العدد الثان - أغسطس - 2025

مجلة السلام العلمية
ISSN:2788-6336

Study of Vitamin D Deficiency, Clinical Characteristics, Tests Used in Benghazi Labs, and Possible Ways of Management . Across-Sectional Study

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Abstract

This cross-sectional study aims to investigate the demographic determinants and contributing factors associated with vitamin D deficiency among patients in Benghazi. The findings revealed that 64.4% of participants had vitamin D deficiency, while 35.6% had sufficient levels. Multiple variables were identified as significant predictors or associated factors, including age, gender, place of residence, type of accommodation, use of vitamin D supplements, type of supplementation, economic status, smoking behavior, reason for testing, clinical symptoms, sun exposure, and comorbid conditions such as diabetes mellitus, hypertension, anemia, endocrine disorders, and digestive diseases. Additionally, factors such as blood group, marital status, motherhood in women, coastal residence, and frequency of testing were found to be associated with variations in vitamin D levels. The study emphasizes the multifactorial nature of vitamin D deficiency and the need for increased public awareness and targeted interventions. It also calls for further longitudinal research to examine causal relationships and develop context-specific strategies to reduce vitamin D deficiency in at-risk populations.

Key Words : Deficiency, Osteomalacia , Vitamin D, Rickets, 25-Hydroxyvitamin.

1. Introduction:

Vitamins are organic nutrients that are required in small quantities for a variety of biochemical functions and which, generally, cannot be synthesized by the body and must therefore be supplied by the diet, the first discovered vitamins, A and B, were found to be fat and water soluble, respectively. As more vitamins were discovered, they were also shown to be either fat or water soluble, and this property was used as a basis for their classification), the water-soluble vitamins were all designated members of the B complex (apart from vitamin C), and the newly discovered fat-soluble vitamins were given alphabetic designations (eg, vitamins D, E, K) (Murray, et al.,1998,p 599) .

Vitamins are required to perform specific cellular functions, for example, many of the water-soluble vitamins are precursors of coenzymes for the enzymes of intermediary metabolism. In contrast to the water-soluble vitamins, only one fat soluble vitamin (vitamin K) has a coenzyme function. These vitamins are released, absorbed, and transported with the fat of the diet. They are not readily excreted in the urine, and significant quantities are stored in the liver and adipose tissue. In fact, consumption of vitamins A and D in excess of the Dietary Reference Intake (DRIs) can lead to toxicity (Richard

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& Denise, 2011,p.373) , absence or relative deficiency of vitamins in the diet leads to characteristic deficiency states and diseases.

Deficiency of a single vitamin of the B complex is rare, since poor diets are most often associated with multiple deficiency states. Nevertheless, definite syndromes are characteristic of deficiencies of specific vitamins. Among the water-soluble vitamins, the following deficiency states are recognized: beriberi (thiamin deficiency); cheilosis, glossitis, seborrhea , and photophobia (riboflavin deficiency), pellagra (niacin deficiency); peripheral neuritis (pyridoxine deficiency); megaloblastic anemia, methylmalonic aciduria, and pernicious anemia (cobalamin deficiency). (Murray, et al.,1998,p599)

Aim of the Study:

-To investigate demographic variables (such as age, gender, etc.) and other contributing factors associated with vitamin D deficiency.

-To identify the most effective strategies for the management of vitamin D deficiency.

-To examine the impact of comorbid conditions on the prevalence and severity of vitamin D deficiency.

Patients and Methods

Design: Cross-sectional study with stratified random sampling teqnique was used to collect patients attending three medical laboratories in Benghazi, Libya between April to June of 2023 .

Participants/setting: All patients attending Al-Saleem Medical Analysis Lab, Alhayah Lab Medical Analysis and The Red Crescent Lab that consider from the most famous and biggest labs of Benghazi were approached. Baseline information and serum 25(OH)D concentrations were provided by 160 subjects; and participation rate was divided into (69.4% females and 30.6% males).

Subject: All patients who attended the three laboratories to undergo a vitamin D test from April to June 2023 were selected .

Tools: We used an data collection paper and provided it directly to each patient to answer the questions we asked, which were about the following factors: age, gender, smoking, underlying diseases, sunlight exposure, blood group, etc.

Ethical Consideration: We did not take the names of the patients or any personal information about them, we only took the medical information that was important to us, through the patient's verbal consent .

Statistical analysis: Description and analysis of data were carried using IBM SPSS Statistics version 22. Level of significance was set at $p \leq 0.05$.

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Results

In terms of gender, male patient accounted for 30.6% (n=49) while, female patients were 69.4% (n=111). This is shown in table (1) . Our study showed that the highest percentage of 44% (n = 71) of the study population aged 20–39 years was followed by patients aged less than 20 and 40–59 years with 23.1% (n = 37) for each class, while the lowest percentage was 9.4% (n = 15) for patients aged 60 years or over). Our study shows that the majority of the patients (92%) of the study stay Lived in Benghazi while only 8% (n=12) patients was lived out of town Of the 160 Patients in the study, 51.3% (n=82) were come from Ground floor, 48.8% (n=78) were come from high floor shown in table (1) .

Table 1.Characteristics of patient population

Characteristic /Variable	Deficiency Count (% vitamin)	Normal Count (% vitamin)	Total	X^2 *P* value [a]
No . of patient	103(64.4%)	57(35.6%)	160(100%)	
Age group				
Less than 20	24(23.3%)	13(22.8%)	37(23.1%)	4.56(0.207)
20-39	49(47.6%)	22(38.6%)	71(44.4%)	
40-59	24(23.3%)	13(22.8%)	37(23.1%)	
60+	6(5.8%)	9(15.8%)	15(9.4%)	
Gender				
Male	29(28.2%)	20(35.1%)	49(30.6%)	0.830 (0.362)
Female	74(71.8%)	37(64.9%)	111(69.4%)	
Residency Site				
Benghazi	94(91.3%)	54(94.7%)	148(92.5%)	0.639 (0.424)
Out of town	9(8.7%)	3(5.3%)	12(7.5%)	
Marital status				
Single	67(65.0%)	28(49.1%)	95(59.4%)	3.858 (0.050)
Married	36(35.0%)	29(50.9%)	65(40.6%)	
Accommodation Type				
Ground floor	53(51.5%)	29(50.9%)	82	0.005 (0.944)
High floor	50(48.5%)	28(49.1%)	78	

According to test results the 160 Patients in the study, 64.4% (n=103) was deficient with vitamin D value less than 30mg/dl , while 35.6% (n=57) of their results was normal with vitamin D value equal or more than 30mg/dl shown in table (1) represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the Vitamin D deficiency according to age groups are not statistically significant ($\chi2$ =4.56, p-value > 0 .05) Interestingly, In this regard, we can conclude that the age was not associated with the Vitamin D deficiency . We observed that the age group that represented the largest percentage of those suffering from vitamin D deficiency was (20-39-year-old category) with a percentage of 47.6% (n = 49), and the age group that represented the lowest percentage of suffering from vitamin D deficiency is (age group 60 years and above) with a percentage of 5.8% (n = 6) .

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As showed in table 2 that represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to gender type are not statistically significant ($\chi2$ =0.83, p-value > 0 .05). Interestingly, In this regard, we can conclude that the gender was not associated with the Vitamin D deficiency **.** We observed that the gender type that represented the largest percentage of those suffering from vitamin D deficiency was females with a percentage of 71.8% (n = 74), and the gender type that represented the lowest percentage of suffering from vitamin D deficiency is males with a percentage of 28.2% (n = 29) . Table 1 describe the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to residency site are not statistically significant ($\chi2$ =0.63, p-value > 0 .05).
Interestingly, in this regard, we can conclude that the residency site was not associated with the Vitamin D deficiency **.**
From total sample 100% (n = 160) , people residing within the city of Benghazi represented 92.5% (n = 148), while (people residing outside the city) represented 7.5% (n = 12) , when we separated the number of patients residing outside Benghazi city from those residing inside it, we found that their total number was 12 as a total percentage 100%, 9 of them were suffered from vitamin D deficiency, represented 75%, and the rest 3 had normal levels of the vitamin , represented a 25%. While the number of patients inside Benghazi city represented a total percentage 100%, 94 of them were suffered from vitamin D deficiency, represented 63.5%, and 54 of them had a normal levels of the vitamin , represented a 36.5%. Table 1 represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the marital status are statistically significant ($\chi2$ =3.85, p-value < 0.10), Interestingly, In this regard, we can conclude that the Marital status was associated with the Vitamin D deficiency **.** We observed that the single category of vitamin D deficiency patients represented the largest present which is was 65.0% (n = 67) , and the married category of patients represented the lowest present which was 35.0% (n = 36) also represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the Vitamin D deficiency according to accommodation type are not statistically significant ($\chi2$ =0.005, p-value > 0 .05). Interestingly, in this regard, we can conclude that the accommodation type was not associated with the Vitamin D deficiency . We observed that (residents who reside on the ground floosr) represented the largest percentage of those suffering from vitamin D deficiency with a percentage of 51.5% (n = 53), and (residents who reside on the high floors) represented the lowest percentage of suffering from vitamin D deficiency with a percentage of 48.5% (n = 50) . Based on the chi-square test results shown in table 1, χ^2-test results can be indicates that the differences observed in the vitamin D deficiency according to vitamin D treatments are not statistically significant ($\chi2$ =1.24, p-value > 0.05). Interestingly, In this regard, we can conclude that the taking of vitamin D treatments was not associated with the Vitamin D deficiency **.** We observed that people who were treated with vitamin D treatments represented the largest percentage of those suffering from vitamin D deficiency with a percentage of 74.8% (n = 77), and people who had not previously with vitamin D treatments represented the lowest percentage of suffering from vitamin D deficiency with a percentage of 25.2% (n = 26) .

Table 2 represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the types of vitamin D treatments are not statistically significant ($\chi2$ =0.77, p-value > 0.05). Interestingly, In this regard, we can conclude that the types of vitamin D treatments was not associated with Vit D deficiency **.** We observed that people who were treated vitamin D tablets represented the largest percentage of those suffering from vitamin D deficiency with a percentage of 37.7% (n = 29), followed by the category of (people who were treated by vitamin D injections) and they represented a 35.1% (n= 27) of those suffering from vitamin D deficiency , as for the

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lowest percentage, it was represented by the category of (people who were treated by both tablets and injections of vitamin D with percentage 27.3% (n= 21) . The total number of patients who were treated with tablets was 48 , 100% as a total percentage, 29 of them still suffered from vitamin D deficiency, and represented 60.4% , and the recovered patients were 19 , represented 39.6% .

The total number of patients who were treated with injections was 40 , 100% as a total percentage, 27 of them still suffered from vitamin D deficiency, and represented 67.5% , and the recovered patients were 13 , represented 32.5% .

The total number of patients who were treated with both tablets and injections was 36 , 100% as a total percentage, 21 of them still suffered from vitamin D deficiency, and represented 58.3% , and the recovered patients were 15 , represented 41.7% .From the previous results , we can note that the type of vitamin D treatment “tablets” was the most effective type of treatment for the patients participating in our study, as this treatment type constituted the largest number of patients recovering from vitamin D deficiency, which numbered 19 patients. Through of representation of chi-square test results that shown in Table 2 , we can inferred from χ^2-test results that the differences observed in the vitamin D deficiency according to the Economic Situations are not statistically significant ($\chi2$ =2.76, p-value > 0.05). Interestingly, In this regard, we can conclude that the Economic Situations was not associated with the Vitamin D deficiency **.** We observed that category of (people with middle economic situation) represented the largest percentage of those suffering from vitamin D deficiency with a percentage of 88.3% (n = 91) , followed by the category of (people with poor economic situation) and they represented 8.7% (n = 8) , as for the lowest percentage, it was represented by the category of (people with high economic situation) with percentage 2.9% (n = 4) .

Table 2 represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the smoking are not statistically significant ($\chi2$ =0.28, p-value > 0.05). Interestingly, In this regard, we can conclude that the smoking was not associated with the Vitamin D deficiency .We observed that the category that represented the largest percentage of those suffering from vitamin D deficiency was (non-smokers) category with a percentage of 81.6% (n = 84), and the category that represented the lowest percentage of suffering from vitamin D deficiency is (Ex-smokers) category with a percentage of 2.9% (n = 3), and (smokers) patients category represented 15.5 % (n = 16) of those suffering from vitamin D deficiency .

The results of chi-square test shown in sable 2, can be inferred from χ^2-test results that indicates that the differences observed in the vitamin D deficiency according to the reasons of the test are not statistically significant ($\chi2$ =5.37, p-value > 0.05). Interestingly, In this regard, we can conclude that the reasons of the test was not associated with the Vitamin D deficiency We observed that the reason of test that represented the largest percentage of those suffering from vitamin D deficiency was the patients who underwent vitamin D test by (Doctor's request) with percentage 58.3% (n = 60) , followed by the patients who underwent vitamin D test as a (routine test) and who represented 22.3% (n = 23) , followed by the patients who underwent vitamin D test as a part of a series of tests they're doing to start a (Diet) with percentage 13.6% (n = 14) and the lowest percentage of suffering from vitamin D deficiency represented by follow-up after taking the treatment reason with a percentage 5.8% (n = 6).

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Table (2) Multivariable Association of Vitamin D Deficiency and risk factors and reason of the test				
Items	Deficiency Count (% vitamin)	Normal Count (% vitamin)	Total	X^2 P *value* [a]
Treatments				
No	26(25.2%)	10 (17.5%)	36(22.5%)	1.24 (0.264)
Yes	77(74.8%)	47(82.5%)	124(77.5%)	
Types of treatments				
Tablets	29(37.7%)	19(40.4%)	48(38.7%)	0.770 (0.680)
Injection	27(35.1%)	13(27.7%)	40(32.3%	
Tablets and injections	21(27.3%)	15(31.9%)	36(29.0%)	
Total	77(100%)	47 (100.0%)	124 (100.0%)	
Economic Situation				
Poor	9(8.7%)	8(14.0%)	17(10.6%)	2.764 (0.251)
Middl	91(88.3%)	45(78.9%)	136(85.0%)	
High	3(2.9%)	4(7.0%)	7(4.4%)	
Smoking habit				
Smoker	16(15.5%)	8(14.0%)	24(15.0)%	0.283 (0.868)
Non-smoker	84(81.6%)	48(84.2%)	132(82.5%)	
Ex-smoker	3(2.9%)	1(1.8%)	4(2.5%)	
Reason of the test				
Routine test	23(22.3%)	6(10.5%)	29(18.1%)	5.376 (0.146)
Diet	14(13.6%)	14(24.6%)	28(17.5%)	
Doctor's request	60(58.3%)	34(59.6%)	94(58.8%)	
Follow-up after taking the treatment	6(5.8%)	3(5.3%)	9(5.6%)	

Table 3 represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the Symptoms of deficiency are not statistically significant ($\chi2$ =4.85, p-value > 0.05). Interestingly, In this regard, we can conclude that the Symptoms was not associated with the Vitamin D deficiency **.**

We observed that the symptom that represented the largest percentage of those suffering from vitamin D deficiency was (General weakness) with percentage 38.8% (n = 40) , followed by (Joints pain) symptoms that represented 25.2% (n = 26) , followed by (Dizziness) symptoms that represented 20.4% (n = 21) and the lowest percentage of suffering from vitamin D deficiency represented by (other symptoms) category with percentage 15.5% (n = 16).

The results of chi-square test that shown in Table 3 , can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to exposing to sunlight during the day are not statistically significant ($\chi2$ =2.85, p-value > 0.05). Interestingly, In this regard, we can conclude that the exposure to sunlight during the day was not associated with the Vitamin D deficiency **.** We observed that the low exposure are represented the largest percentage of those suffering from vitamin D deficiency with percent 61.2% (n = 63) , followed by the medium exposure that represented a 35.9% (n = 37) , and the lowest percentage of suffering from vitamin D deficiency represented by the (High exposure) with percentage 2.9% (n = 3) .

Looking at the above table 3 that represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the

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Diabetes Mellitus are not statistically significant ($\chi2$ =1.99, p-value > 0.05). Interestingly, In this regard, we can conclude that the Diabetes Mellitus was not associated with the Vitamin D deficiency **.**

We absorbed that , the patients that suffering from diabetes mellitus disease are represented the lowest percentage of those suffering from vitamin D deficiency with percent with percentage 14.6% (n = 15) , and the patients who don't have diabetes mellitus disease are represented the largest percentage of those suffering from vitamin D deficiency with percentage 85.4 % (n = 88) . Table 3 represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed according in the vitamin D deficiency to the hypertension are not statistically significant ($\chi2$ =2.47, p-value > 0.05). Interestingly, In this regard, we can conclude that the Hypertension was not associated with the Vitamin D deficiency **.** We absorbed that , the patients that suffering from Hypertension disease are represented the lowest percentage of those suffering from vitamin D deficiency with percent with percentage 14.6% (n = 15) , and the patients who don't have hypertension disease are represented the largest percentage of those suffering from vitamin D deficiency with percentage 85.4 % (n = 88) .

We can conclude from the results of chi-square test that mentioned in Table 3, that χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the Anemia disease are not statistically significant ($\chi2$ =0.81, p-value > 0.05). Interestingly, In this regard, we can inferred that the Anemia was not associated with the Vitamin D deficiency**.**

We absorbed that the patients that don't have an anemia disease are represented the largest percentage of those suffering from vitamin D deficiency with percentage 86.4% (n = 89) , and the lowest percentage are represented by an anemic patients with percentage 13% (n = 14) . Table 3 represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the Endocrine diseases are statistically significant ($\chi2$ =0.04, p-value > 0.05). Interestingly, In this regard, we can conclude that the Endocrine diseases was associated with the Vitamin D deficiency **.**

We absorbed that , Endocrine diseases patients are represented the lowest percentage of those suffering from vitamin D deficiency with percentage 2.9% (n = 3) , and patients that don't have any Endocrine diseases are represented the largest percentage 97.1% (n = 100) .

Table 3 represent the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the digestive system diseases are not statistically significant ($\chi2$ =0.74, p-value > 0.05). Interestingly, In this regard, we can conclude that the digestive diseases was not associated with the Vitamin D deficiency **.**

We absorbed that the largest percentage of those suffering from vitamin D deficiency it was represented by the patients who don't have any digestive system diseases with percentage 70.9% (n = 73) , and the lowest percentage represented by the patients that suffering from digestive system diseases with percentage 29.1% (n = 30) . Looking in the above Table 3 that represent the results of chi-square test ,it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the Other diseases are not statistically significant ($\chi2$ =1.34, p-value > 0.05). Interestingly, In this regard, we can conclude that the Other diseases was not associated with the Vitamin D deficiency **.** We absorbed that the patients who answered this question with a yes answer to (Other diseases) and surfer from vitamin D deficiency are represented the lowest percentage 10.7% (n = 11) , and patients that don't have any (Other diseases) but they suffering from vitamin D deficiency are represented the largest percentage as a 89.3% (n = 92) .

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Table (3) Multivariable Association of Vitamin D Deficiency and comorbidity indicators				
Comorbidity indicators	Deficiency Coun (% vitamin)	Normal Count (% vitamin)	Total	X^2 P *value* [a]
Diabetes Mellitus				
No	88(85.4%)	53(93.0%)	141(88.1%)	
Yes	15(14.6%)	4(7.0%)	19(11.9%)	
Hypertension				
No	88(85.4%)	43(75.4%)	131(81.9%)	2.472 (0.116)
Yes	15(14.6%)	14 (24.6%)	29 (18.1%)	
Anemia				
No	89(86.4%)	52(91.2%)	141(88.1%)	
Yes	14(13.6%)	5(8.8%)	19(11.9%)	0.815 (0.367)
Endocrine diseases				
No	100(97.1%)	55(96.5%)	155(96.9%)	
Yes	3(2.9%)	2(3.5%)	5(3.1%)	0.043 (0.836)
Digestive diseases				
No	73(70.9%)	44(77.2%)	117(73.1%)	
Yes	30(29.1%)	13(22.8%)	43(26.9%)	0.746 (0.388)
Other diseases				
No	92(89.3)%	54(94.7%)	146(91.2%)	1.348 (0.246)
Yes	11(10.7%)	3(5.3%)	14(8.8%)	

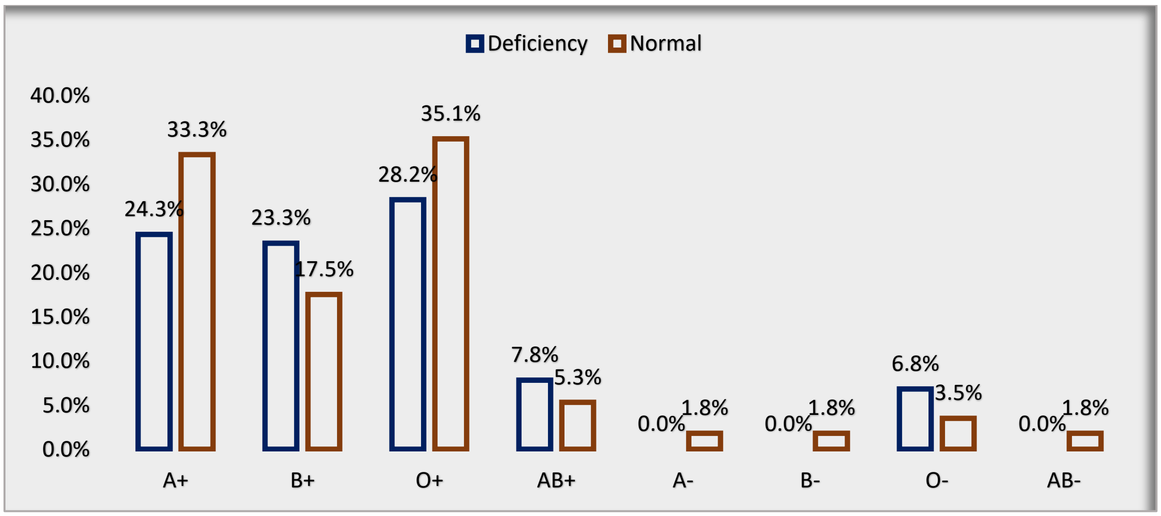

Figure (1) Association between Blood Groups and Vitamin D deficiency

Through the results of chi-square test shown in figure(1), we can inferred from χ^2-test results indicates that the differences observed according to the Blood Groups are not statistically significant ($\chi2$ =7.01, p-value > 0.05). Interestingly, In this regard, we can conclude that the Blood Groups was not associated with the Vitamin D deficiency **.**We observed that the largest percentage of those suffering from vitamin D deficiency was for patients with (O+ Blood Group) with percentage 28.2% (n = 29) ,and followed by the rest of blood groups respectively, as a following arrangement : The patients with (A+ Blood Group) and suffering from vitamin D deficiency represented 24.3% (n = 25) . The patients with (B+ Blood Group) and suffering from vitamin D deficiency represented 7.8% (n = 24) . The patients with (AB+ Blood Group) and suffering

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from vitamin D deficiency represented 23.3% (n = 8) . The patients with (O- Blood Group) and suffering from vitamin D deficiency represented 6.8% (n = 7) .The patients with (A- Blood Group) and suffering from vitamin D deficiency represented 5.8% (n = 6) .The patients with (B- Blood Group) and suffering from vitamin D deficiency represented 3.9% (n = 4)Finally , the (AB- Blood Group) represented the lowest percentage of patients who suffering from vitamin D deficiency with percentage 0.0% (n = 0) . The results of chi-square test are shown in table (4) it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to whether or not a woman is a mother are not statistically significant (χ2 =0.44, p-value > 0.05). Interestingly, In this regard, we can conclude that whether or not a woman is a mother was not associated with the Vitamin D deficiency**.** We absorbed that the largest percentage of patients suffering from vitamin D deficiency represented by women who are not mothers with percentage 76.7% (n = 79) , and the lowest personage of patients suffering from vitamin D deficiency represented by women who are mothers with percentage 23.3% (n = 24) .

Table 4 describe the results of chi-square test , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the test coast are not statistically significant (χ2 =0.17, p-value > 0.05). Interestingly, In this regard, we can conclude that the test coast was not associated with the Vitamin D deficiency **.** We absorved that the patients who suffering from vitamin D deficiency and their opinion was the cost of test is suitable are represents the largest percentage with percent 83.5% (n = 86) , while the lowest persentage that is 16.5% (n = 17) represented by patients whos answered that the cost of test for them is (Expensive). Through the results of chi-square test that shown Table 4 , it can be inferred from χ^2-test results indicates that the differences observed in the vitamin D deficiency according to the test Repetition are not statistically significant (χ2 =0.5, p-value > 0.05). Interestingly, In this regard, we can conclude that the test Repetition was not associated with the Vitamin D deficiency **.** We observed that patient with vitamin D deficiency who repeated the test more than once, regardless of the reason for the repetition , are represents the largest percentage that was 59.2% (n = 61) , while the patients who didn't repeat the test at all , are represents the lowest percentage that was 40.8% (n = 42) .

Table (4) Multivariable Association of Vitamin D Deficiency and symptoms,sunlight exposure, women being a mother, test repetition .

Variable	Deficiency Coun (% vitamin)	Normal Count (% vitamin)	Total	X^2 P *value* [a]
Symptoms				
Joints pain	26(25.2%)	7(12.3%)	33(20.6%)	
General weakness	40(38.8%)	27(47.4%)	67(41.9%)	
Dizziness	21(20.4%)	10(17.5%)	31(19.4%)	4.85 (0.183)
Other symptoms	16(15.5%)	13(22.8%)	29(18.1%)	
Exposure to sunlight				
Low	63(61.2%)	27(47.4%)	90(56.2%)	
Medium	37(35.9%)	28(49.1%)	65(40.6%)	2.85 (0.240)
High	3(2.9%)	2(3.5%)	5(3.1%)	
Women being a mother				
No	79(76.7%)	41(71.9%)	120(75.0%)	0.445 (0.505)
Yes	24(23.3%)	16(28.1%)	40(25.0%)	
Test coast				
Suitable	86(83.5%)	49(86.0%)	135(84.4%)	0.170 (0.680)
Expensive	17(16.5%)	8(14.0%)	25(15.6%)	
Test Repetition				0.500 (0.479)
Yes	61(59.2%)	37(64.9%)	98(61.3%)	
No	42(40.8%)	20(35.1%)	62(38.8%)	

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160 patients contributed to our study was among 3 medical laboratories in Benghazi city, " Al-Saleem Medical Analysis Lab , Alhayah Lab Medical Analysis and The Red Crescent Lab " , the vast majority of contributed patients number was from "Al-Saleem Medical Analysis Lab" with 83 patients , 51 of them represented "the deficiency results" and 32 patients represented "the normal results" , respectively followed by "The Red Crescent Lab" with 64 patients , 43 of them represented "the deficiency results" and 21 patients represented "the normal results" , and finally "Alhayah Lab Medical Analysis" represented the lowest number of the patients that was 13 , 10 patients was had a "deficiency results" while only 3 patients represented "the normal results" .

From our total sample there was 103 patients suffering from vitamin D deficiency , they divided according to their laboratories as a following percentages : 49.5% of Al-Saleem Lab , 41.7% of The Red Crescent Lab and 9.7% of Alhayah Lab , it's clearly that "Al-Saleem Laboratory" represented the largest percentage of deficiency patients, and "Alhayah Laboratory" represented the lowest percentage of them , but we can not consider that this result is fair, simply because the comparison between the lab's was not fair due to the different numbers of contributed patients from each laboratory . Considering that each laboratory is separate from the other, where the patients of each laboratory alone constitute 100% , we can conclude the following points **:** Alhayah Lab Medical Analysis **:** The deficiency results percentage was 76.9% , while only 23.1% was normal results, we can consider that deficiency patients was the vast majority of the contributed patients from this lab . The Red Crescent Lab **:** The deficiency results percentage was 67.2% , while normal results was 32.8% of their contributed patients . Saleem Medical Analysis Lab **:** The deficiency results of this lab contributed patients with percentage 61.4% and 38.6% represented the normal results of them (**Figure 2**).

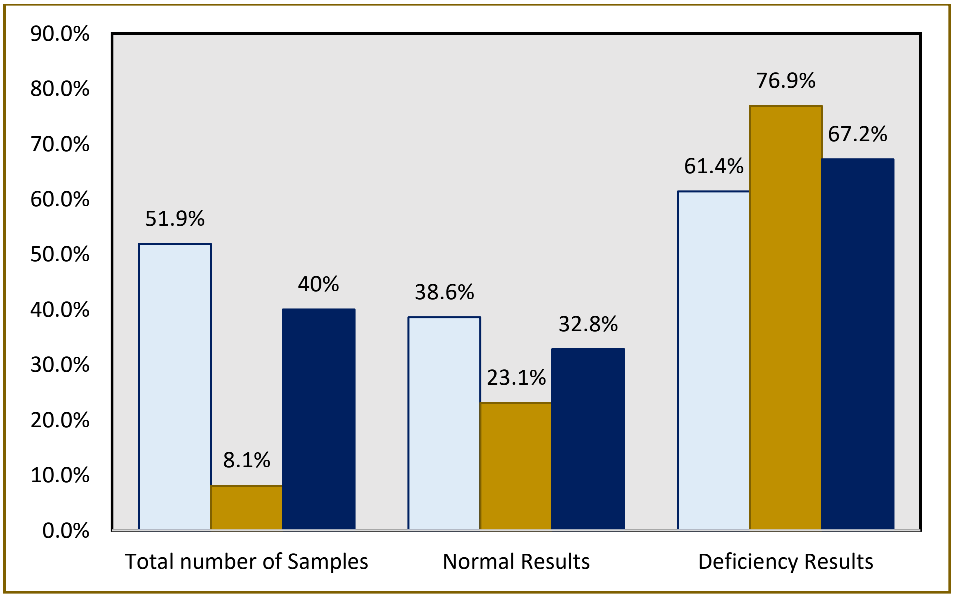

Figure 2 illustrates the distribution of laboratories involved in sample collection .

Discussion

This cross-sectional study aimed to investigate vitamin D deficiency and its associated factors. Regarding age, although no statistically significant association was found between age and vitamin D deficiency in our analysis, the largest proportion of deficient individuals fell within the 20–39-year-old age group, accounting for 47.6% (n = 49). In contrast, only

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5.8% (n = 6) of individuals aged 60 years and above were found to be deficient. This trend may be attributed to the demographic structure of the local population, where younger adults constitute the majority. These findings partially contrast with those reported by Mo et al. (2023) in their study *"The Association of Vitamin D Deficiency, Age, and Depression in US Adults: A Cross-Sectional Analysis,"* which demonstrated a significant association between younger age and vitamin D deficiency. The authors suggested that younger populations may be more vulnerable to deficiency due to factors such as higher metabolic demands, reduced sun exposure, and modern lifestyle behaviors associated with indoor living and limited physical activity,(Mo, et al., 2023)

In our study and through using chi-square test results, we concluded that there was no association between gender and vitamin D deficiency , but we also observed that the gender type that represented the largest percentage of those suffering from vitamin D deficiency was females, with a percentage of 71.8% (n = 74), and the gender type that represented the lowest percentage of those suffering from vitamin D deficiency was males, with a percentage of 28.2% (n = 6), while another previous study's findings showed that correlation coefficients revealed that 25(OH) vitamin D levels were positively correlated with calcium levels in males and females ($r = 0.11$ and 0.15, respectively, $P<0.001$). (AlQuaiz *et al*., 2018).

In our study, no significant association was found between diabetes mellitus and vitamin D deficiency. Interestingly, individuals with diabetes mellitus represented the lowest proportion among those with vitamin D deficiency, accounting for only 14.6% (n = 15), whereas non-diabetic individuals comprised the majority, representing 85.4% (n = 88).

These findings appear to contrast with several previous studies that have reported a significant association between low serum 25(OH)D levels and diabetes. For instance, Greer et al. (2012), Daga et al. (2012), Federico et al. (2018), and Rasoul et al. (2016) all reported a higher prevalence of vitamin D deficiency among patients with type 1 diabetes mellitus compared to healthy controls. The discrepancy between our results and those of earlier studies may be attributed to differences in study design, population characteristics, geographic location, or sample size.

No statistically significant association was established between vitamin D deficiency and endocrine disorders. This outcome may be partially attributed to the self-reported nature of the data collection, which may have introduced bias or underreporting. Patients with endocrine diseases constituted only 2.9% (n = 3) of those identified with vitamin D deficiency, while 97.1% (n = 100) of deficient individuals reported no endocrine conditions.

These findings contrast with evidence presented by Mackawy et al. (2013) in their study *"Vitamin D and Its Association with Thyroid Disease,"* which demonstrated a clear link between hypothyroidism and hypovitaminosis D accompanied by hypocalcemia. The study revealed a significant positive correlation between serum vitamin D and calcium levels with thyroid hormones, alongside a negative correlation with TSH levels. Such results support the recommendation for routine screening of vitamin D and calcium in hypothyroid patients, as well as considering supplementation to manage potential deficiencies.

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Throughout our study, we were interested in asking people about "Smoking" , and in this regard we provided the following options for all participants, [smoker, Non-smoker and Ex- smoker] , and based on the results obtained from chi-square tests , we concluded that there was no relationship between smoking and levels of vitamin D , but we founded that the category which represented by the largest percentage of those suffering from vitamin D deficiency was (non-smokers) category with a percentage of 81.6% (n = 84), and the category that represented the lowest percentage of suffering from vitamin D deficiency was (Ex-smokers) category with a percentage of 2.9% (n = 3), and (smokers) patients category represented by 15.5 % (n = 16) of those suffering from vitamin D deficiency , another previous study had a completely opposite opinion , it had found a strong correlation between 25(OH)D and smoking (kassi, et al., 2015).

We can say it is logical that the largest percentage of patients who suffers from vitamin D deficiency are “ non-smokers”, because females constituted the majority of the patients participating in our study and their total number was 111, 74 of whom suffered from vitamin D deficiency, and females most likely will not be among the smokers due to of the cultural and religious backgrounds of our society.

Also no association between Anemia and vitamin D deficiency, and the patients that didn’t have an anemic disease were represented by the largest percentage of those suffering from vitamin D deficiency with percentage of 86.4% (n = 89) , and the lowest percentage were represented by an anemic patients with percentage of 13% (n = 14), there was another contradictory conclusion from another study indicated that there was association between D25 deficiency and anemia, through the following result: In anemia patients, albumin and D25 had a significant correlation (Pearson's correlation coefficients = 0.21 ; p value < 0.01) , such a correlation did not exist for non-anemic patients (Sim, *et al*., 2010) .

As part of the data collection process, patients undergoing vitamin D testing were asked about the presence of symptoms potentially related to vitamin D deficiency. Based on their responses and the application of chi-square analysis, no statistically significant association was found between reported symptoms and vitamin D deficiency status.Among participants with vitamin D deficiency, general weakness was the most frequently reported symptom, accounting for 38.8% (n = 40), followed by joint pain at 25.2% (n = 26), and dizziness at 20.4% (n = 21). The least frequently reported symptoms fell under the "other symptoms" category, comprising 15.5% (n = 16) of the deficient group.These findings are consistent with those of a study by Kovacs et al. (2017), which specifically examined the relationship between vitamin D levels and vertigo-related symptoms. Their results also demonstrated no significant association between serum vitamin D levels and different types of dizziness or vertigo, supporting the notion that such symptoms may not serve as reliable indicators of vitamin D status. The study was conducted in clinical laboratories located within the city of Benghazi; consequently, the majority of participants (n = 148) were residents of the city, while only a small subset (n = 12) resided outside Benghazi. Given this pronounced imbalance in group sizes, any comparison based on residency location may lack statistical validity and should be interpreted with caution. The unequal distribution limits the generalizability of findings related to geographic residence and their potential association with vitamin D status.

Regarding sun exposure, findings indicated a clear gradient in the prevalence of vitamin D deficiency across exposure levels. Individuals with low sun exposure accounted for the highest proportion of vitamin D deficiency cases, representing 61.2% (n = 63). This was

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followed by participants with medium exposure at 35.9% (n = 37), while those reporting high sun exposure constituted only 2.9% (n = 3) of the deficient group.

This distribution aligns with the well-established role of sunlight as a primary natural source for vitamin D synthesis. Reduced cutaneous exposure to ultraviolet B (UVB) radiation, whether due to lifestyle factors, clothing habits, indoor living, or environmental conditions, likely contributes to lower serum 25(OH)D levels. The trend observed in our findings underscores the importance of adequate sun exposure in maintaining sufficient vitamin D status and highlights the need for public health strategies to raise awareness about safe and effective sun exposure practices, especially in populations at risk of deficiency. Accordingly, we can observe that whenever sun exposure increased, the number of patients with vitamin D deficiency decreased , or in other words , whenever sun exposure decreased, the number of patients with vitamin D deficiency increased. Analysis of blood group distribution among participants revealed that individuals with the O^+ blood type constituted the largest proportion of those diagnosed with vitamin D deficiency (n = 49). This finding, however, is likely reflective of the natural predominance of the O^+ blood group in the general population, rather than suggesting a specific predisposition to deficiency associated with this blood type. In contrast, the AB^- blood group showed no cases of vitamin D deficiency (0.0%, n = 0), a result that can be reasonably attributed to its rarity within the population, rather than any protective association. Given the substantial differences in the prevalence of various blood groups, the observed distribution does not appear to indicate a causal relationship between blood type and vitamin D status. Instead, the pattern seems to mirror general population genetics. Therefore, while the data provide descriptive insights, further studies with more balanced representation across all blood groups are necessary to explore any potential biological association. Individuals categorized as "single" represented the highest proportion of those with vitamin D deficiency. This finding is consistent with the age-related distribution observed in the study, where the majority of deficient individuals fell within the 20–39-year age group a demographic commonly associated with unmarried status. Supporting this, a cross-sectional study among adult Saudi females reported that single individuals had significantly lower serum 25(OH)D levels compared to their married counterparts (P = 0.014; OR = 1.893, 95% CI: 1.130–3.17) (AlFaris, 2016). From a psychosocial perspective, marital status may influence health behaviors and lifestyle. Married individuals are often more likely to engage in regular meal routines, have better dietary intake, and receive greater social and emotional support all factors that may contribute to improved overall health, including adequate vitamin D levels. In contrast, single individuals particularly those in younger age groups may be more prone to erratic sleep and meal patterns, reduced outdoor physical activity, and lower health-seeking behavior, which can collectively increase the risk of vitamin D deficiency. These findings suggest that public health interventions aiming to reduce hypovitaminosis D may benefit from considering social and demographic variables such as marital status and age.

Conclusion :

Through our results we conclude that there was no association between vitamin D deficiency and all the following variables : Age, Gender, residency site, accommodation type, taking vitamin D treatment, types of vitamin D treatments, economic situation, smoking, reason of the test, symptoms, sun exposure, Diseases (Diabetes Mellitus, hypertension, anemia, endocrine diseases,

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digestive diseases, other disease), blood groups, women being a mother, coast and repetition of the test, we also observed that the groups that suffered most from vitamin D deficiency were as follows : the youth category (20-39 year), females, people residing within Benghazi city, residents who reside on the ground floors, people who were treated with vitamin D treatments, people with middle economic situation, non-smokers category, people who suffered from “general weakness” symptom, people with low exposure to the sunlight, patients who don’t have diabetes mellitus disease, patients who don’t have hypertension disease, non-anemic patients, patients that don’t have any endocrine diseases, patients who don’t have any digestive system diseases, patients without any other diseases, O+ Blood Group patients and women who are not mothers .

While we found the only variable that have association with vitamin D deficiency is “Marital status“, the largest present of vitamin D deficiency patients represented by “single category” , while “married category” of patients represented the lowest present .

Recommendation

We recommend increasing awareness and education in our society about the importance of vitamin D for the human body and warning of the dangers of its deficiency, especially females because they are the most vulnerable category to deficiency of this vitamin, as every patient must know which type of vitamin D treatment is appropriate for him / her, whether it was tablets, injections or any other types, and ensure the effectiveness of treatment type by monitoring the vitamin level through conducting the test.

Vitamin D is an important vitamin and its levels indicate several diseases, such as osteoporosis, diabetes Mellitus, and depression, it must be considered among the basic medical tests and tested periodically by following up with the doctor.

We recommend adequate exposure to sunlight during the day, especially in the morning time, as the sun is one of the most important sources of vitamin D.

We recommend that operating devices and reagents for testing vitamin D specimens to be provided in public sector medical laboratories by the state, therefore making testing for this vitamin available to low-economic class patients.

Limitation :

Test is not available in public sector laboratories, and it is only a monopoly on private laboratories We did not find cooperation from some private laboratories that we wanted to get some information about the vitamin D test from them.

Strength :

Fill in the information was not from medical records, it was directly from the patient, which reflects more accuracy of our data.We found for each question we asked patients in the data collection paper the answers we want.

We took permission from each patient before his data was filled out and he was asked if he wanted to participate in our study, data collection papers.

In the laboratories that we dealt with during our study, we first took permission from each laboratory and then brought the formal permit that entitles us to using the patient data.

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