https://doi.org/ 10.33472/AFJBS.6.5.2024. 5610-5624

AFJBS

African Journal of Biological Sciences

The prevalence of serum vitamin D deficiency and its variationsaccording to age and sex in Erbil city, Iraq

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Article History
Volume 6, Issue 5, 2024
Received: 09 may 2024
Accepted: 17 may 2024
doi: ***10.33472/AFJBS.6.5.2024. 5610-5624***

Abstract

Background and Objectives: Vitamin D deficiency is a significant public health concern worldwide. This study aimed to investigate the relationships between age, sex, and serum vitamin D levels in a cohort of participants from Erbil City.

Methods: This cohort study was conducted over a period of two years, from January 2021 to December 2022. A stratified random sampling technique was utilized to guarantee a proportional representation of the population, taking into account both age and sex. The study encompassed a total of 1520 participants ranging in age from 0 to 99 years. The DiaSorin Liaison chemiluminescence assay was utilized to measure serum vitamin D levels.

Results:The mean age of participants was 39.461 ± 20.167 years. The overall mean serum Vitamin D level among the study participants was 61.972 ± 32.425 nmol/L. The results indicated that despite an increase in Vitamin D and 25-hydroxyvitamin D levels observed in the second test, a significant proportion of the individuals still exhibited Vitamin D deficiency. Lower Vitamin D levels were particularly noted among younger age groups and females.

Conclusion:The study revealed a widespread insufficiency of Vitamin D throughout the whole population, with variations in severity seen across different age groups and sexes. Notably, the most substantial deficits were detected among younger individuals and females.

Keywords:Deficiency, IRAQ, Nnutritional supplement, Vitamin D, 25 hydroxyvitamin D

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Introduction

Vitamin D is a vital lipid-soluble vitamin that has a critical function in controlling the levels of calcium and phosphate in the body and enhancing overall health. Vitamin D insufficiency is a prevalent condition (1). Vitamin D insufficiency, defined by serum 25-hydroxyvitamin D (25(OH)D) levels below 30 ng/mL, is estimated to impact around 30-80% of the adult population worldwide(2, 3).Besides its role in regulating bone and mineral metabolism, vitamin D also demonstrates diverse biological impacts, such as antioxidative, anti-inflammatory, antimicrobial, lipid-lowering, and cardiovascular protective effects (4-6). Apart from its relationship with osteoporosis, vitamin D insufficiency has been linked to conditions like hypertension(7), diabetes mellitus, dyslipidemia, obesity, and metabolic syndrome (3, 8).Vitamin D obtained from either the skin's synthesis or from dietary sources is biologically inactive. This form of vitamin D is transformed into 25(OH)D by the enzyme 25-hydroxylase in the liver. Additionally, 25(OH)D, used for assessing an individual's vitamin D levels, must undergo further hydroxylation in the kidneys to become an active form of the vitamin D metabolite(3, 9).Research has established that serum vitamin D levels display considerable variability across different populations, influenced by factors such as geographic latitude, season, and lifestyle choices(10-12). Age and sex are also significant determinants of vitamin D status (13).Recent literature highlights the variations in serum vitamin D levels among different age groups and between sexes. A study conducted by Wang et al. (2024) shows that the female's sex, younger age, and season (winter/spring) are predictors of hypovitaminosis D(14). However, the study conducted by Krasniqi et al. (2024) found no correlation between serum levels of vitamin D and age (15).Similarly, a study conducted by Mouodi et al. (2023) showed that age, sex, and body mass index have no significant impact on serum concentration of 25-OH vitamin D (16).

Despite the various studies conducted in this field, and contradictory results regarding the effect of age and sex on serum vitamin D levels, there is a need for more research to better understand these changes. Therefore, the present study aims to investigate the relationships between age, sex, and serum vitamin D levels in Erbil City, Iraq(17).

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Method

Study Design and Setting

This cohort study was designed to assess the variations in vitamin D levels among participants over a specified period. The study was conducted in a controlled clinical environment at the

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Mydia Diagnostic Center, in Erbil City. The research spanned over a period of two years, starting from January 2021 and concluding in December 2022. This timeframe included participant recruitment, initial assessments, follow-up visits, data collection, and analysis phases.

Sampling Method and Sample Size

A stratified random sample technique was used which enabled a balanced and accurate representation of the population by considering the difference in the age and sex of the people.

$$n = \frac{z^2 \times p \times (1-p)}{E^2}$$

Where: *n* is the sample size; *Z* is the Z-score (1.96 for 95% confidence interval); *p* is the estimated prevalence of vitamin D deficiency in the general population (assumed to be 0.5 for maximum sample size); and *E* is the margin of error (set at 0.05).

$$n = \frac{(1.96)^2 \times 0.5 \times (1-0.5)}{(0.05)^2} = 384.16$$

Considering a response rate of 80%, the adjusted sample size is:

$$n_{adj} = \frac{n}{response\ \ rate} = \frac{384.16}{0.8} = 480.2$$

The minimum needed sample size of 481 individuals was calculated via the process of rounding. However, to enhance the statistical power of the research and accommodate for any dropouts, a greater number of individuals were included. The research had a total of 1520 individuals.

The study comprised participants ranging in age from 0 to 99 years, of both sexes, who were willing to offer informed permission. The individuals were inhabitants of Erbil City or the neighboring regions and were accessible for subsequent evaluations.

The study involved the exclusion of subjects with pre-existing diseases, renal and hepatic conditions or medications like steroids and anti-convulsants, pregnant and lactating mothers or subjects who influence vitamin D metabolism significantly.

Data Collection

The data were collected in two phases: initiating assessment and follow-up. Screening the participants during the initial visit would involve a standardized health screening that included a detailed questionnaire to collect such as demographic details, personal health history, and lifestyle factors. Blood collection was performed by certified phlebotomists with an aseptic

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technique as standard using BD Vacutainer® blood collection tubes. Vitamin D levels in the serum were determined with the aid of the DiaSorin Liaison® chemiluminescence assay (DiaSorin Inc., Stillwater, MN, USA) (17). Follow-up visits were scheduled within 6 months to 1 year for repeat testing.

Ethical Endorsement

The study protocol was reviewed and approved by the Ethics Committee of Hawler Medical University. All procedures performed in the study adhered to the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written informed consent was obtained from all individual participants included in the study. In the case of minors, consent was obtained from a parent or guardian.

Statistical Analysis

Statistical analysis was conducted using SPSS software (IBM SPSS Statistics for Windows, Version 26.0, Armonk, NY: IBM Corp.). Descriptive statistics were used to summarize the data. Continuous variables were measured as mean and standard deviation, meanwhile frequency and percentages were calculated for categorical variables. To determine the statistical significance of changes concerning categorical variables, the Chi-square test was applied while the independent t-test and ANOVA were used in the case of continuous variables. A p-value less than 0.05 was considered statistically significant.

Result

This study examined a cohort of 1,520 participants to assess variations in vitamin D levels. The mean age of the participants was 39.461 ± 20.167 years. The mean vitamin D concentration across the study population was 61.972 ± 32.425 nmol/L (Table 1). Sex distribution within the sample was 612 (40.3%) male and 908 (59.7%) female participants, as depicted in Figure 1.

Table 1. Socio-demographics in participations in study

Variable		Mean±SD	Frequency (%)
Age		39.461 ± 20.167	
Vitamin D		61.972 ± 32.425	
Sex	Male		612 (40.3%)

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	Female		908 (59.7%)

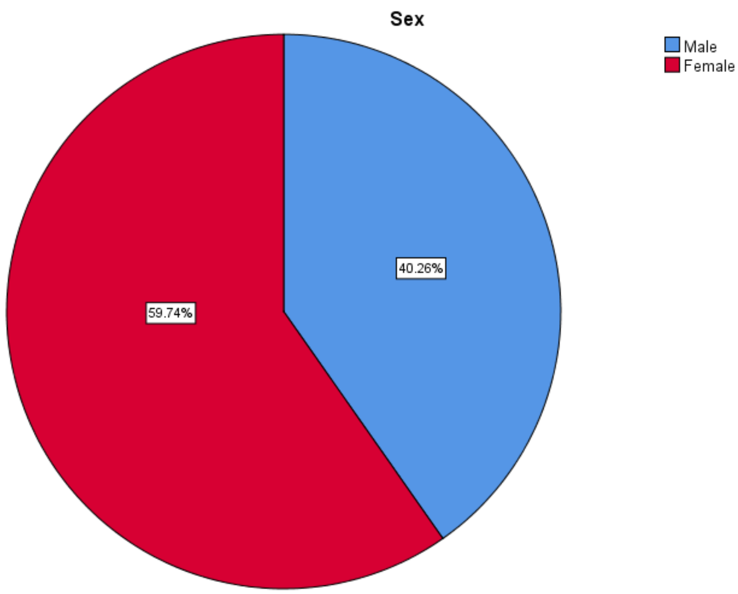

Figure 1. Sex distribution of the participants

In the current study, individuals' Vitamin D levels were assessed during their initial visit and subsequently at a follow-up visit within a specified timeframe. Vitamin D levels were categorized into three groups: Sufficient, Insufficient, and Deficient.

Table 2 presents the number of individuals in each age group and the sex distribution of participants whose initial Vitamin D test results were Sufficient. Among men, 152 individuals had Sufficient levels of Vitamin D. Of these, 28 (18.42%) were in the 40-49 age group and 27 (17.76%) were in the 30-39 age group. Among women, 315 had Sufficient levels of Vitamin D, with 72 (22.85%) in the 40-49 age group, 61 (19.36%) also in the 40-49 age group, and 52 (16.50%) in the 60-69 age group.

Table 2. Frequency of Vitamin D Sufficient according to age groups among male and female

Sufficient	**Male**	**Female**
	n = 152	**n = 315**
Under 01 year	3 (0.55%)	3 (0.95%)
01 - 09 year	23 (15.13%)	13 (4.12%)
10 - 19 year	8 (5.26%)	12 (3.80%)

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20 - 29 year	8 (5.26%)	29 (9.20%)
30 - 39 year	27 (17.76%)	72 (22.85%)
40 - 49 year	28 (18.42%)	61 (19.36%)
50 - 59 year	23 (15.13%)	43 (13.65%)
60 - 69 year	19 (12.5%)	52 (16.50%)
70 - 79 year	10 (6.57%)	25 (7.93%)
80 - 89 year	3 (1.97%)	5 (1.58%)
90 - 99 year	0	0

In the initial assessment, 174 men had Insufficient levels of Vitamin D. Within this group, 39 (22.41%) were aged 40-49, 34 (19.54%) were aged 50-59, and 30 (17.24%) were aged 30-39. Among women, 257 had Insufficient Vitamin D levels in the initial test. Of these women, 72 (28.08%) were in the 30-39 age group, 58 (22.56%) were in the 40-49 age group, and 31 (12.06%) were in the 50-59 age group. These details are displayed in Table 3.

Table 3. Frequency of Vitamin D Insufficient according to age groups among male and female

Insufficient	**Male**	**Female**
	n = 174	**n = 257**
Under 01 year	0	0
01 - 09 year	24 (13.79%)	17 (6.61%)
10 - 19 year	8 (4.59%)	9 (3.50%)
20 - 29 year	9 (5.17%)	29 (11.28%)
30 - 39 year	30 (17.24%)	72 (28.08%)
40 - 49 year	39 (22.41%)	58 (22.56%)
50 - 59 year	34 (19.54%)	31 (12.06%)
60 - 69 year	20 (11.49%)	26 (10.11%)
70 - 79 year	7 (4.02%)	8 (3.11%)
80 - 89 year	3 (1.72%)	6 (2.33%)
90 - 99 year	0	1 (0.38%)

For the initial Vitamin D test, 213 men and 309 women had levels below the normal range. In descending order, the most affected age groups among men were 40-49 years, with 45 (21.12%) having low Vitamin D levels, followed by 30-39 years, with 42 (19.71%) below the normal range. Among women, the 20-29 and 30-39 age groups showed the highest prevalence of below-normal Vitamin D levels, with 57 (18.44%) affected, followed by the 40-49 age group with 48 (15.53%) below normal. This information is shown in Table 4.

Table 4. Frequency of Vitamin D Deficient according to age groups among male and female

Deficient	**Male**	**Female**
	n = 213	**n = 309**

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Under 01 year	0	0
01 - 09 year	23 (10.79%)	29 (9.38%)
10 - 19 year	28 (13.14%)	42 (13.595)
20 - 29 year	33 (15.49%)	57 (18.44%)
30 - 39 year	42 (19.71%)	57 (18.44%)
40 - 49 year	45 (21.12%)	48 (15.53%)
50 - 59 year	22 (10.32%)	34 (11%)
60 - 69 year	13 (6.10%)	30 (9.70%)
70 - 79 year	7 (3.28%)	10 (3.23%)
80 - 89 year	0	2 (0.64%)
90 - 99 year	0	0

During the second assessment, 66 men and 148 women had normal levels of Vitamin D. The age groups and the number of individuals within each group with Sufficient Vitamin D levels are displayed in Table 5. Of these, 17 (25.5%) men were in the 01-09 age group, and 34 (22.97%) women were in the 60-69 age group with sufficient Vitamin D levels.

Table 5. Frequency of Vitamin D Sufficient according to age groups among male and female

Sufficient	**Male**	**Female**
	n = 66	**n = 148**
Under 01 year	1 (1.51%)	2 1.35%)
01 - 09 year	17 (25.5%)	7 (4.72%)
10 - 19 year	3 (4.54%)	5 (3.37%)
20 - 29 year	1 (1.51%)	10 (6.75%)
30 - 39 year	10 (15.15%)	25 (16.89%)
40 - 49 year	14 (21.21%)	24 (16.21%)
50 - 59 year	7 (10.60%)	22 (14.86%)
60 - 69 year	8 (12.12%)	34 (22.97%)
70 - 79 year	4 (6.06%)	18 (12.16%)
80 - 89 year	1 (1.51%)	1 (0.67%)
90 - 99 year	0	0

Table 6 illustrates the number of individuals in each age group with insufficient Vitamin D levels during the second test. Among the 99 men, 22 (22.22%) were aged 40-49, 19 (19.19%) were aged 50-59, 18 (18.18%) were aged 01-09, and 14 (14.14%) were aged 30-39. In the second assessment, 126 women had insufficient levels of Vitamin D. Within this group, 35 (27.77%) were in the 40-49 age group, 25 (19.84%) in the 30-39 age group, 21 (16.66%) in the 50-59 age group, and 15 (11.90%) in the 60-69 age group.

Table 6. Frequency of Vitamin D Insufficient according to age groups among male and female

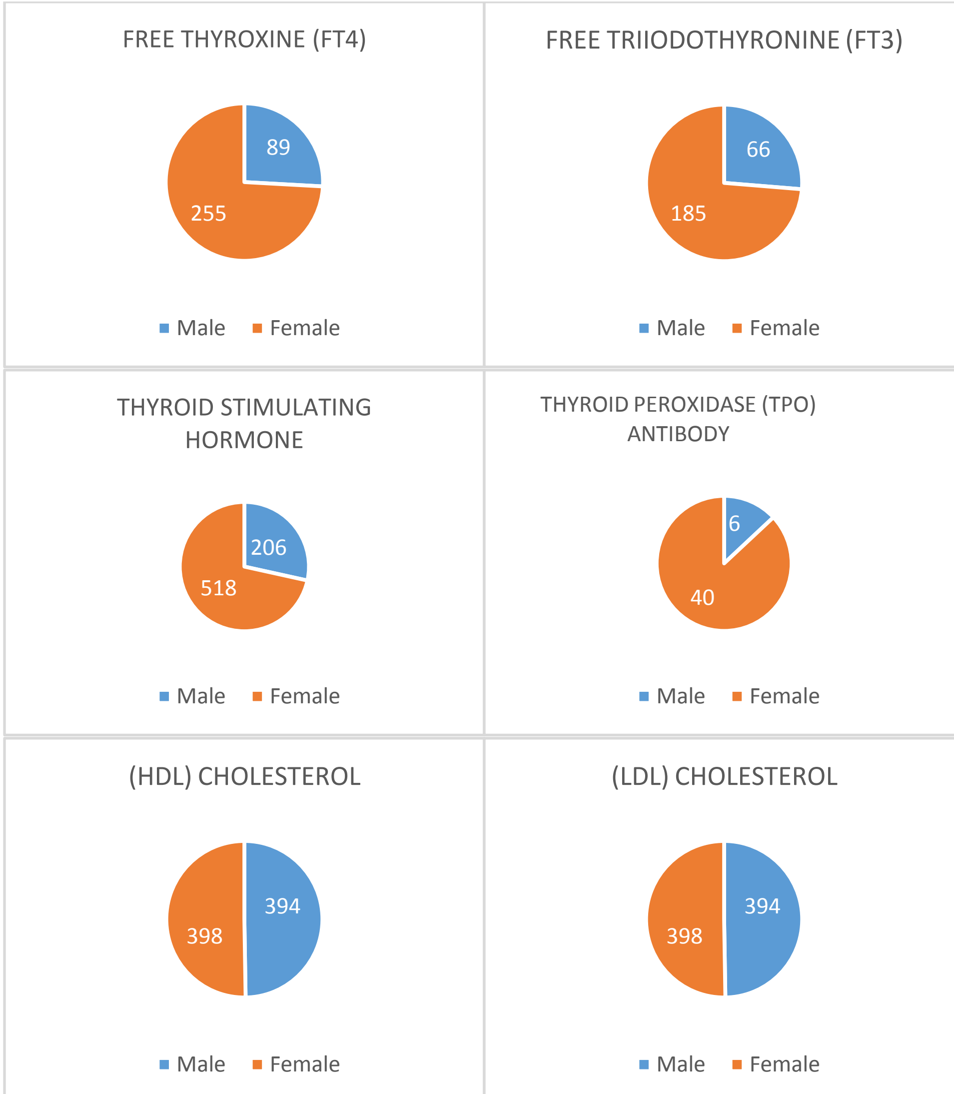
Insufficient	**Male**	**Female**
	n = 99	**n = 126**
Under 01 year	0	0
01 - 09 year	18 (18.18%)	12 (9.52%)
10 - 19 year	5 (5.05%)	4 (3.17%)
20 - 29 year	2 (2.02%)	7 (5.55%)
30 - 39 year	14 (14.14%)	25 (19.84%)
40 - 49 year	22 (22.22%)	35 (27.77%)
50 - 59 year	19 (19.19%)	21 (16.66%)
60 - 69 year	13 (13.13%)	15 (11.90%)
70 - 79 year	5 (5.05%)	4 (3.17%)
80 - 89 year	1 (1.01%)	3 (2.83%)
90 - 99 year	0	0

Results from the second phase of the Vitamin D assay indicated that 144 men and 183 women were deficient. The most affected male age group was 40-49 years, with 29 (20.13%) being deficient, followed by the 30-39 age group, with 25 (17.36%) deficient. Among females, the 40-49 age group had the highest frequency of deficiency, with 33 (18.03%) affected, followed by the 30-39 age group, with 29 (15.84%) deficient. These findings are presented in Table 7.

Table 7. Frequency of Vitamin D Deficient according to age groups among male and female

Deficient	**Male**	**Female**
	n = 144	**n = 183**
Under 01 year	0	0
01 - 09 year	18 (12.5%)	21 (11.47%)
10 - 19 year	20 (13.88%)	20 (10.92%)
20 - 29 year	23 (15.97%)	24 (13.11%)
30 - 39 year	25 (17.36%)	29 (15.84%)
40 - 49 year	29 (20.13%)	33 (18.03%)
50 - 59 year	14 (9.72%)	24 (13.11%)
60 - 69 year	10 (6.94%)	27 (14.75%)
70 - 79 year	5 (3.47%)	4 (2.18%)
80 - 89 year	0	1 (0.54%)
90 - 99 year	0	0

Figure 2 illustrates the number of individuals who underwent blood tests. The results revealed that a higher number of females participated in these tests.


FREE THYROXINE (FT4)
89
255
Male
Female
FREE TRIIODOTHYRONINE (FT3)
66
185
Male
Female
THYROID STIMULATING HORMONE
206
518
Male
Female
THYROID PEROXIDASE (TPO) ANTIBODY
6
40
Male
Female
(HDL) CHOLESTEROL
394
398
Male
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394
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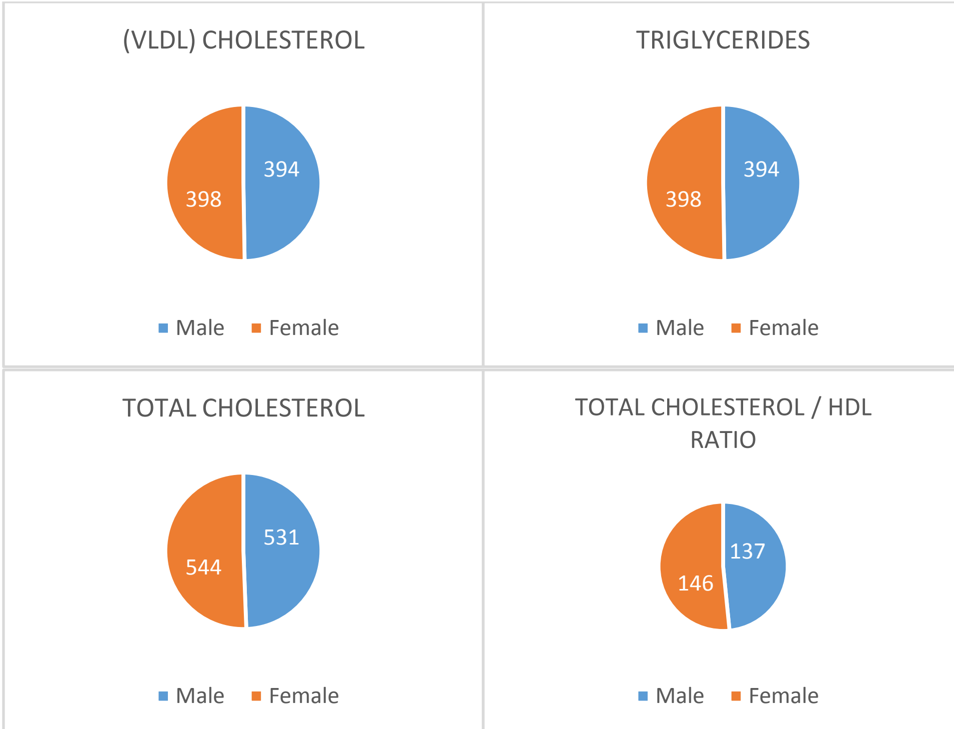

Figure 2. Blood tests along with clinical parameters in people participating in the study

Discussion

In the present study, the main purpose was to clarify the alterations in blood Vitamin D levels. The levels of blood vitamin D varied. Furthermore, some people still had deficient levels of the said vitamin. The levels of Vitamin D were distinct by sex and age and varied. It is important to note that Vitamin D exists in two isomeric forms: Vitamin D2 (ergocalciferol) which can be found in plants, fortified foods, and supplements; as well as vitamin D3 (cholecalciferol) is synthesized in the skin epidermis upon sun exposure or obtained from fish oil and fortified foods(18-20).Vitamin D gets converted in the liver to 25-hydroxyvitamin D which is the major active metabolite of Vitamin D(21).The absence of food supplements to meet the vitamin and mineral requirements and the low exposure to sunlight because of lifestyle changes are the main exogenous factors responsible for hypovitaminosis (22, 23). It is of essence for us to acknowledge that sunlight in appropriate quantities ideally suffices the body's Vitamin D requirements (24). Moreover, attention should be paid to living in colder climates, air quality (pollution), climatic conditions, clothing styles, skin color, use of sunscreens, and the duration of sun exposure, which represent the significant variables, that change the body's ability to fully absorb the vitamin D(25).A study conducted by Blbas et al. (2024) investigated the levels of

Vitamin D and associated deficiency factors based on data from laboratories in Erbil, gathered through questionnaires. The outcomes indicated that the mean Vitamin D level was low in the population, particularly among smokers and individuals who are not exposed to sunlight indoors. It should be noted that Vitamin D plays a crucial role in maintaining general health and preventing various diseases (11).Another study in Sulaymaniyah, Iraq, by Hussein et al. (2022) targeted the assessment of Vitamin D levels in the Kurdistan region of northern Iraq. This population-based study included 991 healthy individuals, comprising 582 men and 409 women. Demographic data were collected via questionnaires, and clinical and laboratory information was gathered from blood samples. The results showed that 74.33% of the participants had low Vitamin D levels. There was a significant variation in 25-hydroxyvitamin D levels based on sex and age, with higher levels observed in men and older age groups. The findings underscored a high deficiency of Vitamin D in the Kurdistan region, necessitating serious intervention (26).

Further studies in Iraq have consistently shown low Vitamin D levels across the country's population. A review by Salim et al. (2023) revealed a high prevalence of Vitamin D deficiency across various regions (27). Similarly, a study by Al-Hadithy et al. (2024) demonstrated low levels of Vitamin D and 25-hydroxyvitamin D, with more pronounced deficiencies among women (28).Vitamin D deficiency is recognized as a global public health issue due to its implications and associated diseases, highlighting the importance of addressing this issue from birth (29). Despite recommendations exclusively for breastfeeding, breast milk alone does not suffice in meeting infants' Vitamin D needs (30). Taking Vitamin D supplements every day can increase the levels of 25-hydroxyvitamin D in adults and during pregnancy and help prevent a state of vitamin D deficiency (31). Vitamin D is a crucial vitamin for bone health, and particularly as people get older, it is so important to consume enough each day(32).

Furthermore, food fortification can mitigate Vitamin D deficiency in communities. In countries like the USA and Japan, food fortification and the consumption of Vitamin D-rich food sources have effectively addressed these deficiencies (33).

Conclusion

The study's results confirm that Vitamin D deficiency is prevalent, varying by age group and sex, with younger individuals and females facing greater challenges. Addressing this issue requires planned strategies and appropriate policy implementations. Measures such as food fortification, lifestyle changes, and the development of health-focused and sanitary policies could significantly reduce the impact of Vitamin D deficiency.

Acknowledgments: We would like to extend our thanks to everyone who has dedicated their time, energy, and skills towards the successful culmination of this study.

Conflict of interest: The authors declare no conflict of interest regarding the publication of this study.

Data availability: The data of this study are available from the corresponding author upon reasonable request.

Funding: None

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