang, S. Lin, J. Li, X. Song, G. Chen, and L. Pei. Interaction of passive smoking and diet habits on vitamin D deficiency among women of reproductive age in rural central china. *Nutrients*, 15(1), 2022.

[30] V. Hirani et al. Vitamin D status among older community dwelling men and lifestyle factors. *J Nutr Health Aging*, 17(7):587–593, 2013.