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Original article

Evaluation of Vitamin D Levels in A Sample of Healthy Children and Adolescents in the City of Zawia, Western Libya

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A B S T R A C T

In this study, vitamin D levels were evaluated in a sample of children and adolescents in the city of Zawia, Libya, during the years 2021 and 2024. 500 children and adolescents participated in the study, at a rate of 250 participants per year. Laboratory examinations were conducted in some medical clinics in the city, and vitamin D levels were classified as follows: Vitamin D deficiency: ≥20 ng/ml; inadequacy: 21-29 ng/ml. adequacy: ≤30 ng/ml. Overall, 39.2% of participants had vitamin D insufficiency in 2021, with a mean value of 9.77±4.50 ng/ml, according to the data. In 2024, 52% of participants had vitamin D deficiency, with a mean value of 18.03±1.14 ng/ml. The prevalence of vitamin D deficiency was higher in both years among females than males (P<0.001), and it rose in both sexes in 2024 compared to 2021. Additionally, adolescents in the 13–18 age group had a significantly higher rate of vitamin D deficiency than those in the 1–6 age group (P<0.001), and the rate of deficiency increased in 2024 compared to 2021 across all age groups. The study concluded that vitamin D deficiency is common in the sample and became more prevalent in 2024 than in 2021, especially among adolescents and females. In light of this increase, awareness programmes highlighting the importance of adequate sun exposure, food fortification, and vitamin D supplements are required, especially for categories that are more vulnerable to deficiencies.

Introduction

Research on vitamin D status and its possible health implications has been quite active in recent years. Because the gut must absorb calcium, vitamin D is crucial for bone health; as a result, rickets in children and osteomalacia in adults are linked to vitamin D insufficiency. Despite conflicting data, research has linked vitamin D insufficiency to skeletal health as well as several other adult health problems, including autoimmune illness, type 1 diabetes, cancer, and cardiovascular disease [1]. The general term "vitamin D" includes both vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). Both types of vitamin D are present in nature; although vitamin D3 comes from animal sources, vitamin D2 comes from plants. Nevertheless, dietary vitamin D contribution is minimal, and the amount of vitamin D found in natural food sources is limited. The primary source of vitamin D3 is the skin's production of 7-dehydrocholesterol, or pre-vitamin D3, in reaction to UVB radiation [2]. In plasma, the most widely used and suitable biochemical indicator of vitamin D status is 25(OH)D3. The most physiologically active form of vitamin D, $1,25(OH)_2D_3$ (calcitriol), is created in the kidney when 25(OH)D is further hydroxylated at the first carbon by 1α-hydroxylase.

Despite being the active form of the vitamin, $1,25(OH)_2D_3$ is not a reliable measure of vitamin D levels because of strict regulation of its synthesis and a brief half-life [3]. Every stage of life is at risk for vitamin D deficiency, including pregnancy, infancy, childhood, and maturity. Recommended sun avoidance techniques, low vitamin D storage, the possibility of inadequate vitamin D in exclusively breastfed newborns, and a lack of knowledge about regular vitamin D supplementation can all increase this risk in infants [4]. Vitamin D deficiency and insufficiency, as determined by the serum concentration of 25-hydroxycholecalciferol, or 25(OH)D, in the pediatric population, are prevalent worldwide, with rates ranging on average between 40 and 75%, even in wealthy nations [5]. The increased nutrient and energy requirements of adolescents for proper growth and development, which change with age, make them a risk category for malnutrition [6]. The cutaneous production of vitamin D can be affected by a number of factors, including time of day, season, latitude, ageing, sunscreen use, skin pigmentation, and air pollution. Children and teenagers are spending more time inside doing things such as using computers and smartphones due to a recent change in living habits, especially with the introduction of technology. This demographic may experience potential medical problems as a result of this trend [7]. The objective of this study was to ascertain the prevalence of vitamin D deficiency in a sizable sample of

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healthy children and adolescents in Zawia City, Libya, and assess any age and gender differences between children and adolescents with low vitamin D levels.

Materials and Methods

This study was conducted in some medical laboratories in Zawia City, Libya, during the years 2021 and 2024. It included 500 participants of children and adolescents (250 per year) aged between 1 and 18 years. After gathering information on the participants' age and gender, a blood sample was drawn from each participant. The blood was allowed to coagulate completely at 37°C for 10 minutes. The serum was then separated using a centrifuge set to 3000 rpm for 5 minutes, then immediately checked to determine the concentration of vitamin D 25(OH)D in the serum using the I-CHROMA device. According to Holick, there are three types of vitamin D status: deficiency (≤20 ng/ml), inadequacy (21–29 ng/ml), and adequacy (≥30 ng/ml) [8].

Statistical Analysis

Statistical analysis of the data was conducted using the SPSS program, version 2023, and frequencies, percentages, and arithmetic means were extracted. The chi-square test was applied to determine the differences between groups, and a significance level of $P<0.05$ was considered statistically significant.

Results

A total of 500 individuals were included in the study, (250 in 2021 and 250 in 2024) their age ranged between 1 to 18 years old.

In terms of gender, females were more numerous, constituting 50.8%, while males constituted 49.2%. In addition, the age distribution indicates that the majority of participants were between 7 and 12 years old, accounting for 39.6% of the sample. Participants aged 13-18 years, who represented 33.2%, followed this. The younger age group of 1-6 years comprised 27.2%, with a mean value at 9.77±1.50 years old, reflecting that most cases are in the middle category. Regarding vitamin D levels, 39.2% of cases were suffering deficiency, 18% were inadequacy and 42.8% were adequacy with a mean value at 22.52±1.90 ng/ml (Table 1).

Table 1. Distribution of cases included in the study according to gender, age, and vitamin D levels during 2021.

Variables		N	%	Mean±SD
Gender	Male	123	49.2%	
	Female	127	50.8%	
Age (years)	1-6	68	27.2%	9.77±1.50
	7-12	99	39.6%	
	13-18	83	33.2%	
Vit.D levels (ng/ml)	Adequacy	107	42.8%	22.52±1.90
	Inadequacy	45	18%	
	Deficiency	98	39.2%	

Among 250 participants, 52.8% were female and 47.2% were male. Regarding age, the largest group was 13-18 years old, accounting for 42.4%. This was followed by 32.4% who had experienced 7-12 years old and 25.2% who were in their 1-6 years, with a mean value of 11±1.22 years old. When the vitamin D values of the individuals were examined, it was determined that 52% were deficient, 32% were inadequate, and 16% were adequate, with a mean value of 18.03±1.14 ng/ml.

Table 2. Distribution of cases included in the study according to gender, age, and vitamin D levels during 2024.

Variables		N	%	Mean±SD
Gender	Male	118	47.2%	
	Female	132	52.8%	
Age (years)	1-6	63	25.2%	11±1.22
	7-12	81	32.4%	
	13-18	106	42.4%	
Vit.D levels (ng/ml)	Adequacy	40	16%	18.03±1.14
	Inadequacy	80	32%	
	Deficiency	130	52%	

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Table 3 shows the results of the chi-square test that examines the relationship between several variables (gender, age group) and the prevalence of vitamin D deficiency among study participants during the years 2021 and 2024. There were varying degrees of the prevalence of vitamin D deficiency among the different study variables. Gender showed a strong and statistically significant association with deficiency of vitamin D (P = 0.000). Moreover, females had the highest vitamin D deficiency rate at 52.8% in 2021, and in 2024 it was 63.6%, whereas males exhibited the lowest rate of vitamin D deficiency, 25.2% and 39%, during the years 2021 and 2024, respectively. Similarly, age showed a strong, statistically significant association with vitamin D deficiency (P=0.000). A significant decrease in the level of vitamin D was observed in the 13-18 age group during the years 2021 and 2024, by 56.6% and 62.3%, respectively. Followed by the 7-12 age group with a deficiency rate of 38.4% and 51.9% during the years 2021 and 2024, respectively. Whereas, in the 1-6 years, as many as 19.1% and 34.9% fell into the deficient category during the years 2021 and 2024, respectively, making it the least common category for vitamin D deficiency.

Table 3. Distribution of vitamin D levels according to gender, age During the years 2021 and 2024.

Parameters		25(OH)D Concentration categories, n(%)			x^2 test	P-value
		Adequacy (≥30 ng/ml)	Inadequacy (21–29 ng/ml)	Deficiency (≤20 ng/ml)		
2021						
Gender	Male	69(56.1%)	23(18.7%)	31(25.2%)	22.170	0.000
	Female	38(29.9%)	22(17.3%)	67(52.8%)		
2024						
Gender	Male	26(22%)	46(39%)	46(39%)	15.773	0.000
	Female	14(10.6%)	34(25.8%)	84(63.6%)		
2021						
Age	1-6	49(72.1%)	6(8.8%)	13(19.1%)	38.988	0.000
	7-12	37(37.4%)	24(24.2%)	38(38.4%)		
	13-18	21(25.3%)	15(18.1%)	47(56.6%)		
2024						
Age	1-6	22(34.9%)	19(30.2%)	22(34.9%)	25.729	0.000
	7-12	10(12.3%)	29(35.8%)	42(51.9%)		
	13-18	8(7.5%)	32(30.2%)	66(62.3%)		

Discussion

In both developed and developing nations, low vitamin D levels continue to be a significant health issue. This study aimed to evaluate vitamin D levels in children and adolescents according to age and gender in two different years (2021 and 2024) in some health centers in Zawia, Libya. It found that the overall prevalence of vitamin D deficiency in 2021 was 39.2% with a mean value at 22.52±1.90 ng/ml, while in 2024 it was 52% with a mean value at 18.03±1.14 ng/ml. This rate is in line with the rates recorded in a study that included 384 children and adolescents in Iran, the results of which revealed that 49% of the participants suffer from vitamin D deficiency [9]. It is also similar to the rates recorded among Egyptian children and adolescents, where 58% of them showed vitamin D deficiency, despite the fact that Egypt is a sunny country [4]. A study in Ankara that included a total of 440 children and adolescents between January 2008 and January 2010 found that 40% of the participants had low levels of vitamin D:25(OH)D <20 ng/ml [10]. A similar study was conducted in Bahrain that included 531 children aged between 1 month and 16 years; most children (78.3%) had vitamin D deficiency. This rate is much higher than in our study, despite Bahrain being a sunny country [11]. In addition, some European countries show a similar prevalence, indicating that vitamin D deficiency is common even in these regions [1,2,12].
The prevalence of vitamin D deficiency between children and adolescents varies across studies; for example, in a study in China [13], the mean vitamin D concentration in children and adolescents was found to be 20.84 ng/ml, with a deficiency rate of 45.2%. In a Turkish study aimed at assessing vitamin D levels in 51,560 participants aged 0 to 18 years between 2015 and 2017, 20% of them were found to be vitamin D deficient [14]. A Brazilian study on a sample of children and adolescents aged 0–18 years, collected between January 2014 and October 2018, showed that the mean vitamin D concentration was 29.2 ng/ml, with 0.8% having a concentration <12 ng/ml and 12.5% having a concentration <20 ng/ml [7].

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The statistical test results indicate a statistically strong significant relationship between gender and vitamin D deficiency (P <0.001), with a higher prevalence of vitamin D deficiency among females than males in both years (2021 and 2024). Additionally, compared to 2021, the results showed a rise in the incidence of vitamin D insufficiency in 2024 in both genders. The findings of this investigation are in line with those of a study carried out in Turkey's southeast Anatolia, which showed that the proportion of females with vitamin D deficiency was significantly higher than that of males, P = 0.001 [15]. Males showed higher vitamin D concentrations than females (P < 0.05) in an Indian study [16]. Similar findings were noted in Brazilian child groups, where vitamin D insufficiency was more common in females than in males [7]. In research by Sari et al [14] vitamin D levels were higher in males than in females, P < 0.001. Our findings are in contrast to a study which examined a large sample of Belgian children and adolescents from 2014 to 2021 and found no correlation between gender and vitamin D levels [2]. Male and female vitamin D concentrations did not differ significantly, according to other investigations [11,17].

Regarding age, a statistically significant difference was observed between age and the high rate of vitamin D deficiency among participants (P<0.001), as vitamin D levels gradually decreased with age. It was found that vitamin D deficiency during the year 2021 was at rates of 19.1%, 38.4%, and 56.6%, respectively, in the age groups 1-6, 7-12, and 13-18. The rate of vitamin D deficiency increased during the year 2024 in all age groups at rates of 43.9%, 51.9%, and 62.3%, respectively. These results are largely consistent with what was reported in the study Bener et al in Qatar, which revealed that vitamin D deficiency was common among Qatari adolescents aged 11-16 years at a rate of 61.6%, followed by the age group 5-10 years at a rate of 28.9%, and those under 5 years at a rate of 9.5%, at a probability value of P = 0.013 [18]. There was a significant difference between serum vitamin D levels and age groups, as the highest average was found in infants (33.95 ng/ml) and the lowest average in adults (18.3 ng/ml) in a study conducted between 2015 and 2017 in Turkey [14]. Similar results were obtained from a study by Van de Walle et al., which concluded that the number of primary school children and adolescents suffering from vitamin D deficiency was higher than the number of preschool children [2]. Furthermore, a study in India across different age groups showed that 49.12% of children aged 0-4 years suffered from vitamin D deficiency, and the prevalence of deficiency was relatively higher among adolescents (76.16%) [19]. Overall, the studies' findings generally align with our investigation. This agreement may be attributed to several interrelated factors, including lack of exposure to sunlight, lifestyle changes that lead to spending more time indoors in front of the television and smart devices, and not consuming food sources rich in vitamin D, which calls for intervention to treat vitamin D deficiency in this population group.

Conclusion:
This study concluded that vitamin D deficiency was extremely prevalent in the sample and worsened during 2024, especially in females and teenagers aged 13 to 18. The high prevalence of vitamin D deficiency in Libya, a nation with plenty of sunshine, emphasizes the need for efficient public health interventions, like boosting sun exposure and giving vitamin D supplements to all populations at risk, especially during adolescence. In order to ascertain whether vitamin D deficiency throughout childhood and adolescence has an impact on subsequent health, more research is required to assess the association between vitamin D deficiency and other risk factors.

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Conflicts of Interest
The authors declare no conflicts of interest.

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