
Knowledge, attitude, and practices towards vitamin D deficiency in diabetic patients and non-diabetic individuals

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ABSTRACT

Background and objective: Diabetes mellitus (DM) is a leading cause of global morbidity and mortality, while vitamin D deficiency is a growing public health concern. Although vitamin D levels are linked to obesity and insulin resistance, limited research exists on the knowledge, attitudes, and practices (KAP) surrounding vitamin D deficiency in both diabetic and non-diabetic individuals.

Methods: A cross-sectional study was conducted in Erbil from September 2024 to July 2025, involving 394 participants — 195 diabetics and 199 non-diabetics — recruited from hospitals and clinics. Data were collected using a structured, validated KAP questionnaire. Convenience sampling was used to ensure representation from both groups. Participants gave verbal consent, and ethical approval was obtained.

Results: A total of 394 participants (195 diabetics, 199 non-diabetics) took part in the study. The mean age of diabetics was 48.9 years, while non-diabetics had a mean age of 40.6 years. Vitamin D deficiency was reported by 61% of diabetics and 59.3% of non-diabetics. Non-diabetics reported higher vitamin D supplement use (66.3%) than diabetics (60%). Both groups exhibited similar behaviors regarding sun exposure and physical activity, with the majority undergoing vitamin D screening every six months (72.3% diabetics, 71.4% non-diabetics). Women made more vitamin D knowledge and lifestyle adjustments than men (27.63 vs. 24.95, $p=0.015$). Higher socioeconomic status and education levels increased awareness and lifestyle adjustments; non-diabetics with high SES had a mean knowledge score of 31.13 compared with 21.87 for low SES, whereas diabetics had 32.55 compared with 25.00 ($p=0.001$).

Conclusion: Vitamin D deficiency is common among adults with and without diabetes in Erbil. Non-diabetics are more likely to use supplements, while gender, education, and socioeconomic status significantly influence awareness and health behaviors. Targeted educational interventions are recommended to address these disparities.

Keywords: Vitamin D, Knowledge, Attitude, Practices, Diabetes mellitus, Erbil, Iraq

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INTRODUCTION

Vitamin D deficiency is a global health concern, affecting approximately one billion people worldwide, with the highest prevalence in regions like the Middle East and North Africa. Despite abundant sources of vitamin D, such as sunlight and vitamin D-rich foods, deficiency is widespread due to factors including limited sun exposure, dietary habits, and skin pigmentation (1-3). Vitamin D deficiency affects 5.9% of Americans, 7.4% of Canadians, and 13% of Europeans; over 20% of Afghans, Pakistanis, and Tunisians are deficient. India has the highest insufficiency rates, especially in children (31%) and adults/elders (56–65%). The Gulf states have high rates of vitamin D deficiency despite abundant sunlight (4, 6), a pattern echoed regionally, where a KAP study among healthcare workers in Erbil similarly found only fair-to-poor vitamin D knowledge in the large majority of respondents (5).

Vitamin D is necessary for bone mineral metabolism, including calcium and phosphorus metabolism, in addition to its immunomodulatory effects, which have been among the most commonly reported features of the COVID-19 pandemic. Numerous preclinical and clinical studies show that vitamin D improves multiple sclerosis, malignancies, diabetes, depression, and cardiovascular disease (7, 8). People with diabetes have high blood sugar; extreme hyperglycemia causes frequent urination, thirst, exhaustion, reduced function, unexplained weight loss, visual issues, infection risk, and ketoacidosis with coma. Chronic hyperglycemia damages the kidneys, heart, blood vessels, nerves, eyes, and insulin secretion. Diabetes can be gestational, type 1, or type 2 (9), and it is frequently accompanied by other micronutrient deficiencies in affected patients — an Erbil-based study, for example, similarly found a substantial prevalence of vitamin B12 deficiency

among type 2 diabetics on long-term metformin therapy (10).

Insulin resistance and type 2 diabetes are major issues nowadays. Skeletal muscle, fat tissue, and the liver need insulin; it influences glucose transport and lipid synthesis genes. Insulin resistance occurs when blood insulin levels are too high, and can cause polycystic ovary syndrome (PCOS) and non-alcoholic fatty liver disease (NAFLD). Due to insulin need, beta cells in the islets of Langerhans atrophy, and damage worsens type 2 diabetes. Various research has linked vitamin D deficiency to diabetes (11, 12). Insulin resistance increases with vitamin D deficiency, promoting type 2 diabetes and obesity; beta cells have the vitamin D receptor (VDR), which helps balance insulin production, and vitamin D supplementation decreases diabetes disease progression (13). Hyperglycemia and type 2 diabetes are inversely related to vitamin D levels; in diabetics, vitamin D supplementation enhances insulin resistance and fasting blood sugar (14). Vitamin D has a critical role because deficiency can cause problems in many physiological systems. It's essential to raise public awareness to understand the relation between the symptoms of deficiency and health issues, emphasizing the need for more research to determine its prevalence and raise awareness (15). Vitamin D deficiency is more prevalent in diabetics and non-diabetics with low education and employment levels. People with diabetes, who are more susceptible to vitamin D deficiency, need to be made more aware of the risks (16). Many previous studies show a strong link between vitamin D deficiency and diabetes; supplementation with vitamin D may reduce the risk of development (17). This study aimed to assess and compare the KAP towards vitamin D deficiency among diabetic and non-diabetic adults in Erbil City. Their awareness, perception, and practices will be evaluated so as to determine how they manage vitamin D deficiency and to identify areas where

focused interventions are required to improve awareness and management.

METHODS

Study Design and Setting

This cross-sectional study was conducted on patients with diabetes mellitus and non-diabetic individuals in the city of Erbil. The study was carried out from September 2024 to August 2025, at Galiawa Diabetes and Endocrinology Teaching Center, Erbil Teaching Hospital, Rizgary Teaching Hospital, and private clinics.

Study Population

A total of 394 participants were recruited: 195 diabetic patients and 199 non-diabetic individuals, selected from local hospitals and clinics. Inclusion criteria were adults aged 18 years and older living in Erbil city; exclusion criteria included pregnant women and patients with communication impairment. The study involved two groups: the diabetic group (individuals diagnosed with type 1 or type 2 diabetes mellitus) and the non-diabetic group (adults without a diagnosis of diabetes, included for comparative purposes).

Sample Size

The sample size was calculated using Epi Info™ StatCalc software for a population survey, using the formula $n = (Z^2 \times P \times (1-P))/d^2$, where $Z=1.96$, $P=0.5$, $d=0.05$; this gave an estimated sample size of 385. To enhance statistical power and account for potential incomplete or non-responses, 394 participants were enrolled, a 2.34% increase over the estimated sample size, ensuring adequate representation of both groups even with potential data attrition.

Data Collection

Data were collected using a structured questionnaire developed to assess knowledge, attitudes, and practices regarding vitamin D deficiency, comprising four sections: demographic

data (gender, age, socioeconomic status, education level); knowledge of vitamin D and its roles in health; attitudes towards supplementation, sun exposure, and diet; and practices related to screening, supplementation, and dietary intake.

Recruitment was through convenience sampling from various healthcare centers and private clinics. Verbal informed consent was obtained prior to participation. The questionnaire was administered either through face-to-face interviews or self-administered surveys, depending on participant preference, and was conducted in Arabic and Kurdish to ensure full understanding. It was validated through a pilot test with a small group of participants, including both diabetic ($n=15$) and non-diabetic ($n=15$) individuals; content validity was assessed through expert review, in which 4 experts reviewed the questionnaire for clarity, reliability, and validity, and feedback from both the pilot test and expert review was used to refine the questionnaire.

Socioeconomic Status (SES) Assessment

SES was calculated using a composite index developed by Omer and Al-Hadithi (2017), incorporating education level, occupation, house ownership, car ownership, and age, using the equation: $SES = \text{Education} + \text{Occupation} + (\text{House ownership} \times 0.5) + (\text{Car ownership} \times 0.1) + ((\text{age}-20)/100) - (\text{Retired/unemployed/deceased})$. Education was scored by highest level attained (e.g., 1 for illiterate, 2 for primary, 3 for secondary); occupation was categorized by job type (1 for unskilled through 4 for professional); house ownership was scored (1 for rented, 2 for owned); car ownership was weighted 0.1 to reflect its lesser relative importance; age was adjusted by subtracting 20 and dividing by 100; and a deduction was applied if the participant was retired, unemployed, or deceased. The SES score was calculated by summing the weighted factors, and

participants were classified into low, medium, or high SES based on their total score.

Data Analysis

Demographic and questionnaire data were coded. Descriptive statistics (frequencies, mean, standard deviation) and inferential statistics (chi-square test, independent t-test, one-way ANOVA, and Pearson correlation) were conducted using SPSS version 23 for Windows. A p-value ≤ 0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Scientific and Higher Education Committee of the College of Medicine, Hawler Medical University, and the Ethical Committee of the College of Medicine. Official acceptance was obtained from the Galiawa Center for Diabetes, Erbil Teaching Hospital, Rizgary Teaching Hospital, and private clinics in Erbil city for conducting the study. Oral informed consent was

obtained from willing participants after detailed explanation of the study's aim and expected benefits, and confidentiality was assured by coding the forms to preserve anonymity.

RESULTS

The study population comprised 394 participants: 195 diabetics and 199 non-diabetics. The mean age was 48.9 ± 12.57 years for diabetics and 40.64 ± 11.64 years for non-diabetics (median 49 and 42.5 years, respectively). Age ranged from 18 to 79 years for diabetics and 21 to 77 years for non-diabetics, with the 40–59 age group most prevalent in both. Gender distribution was similar, with females comprising 51.3% of diabetics and 56.0% of non-diabetics. Illiteracy rates were higher among diabetics (10.3%) than non-diabetics (1.0%). A greater proportion of diabetics were of low SES (40.0%) compared with non-diabetics (26.1%), while more non-diabetics were of medium SES (66.3%), as shown in Table 1.

Table 1. Basic demographic characteristics of the two study groups

Variable	Category	Diabetic No. (%)	Non-diabetic No. (%)	Total No. (%)
Age (years)	<39	44 (28.0)	113 (56.8)	157 (39.8)
	40-59	106 (54.4)	68 (34.2)	174 (44.2)
	60-79	45 (23.1)	18 (9.0)	63 (16.0)
Gender	Male	95 (48.7)	98 (44.0)	193 (48.9)
	Female	100 (51.3)	101 (56.0)	201 (51.0)
Education	No formal education	20 (10.3)	2 (1.0)	22 (5.5)
	Primary	43 (22.1)	19 (9.5)	62 (15.7)
	Intermediate	26 (13.3)	34 (17.1)	60 (15.2)
	High	34 (17.4)	37 (18.6)	71 (18.0)
	Diploma	38 (19.5)	43 (21.6)	81 (20.5)
	Bachelor's	29 (14.9)	60 (30.2)	89 (22.5)
	Postgraduate	5 (2.6)	4 (2.0)	9 (2.3)
SES	Low	78 (40.0)	52 (26.1)	130 (33.0)
	Medium	106 (54.4)	132 (66.3)	238 (60.4)
	High	11 (5.6)	15 (7.6)	26 (6.6)
Total		195 (100.0)	199 (100.0)	394 (100.0)

Two corrections have been made to this table as originally supplied. [1] The “Age <39” row's Total column read “157(100.0)”; since 44+113=157 is the row's own count, its share of the full sample of 394 is 39.8%, matching the pattern used for the other two age rows (which already correctly showed 44.2% and 16.0%). [2] The “Postgraduate” row's percentages (originally shown as 5(27.7), 4(22.2), 9(50.0)) did not match their own counts — 5/195, 4/199, and 9/394 are 2.6%, 2.0%, and 2.3% respectively, not 27.7%/22.2%/50.0%, which appear to have been copied from an unrelated row. Both have been corrected here; we recommend verifying against the original dataset.

Table 2 presents baseline vitamin D awareness in diabetics (n=195) and non-diabetics (n=199).

Approximately half of both groups recognized sunlight as a major source of vitamin D (54.9% of diabetics vs. 51.8% of non-diabetics). Regarding supplements, 45.1% of diabetics vs. 49.2% of non-diabetics considered them a primary source, with no significant difference ($p=0.757$). Awareness of fatty fish as a source was similar between groups (33.8% diabetics vs. 39.2% non-diabetics; $p=0.567$), and more diabetics (29.2%) than non-diabetics (20.1%) identified eggs as a source, though the difference was not significant ($p=0.189$). Dairy products were more often recognized as a source by diabetics (35.4%) than non-diabetics (27.6%). Overall, there were no statistically significant differences between the groups regarding knowledge of vitamin D sources.

Table 2. Baseline knowledge of vitamin D sources in study groups

Source	Group	I don't know	Major	Moderate	Not a source	Slight	p
Sunlight	Diabetic	9 (4.6)	107 (54.9)	53 (27.2)	2 (1.0)	24 (12.3)	0.962
	Non-diabetic	8 (4.0)	103 (51.8)	60 (30.2)	2 (1.0)	26 (13.0)	
Fatty fish	Diabetic	29 (14.9)	54 (27.7)	66 (33.8)	8 (4.1)	38 (19.5)	0.567
	Non-diabetic	25 (12.6)	50 (25.1)	78 (39.2)	4 (2.0)	42 (21.1)	
Fruits	Diabetic	55 (28.2)	19 (9.7)	52 (26.7)	13 (6.7)	56 (28.7)	0.320
	Non-diabetic	57 (28.6)	21 (10.6)	36 (18.1)	17 (8.5)	68 (34.2)	
Eggs	Diabetic	55 (28.2)	57 (29.2)	51 (26.2)	3 (1.5)	29 (14.9)	0.189
	Non-diabetic	55 (27.6)	40 (20.1)	58 (29.2)	6 (3.0)	40 (20.1)	
Supplement	Diabetic	6 (3.1)	88 (45.1)	38 (19.5)	47 (24.1)	16 (8.2)	0.757
	Non-diabetic	6 (3.0)	98 (49.2)	38 (19.2)	47 (23.6)	10 (5.0)	
Dairy products	Diabetic	30 (15.4)	69 (35.4)	53 (27.2)	11 (5.6)	32 (16.4)	0.545
	Non-diabetic	37 (18.6)	55 (27.6)	56 (28.2)	14 (7.0)	37 (18.6)	

Table 3 shows baseline knowledge of health issues caused by vitamin D deficiency. Both groups displayed a high level of uncertainty regarding the health conditions caused by vitamin D deficiency, particularly concerning cardiovascular disease (79.0% diabetics vs. 79.9% non-diabetics) and type 2 diabetes (72.8% vs. 75.4%), with no significant difference between groups ($p > 0.05$). Overall, both groups demonstrated low awareness of the health consequences of vitamin D deficiency.

Table 3. Baseline knowledge of health conditions attributed to vitamin D deficiency

Condition	Group	I don't know	High	Moderate	Little	p
Cardiovascular disease	Diabetic	154 (79.0)	8 (4.1)	10 (5.1)	23 (11.8)	0.555
	Non-diabetic	159 (79.9)	4 (2.0)	8 (4.0)	28 (14.1)	
Type 2 diabetes	Diabetic	142 (72.8)	7 (3.6)	19 (9.7)	27 (13.8)	0.180
	Non-diabetic	150 (75.4)	2 (1.0)	13 (6.5)	34 (17.1)	
Seasonal allergy	Diabetic	129 (66.2)	5 (2.6)	30 (15.4)	31 (15.9)	0.929
	Non-diabetic	129 (64.8)	7 (3.5)	33 (16.6)	30 (15.1)	
Immune disorders	Diabetic	35 (17.9)	43 (22.1)	98 (50.3)	19 (9.7)	0.758
	Non-diabetic	34 (17.1)	36 (18.1)	108 (54.3)	21 (10.6)	
Obesity	Diabetic	133 (68.2)	7 (3.6)	26 (13.3)	29 (14.9)	0.702
	Non-diabetic	144 (72.4)	4 (2.0)	23 (11.6)	28 (14.1)	
Acne	Diabetic	168 (86.2)	4 (2.1)	9 (4.6)	14 (7.2)	0.377
	Non-diabetic	171 (85.9)	1 (0.5)	7 (3.5)	20 (10.1)	
Headache	Diabetic	60 (30.8)	31 (15.9)	78 (40.0)	26 (13.3)	0.266
	Non-diabetic	70 (35.2)	20 (10.1)	76 (38.2)	33 (16.6)	

Table 4 highlights significant associations between sociodemographic/clinical factors and total vitamin D knowledge scores. Among non-diabetic participants, females had significantly higher knowledge scores than males (27.63 vs. 24.95, $p=0.015$). SES significantly affected knowledge in both diabetics ($p=0.001$) and non-diabetics ($p=0.001$), with higher knowledge scores in the high-SES group: for diabetics, 25.00 (low), 27.81 (moderate), and 32.55 (high); for non-diabetics,

21.87 (low), 27.52 (moderate), and 31.13 (high). Educational level also had a significant impact in both diabetics ($p=0.003$) and non-diabetics ($p < 0.001$), with participants with secondary education or higher showing greater knowledge; for diabetics, scores ranged from 24.72 (primary) to 35.34 (postgraduate), while for non-diabetics, scores ranged from 18.95 (primary) to 29.87 (bachelor's degree).

Table 4. Association between demographic variables and total knowledge scores

Group	Variable	Category	n	Mean score	Test	p
Diabetic	Gender	Male	95	26.52	$t=-0.82$	0.413
		Female	100	27.37		
	SES	Low	78	25.00	$F=7.26$	<0.001
		Moderate	106	27.81		
		High	11	32.55		
	Education	No formal	20	25.80	$F=3.24$	0.003
		Primary	43	24.72		
		Intermediate	26	24.15		
		High school	38	28.09		
		Diploma	34	27.66		
		Bachelor's	29	29.86		
		Postgraduate	5	35.34		
	Diabetes duration	Short	105	27.16	$F=0.192$	0.008
		Medium	39	27.10		
		Long	51	26.41		
Non-diabetic	Gender	Male	98	24.95	$t=-2.46$	0.015
		Female	101	27.63		
	SES	Low	52	21.87	$F=14.62$	<0.001
		Moderate	132	27.52		
		High	15	31.13		
	Education	No formal	2	20.00	$F=6.29$	<0.001
		Primary	19	18.95		
		Intermediate	34	24.53		
		High school	37	26.16		
		Diploma	43	26.30		
		Bachelor's	60	29.87		
		Postgraduate	4	27.75		

Note: the "Diabetes duration" row reports $F=0.192$ alongside $p=0.008$; an F -statistic this close to zero would not typically reach significance at this level with these group sizes. This is reproduced as supplied — we recommend the authors verify this specific F -value/ p -value pairing against the original ANOVA output.

Discussion

The aim of this study was to evaluate the knowledge, attitudes, and practices (KAP) related to vitamin D deficiency among both diabetic and non-diabetic patients in Erbil City, examining sociodemographic variables that influence knowledge and lifestyle, identifying gaps in vitamin D awareness, and evaluating the impact of these factors on the management of vitamin D deficiency.

According to the findings, the most prevalent age group among diabetics was 40–59 years, associated with low socioeconomic status, aligning with previous research. A study of 947,000 HbA_{1c} readings from type 1 and type 2 diabetics in Canada found a correlation between higher levels and poorer socioeconomic position, particularly among those aged 30 to 70, identifying SES and age as key factors in the higher prevalence of diabetes and poorer health outcomes (18).

On the other hand, other research has reported a high prevalence of diabetes at a younger age (20–39), particularly in lower socioeconomic groups. Despite our finding of increased diabetes prevalence in the 40–59 age group, those researchers argued that socioeconomic gaps affected younger people more than older people, highlighting differences in social determinants of health and access to healthcare (19). This may be due to differences in how early type 2 diabetes appears in younger groups, lifestyle factors including diet and physical exercise, and barriers to healthcare access for younger people.

In terms of education, the illiteracy rate among diabetics was greater (10.3%) than among non-diabetics (1.0%). Lower educational attainment may be linked to a higher risk of developing and managing chronic conditions like diabetes, according to the findings. This is in line with another study, which found that people who are less

educated or illiterate are more likely to underestimate their risk of developing and managing diabetes, lowering their likelihood of taking preventive action or effectively managing the condition (20). However, a contrasting study found no impact of educational level on glycemic control in type 2 diabetes patients, though greater education improved complication recognition and diet adherence, suggesting education improves illness management through targeted approaches but may not directly predict treatment compliance (21). Differences in education assessment or financial/medical barriers may explain this variance.

In terms of vitamin D sources, sunlight exposure was widely recognized as a major source (54.9% of diabetics, 51.8% of non-diabetics; $p=0.962$). Supplements were identified as a source by 45.1% of diabetics and 49.2% of non-diabetics ($p=0.757$). However, many participants were unaware of the role of fatty fish, eggs, or fruits in vitamin D intake, and there were no statistically significant differences in awareness of vitamin D sources between diabetics and non-diabetics (p -values for fatty fish=0.567, eggs=0.189, dairy=0.545). This is in line with a study by Al-Neklawy et al., in which most participants were aware of vitamin D supplementation and sun exposure as major sources of vitamin D (22). By contrast, a previous study by Vaes et al. identified butter and margarine as primary sources for vitamin D, followed by fatty fish and shellfish, emphasizing that fortified foods are essential for vitamin D, especially in at-risk groups (23). This may be due to differences in dietary choices and food availability, with some groups relying on fortified foods and others on natural vitamin D sources; differences in assessment methodology (survey versus interview) may also explain differing awareness levels. This study demonstrated high levels of uncertainty regarding the health conditions to which vitamin D

deficiency contributes, particularly cardiovascular disease (79.0% diabetics vs. 79.9% non-diabetics, $p=0.555$) and type 2 diabetes (72.8% vs. 75.4%, $p=0.180$). There was very little awareness of conditions like seasonal allergies (66.2% vs. 64.8%, $p=0.929$), immune system disorders (50.3% vs. 54.3%, $p=0.758$), obesity (68.2% vs. 72.4%, $p=0.702$), and headaches (30.8% vs. 35.2%, $p=0.266$), with no significant differences between groups. This confirms Alibrahim et al.'s earlier study in Syria, which found uncertainty about the link between vitamin D insufficiency and certain health issues, highlighting the need for more public education on its detrimental effects (24). By contrast, a previous study suggested that despite the association between vitamin D deficiency and cardiovascular disease risk, it is not as critical a factor as commonly believed (25).

The concept of vitamin D insufficiency and genetic variation in its metabolism may affect participants' knowledge and understanding of its health implications.

Demographic and clinical characteristics significantly correlated with overall vitamin D knowledge scores in both study groups. Women had higher knowledge scores than men among non-diabetics ($p=0.015$). For both diabetics ($p=0.001$) and non-diabetics ($p=0.001$), increased SES was associated with higher knowledge scores, and higher education was similarly associated with higher knowledge scores in both diabetics ($p=0.003$) and non-diabetics ($p < 0.001$), with respondents with secondary education or higher demonstrating greater understanding. A study by Žmitek et al. indicated that education and SES positively impacted vitamin D knowledge, and that women were more knowledgeable than men, emphasizing the influence of demographic and clinical characteristics — SES, gender, and education — on

vitamin D supplementation awareness and practice (26). By contrast, Voulgaridou et al. found no significant link between these variables and Greek women's awareness of vitamin D; instead, factors such as urban residency and the frequency of vitamin D assessments were more significant, underscoring how local settings, such as access to healthcare and urban–rural disparities, can affect vitamin D knowledge (27).

LIMITATIONS OF THE STUDY

Some participants may overestimate their knowledge of vitamin D due to self-reporting, which introduces bias.

Because convenience sampling did not select participants at random, it may have resulted in selection bias not representative of the community; face-to-face questioning can also introduce interviewer bias, where the interviewer's presence or attitude may affect responses. Such bias limits the ability to establish causal relationships between demographic and clinical characteristics — such as education, SES, and gender — and awareness of vitamin D; this is compounded by the cross-sectional design.

The study's focus was on the main determinants (education, SES, and gender), but other factors, such as healthcare access and interventions, which could affect vitamin D understanding, were not assessed. The study also did not screen subjects for vitamin D deficiency biochemically, making it more difficult to relate awareness to true health status.

Conclusion

This study demonstrated that individuals with higher SES and educational levels are more aware of vitamin D sources and health concerns, in both diabetics and non-diabetics. The diabetic group showed a notable lack of knowledge, especially regarding the importance of vitamin D in preserving

health. Both groups showed a deficit in knowledge regarding dietary sources of vitamin D and its health impacts. Health campaigns should aim to improve awareness, especially among people with lower socioeconomic status and education levels. Targeted educational initiatives concerning the health risks linked to vitamin D deficiency and the need for supplementation are essential for the diabetic group. To fill these knowledge gaps, digital platforms, healthcare professional training, and community-based efforts should be pursued.

COMPETING INTEREST

The authors declare that they have no competing interests.

REFERENCES

1. Ayadi ID, Nouaili EBH, Talbi E, Ghdemssi A, Rached C, Bahlous A, et al. Prevalence of vitamin D deficiency in mothers and their newborns in a Tunisian population. *Int J Gynaecol Obstet*. 2016;133(2):192-5. <https://doi.org/10.1016/j.ijgo.2015.09.029>
2. Chakhtoura M, Rahme M, Chamoun N, El-Hajj Fuleihan G. Vitamin D in the Middle East and North Africa. *Bone Rep*. 2018;8:135-46. <https://doi.org/10.1016/j.bonr.2018.03.004>
3. Wimalawansa SJ. Physiological basis for using vitamin D to improve health. *Biomedicines*. 2023;11(6):1542. <https://doi.org/10.3390/biomedicines11061542>
4. Cashman KD. Vitamin D deficiency: defining, prevalence, causes, and strategies of addressing. *Calcif Tissue Int*. 2020;106(1):14-29. <https://doi.org/10.1007/s00223-019-00559-4>
5. Saeed SQ, Shabu SA. Knowledge and practices towards vitamin D sources and insufficiency among healthcare workers in Erbil, Iraq, 2025. *Zanco J Med Sci*. 2026;30(2):333-44. <https://doi.org/10.15218/zjms.2026.023>
6. Hajizadeh S, Rankin Shary J, Gayle Reed S, Lynn Wagner C. The prevalence of hypovitaminosis D and its risk factors in pregnant women and their newborns in the Middle East: a systematic review. *Int J Reprod Biomed*. 2019;17(10):685-708. <https://doi.org/10.18502/ijrm.v17i10.5284>
7. Burton JM, Kimball S, Vieth R, Bar-Or A, Dosch HM, Cheung R, et al. A phase I/II dose-escalation trial of vitamin D3 and calcium in multiple sclerosis. *Neurology*. 2010;74(23):1852-9. <https://doi.org/10.1212/WNL.0b013e3181e1cec2>
8. Janoušek J, Pilařová V, Macáková K, Nomura A, Veiga-Matos J, Silva DDD, et al. Vitamin D: sources, physiological role, biokinetics, deficiency, therapeutic use, toxicity, and overview of analytical methods for detection of vitamin D and its metabolites. *Crit Rev Clin Lab Sci*. 2022;59(8):517-54. <https://doi.org/10.1080/10408363.2022.2070595>
9. Harreiter J, Roden M. Diabetes mellitus — definition, Klassifikation, Diagnose, Screening und Prävention (Update 2023). *Wien Klin Wochenschr*. 2023;135(S1):7-17. <https://doi.org/10.1007/s00508-022-02122-y>
10. Farajulla SI, Meena MQ. Serum vitamin B12 level in type 2 diabetes patients on metformin therapy. *Adv Med J*. 2026;11(1):39-46. <https://doi.org/10.56056/amj.2026.426>
11. Rafiq S, Jeppesen PB. Insulin resistance is inversely associated with the status of vitamin D in both diabetic and non-diabetic populations. *Nutrients*. 2021;13(6):1742. <https://doi.org/10.3390/nu13061742>

12. Norton L, Shannon C, Gastaldelli A, DeFronzo RA. Insulin: the master regulator of glucose metabolism. *Metabolism*. 2022;129:155142. <https://doi.org/10.1016/j.metabol.2022.155142>
13. Kositsawat J, Freeman VL, Gerber BS, Geraci S. Association of A1C levels with vitamin D status in U.S. adults. *Diabetes Care*. 2010;33(6):1236-8. <https://doi.org/10.2337/dc09-2150>
14. Al Dossari KK, Ahmad G, Aljowair A, Alqahtani N, Shibrayn MB, Alshathri M, et al. Association of vitamin D with glycemic control in Saudi patients with type 2 diabetes: a retrospective chart review study in an emerging university hospital. *J Clin Lab Anal*. 2020;34(2):e23048. <https://doi.org/10.1002/jcla.23048>
15. Sorrenti V, Buriani A, Davinelli S, Scapagnini G, Fortinguerra S. Vitamin D physiology, deficiency, genetic influence, and the effects of daily vs. bolus doses of vitamin D on overall health: a clinical approach. *Nutraceuticals*. 2023;3(3):403-20. <https://doi.org/10.3390/nutraceuticals3030030>
16. Nasr MH, Hassan B, Abdul Rasool B, Othman N, Karuppannan M, Mahmathi A, et al. Prevalence of vitamin D deficiency between type 2 diabetes mellitus patients and non-diabetics in the Arab Gulf. *Diabetes Metab Syndr Obes*. 2022;15:647-57. <https://doi.org/10.2147/DMSO.S350626>
17. AlHewishel MA, Bahgat M, Al Huwaiyshil A, Alsubie MA, Alhassan A. 25(OH)D serum level in non-diabetic and type II diabetic patients: a cross-sectional study. *Cureus*. 2020;12(6):e8910. <https://doi.org/10.7759/cureus.8910>
18. Mousavi S, Tannenbaum Greenberg D, Ndjaboué R, Greiver M, Drescher O, Chipenda Dansokho S, et al. The influence of age, sex, and socioeconomic status on glycemic control among people with type 1 and type 2 diabetes in Canada: patient-led longitudinal retrospective cross-sectional study with multiple time points of measurement. *JMIR Diabetes*. 2023;8:e35682. <https://doi.org/10.2196/35682>
19. Omura T, Goto A, Nakayama I, Saito J, Noda M, Yasuda N, et al. Socioeconomic status and diabetes prevalence in the Japanese: insights from the JPHC-NEXT study. *Mayo Clin Proc*. 2025;100(3):452-64. <https://doi.org/10.1016/j.mayocp.2024.08.016>
20. Tajdar D, Lühmann D, Fertmann R, Steinberg T, Van Den Bussche H, Scherer M, et al. Low health literacy is associated with higher risk of type 2 diabetes: a cross-sectional study in Germany. *BMC Public Health*. 2021;21(1). <https://doi.org/10.1186/s12889-021-10508-2>
21. Al-Rasheedi AAS. The role of educational level in glycemic control among patients with type II diabetes mellitus. *Int J Health Sci*. 2014;8(2):177-87. <https://doi.org/10.12816/0006084>
22. Al-Neklawy AF, Mohammed Aljohani G, Abdullah Alrefaei M, Bajawi A, Waleed Hammoda A, Khaled Tasji W. Knowledge and awareness of the relationship between vitamin D deficiency and depression among a sample of adults in Saudi Arabia. *Cureus*. 2025. <https://doi.org/10.7759/cureus.85555>
23. Vaes AMM, Brouwer-Brolsma EM, Van Der Zwaluw NL, Van Wijngaarden JP, Berendsen AAM, Van Schoor N, et al. Food sources of vitamin D and their association with 25-hydroxyvitamin D status in Dutch older adults. *J Steroid Biochem Mol Biol*. 2017;173:228-34. <https://doi.org/10.1016/j.jsbmb.2016.10.004>
24. Alibrahim H, Swed S, Bohsas H, Abouainain Y, Jawish N, Diab R, et al. Assessment of the awareness of vitamin D deficiency among the general population in Syria: an online cross-

- sectional study. BMC Public Health. 2024;24(1).
<https://doi.org/10.1186/s12889-024-18376-2>
25. Rubab M, Kelleher JD. Assessing the relative importance of vitamin D deficiency in cardiovascular health. Front Cardiovasc Med. 2024;11.
<https://doi.org/10.3389/fcvm.2024.1435738>
26. Žmitek K, Hribar M, Lavriša Ž, Hristov H, Kušar A, Pravst I. Socio-demographic and knowledge-related determinants of vitamin D supplementation in the context of the COVID-19 pandemic: assessment of an educational intervention. Front Nutr. 2021;8.
<https://doi.org/10.3389/fnut.2021.648450>
27. Voulgaridou G, Athanassiou F, Kravvariti E, Doulgeraki S, Papadopoulou SK, Kokokiris LE. Knowledge and predictors of vitamin D awareness among Greek women: a cross-sectional study. Diseases. 2025;13(2):58.
<https://doi.org/10.3390/diseases13020058>