The Epidemic and Health Risks of Vitamin-D Deficiency in Erbil

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Doi: 10.23918/eajse.v7i2p163

Abstract: Vitamin D, the sunshine vitamin, is any of the various vitamins that are fat-soluble, chemically related to steroids, and naturally found in very few food products. In the skin, it is produced endogenously through the exposure to sunlight (ultraviolet rays), which triggers vitamin D synthesis. Vitamin D deficiency can cause major health risks as it is linked to diabetes, cardiovascular disease, hypertension, rickets, and osteoporosis. The aims of this study are: 1- to determine the vitamin D levels of individuals (n=275) of different genders and ages who were examined in various laboratories and hospitals in Erbil. 2- To evaluate the relation between gender and age with vitamin D deficiency. 3- To determine if vitamin D deficiency is becoming an epidemic in Erbil. 4- To evaluate the major risk factors of this nutritional deficiency. In this project, vitamin D test results were collected from five different laboratories and hospitals in Erbil city, Iraq. A total of 275 samples were collected, including 166 females and 109 males of different ages ranging from 19 years or younger to 60 years or older. The results were divided based on demographic information, including age and gender. The population was further categorized according to the vitamin D levels, which consisted of deficient (0 – 20 ng/mL), insufficient (21 – 29 ng/mL), and sufficient (30 – 100 ng/mL). The results have shown that 86% of the female group was below the optimal vitamin D levels, while 82% of the males showed low levels. The results showed that there was no effect of gender and age on vitamin D levels. There was a high percentage of vitamin D deficiency in males and females in Erbil city; therefore, this research suggests that long-term vitamin D supplementation, adequate exposure to sunlight, and a balanced diet rich with enough dosage of vitamin D reduces the risk of multiple health issues.

Keywords: Epidemic, Vitamin D, Deficiency, Health Risks, Erbil

1. Introduction

Vitamin D, the sunshine vitamin, is any of the various vitamins that are considered fat-soluble and are steroids in their chemical nature (Micozzi & Maryland, 2008). Vitamin D refers to inactive precursors known as vitamin D3 or cholecalciferol and vitamin D2 or ergocalciferol (Micozzi & Maryland, 2008). Vitamin D is considered a unique vitamin because it can be synthesized, from exposure to sunlight, in the skin (Lappe et al., 2007; Lips et al., 2006). Vitamin D has a vital role in the absorption of dietary calcium (10–15%) and phosphorus (60%) (Lappe et al., 2007; Lips et al., 2006). The sufficiency of vitamin D enhances the absorption of dietary calcium by 30–40% and phosphorus by 80% (Lappe et al., 2007; Lips et al., 2006). The body requires vitamin D to ensure good health, and it is important for the structure of bone and teeth. Vitamin D deficiency is a global epidemic; however, it remains an issue that is unknown by most of the population (Lhamo et al., 2017).

Received: September 12, 2021
Accepted: December 23, 2021
Surji, H.K., & Sultan, S. (2021). The Epidemic and Health Risks of Vitamin-D Deficiency in Erbil. *Eurasian Journal of Science and Engineering*, 7(2), 163-175.

The insufficiency of vitamin D could affect approximately 50% of the global population, and there are an estimated 1 billion humans of different ages and gender who have a vitamin D deficiency worldwide (Holick, 2007; Lips et al., 2006). One of the primary explanations for the epidemic of this nutritional deficiency is being unaware of the benefits of vitamin D for health and the important role of this vitamin in the prevention of many chronic diseases (Mithal et al., 2009). There are many factors that attributed to the pandemic of hypovitaminosis D, such as lifestyle and environmental factors which decrease the exposure of the skin to sunlight, especially ultraviolet-B (UVB). The production of vitamin D in the skin is enhanced by UVB (Rostand, 1997). Vitamin D deficiency could lead to harmful effects that may cause many chronic diseases such as osteoporosis, bone metabolic disorders, fractures, cancer, cardiovascular diseases, and diabetes (Wang et al., 2017).

2. Hypothesis

Vitamin D deficiency is rising in Erbil city, which could become an epidemic health issue that may contribute to severe diseases.

2.1 Purpose of the Study

The aims of this research are to: 1- determine the vitamin D levels of individuals (n=275) of different genders and ages who were examined in various laboratories and hospitals in Erbil. 2- evaluate the relationship between gender and age with vitamin D deficiency. 3- determine if vitamin D deficiency is becoming an epidemic in Erbil. 4- evaluate the major risk factors of this nutritional deficiency.

2.2 Historical Perspective

Francis Glisson was the first to recognize rickets as a bone disorder in children in 1650, and this led to vitamin D being discovered (Dini & Bianchi, 2012). Moreover, Edward Mellanby, in 1919, described the way vitamin D plays a role in the prevention of rickets. The initial explanation of the anti-rachitic characteristics of vitamin D was provided by Elmer McCollum in the year 1922. Mellanby showed the treatment of rickets by feeding dogs cod liver oil, and the vitamin's presence was defined as vitamin D (Shaw, 2003). Furthermore, during the 1930s, cod liver oil being utilized as a management and prevention method for rickets had become frequent. During the beginning of the 20th century, rickets was known as the most distressing health concern (Holick, 2010). Approximately ninety percent of Northern Europe children showed evidence of this disease (Holick 2010).

According to Holick (2010), Sniadecki, in 1822, discovered that sun exposure is beneficial for the prevention of skeletal deformities. Hess (1922) conducted a study on exposing children with rickets to sunlight, and they showed a great improvement. Steenbock (1924) introduced the idea of fortifying milk as a traditional way that was used to prevent rickets in children. This concept resulted in fortifying milk with vitamin D that eventually helped eliminate rickets in countries that utilized the fortified milk (Holick, 2005). In the early twentieth century, the role of sunshine and nutrition in the underlying etiology of vitamin D insufficiency was defined (Shaw, 2003).

During the 1920s, exposure of yeast to radiation was discovered to stimulate anti-rachitic actions (Holick, 2010). Throughout this process, the sterol that was found to have such activity was recognized as ergosterol. The term pro-vitamin D2 was used for ergosterol, and the result of irradiation was termed vitamin D2. Soon, ergosterol was used inside of milk after irradiating it with ultraviolet to increase its anti-rachitic actions of the milk. Then, an ergosterol analog was formed by Windaus and co-workers, which had the same anti-rachitic activity as the ergosterol after irradiation (Holick, 2010). The novel pro-vitamin D was termed 7-dehdrocholesterol, and the product was named vitamin D3. After several years of research, in the year 1960, it was evident that the effects attributed to vitamin D resulted from the production of a hormone that was reliable on the ultraviolet light's activity on an endogenous steroid precursor from 7-dehydrocholesterol in the skin and irradiated ergosterol.

2.3 Health Benefits and Sources of Vitamin D

Vitamin D plays a significant role in controlling the absorption of calcium and phosphorus, in muscle function, and cell growth (Ross et al., 2011). According to Silva and Rodolfo (2016), vitamin D had shown to have a positive effect on muscle strength in the elderly. Ross et al. (2011) stated that the required daily intake of vitamin D was 400 – 800 IU. Attaining adequate amounts of vitamin D is closely associated with preventing chronic diseases such as diabetes, bone metabolic disorders, and cardiovascular diseases (Wang et al., 2017). Studies suggest that vitamin D may also be effective for preventing certain cancers such as breast, colorectal, and prostate cancer (Rhee et al., 2009); however, further studies are needed to verify its exact role in cancer prevention. Additionally, vitamin D is known to improve immunity by increasing the phagocytosis process of Mycobacterium tuberculosis and preventing tuberculosis disease (Grant & Holick, 2005). Tuberculosis is commonly correlated with low serum calcifediol levels in individuals.

An increase in vitamin D levels can be from natural sunlight, food, and supplements. One major source of vitamin D is sunlight (Hamza et al., 2011). A reaction that allows the skin cells to produce vitamin D occurs when the sun's UV-B rays shine on the skin (Holick, 2010). In the skin, 7-dehydrocholesterol absorbs UV-B radiation leading to the production of pre-vitamin D, which is then converted to vitamin D after the reorganization of double bonds (Holick, 2010). Although only small amounts of vitamin D can be taken from food, it is still a great source (Ross et al., 2011). The best source of food for vitamin D is from fatty fish and fish liver oils, and beef liver, cheese, egg yolks, fortified foods such as milk or yogurt contain small amounts of the nutrient (Ross et al., 2011).

2.4 Mechanism of Vitamin D

After the ingestion of vitamin D or the formation of it in the skin, it goes through the hydroxylation process, which first occurs in the liver to 25-hydroxyvitamin D {25 (OH) D} (Holick, 2005). Attached to its D-binding protein (DBP), 25(OH) D moves through the circulation and arrives at the kidney, where the DBP-25(OH) D is transferred into the renal tubule by megalin (Gil et al., 2018). In the mitochondria, a hydroxyl function then creates 1, 25-dihydroxyvitamin D {1, 25(OH) 2D} (Gil et al., 2018). VDR reacts with 1, 25(OH) 2D and adheres to the retinoic acid-X-receptor (Bikle, 2014). Vitamin D responsive elements (VDRE) recognize this bond and activate genetic codes which are used in its biological functions (Holick, 2005).

Generally, during transcription activation, VDRE involves two straight repetitions of the hexanucleotide sequencing known as GGGTGA, which is divided by three pairs of nucleotides (Bikle et al., 2009). The processes included in transcription that are facilitated by VDR following the combining of 1, 25(0H), D3-VDR-RXR to DNA have been explained. Numerous TAFS, TFIIB, and the p160 co-activators, which present with histone acetylation actions, have been described to be included in the transcription process facilitated by VDR. Additionally, methylation takes place on primary histones as well. Research has shown that collaboration between p160 co-activators ad histone methylation could play a role in a transcriptional activity facilitated by VDR (Bikle et al., 2009).

DRIP, the VDR cooperating protein, also facilitates the transcription process. Such involvement does not include histone acetylation activity; however, it is partly responsible for the conscription of RNA polymerase 11. It was reported that the binding protein, SRCiCREB, is initially conscripted for the purpose of modifying chromatin, then the transcription procedure is conscripted through DRIP. Furthermore, transcription factors such as CCAAT and YY1 have been described to control the transcription process. Moreover, it was reported that the function of VDR, particularly cell and promoter function, might be facilitated via co-activators differential recruitment (Bikle et al., 2009).

2.5 Causes of Vitamin D deficiency

Serum levels that are below 20 ng/ml specify that a person is at risk of deficiency, and the "level for promoting health is at 30 ng/ml" (Flood-Nichols et al., 2015) (Table 1). Vitamin D deficiency is due to lack of sunlight exposure, not consuming enough vitamin D, or the body being incapable of absorbing and metabolizing the vitamin D that was consumed (Parva et al., 2018). Some other factors that affect whether a person is at risk of vitamin D deficiency include dark skin pigmentation, obesity, pregnancy, etc. (Flood-Nichols et al., 2015). Specifically, the quantity of UVB photons reaching earth is affected by the direction in which the sun reaches the surface (Holick & Chen, 2008). For this reason, during the increase of the zenith angle throughout the winter season and morning and evening time, very low vitamin D production happens.

Moreover, those who cover their skin due to religious or cultural reasons prevent sunlight exposure and are at a higher risk of lacking vitamin D. This clarifies the high vitamin D deficiency in individuals who reside in very sunny regions. Furthermore, aging is also correlated with reduced absorption of 7-dehydrocholesterol. For instance, an individual in their 70s has approximately 25 percent of 7-dehyrocholesterol that a younger individual has and therefore has a 75 percent decreased ability to produce vitamin D with the skin (Holick & Chen, 2008). Moreover, due to the fact that vitamin D is dissolved in fats, it is immediately absorbed by fat cells. Therefore, vitamin D deficiency is correlated with obesity, and it is suggested that it is caused by the absorption of the vitamin by fats. Additionally, other causes of vitamin D deficiency are medications, particularly fat malabsorption, glucocorticoids, and anti-seizure (Holick & Chen, 2008).

Table 1: Recommended vitamin D levels

Deficient	0 – 20 ng/mL
Insufficient	21 – 29 ng/mL
Sufficient	30 – 100 ng/mL

Note. Adapted from Evaluation, treatment, and prevention of vitamin D deficiency: An Endocrine Society Clinical Practice Guideline by Holick et al., 2011 The Journal of Clinical Endocrinology & Metabolism, 96(7), 1911-1930.

2.6 Health Risks Linked to Vitamin D Deficiency

One of the vital vitamins in the body to sustain human health is vitamin D, and the deficiency of this nutrient is considered a major risk factor for many health disorders and diseases (Wang et al., 2017). Vitamin D deficiency can have a severe effect on bone health, which can result in osteoporosis and a greater chance of fractures (Holick, 2007). Rickets is a skeletal disorder of children that is caused by severe vitamin D deficiency, which usually occurs between 3 and 18 months of age (Wagner & Greer, 2008). Rickets causes weak and soft bones, bowed legs, stunted growth, and sometimes skeletal deformities. A similar disorder diagnosed in adults is called osteomalacia. It causes bowing of the legs and soft, fragile bones that can lead to easy fractures, especially in the elderly. Vitamin D deficiency and osteoporosis have a connection with a higher possibility of long-term illnesses such as type 2 diabetes, asthma, autoimmune and infectious diseases, and heart disease (Holick, 2010). Furthermore, vitamin D deficiency results in hyperparathyroidism, which leads to an increase in insulin resistance and is linked with diabetes, cardiovascular disease, inflammation, and hypertension (Lee et al., 2008).

Moreover, insufficient vitamin D is related to cardiovascular disease (Nasri, 2017). The deficiency of vitamin D results in an increased rennin-angiotensin-aldosterone system, which has a negative effect on the cardiovascular system. Furthermore, vitamin D insufficiency has negative effects on the initiation of cardiovascular diseases such as heart failure and coronary artery disease. Vitamin D stimulates the production and expression of the smooth muscle cells and endothelial growth factors of the vascular system (Nasri, 2017). Additionally, it was reported that deficient vitamin D is correlated with stroke (Nasri, 2017). Moreover, research shows that intake of vitamin D prevents musculoskeletal disorders in individuals with stroke.

Furthermore, according to Liu et al. (2013), vitamin D is also responsible for the proper functioning of the kidneys. Results from experiments displayed that insufficient vitamin D is related to renal disorders. The irregular metabolism of vitamin D takes part in the incidence of skeletal and mineral disorders and the initiation of hypertension that results in renal damage (Liu et al., 2013). Moreover, it was reported that there is a correlation between deficient vitamin D and a higher chance of albuminuria. This could be due to vitamin D having a central role in anti-proteinuria activities, or a majority of vitamin D binding to the albumin is released throughout albuminuria (Liu et al., 2013.

3. Methodology

3.1 Study Design and Setting

In this research, vitamin D test samples (n= 275) were collected from five different laboratories and hospitals in Erbil City (Figure 1). The names of the laboratories and hospitals will be kept anonymous as requested. This cross-sectional study was conducted after permission was given from the laboratories and hospitals to utilize the results for the given purpose. The results were obtained in December 2018 and February 2019.

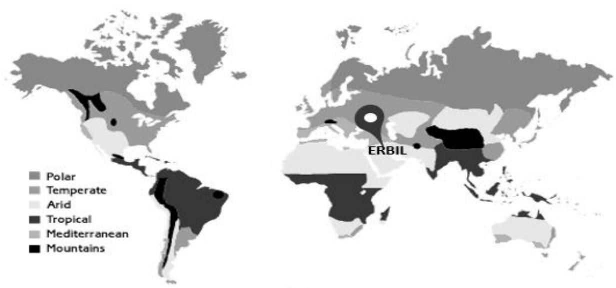

Figure 1: World Map and Climate Zones. Internet Geography. 2015

3.2 Data Collection and Analysis

A total of 275 samples were acquired, including 166 females and 109 males. The samples were divided based on demographic information, including age and gender (Table 2). The population was further categorized according to the vitamin D levels, which consisted of deficient (0 – 20 ng/mL), insufficient (21 – 29 ng/mL), and sufficient (30 – 100 ng/mL). These vitamin D levels were chosen as most experts agree on it, and it was approved by The Endocrine Society (Holick et al., 2011). The data was recorded via Microsoft Excel and was analyzed using GraphPad Prism. The analysis included a descriptive approach consisting of frequencies and percentages. The data collected was used only for the proposed aim of this study.

Table 2: Demographics of the study population

Age Groups	Females	Males	TOTAL
≤ 19	14	20	34
20-29	31	14	45
30-39	52	28	80
40-49	30	21	51
50-59	20	15	35
≥ 60	19	11	30
TOTAL	166	109	275

4. Results

4.1 General Demographic Characteristics

A total of 275 results were collected from five different laboratories and hospitals. The majority of the patients were female, which made up 60% of the results, while the other 40% were male (Figure 2). The results have been categorized into six different age groups. There were 34 patients aged 19 years or younger. Fourteen out of the thirty-four were female, and the other twenty were male. There was a total of 45 participants aged 20 to 29 years. A greater number of the participants, which included 52 males and 28 females, were found to be aged from 30 to 39 years. Between the ages of 40 to 49, there were 30 females and 21 males. A total of 20 females and 15 males were aged from 50 to 59 years. From the age of 60 years and older, 19 were female, and 11 tests were from males (Figure 3).

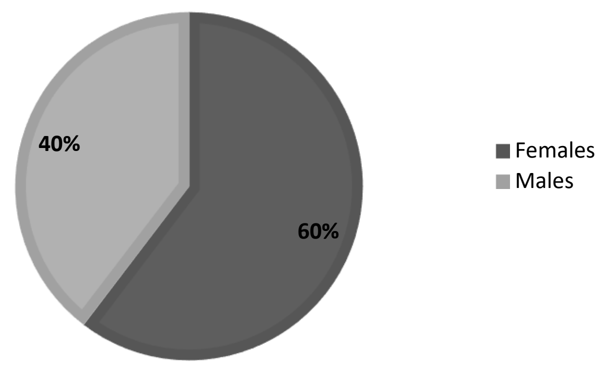

Figure 2: The study population

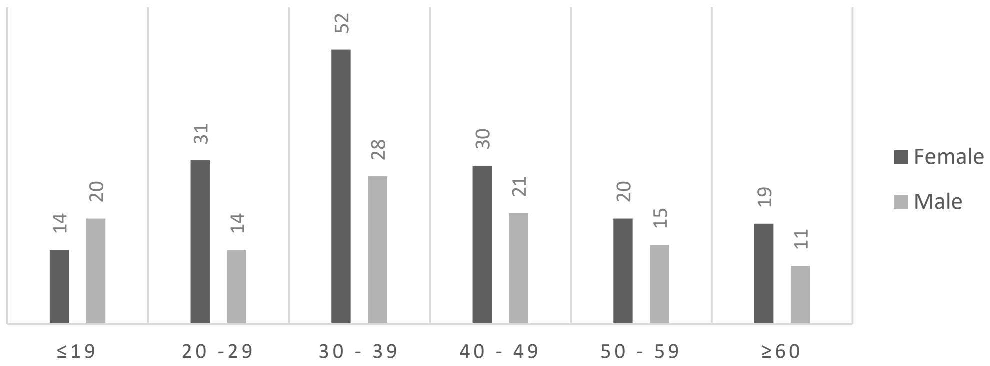

Figure 3: The study population according to the different age groups (Excel)

4.2 Vitamin D Levels of Different Genders

According to Holick et al. (2011), the optimal Vitamin D level is between 30 to 100 ng/mL (Table 1). Out of a total of 166 female patients, 103 (62%) had a vitamin D level between 0 – 20 ng/ml, and 40 (24%) had levels between 21 – 29 ng/mL (Table 3). From a total of 109 male participants, 68 (63%) showed a deficiency in vitamin D, and 21 (19%) showed insufficiency (Table 3). A total of 171 (62%) participants from the 275 patients were deficient (Table 3). The results indicated that 61 (22%) patients had vitamin D levels between 21 to 29 ng/mL, which included 40 females and 21 males (Table 3). Only 16% of the 275 participants had sufficient levels of vitamin D, and this consisted of 23 females and 20 males (Table 3).

Table 3: Percentage of vitamin D levels of different genders

Range	Total (n = 275)	Females (n = 166)	Males (n = 109)
Deficient: 0-20 ng/mL	171 (62%)	103 (62%)	68 (63%)
Insufficient: 21-29 ng/mL	61 (22%)	40 (24%)	21 (19%)
Sufficient: 30-100 ng/mL	43 (16%)	23 (14%)	20 (18%)

4.3 Vitamin D Levels of Females from Different Age Groups

The results have shown that 86% of females had insufficient vitamin D levels between 0 – 29 ng/mL (Table 4). Only 23 (14%) of the female participants had optimal levels (30 – 100 ng/mL) (Table 4). The age of 45% of the female patients that were tested for vitamin D deficiency was between 20 – 39 years, and only 14 of them were aged 19 or younger. There was a total of 166 patients, and the results of this study have been divided into six groups.

The first group, which was between the age of 19 or younger have showed that only 7% of the 14 female patients had sufficient vitamin D levels (30 – 100 ng/mL) (Table 4). The second group was between the ages of 20 – 29, and the results showed that 20 (65%) patients were deficient (0 – 20 ng/mL), and 7 (22%) had vitamin D levels between 21 – 29 ng/mL (Table 4). A high level of vitamin D deficiency was shown in the age range of 20 – 29, with a total of 87% (Table 4). In the third group, which included ages between 30 – 39, 38 (73%) showed a deficiency in the range of 0 – 20 ng/ml, and 9 (17%) of them showed insufficiency (21 – 29 ng/mL) (Table 4). The results of the fourth group with the age range of 40 – 49 showed that 16 (53%) of the patients had vitamin D levels between 0 – 20 ng/ml, and 8 (27%) with levels between 21 – 29 ng/mL (Table 4). The results of group five, which included the ages between 50 – 59, showed that 7 (35%) had deficient vitamin D levels and 10 (50%) had insufficient levels (Table 4). The sixth group who participated in this study were aged 60 or higher, with 12 (63%) of the patients having levels between 0 – 20 ng/mL and 3 (16%) showing levels between 21 – 29 ng/mL (Table 4).

Table 4: Vitamin D levels in females of different age groups

Vitamin D Levels	Age						TOTAL
	≤ 19	20 – 29	30 – 39	40 – 49	50 – 59	≥ 60	
0 – 20 ng/mL	10 (72%)	20 (65%)	38 (73%)	16 (53%)	7 (35%)	12 (63%)	103 (62%)
21 – 29 ng/mL	3 (21%)	7 (22%)	9 (17%)	8 (27%)	10 (50%)	3 (16%)	40 (24%)
30 – 100 ng/mL	1 (7%)	4 (13%)	5 (10%)	6 (20%)	3 (15%)	4 (21%)	23 (14%)
TOTAL	14	31	52	30	20	19	166

4.4 Vitamin D Levels of Males from Different Age Groups

Out of 109 males, 67 (62%) had vitamin D levels between 0 – 20 ng/ml, and 22 (20%) had levels between 21 – 29 ng/mL, which makes a total of 82% that was below the optimal range (30 – 100 ng/mL) (Table 5). The male patients were divided into six different age groups. The first group included those who were aged 19 or younger, and 14 (70%) displayed vitamin D deficiency, while 5 (25%) showed insufficiency (Table 5). In the second group, which was from the age range of 20 – 29, 11 (79%) were deficient (0 – 20 ng/mL), and 2 (14%) had insufficient vitamin D levels between 21 – 29 ng/mL (Table 5). The results have shown that the third group, ages 30 – 39, had a total of 15 (54%) patients that had deficient vitamin D levels and 8 (28%) had levels between 21 – 29 ng/mL (Table 5). The results of the fourth group that consisted of the ages of 40 – 49 years displayed that 13 (62%) of the patients showed deficiency and 3 (14%) had insufficient vitamin D levels (Table 5). The fifth group, which was between the ages of 50 – 59 years, showed that 10 (67%) of the patients had deficient vitamin D levels (Table 5). The sixth group who participated in this study were aged 60 or higher, and 4 (36%) had deficient vitamin D levels while another 4 (36%) patients had insufficient levels between 21 – 29 ng/mL (Table 5). In total, a small percentage (18%) from all the age groups in males had sufficient levels of vitamin D (30 – 100 ng/mL) (Table 5).

Table 5: Vitamin D levels in males of different age groups

Vitamin D Levels	Age						TOTAL
	≤ 19	20 – 29	30 – 39	40 – 49	50 – 59	≥ 60	
0 – 20 ng/mL	14 (70%)	11 (79%)	15 (54%)	13 (62%)	10 (67%)	4 (36%)	67 (62%)
21 – 29 ng/mL	5 (25%)	2 (14%)	8 (28%)	3 (14%)	0	4 (36%)	22 (20%)
30 – 100 ng/mL	1 (5%)	1 (7%)	5 (18%)	5 (24%)	5 (33%)	3 (28%)	20 (18%)
TOTAL	20	14	28	21	15	11	109

4.5 Analysis of Data

According to the results, there is no significant difference between vitamin D levels and the gender of the patients. The mean of the females' vitamin D levels was 18.62, with a standard error of 0.9657 (Table 6). The mean and standard error of the males' vitamin D levels was 20.89 and 1.423, respectively (Table 6).

Table 6: Mean and standard error of vitamin D levels of both gender groups

	Total	Mean ± SEM
Female	166	18.62 ± 0.9657
Male	109	20.89 ± 1.423
P-Value	0.1729	

After conducting the Kruskal-Wallis test for the female group based on their age, the results showed that the difference was significant between the ages of 19 or lower and 50-59 (Figure 4). The median for the ages of 19 or lower was 9.835, with a 25% Percentile of 6.8 and the 75% Percentile as 23.25 (Figure 4). For ages between 20-29, it displayed a median of 12 and the 25% Percentile/75% Percentile as 6.8 and 28, respectively (Figure 4). Between the ages of 30-39, the median was 14, with 9.265 as the 25% Percentile and 22.50 as the 75% Percentile (Figure 4). A median of 16.54 was displayed for the age group of 40-49, and the 25%/75% Percentile was 9.47 and 29, respectively (Figure 4). For the age group of 50-59, the median was 23.50, the 25% Percentile was 16.28, and the 75% Percentile was 27.65 (Figure 4). From the age of 60 and older, the median was 16.89, the 25% Percentile was 12.19, and the 75% Percentile was 29.69 (Figure 4). The correlation test did not indicate a relationship between the females' ages with their vitamin D levels.

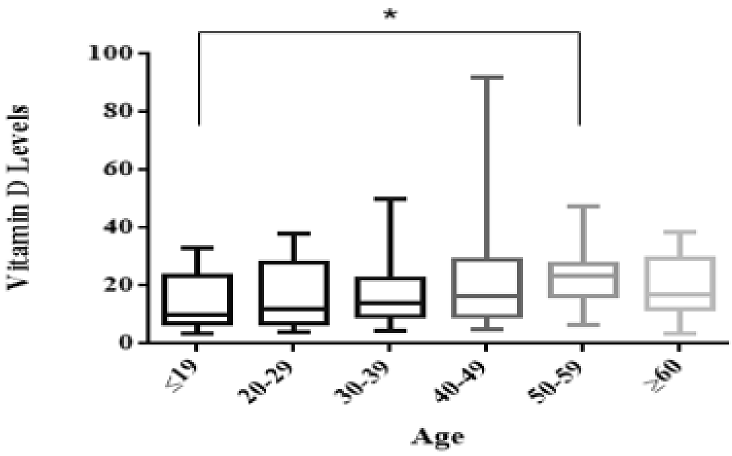

Figure 2: Median and 25%/75% Percentile of females of different age groups (GraphPad Prism)

According to Kruskal-Wallis, there was no significant difference between the male age groups (P-value = 0.4223). The median for the age group of nineteen or lower was 15.69, with the 25% percentile as 12.28 and the 75% percentile as 21.75 (Figure 5). The age group of 20-29 displayed a median of 13.69 (25% percentile = 11.55 and 75% percentile = 17.06) (Figure 5). From ages 30-39, the median was 16.63; the 25% percentile was 10.06, and the 75% percentile was 27.50 (Figure 5). The median for the age group of 40-49 was 19.03, with a 25% percentile of 11.46 and 75% percentile as 28.42

(Figure 5). For the age group of 50- 59, the median was shown as 15 (25% percentile = 10.07 and 75% percentile = 31) (Figure 5). From the ages of 60 and older, the median was 26, with the 25% percentile as 13 and the 75% percentile as 30.39 (Figure 5). After conducting the correlation test, it was confirmed that there was no effect of the males' ages on the vitamin D levels.

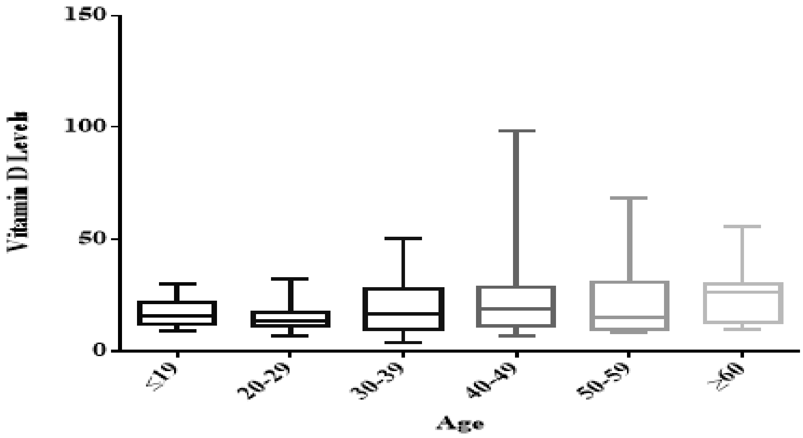

Figure 3: Median and 25%/75% Percentile of males of different age groups (GraphPad Prism)

5. Discussion

There were many major aims of this study. One of these was to determine the vitamin D levels among a population of 275 patients examined at different laboratories and hospitals in Erbil. The main methods that were used for evaluation were by comparing the medical analysis report of the patients to the standard vitamin D levels, which were divided into deficient, sufficient, and insufficient. The second aim was to compare the relation of the selected factors such as gender and age with vitamin D deficiency. The third objective of this project was to determine whether vitamin D deficiency is becoming an epidemic in Erbil.

Erbil usually has very sunny weather, so it is expected that the population has optimal vitamin D levels. However, this study indicated that a great percentage of the inhabitants showed vitamin D levels below the optimal range (30 – 100 ng/mL). This was comparable to a similar study done in Erbil City, which specified that a high percentage of the people were vitamin D deficient (Abdulrahman and Rahman, 2018). A study carried out in Sulaymaniyah City, Iraq, showed that 93% of the samples (n = 3520) displayed vitamin D levels below the optimal range of 30 – 100 ng/mL (Abdullah et al., 2018). Low vitamin D levels seem to be common in the Middle East. A review study conducted in Saudi Arabia by Al-Daghri (2018) stated that between 2011-2016, a total of 81% of the population showed deficient vitamin D levels.

The results of the current study were divided according to gender, age, and vitamin D levels. In the female group, 86% of the patients were below optimal vitamin D levels, while 82% of the males showed low levels (Table 2). In Erbil city, the vitamin D deficiency levels were comparable between males and females with no significant variations, and this may be due to the traditional attire, which prevents the absorption of the necessary sunlight exposure and explains the reason for such a great percentage of deficit. Another study carried out by Khazaei et al. (2018) on 102 patients tested for vitamin D showed there was no relationship between gender and vitamin D deficiency.

According to the correlation test, the results illustrated that there is no significant relationship between the age of the individuals and vitamin D deficiency in comparison to the study that was conducted previously by Abdulrahman (2018) in Erbil City, indicating a relationship between vitamin D levels and age groups. Perhaps, this is due to the difference in the sample sizes used in the researches.

Vitamin D deficiency is one of the commonly underdiagnosed disorders that started increasing in the world. There is much evidence from hundreds of studies around the world that showed and suggested that vitamin D deficiency is related to various chronic illnesses (Hossein-nezhad and Holick, 2013). Our research study suggested that vitamin D deficiency is increasing in Erbil city, and it could be an epidemic disorder that may lead to many chronic diseases in Erbil. In order to avoid extensive health consequences, educational programs about vitamin D aimed towards the general public have been suggested (Lhamo et al., 2017).

6. Conclusion and Recommendations

One of the necessary vitamins that are vital for the structure and maintenance of healthy bones is vitamin D. Vitamin D has a vital role in the absorption of calcium, which is the primary component of bones (Khazaei et al., 2018). Vitamin D can be obtained by the body when exposed to direct sunlight and convert the chemical, 7-dehydrocholesterol, into an active form of the nutrient (Khazaei et al., 2018). Vitamin D is naturally found in very few food products such as milk, cereal, and fatty fish, including salmon and sardines.

The study indicates a dramatic increase in deficiency of vitamin D levels among citizens in Erbil city, which potentially leads to an epidemic source of numerous unwanted health problems. The results displayed that 84% of the patients had vitamin D levels below the optimal range (30 – 100ng/mL). Gender and age did not show a significant effect on vitamin D levels. Vitamin D deficiency can cause major health risks as it is linked to diabetes, cardiovascular disease, hypertension, rickets, and osteoporosis (Holick, 2010). Vitamin D is very vital for regulating the number of nutrients such as calcium and phosphate in the body. This is important for the normal development of bones, teeth, muscles, etc. (Ross et al., 2011). According to a study conducted in Erbil city, Iraq, by Zangana et al. (2016), the data suggested that deficient vitamin D levels and high parathyroid hormone levels have a relationship with left ventricular hypertrophy in the patients who are diagnosed with hypertension.

The data showed that there is a high percentage of vitamin D deficiency in the Erbil population. Therefore, it is recommended to obtain adequate exposure to sunlight, a balanced diet rich in vitamin D, and supplements as a source to maintain a healthy level of this vital nutrient.

6.1 Further Studies

The data set presented in this study has provided significant results about vitamin D deficiency in Erbil city, which has affected human health. This information also suggests several areas for future studies such as increasing the size of samples, expanding the geographic areas to include more cities in Kurdistan such as Erbil, Sulaymaniyah, and Duhok, and studying the relation between vitamin D deficiency with other mineral deficiencies and unbalanced hormones. Also, the laboratories need proficiency in recording data through technology for easier accessibility and reliability.

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