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Assessing the Prevalence of Vitamin D Deficiency: The Interplay with Diet, Weather, COVID-19, and Age, using SPSS Analysis

تقييم حالة نقص فيتامين D
التفاعل مع النظام الغذائي والطقس وكوفيد-19 والعمر، باستخدام تحليل برنامجSPSS

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Abstract:
Vitamin D is crucial in various physiological processes, influenced by a complex interplay of environmental and genetic factors. Recent studies highlight the impact of diet, weather, age, and the COVID-19 pandemic on vitamin D levels and its overall effectiveness. Understanding these interactions is essential for developing comprehensive health strategies to perfect vitamin D status across diverse populations. This narrative study focused on data collected and available evidence among different ages and genders in the city of Bani-Waleed - Libya. The evidence shows a wide range of vitamin D with different diet programs. Other factors were detected to connect them with the deficiency of vitamin D, including the Coronavirus infection and the intake of antibiotic supplements. Results indicated that vitamin D levels increased by 10% as age increased. The elderly, who were

defined as having a higher risk of vitamin D insufficient, were found to have the best range of vitamins in their body. Children were indicated with a deficiency rate of approximately 73.13% compared to adult people (15–30 years old) with a deficiency rate of 91.25%.

Keywords: **vitamin D deficiency**, **nutrition diet**, **Coronavirus**, **antibiotic supplements**.

الملخص:

فيتامين د ضروري في العديد من العمليات الفسيولوجية، ويتأثر بتفاعل معقد من العوامل البيئية والوراثية. تسلط الدراسات الحديثة الضوء على تأثير النظام الغذائي والطقس والعمر وجائحة كوفيد–19 على مستويات فيتامين د وفعاليته بشكل عام. إن فهم هذه التفاعلات ضروري لتطوير استراتيجيات صحية شاملة لتحسين حالة فيتامين د بين مختلف السكان. ركزت هذه الدراسة السردية على البيانات التي تم جمعها والأدلة المتاحة بين مختلف الأعمار والجنسين في مدينة بني وليد – ليبيا. تظهر الأدلة مجموعة واسعة من فيتامين د مع برامج غذائية مختلفة. تم الكشف عن عوامل أخرى لربطها بنقص فيتامين د، بما في ذلك عدوى فيروس كورونا وتناول مكملات المضادات الحيوية. أشارت النتائج إلى أن مستويات فيتامين د زادت بنسبة 10٪ مع تقدم العمر. وجد أن كبار السن، الذين تم تعريفهم على أنهم أكثر عرضة لنقص فيتامين د، لديهم أفضل مجموعة من الفيتامينات في أجسامهم. تم الإشارة إلى الأطفال بمعدل نقص يبلغ حوالي 73.13٪ مقارنة بالبالغين (15–30 عامًا) بمعدل نقص 91.25٪.

الكلمات المفتاحية: نقص فيتامين د، النظام الغذائي، فيروس كورونا، مكملات المضادات الحيوية.

Introduction:

Vitamin D is no longer defined as a vitamin, it's a bro hormone with great importance to the body. It's associated with many skeletal and non-skeletal disorders, Vitamin D is essential for maintaining calcium and phosphorus levels and a deficiency can led to various health issues and diseases (Kevin, 2019). Spiro & Buttriss (2014) defined the prevalence of vitamin D deficiency as a plasma level of 25(OH)D below 25 nmol/l. Sunlight is the primary source of vitamin D, stimulating the production of vitamin D3 in the skin, which varies depending on age, skin pigmentation, clothing style, and sunscreen use (Lips *et al.*, 2014). Other sources of vitamin D include diet and fortified foods, while risk factors for

deficiency include air pollution, latitude, season, Sun exposure avoidance, melanin in pigmented skin, and proper use of sun protection creams (Cui *et al.*, 2023; Macdonald, 2012; Pfeifer & Minne, 2002) can significantly reduce vitamin D synthesis., sedentary lifestyle, and diet (Cui *et al.*, 2023).

Vitamin D levels can be increased by consuming fatty fish and through the fortification of milk or orange juice. A high intake of dietary calcium has a sparing effect on vitamin D as it extends the half-life of 25(OH)D (Lips *et al.*, 2014). However, seasonal changes have been associated with several conditions, consistent with seasonal variations in serum 25-OHD (Cui *et al.*, 2023; Pfeifer & Minne, 2002). Reports from various countries' nutrition surveillance data have shown that habitual vitamin D intakes in the population are much lower than the recommendations due to limited sources of vitamin D that are infrequently consumed (Kevin, 2019). Mihail and Mira (2023) reported that the intake of vitamin D supplements should be tailored accordingly, with a daily recommended intake of 800–2000 IU. Earlier reviews have examined serum 25(OH)D levels and vitamin D deficiency in various regions, but there is still no comprehensive study on the global and regional prevalence of vitamin D deficiency (Cui *et al.*, 2023). The use of supplements is essential and appears to be high in some countries. Current dietary intake recommendations are too low to keep or reach best S-25-OHD concentrations when there is no exposure to UVB radiation (Lamberg, 2006). As (Nakamura *et al.*,2002) mentioned in their research, for elderly individuals who do not receive sufficient sunlight, consuming good di*et al*one may not be adequate, and taking vitamin D supplements additionally.

Generally, the risk of vitamin D deficiency increases in older adults, not only due to reduced skin production of vitamin D with age but also because of age-related factors that can result in limited sun exposure, as they likely to be more housebound (Spiro & Buttriss, 2014). An analytical study reported by (HA Bischoff *et al.*, 2004) mentioned that there is an inverse relationship between age and expression of the 1,25-dihydroxy vitamin D receptor (VDR), the study found that older age was significantly associated with decreased VDR expression. A study called the Survey in Europe on Nutrition and the Elderly, a Concerted Action (SENECA) found that older men had higher average levels of serum 25(OH)D than older women,

specifically, 36% of older men and 47% of older women had 25(OH)D serum concentrations below 30 nmol/l (Spiro & Buttriss, 2014). This may have a related aspect to the body mass indicator (BMI), where men usually have a higher body mass than women, this was reported in a study by Martin and his colleagues (2002), which assessed the relationship between vitamin D and body mass index in a sample of 483 adults, showing a positive correlation between vitamin D levels and body mass. This highlights the correlation between vitamin D and gender, with men generally having higher body mass compared to women. However, a study aimed at assessing the correlation between the serum level of 25(OH) vitamin D and body mass index in Egypt found that overweight individuals are negatively correlated with 25(OH) D levels (Zamzam *et al.*, 2019). Another report suggests a different outcome, published by (Alaniz *et al.*, 2018) disagreed when they found a high deficiency of vitamin D in men when compared to women, mentioning that obesity can affect the levels of vitamin D in the body.

The use of supplements is important and appears to be high in certain countries. In a European study, it was found that approximately 38% of elderly women, on average, used supplements, with the highest usage in Denmark (62%) and the lowest in Poland (23%). In comparison, 19% of 12-year-old girls took supplements, with Denmark again showing the highest use (34%) and Poland the lowest (11%) (Calvo *et al.*, 2005). When it comes to the exact amount of vitamin D intake, it leads to a controversial aspect. The recommended dietary intake of vitamin D varies between countries, often based on US dietary reference intakes (DRIs) (Lamberg, 2006). In the study published by (Lamberg, 2006), reported that the recommended guidelines to vitamin D supplements should be raised to at least 10 go per day in all age groups when solar UVB is scarce. The elderly may need a daily intake of 25 go of vitamin D. It is essential to increase their dietary intake of vitamin D and to change their food habits accordingly. In 2005, Calvo and colleagues compared intake reports from 72 studies. These studies provided quantified vitamin D intake estimates from various sources such as Food Frequency Questionnaires (FFQs), 24-hour recalls, or multiple-day food records. The purpose was to prove how food fortification, dietary supplement use, or high fish consumption in specific dietary

patterns can affect these intake estimates, especially when extensive food fortification is not present. Environmental factors and personal characteristics prevent or impede dermal synthesis. There are several complexities and concerns in advocating sun exposure as a public health approach to increasing vitamin D status. Data indicated that there is a pressing need to address this deficiency even using the most conservative serum 25(OH)D threshold of < 25/30 nmol/L in both low- and high-income country settings (Kevin, 2019).

There is no consensus on the ideal plasma levels of vitamin D, but the blood levels of 25-hydroxyvitamin D [25(OH)D] are often lower than the recommended range for the general population. This deficiency is especially pronounced in certain subgroups of the population (Spiro & Buttriss, 2014). A summarized published data on vitamin D intake and the estimated prevalence of vitamin D deficiency, was reported by (Cui *et al.*, 2023) indicating the global prevalence of low serum 25-hydroxyvitamin D levels is high, with 15.7% having levels less than 30 nmol/l, 47.9% less than 50 nmol/l, and 76.6% less than 75 nmol/l. While there was a slight decrease in prevalence from 2000–2010 to 2011–2022, it remains high.

Illi *et al* (2019) has published that Vitamin D levels are severely low in the aging population who also the most vulnerable group of the population to COVID-19. Several studies have identified a potential correlation between the average vitamin D levels (Victor & Florentin, 2020), In a study conducted by (Ghasemian *et al.*, 2021), it was found that most COVID-19 patients suffered from either a deficiency or insufficiency of vitamin D. The study also revealed that individuals deficient in vitamin D had approximately three times higher risk of contracting SARS-CoV-2 and were about five times more likely to develop a severe form of the disease. However, the research did not find a significant association between vitamin D deficiency and mortality rates in this population, which is similar to a study in different European countries published by (Feketea *et al.*, 2021). The results of the study made by (Suvarna & Mohan, 2020) suggested that an increase in serum 25(OH)D level in the body could either improve clinical outcomes or mitigate worst (severe to critical) outcomes, while a decrease in serum 25(OH)D level in the body could worsen clinical outcomes of COVID-2019 patients. The connection between vitamin D and the infection with covid-19 has been related to the ACE2

factor. ACE2 (the receptor for viral cell entry) deficiency is associated with alterations in tissue repair and vascular permeability, as well as fluid accumulation in extra-alveolar spaces (Fabio *et al.*, 2019). Calcitriol (1,25-dihydroxy vitamin D3) has a significant impact on the ACE2 axis, which handles mediating infection by SARS-CoV-2, leading to increased expression of ACE2. This suggests a higher risk of infection (Illi *et al* 2019).

This research aims to study the impact of diet, vitamin D supplements, and sun exposure on blood vitamin D levels in different age groups. The primary hypothesis of this research is that there are significant differences in blood vitamin D levels between various age groups and among groups following different diets, using different vitamin D supplements, or having varying levels of sun exposure.

The scientific and practical significance of this research lies in its potential to identify factors influencing blood vitamin D levels, thereby improving the health and quality of life of different age groups.

Data collection:

Results were collected from approximately 500 individuals within the city of Bani Walid, Libya, over the consecutive years of 2022 and 2023. These individuals were sourced from five different city-accredited laboratories under the Libyan Ministry of Health. The sample pool encompasses varying ages from 1 to 90 years, representing both genders, derived into four groups: (1-15/ 15 -30/ 30-50/ 50 – +). These groups aim to reflect the familial diversity within Bani Walid. Subsequently, the samples were categorized into four main age groups and eight subgroups based on gender. The total number of samples was 502, with 349 females (69.52%) and 153 males (30.47%).

Statistical Analysis

In this research, the SPSS program was used for the statistical analysis of the obtained data. This was done to identify the significant differences in vitamin D levels, as well as the rate of deficiency and excess in relation to age, and the relationship between vitamin D levels, age, and gender. The data was analyzed

statistically for each age group separately and then the overall data for all ages and both genders was analyzed.

Investigation and Attempt to Identify the Cause of the Widespread Deficiency within the City

A specific questionnaire was designed concerning vitamin D, nutrition, COVID-19 infection, and the use of antibiotics. This was done to try to understand and link some causes to vitamin D deficiency. The questionnaire was randomly distributed to various age groups, including elementary and high school students, university students, housewives, the elderly, some patients at the city's main hospital, and some clinics within the city limits.

Results & Discussion:

The collected data showed a variation in the vitamin D levels among 502 individuals (349 females and 153 males), aged between 1 and 90 years, within the city of Bani Walid. This data was recorded over two consecutive years, 2021 and 2022. The obtained results were divided into four age groups, and then the vitamin D levels in males and females within each group were compared separately, as mentioned in the previous chapter. The data showed the following results:

Group 1: Ages 1–15 Years

The results showed a significant decrease in vitamin D levels in this group (below the minimum vitamin D level of 30 nanograms/ml), with a deficiency rate of approximately 73.13%. The graph in Figure 1 illustrates the distribution of vitamin D levels between males and females.

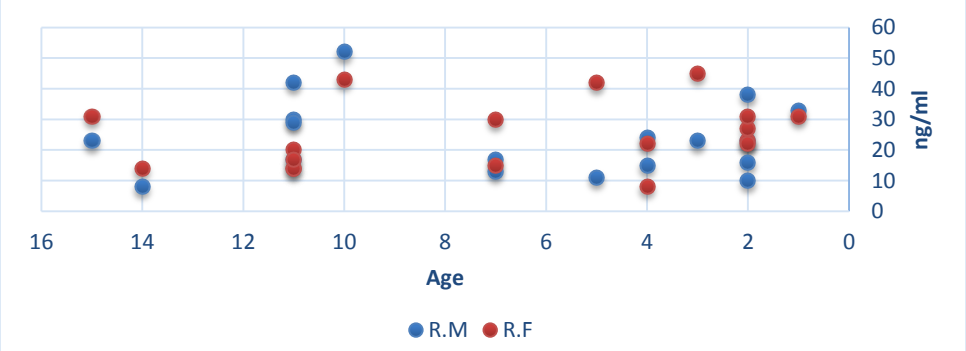

Figure 1: Vitamin D levels among (1–15 ages).

Group 2: Ages 15–30 years

The results for this group showed the highest rate of decrease in vitamin D levels, with a deficiency rate of 91.25%. Figure 2 illustrates this sharp decline. The results also indicated that this group included the lowest recorded vitamin D level in this study, which was for a 26-year-old female with a level of 1 nanogram/ml.

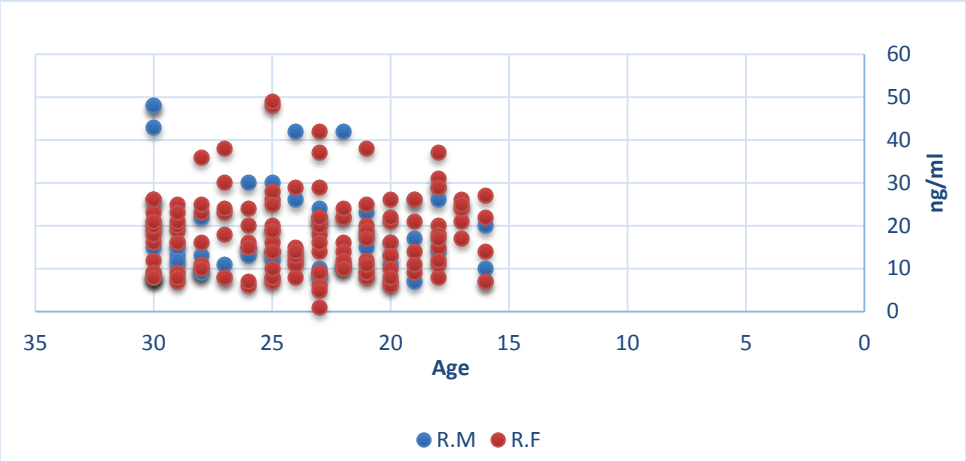

Figure 2: Vitamin D levels among (15–30 ages).

Group 3: Ages 30–50 years

The results showed the lowest rate of vitamin D decrease in this group compared to the other groups, with a deficiency rate of 73%. Figure 3 graphically illustrates the distribution of males and females, where the vitamin D levels in males were higher than in females.

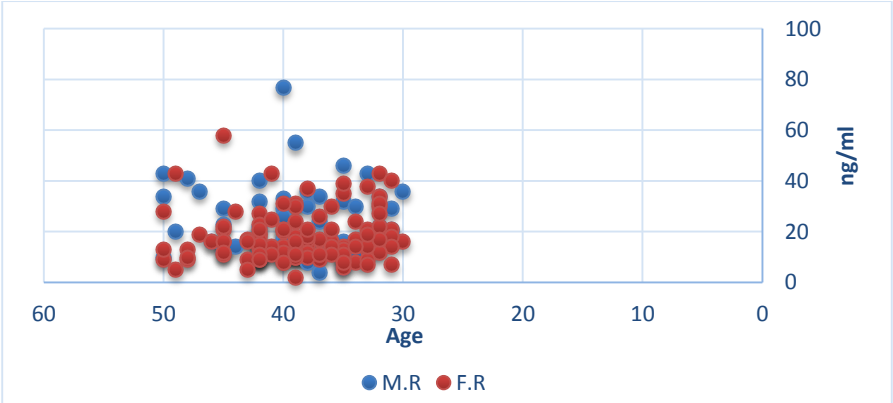

Figure 3: Vitamin D levels among (30–50 ages).

Group 4: Ages 50 and Above

The results showed that the vitamin D deficiency rate in this group was 77%. This group also recorded the highest vitamin D level, which was 67 nanograms/ml, in a

60-year-old female. This result agreed with the study of Heidari & Haji (2011) where vitamin D levels are close to normal level in the elderly, as well as (Tieland *et al.*, 2013) who concluded that their study results indicated an inverse association between serum 25(OH)D concentration and frailty severity of elderly. Contrary to the expectations of previous studies, where vitamin D deficiency is more common among the elderly than younger age groups (Beaudart, & Rizzoli, 2014), Figure 4 shows the graphical distribution of vitamin D levels between males and females in this age group."

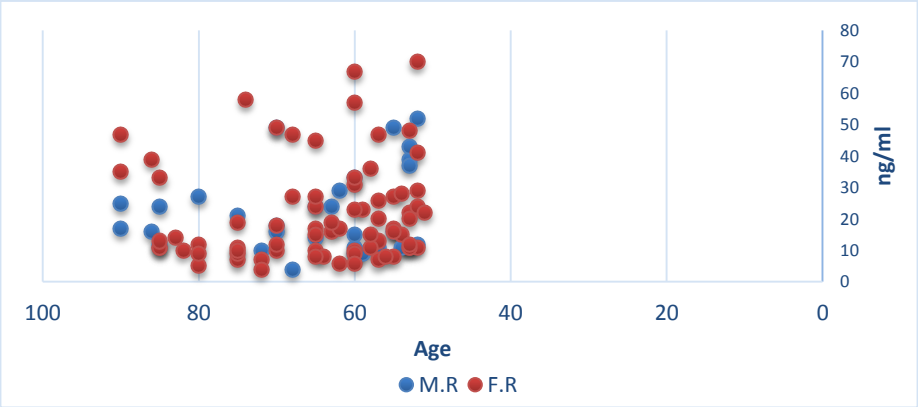

Figure 4: Vitamin D levels among (50 – + ages).

Comparison of Average Vitamin D Levels Between Age Groups for Both Genders: The arithmetic mean values for both males and females in each group were determined separately for comparison. The results showed that the highest average vitamin D level was in females aged 1-15 years, with an average of 23.76 nanograms/ml. For males, the highest average vitamin D level was in the 30-50 years age group, with an average of 23.58 nanograms/ml. The lowest average value was 17.48 nanograms/ml for females in the 15-30 years age group. Figure 5 illustrates the comparison between these averages.

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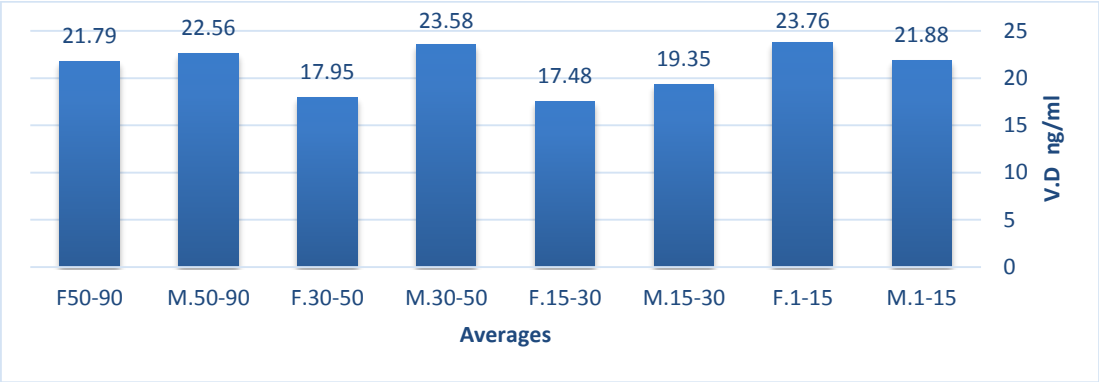

Figure 5: **Average Vitamin D Levels Between Age Groups for Both Genders**

120 Volunteers Participated in this Survey from Different Age Groups:

The survey was designed to attempt to understand the potential causes associated with decreased vitamin D levels across different genders and age groups from the researcher's perspective.

The results of this survey highlighted several points that may be major causes of the severe vitamin D deficiency in the various groups:

- The use of animal fats such as butter or ghee in the diet or cooking with animal fats was low in all age groups except the 50 and above group.
- The consumption of vegetable oils like corn oil and sunflower oil was high compared to olive oil, except for males in the 30–50 group and females in the 50 and above group.
- The intake of antibiotics without a prescription was high, especially in the 15–30 and 30–50 groups.
- The intake of vitamin D supplements was low across all groups.
- The consumption of fast food was widespread, particularly in the 1–15, 15–30, and 30–50 groups, especially the second and third groups.
- Daily sun exposure was high, except for females in the 30–50 age group.

The following table shows the percentages obtained from the survey after statistical analysis, and the results were as follows:

Table 1: **the percentages obtained from the survey after statistical analysis**,

Age group	Sex	Animal fats intake	Olive oil intake	Anti bio intake	Covid 19	V.D supplement	Fast food	Sun exposure
1-15	M	12%	20%	20%	15%	18%	48%	90%
1-15	F	23%	18%	16%	10%	22%	55%	70%
15-30	M	15%	22%	65%	28%	10%	90%	75%
15-30	F	9%	34%	68%	20%	15%	89%	65%
30-50	M	28%	55%	60%	33%	35%	78%	85%
30-50	F	13%	20%	85%	24%	38%	84%	45%
50+	M	31%	55%	18%	18%	32%	20%	88%
50+	F	39%	62%	32%	30%	36%	30%	80%

Using the SPSS program, vitamin D levels for the age group (1-15) were compared, and it was found that as age increased, vitamin D levels decreased by 23%. The analysis results also showed no significant differences between genders, indicating that gender had no effect on vitamin D levels (no significant differences between males and females). Conversely, for the age group (15-30), as age increased, vitamin D levels increased by about 14%, with no significant differences between genders (gender had no effect on this group). For the 50 and above group, it was found that as age increased, vitamin D levels increased by 10%, and the analysis results showed no significant differences between genders, indicating that gender had no clear effect on the vitamin D levels in this group.

The SPSS program indicates that the increase rate is 1% with age (no clear effect of age). Unlike the previous two groups, significant differences between genders were found, indicating that gender had an impact on vitamin D levels, with values being clearly higher in males than in females. Additionally, the analysis showed a positive correlation between age and vitamin D levels, where results indicated that as age increased, the level increased by 0.07%. Regarding gender, its effect was significant in favor of males, with males having higher vitamin D levels than females across all age groups (gender had a significant effect on vitamin D levels).

From the above, it was observed that the collected data in this study, after statistically analyzing and comparing it with previous research in different regions

of the world, showed a high rate of vitamin D deficiency among both genders and all age groups. This could be attributed to several reasons, including:

1. **Study Conducted During COVID-19 Pandemic**: The study was conducted in 2021/2022, during the widespread prevalence of COVID-19 in Bani Walid. This may have significantly impacted individuals, leading to a decrease in vitamin D levels post-infection.

2. **Gender Impact on Vitamin D Levels**: The study revealed a gender effect on vitamin D levels, favoring males. This could be attributed to physiological factors between genders and sun exposure habits, where females, especially in younger age groups, tend to avoid direct sun exposure due to concerns about skin color change.

3. **Age Impact on Vitamin D Levels**: Although age had less impact compared to gender, there was noticeable deficiency in the age group (1-15 years). Previous studies in different countries corroborated this deficiency, which could be attributed to reasons such as:

- Inadequate intake of vitamin D supplements. WHO recommends a daily intake of 400 international units, which is difficult to achieve through natural diet, especially in Libya, due to the types of daily consumed foods.
- COVID-19 infection, as it affects the body's immune system, leading to a decrease in vitamin D levels in the blood.
- Low consumption of animal fats, which are necessary for the absorption of vitamin D.
- High consumption of fast food, especially in the 15-30 age group, containing saturated fats, directly affecting vitamin D absorption.
- High use of antibiotics in Bani Walid, indirectly affecting vitamin D levels by disrupting the gut microbiota and digestion process, which are directly related to vitamin absorption.
- Low consumption of olive oil in the diet, particularly in younger age groups. Olive oil, rich in monounsaturated fats, aids in vitamin D absorption.

Overall, the study underscores the multifactorial nature of vitamin D deficiency and highlights the importance of addressing dietary habits, supplement intake, and other lifestyle factors to mitigate deficiencies effectively.

Conclusion:

Vitamin D appears to be generally deficient, especially in a sunny climate city like Bani Walid, which tends to increase relatively with age. These conclusions still need to be reinforced by subsequent studies, especially since the deficiency of this vitamin is associated with several other factors, including levels of other vitamins and minerals, obesity, and diabetes. However, it serves as an important and foundational database and reference for future studies and research.

Recommendations:

This study recommends the necessity of raising awareness among people to consume foods rich in vitamin D and enhance their health with vitamin D supplements, in addition to adequate exposure to sunlight. Furthermore, conducting broader future studies and providing necessary data to assess vitamin D levels and identify the reasons for its deficiency among all segments of society in the region and other areas is crucial.

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