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Original Article

Vitamin D Deficiency and Its Association with Dental Caries: A Cross-Sectional Study

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Abstract
Background: Vitamin D plays a crucial role in calcium absorption and bone mineralization, which may influence dental health. Despite extensive research, the relationship between vitamin D deficiency and dental caries remains inconsistently reported. **Objective:** This study aimed to investigate the potential association between vitamin D deficiency and the prevalence of dental caries in adults. **Methods:** A cross-sectional study was conducted involving 78 adults. Data were collected via a structured questionnaire assessing demographic characteristics, medical history, vitamin D status, and oral health. Dental caries experience was measured using the DMFS and DMFT indices. Statistical analyses included descriptive statistics, chi-square tests, t-tests, ANOVA, and correlation analyses using SPSS. **Results:** The sample consisted predominantly of females (95%) and individuals under 30 years (86%). A high prevalence of vitamin D deficiency (96%) and dental caries (95%) was observed. While a significant association was found between vitamin D deficiency and self-reported oral problems (p=0.034), no significant association was found between vitamin D deficiency and the presence of dental caries (p=0.681), gum disease (p=0.925), or history of tooth extractions (p=0.111). Vitamin D levels did not significantly differ across age or gender groups. **Conclusion:** Despite the high co-prevalence of vitamin D deficiency and dental caries in this cohort, no direct statistical association was established. The findings suggest that while vitamin D deficiency may be linked to general oral health complaints, its specific role in caries etiology warrants further investigation through longitudinal or interventional study designs.
Keywords: Vitamin D deficiency, dental caries, oral health, DMFS, DMFT, cross-sectional study

Introduction

Maintaining optimal oral health is integral to overall well-being. Vitamin D, often referred to as the "sunshine vitamin," is essential for calcium absorption and bone metabolism, and it has been implicated in various systemic and oral health outcomes [1]. Deficiencies in vitamin D have been associated with conditions such as osteoporosis, impaired immune function, and, more recently, oral health disorders, including periodontal disease and dental caries [2].Dental caries remains one of the most prevalent chronic diseases worldwide, influenced by a complex interplay of dietary, microbial, and host factors. The potential role of nutritional status, particularly vitamin D, in modulating caries risk has gained attention. Vitamin D is critical for tooth mineralization and enamel integrity, and its deficiency could theoretically increase susceptibility to demineralization and decay [3].
Despite plausible biological mechanisms, empirical evidence remains inconsistent. While some observational studies suggest a correlation between low vitamin D levels and increased caries prevalence [4], others report no significant association [5]. Furthermore, much of the existing literature is derived from pediatric or elderly populations, with limited data on adults.
This study aimed to address this gap by examining the relationship between vitamin D deficiency and dental caries in an adult population. The findings contribute to the ongoing discourse on nutritional influences in preventive dentistry.

Materials and Methods

Study Design and Participants

A descriptive cross-sectional study was conducted between November 2023 and January 2024. A convenience sample of 78 adults was recruited from Tripoli, Libya, and its suburbs. Inclusion criteria were age ≥18 years and willingness to participate. Exclusion criteria included severe systemic illness affecting bone metabolism (e.g., chronic kidney disease, hyperparathyroidism) and use of medications known to significantly affect vitamin D metabolism (e.g., anticonvulsants, glucocorticoids).

Data Collection

Data were collected through:
1. A structured questionnaire covering:

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- Sociodemographic information (age, gender, marital status, residence)
- Medical history and current medications
- Self-reported vitamin D deficiency status and date of last test
- Oral health history (history of caries, gum disease, tooth extractions)

2. Clinical assessment using the DMFS (Decayed, Missing, Filled Surfaces) and DMFT (Decayed, **Missing,** Filled Teeth) indices to quantify caries experience.
3. Oral hygiene index categorized as Poor, Acceptable, Very Good, or Excellent.

Variable Definitions

- Independent variables: Age, sex, marital status, and residence.
- Dependent variables: Vitamin D level (numerical and categorical: Deficient <20 ng/mL, Suboptimal 20–29 ng/mL, Optimal ≥30 ng/mL), presence of dental caries, DMFS, DMFT, gum disease, and history of extractions.

Ethical Considerations

Informed consent was obtained from all participants. The study protocol adhered to the principles of the Declaration of Helsinki.

Statistical Analysis

Data were analyzed using SPSS version 26. Descriptive statistics were presented as frequencies, percentages, means, and standard deviations. Normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Associations between categorical variables were examined using chi-square tests with contingency coefficients. Group comparisons for continuous variables were performed using independent t-tests, ANOVA, or non-parametric equivalents (Mann-Whitney U, Kruskal-Wallis) as appropriate. A p-value <0.05 was considered statistically significant.

Results

Sample Characteristics

The majority of participants were female (95%), under 30 years old (86%), single (82%), and residing in Tripoli city (73%). A high proportion reported no systemic diseases (79%). Vitamin D deficiency was nearly universal (96%), with a mean serum level of 12.09 ng/mL (SD=8.26). Dental caries was reported by 95% of participants.

Table 1. The percentage distribution of the sample Sex

Sex	f (p%)	Chi-Square	df	Asymp.Sig. (p-value)
male	4 (5%)	62.821	1	0.000
female	74 (95%)			
Total	78 (100%)			

Table 2. The frequency and percentage distribution of the sample Diseasessuffering

Disease suffering	f(p%)	Chi-Square	df	Asymp.Sig. (p-value)
yes	16 (21%)	27.128	1	0.000
no	62 (79%)			
Total	78 (100%)			

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Dental Health Indicators

The mean DMFS score was 11.68 (SD=10.46), and the mean DMFT score was 4.19 (SD=2.47). Caries was the most common self-reported oral problem (63%). Gum disease was reported by 36% of participants, and 55% had a history of tooth extraction, primarily due to caries (74%).

Association Analyses

A significant but weak association was found between vitamin D deficiency and self-reported oral problems (Contingency Coefficient=0.233, p=0.034).

· No significant associations were found between:

· Vitamin D deficiency and dental caries (p=0.681)

· Vitamin D deficiency and gum disease (p=0.925)

· Vitamin D deficiency and history of extractions (p=0.111)

· Vitamin D level categories and dental caries, gum disease, or extractions (all p>0.05).

Table3. TheassociationbetweenVitaminDdeficiencyandTeethdecay

	Teeth decay			Pearson Chi-Square Value	df	Asymp.Sig. (2-sided)	Contingency CoefficientValue
Vit .D deficiency	Yes	No	Total				
Yes	71	4	75	.169[a]	1	.681	.046
No	3	0	3				
Total	74	4	78				

Table4. TheassociationbetweenVitaminDdeficiencyandGumdisease

	Gumdisease			PearsonChi-Square Value	df	Asymp.Sig. (2-sided)	Contingency CoefficientValue
Vit.D deficiency	Yes	No	Total				
Yes	27	48	75	.009[a]	1	.925	.011
No	1	2	3				
Total	28	50	78				

Table 5. TheassociationbetweenVitaminDdeficiencyandToothextractionsinthe past

	Toothextractionsin the past			PearsonChi-Square Value	df	Asymp.Sig. (2-sided)	Contingency CoefficientValue
Vit.D deficiency	Yes	No	Total				
Yes	40	35	75	2.540[a]	1	.111	.178
No	3	0	3				
Total	43	35	78				

Table 6. Theassociationbetween VitaminDlevelandTeethdecay

	Teethdecay			PearsonChi-SquareValue	df	Asymp.Sig.(2-sided)	Contingency CoefficientValue
Vit.Dlevel	Yes	No	Total				
Deficient:below20 ng/mL	58	4	62	1.088[a]	2	.580	.117
Suboptimal:20to29 ng/mL	12	0	12				
Optimal:30to100 ng/mL	4	0	4				
Total	74	4	78				

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Table 7. TheassociationbetweenVitaminDlevelandGum disease

	Gum disease			PearsonChi-SquareValue	df	Asymp.Sig.(2-sided)	Contingency CoefficientValue
Vit.Dlevel	Yes	No	Total				
Deficient:below20 ng/mL	25	37	62	3.387[a]	2	.184	.204
Suboptimal:20to29 ng/mL	3	9	12				
Optimal:30to100 ng/mL	0	4	4				
Total	28	50	78				

Table 8. TheassociationbetweenVitaminDlevelandToothextractionsinthe past

	Toothextractionsin the past			PearsonChi-Square Value	df	Asymp.Sig. (2-sided)	Contingency CoefficientValue
Vit.Dlevel	Yes	No	Total				
Deficient:below20 ng/mL	32	30	62	1.594[a]	2	.451	.142
Suboptimal:20to 29ng/mL	8	4	12				
Optimal:30to100 ng/mL	3	1	4				
Total	43	35	78				

Group Comparisons

No significant differences in vitamin D levels, caries presence, or DMFT/DMFS scores were observed across age groups or between genders (all p>0.05).

Table 9. DescriptiveofAgegroupsforVitaminDmeasure

Age groups	N	Mean	Std. Deviation
Less than30	67	12.162	8.5958
30-45	6	12.333	5.6804
Greater than 45	5	10.880	7.1114
Total	78	12.093	8.2558

Table 10. ANOVAtestcomparingthedifferencesbetweenAgegroupsonVitaminDmeasure

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	Sum of Squares	df	MeanSquare	F	Sig.
BetweenGroups	8.025	2	4.012	.057	.944
WithinGroups	5240.191	75	69.869		
Total	5248.215	77			

Table11. KruskalWallisTestcomparingthedifferencesbetweenAgegroupsonTeethdecay

Agegroup	N	Chi-Square	df	Asymp.Sig.
lessthan30	67	0.683	2	.711
30-45	6			
greaterthan45	5			
Total	78			

Table 12. KruskalWallisTestcomparingthedifferencesbetweenAgegroupsonNumbersofteethdecay

Agegroups	N	Chi-Square	df	Asymp.Sig.
lessthan30	61	1.957	2	.376
30-45	6			
greaterthan45	4			
Total	71			

Table 13. DescriptiveofAgegroupsforVitaminDlevel

Agegroups	N	Mean	Std. Deviation
lessthan30	67	1.28	.572
30-45	6	1.00	0.000
greaterthan45	5	1.20	.447
Total	78	1.26	.545

Table 14. ANOVAtestcomparingthedifferencesbetweenAgegroupsonVitaminDlevel

	Sum of Squares	df	MeanSquare	F	Sig.
BetweenGroups	.460	2	.230	.769	.467
WithinGroups	22.412	75	.299		
Total	22.872	77			

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Table 15. KruskalWallisTestcomparingthedifferencesbetweenAgegroupsonVitaminDlevel

Agegroups	N	Chi-Square	df	Asymp.Sig.
lessthan30	67	1.674	2	.433
30-45	6			
greaterthan45	5			
Total	78			

Discussion

This study found a strikingly high prevalence of both vitamin D deficiency (96%) and dental caries (95%) in a predominantly young adult female population in Libya. Despite this co-occurrence, statistical analysis did not support a direct association between vitamin D status and caries experience, aligning with some previous reports that question a strong independent role of vitamin D in caries etiology [1]

The significant association between vitamin D deficiency and self-reported oral problems suggests that deficiency may manifest as nonspecific oral symptoms (e.g., sensitivity, gingival inflammation) rather than directly as caries. This is consistent with the known roles of vitamin D in immune modulation and inflammatory response within oral tissues [2].

The lack of association in this study could be attributed to several factors:

1. Study design: The cross-sectional nature limits causal inference.
2. Sample homogeneity: The overwhelming prevalence of both conditions may have limited the variability needed to detect an association.
3. Confounding factors: Dietary habits, oral hygiene practices, fluoride exposure, and genetic factors were not controlled for and may overshadow the contribution of vitamin D.
4. Threshold effect: Severe, prolonged deficiency may be required to significantly impact caries risk, whereas milder deficiency may not be a strong independent factor.

These findings highlight the complexity of caries etiology and suggest that vitamin D deficiency, while highly prevalent, may not be a primary driver of caries in this population. Public health efforts should continue to promote adequate vitamin D levels for general and skeletal health, but caries prevention strategies should remain focused on established measures such as fluoride use, dietary sugar reduction, and effective plaque control.

Limitations and Future Research

Limitations:

· Cross-sectional design precludes causality.
· Self-reported vitamin D status and medical history may be subject to recall bias.
· Limited generalizability due to homogeneous, convenience-based sampling.
· Lack of biochemical verification of vitamin D levels for all participants.
· Unmeasured confounders (e.g., detailed dietary intake, oral hygiene frequency, socioeconomic status).

Future Research Directions:

· Longitudinal or interventional studies to establish temporality.
· Larger, more diverse samples including different age groups and geographic regions.
· Integrated assessment of dietary patterns, oral microbiome, and genetic markers.
· Randomized controlled trials evaluating the effect of vitamin D supplementation on caries incidence and progression.

Conclusion

This study did not find a statistically significant association between vitamin D deficiency and dental caries in this sample of Libyan adults, despite the high prevalence of both conditions. While vitamin D is essential for systemic and skeletal health, its role as an independent risk factor for dental caries remains unconfirmed in this context. Future research employing robust longitudinal designs and comprehensive covariate assessment is needed to clarify this relationship and inform potential nutritional interventions in caries prevention.

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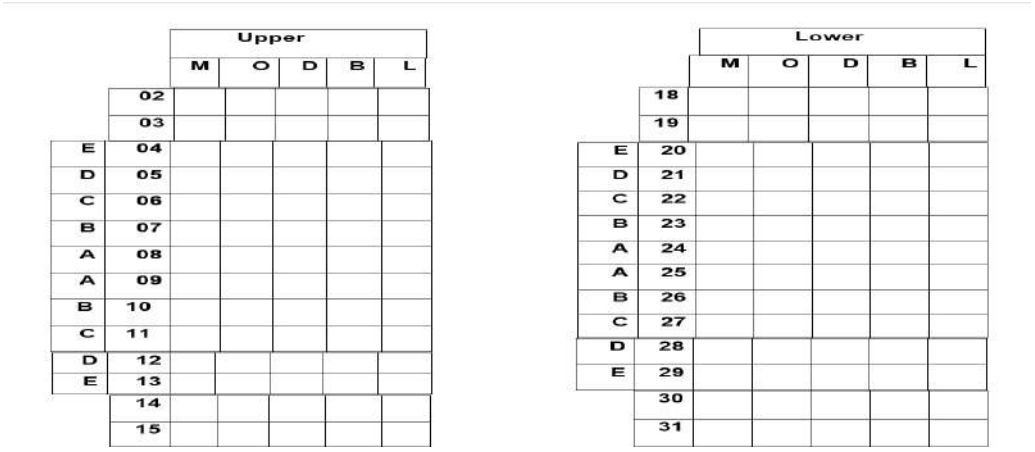
Questionnaire

Thisquestionnairewaspreparedtohelpstudythereconciliationbetweencaries and vitamin D.

1- Age…….
2- Gender:Male() Female()
3- Maritalstatus:Single() Married ()Divorced ( )Widowed()
4- Residence address: Tripoli ()suburbs ofTripoli ()Western Mountain( )
5- Doyousuffer from any diseases?Yes No()
   Iftheanswer isyes, what isthisdisease?.....
6- Arethereanytypes of medicines?YesNo ()
7- Whatmedicationsarethere? .....
8- Wasanymedicalexaminationperformed?YesNo()
   Whenwasthe lastexamination?.....
9- Haveany medicaltestsbeentested? YesNo( )
10- Whatisthereason forconductingtests? .....
11- DoyousufferfromvitaminDdeficiency?YesNo()
   Whatis the resultof thelastvitamin D test?.....
   Whenwastheresultdateapproximately? .....
12- Doyousuffer from any problemswith yourpersonal account?Yes No ( )
   Ifthe answeris yes, what isthis problem? .....
13- Doyousuffer fromtoothdecay?YesNo()
14- Howmuchwill wesuffer from toothdecay?.....
15- Doyousufferfrompainfuldiseases? YesNo()
16- Haveanyteethbeenextractedin thepast?YesNo()
   Whatisthereason forToothextraction?.....

DentitionstatusDMFS/dmfsandDMFT/dmftindex



DS=…… **ds =……**
MS=…… **ms=……**
FS=…… **Fs =……**
DMFS=…… **dmfs=……**
DMFT=…… **dmft =……**

Theoral hygieneindexis:Excellent()good()verygood ()acceptable()poor()

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