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Prevalence and Correlation of Vitamin B12 and Vitamin D Levels Among Jordanian Patients

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Abstract

Introduction: Essential nutrients for many physiological processes, such as bone integrity and neurological functioning, include vitamin D and B12. Notwithstanding their significance, deficits in these vitamins are common and can result in serious health issues. The objective of the study is to evaluate the vitamin B12 and vitamin D levels in a convenient sample of Jordanians who were referred to the Royal Medical Services' King Hussein Medical Center, a major referral medical center in the capital city of Jordan, Amman. *Methods:* For this study, a total of 70 participants—45 females and 25 males—were randomly chosen. Vitamin B12 and Vitamin D levels were determined by analyzing blood samples already requested for medical purposes. To compare levels and insufficiency rates between sexes, descriptive statistics were calculated and independent samples t-tests and chi-square tests were used. To investigate the correlations between age, vitamin B12, and vitamin D levels, Pearson correlation coefficients were computed. *Results:* The mean levels of vitamin B12 and vitamin D in females were 388.10 pg/mL and 21.40 ng/mL, respectively. The mean levels of

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vitamin B12 and vitamin D in males were 429.91 pg/mL and 25.44 ng/mL, respectively. There were no discernible variations in vitamin B12 and vitamin D levels between the sexes ($p > 0.05$). On the other hand, males (9.5%) had considerably greater levels of vitamin B12 deficiency than females (0.0%) ($p = 0.036$). Males' vitamin B12 and vitamin D levels showed a significant positive correlation ($r = 0.448$, $p = 0.042$) as did the pooled sample ($r = 0.316$, $p = 0.020$). *Conclusion:* The study shows that there is a significant positive correlation between vitamin B12 and vitamin D levels and that male participants were more likely to be insufficient in vitamin B12. These findings highlight the necessity of focused dietary interventions and public health initiatives to address and prevent these deficiencies in the Jordanian population. The high prevalence of vitamin B12 and D deficiencies underscores the urgent need for public health strategies, including educational campaigns, nutritional supplementation programs, and dietary modifications, to improve the nutritional status and overall health outcomes in Jordan.

Keywords: Vitamin B12, Vitamin D, deficiency, Jordan, King Hussein Medical Center, nutritional assessment, public health

Introduction

The vitamins B12 and D are vital and are involved in many physiological functions. Cobalamin, another name for vitamin B12, is essential for the healthy development of red blood cells as well as the brain and nervous system (NIH, 2021). It is naturally present in animal products and may be lacking in people who have malabsorption problems or inadequate dietary intake (ODS, 2022). As a fat-soluble vitamin, vitamin D is essential for healthy bones and the absorption of calcium (Holick, 2007). Sunlight exposure can cause the body to synthesize it; however, shortages are frequently caused by inadequate sun exposure, insufficient nutrition, or malabsorption (Holick, 2007; ODS, 2022).

These vitamin insufficiencies are common around the world and linked to a number of health issues. Cognitive deficits, neurological disorders, and megaloblastic anemia can result from a vitamin B12 shortage (Stabler, 2013). In a similar vein, a lack of vitamin D has been connected to an increased risk of chronic illnesses like cardiovascular disease and some types of cancer, as well as bone problems like osteomalacia in adults and rickets in children (Holick, 2007; Pilz, 2011). Studies are required to determine the degree and consequences of certain micronutrient deficiencies because, like many other nations, Jordan's prevalence of these deficiencies has not been fully examined (WHO, 2019).

The objective of this study is to evaluate the vitamin B12 and vitamin D levels in a random sample of Jordanians who were sent to the Royal Medical

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Services' King Hussein Medical Center, a major referral medical center in the capital city of Jordan, Amman. We compare the levels between male and female participants, look for relationships between age, vitamin B12, and vitamin D levels, and determine the prevalence of deficiencies and possible insufficiencies by looking at these levels.

Significant global issues about vitamin B12 and vitamin D deficits have been brought to light by earlier studies. For example, according to a study by Allen et al. (2010), vitamin B12 deficiency affects about 6% of people in the United States and the United Kingdom who are 60 years of age or older, with larger percentages seen in underdeveloped nations. Similar to this, Holick (2007) reported that around a billion individuals globally suffer from a widespread vitamin D shortage.

Studies conducted in the Middle East have revealed differing prevalence rates of various insufficiencies. According to a Saudi Arabian study, 40% of adults had vitamin D levels that were below 20 ng/mL, which is considered deficient (Ardawi et al., 2012). El-Hajj Fuleihan et al. (2001) reported that 60% of teenage girls in Lebanon had Vitamin D levels that were below the recommended threshold. Although there is a shortage of data on Jordan, research from nearby nations indicates that similar trends are quite likely. Future studies should consider examining deficiencies in other vitamins, such as vitamin B12, and report these findings stratified by sex. Furthermore, investigating potential correlations between vitamin levels could provide a more comprehensive understanding of nutritional health in the region.

The literature surrounding vitamin deficiencies in the Middle East reveals a complex interplay between dietary habits, public health initiatives, and cultural factors that contribute to the prevalence of micronutrient deficiencies. (Hwalla et al., 2017) provide a foundational understanding of the micronutrient landscape in the region, highlighting that suboptimal nutrient status among adults is linked to an increased risk of chronic diseases. Their analysis underscores the importance of adequate vitamin and mineral intake, which is essential for mitigating the risks associated with inadequate micronutrient levels. The authors note that while government-mandated food fortification programs have been implemented, many remain small-scale and outdated, leading to persistent public health challenges, such as the ongoing prevalence of anemia and neural tube defects (NTDs) despite interventions like folic acid fortification. This calls for a critical reassessment of national data to guide effective policy-making and program development.

The focus on vitamin D deficiency is further elaborated by (Gariballa et al., 2022), who investigate the prevalence and health implications of vitamin D deficiency among UAE citizens. Despite the region's abundant sunlight, the study reveals that vitamin D deficiency is widespread, indicating a disconnect

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between environmental factors and actual health outcomes. This observation sets the stage for a deeper exploration of the underlying causes of vitamin D deficiency, as discussed by (Qureshi et al., 2024). Their work emphasizes that lifestyle factors, including dietary habits and cultural practices, significantly influence vitamin D synthesis and absorption. They highlight that traditional clothing and environmental pollution contribute to limited sun exposure, exacerbating the deficiency problem in a region that might otherwise be expected to have adequate levels of this vital nutrient.

Moreover, (Qureshi et al., 2024) advocate for a multi-faceted approach to combat vitamin D deficiency, emphasizing the need for educational initiatives that raise awareness about both the skeletal and non-skeletal health risks associated with hypovitaminosis D. Their findings point to a critical gap in public knowledge regarding the broader health implications of vitamin D deficiency, which extends beyond the commonly recognized conditions such as rickets and osteomalacia. This literature review thus aims to synthesize these insights and contextualize the urgent need for enhanced public health strategies to address vitamin deficiencies in the Middle East effectively.

The present study endeavors to bridge the knowledge gap in the literature by offering comprehensive information on the vitamin B12 and vitamin D status of Jordanians. This is due to the significance of sufficient levels of these vitamins for overall health and the possible high incidence of deficiencies in the Middle Eastern Arab region. The results will assist in guiding public health initiatives to mitigate and avoid these inadequacies.

Material and Methods

Study Population

A randomly chosen sample of patients from different parts of Jordan who were referred to the King Hussein Medical Center of the Royal Medical Services for other medical purposes made up the study population. It is noteworthy to mention that the King Hussein Medical Center is one of the major referral medical centers in the capital city of Jordan, Amman. Participants of all ages, both male and female, were included in the sample. As such, the sample of the present study is believed by the authors of the present study to likely represent the general population of Jordan. Adequate ethical approval was obtained from the IRB committee of the King Hussein Medical Center, and informed consents were obtained from all the participants according the guidelines of the IRB committee before the commencement of the study.

Seventy participants were included in the study: 25 males and 45 females. Tables 1, 2, and 3 provide the comprehensive demographic distribution and descriptive information of the participants.

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Inclusion and Exclusion Criteria

Participants were included in the study if they were Jordanian patients referred to the King Hussein Medical Center for medical assessments unrelated to vitamin deficiencies. Individuals were eligible regardless of sex or age, ensuring a broad representation of the general population.

Exclusion criteria were established to ensure the integrity of the study data. Patients were excluded if they had a known history of vitamin B12 or vitamin D supplementation within the past six months, any diagnosed metabolic disorders (such as chronic kidney disease, liver disease, or malabsorption syndromes), or recent major surgery that could impact vitamin levels. Additionally, individuals with ongoing pregnancy or lactation were excluded due to potential variations in vitamin levels. Patients with hematological or oncological diseases that could interfere with vitamin B12 and vitamin D metabolism were also excluded. Those who declined to provide informed consent were not included in the study.

Study Area

The study was conducted at the King Hussein Medical Center, a major referral medical facility in Amman, the capital of Jordan. This center is recognized as a leading institution in the region due to its specialized medical services and comprehensive healthcare capabilities, attracting patients from various parts of the country. Its status as a referral center is further supported by its accreditation and the expertise of its medical professionals, making it an ideal location for investigating vitamin deficiencies within a diverse patient population.

Sampling

The study population was comprised of a random sample of patients from various regions of Jordan who were referred to the King Hussein Medical Center for medical assessments related to other health issues. The sample included participants of all ages and both sexes. Ethical approval for the study was granted by the Institutional Review Board (IRB) of the King Hussein Medical Center. Informed consent was obtained from all participants in accordance with the guidelines set forth by the IRB prior to the initiation of the study. A total of 70 participants were included in the final sample, consisting of 25 males and 45 females. Detailed demographic information is provided in Tables 1, 2, and 3. The ethics committee's decision is pivotal and is documented at the conclusion of the article, prior to the references.

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Table 1. Descriptive statistics of female participants

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age (years)	45	63	4	67	39.36	17.54
VB12 level (pg/mL)	33	659.00	233.00	892.00	388.10	139.75
VD level (ng/mL)	45	44.81	6.31	51.12	21.40	10.83
Valid N (listwise)	33					

Std: Standard; N: number of participants; VB12: Vitamin B12; pg/mL: picograms per milliliter; VD: Vitamin D; ng/mL: nanograms per milliliter

Table 2. Descriptive statistics of male participants

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age (years)	25	81	2	83	47.04	22.39
VB12 level (pg/mL)	21	1134.00	134.00	1268.00	429.91	273.54
VD level (ng/mL)	25	45.05	7.98	53.03	25.44	13.45
Valid N (listwise)	21					

Std: Standard; N: number of participants; VB12: Vitamin B12; pg/mL: picograms per milliliter; VD: Vitamin D; ng/mL: nanograms per milliliter

Table 3. Descriptive statistics of all participants (sexes pooled)

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age (years)	70	81	2	83	42.10	19.60
VB12 level (pg/mL)	54	1134.00	134.00	1268.00	404.36	201.12
VD level (ng/mL)	70	46.72	6.31	53.03	22.84	11.90
Valid N (listwise)	54					

Std: Standard; N: number of participants; VB12: Vitamin B12; pg/mL: picograms per milliliter; VD: Vitamin D; ng/mL: nanograms per milliliter

Data Collection

Data were collected through standard medical examinations performed at the King Hussein Medical Center. Participants provided blood samples for the measurement of vitamin B12 and vitamin D levels, which were assessed as part of their routine medical evaluations.

Measurement of Variables

The following were the main variables this study measured:

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- Age: Stated as years.
- The level of vitamin B12 is expressed in picograms per milliliter, or pg/mL.
- The level of vitamin D is expressed in nanograms per milliliter, or ng/mL.

Statistical Analysis

All statistical analyses were conducted using SPSS (Statistical Package for the Social Sciences) software, version 25.0. The mean, standard deviation, range, minimum, and maximum values of descriptive statistics were computed for age, vitamin B12 and vitamin D levels for male and female individuals, as well as for all participants combined.

Independent samples t-tests were used to compare the vitamin B12 and vitamin D levels between male and female subjects. The percentages of Vitamin B12 insufficiency and potential insufficiency, as well as Vitamin D deficiency and low suboptimal cases were determined and compared between the sexes using chi-square tests.

The study used Pearson correlation coefficients to examine the associations between age, Vitamin B12 and Vitamin D levels in both the male and female participants separately and within the pooled sample. P-values of less than 0.05 were considered statistically significant for all the analyses conducted in this study.

Materials

The study assessed several variables using specific data collection tools and protocols:

- **Age**: Participants' ages were recorded in years using a structured questionnaire administered during the initial assessment.
- **Vitamin B12 Levels**: Blood samples were collected from participants, and serum vitamin B12 levels were analyzed using an enzyme-linked immunosorbent assay (ELISA) method, with results reported in picograms per milliliter (pg/mL).
- **Vitamin D Levels**: Similarly, blood samples were collected for the measurement of serum vitamin D levels, which were quantified using a chemiluminescent immunoassay (CLIA) technique, with results reported in nanograms per milliliter (ng/mL).
  These protocols ensured accurate and consistent data collection throughout the study.

Data Processing and Analysis

Statistical analyses were performed utilizing SPSS (Statistical Package for the Social Sciences) software, version 25.0. Descriptive statistics,

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including mean, standard deviation, range, minimum, and maximum values, were computed for age, vitamin B12, and vitamin D levels, both for males and females as well as for the total sample. Independent samples t-tests were employed to compare vitamin B12 and vitamin D levels between male and female participants. The prevalence of vitamin B12 insufficiency, potential insufficiency, vitamin D deficiency, and suboptimal levels were calculated and compared between sexes using chi-square tests. Pearson correlation coefficients were utilized to assess the associations between age, vitamin B12, and vitamin D levels separately for male and female participants and for the entire sample. A p-value of less than 0.05 was considered statistically significant for all analyses conducted in this study.

Results

Descriptive Statistics

Female Participants

Table 1 provides an overview of the descriptive statistics for the female participants. The participants' ages were 4–67 years old, with a mean age of 39.36 years (SD = 17.54) among the females. The mean levels of vitamin D and B12 in the females were 21.40 ng/mL and 388.10 pg/mL, respectively, with a standard deviation of 139.75 and 10.83, respectively.

Male Participants

The descriptive data for the male participants are displayed in Table 2. Their average age was 47.04 years (SD = 22.39), with a range of ages from 2 to 83. Males had mean levels of 429.91 pg/mL (SD = 273.54) for vitamin B12 and 25.44 ng/mL (SD = 13.45) for vitamin D.

All Participants (Sexes Pooled)

Table 3 displays descriptive statistics for all participants combined. The mean age of the participants was 42.10 years (SD = 19.60), with a range of ages from 2 to 83. Vitamin D and Vitamin B12 levels were 22.84 ng/mL (SD = 11.90) and 404.36 pg/mL (SD = 201.12), respectively, on average.

Comparison Between Male and Female Participants

The levels of vitamin B12 and vitamin D in male and female subjects are compared in Table 4. The mean level of vitamin B12 in males and females was 429.91 pg/mL (SD = 273.54) and 388.10 pg/mL (SD = 139.75), respectively. A p-value of 0.522 indicated that there was no significant difference between the two groups. There was no significant difference in the mean Vitamin D level between the male (mean = 25.44 ng/mL, SD = 13.45) and female (mean = 21.40 ng/mL, SD = 10.83) subjects (p-value = 0.176).

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There was a significant difference (p = 0.036) in the percentage of males and females with Vitamin B12 insufficiency (less than 180 pg/mL), with 9.5% of males and 0.0% of females. There was no significant difference (p = 0.295) in the percentage of individuals with Vitamin D deficiency (less than 20 ng/mL), with 46.7% of females and 40.0% of males affected

Table 4. male-female differences in the levels of vitamin B12, and vitamin D

Variable	Females	Males	p-value	Sexes pooled
Vitamin B12 level	388.1±139.8 (mean±SD) (n=33)	429.9±273.5 (mean±SD) (n=21)	0.522	404.4±201.1 (mean±SD) (n=54)
Vitamin D level	21.4±10.8 (n=45)	25.4±13.5 (n=25)	0.176	22.8±11.9 (n=70)
Percentage of Vitamin B12 insufficiency (less than 180 pg/mL)	0.0% (0/33)	9.5% (2/21)	**0.036***	3.7% (2/54)
Percentage of Vitamin B12 potential insufficiency (180-250 pg/mL)	9.1% (3/33)	14.3% (3/21)	0.277	11.1% (6/54)
Percentage of Vitamin B12 borderline cases (200-300 pg/mL)	27.3% (9/33)	19.0% (4/21)	0.243	24.1% (13/54)
Percentage of Vitamin D deficiency (less than 20 ng/mL)	46.7% (21/45)	40.0% (10/25)	0.295	44.3% (31/70)
Percentage of Vitamin D low suboptimal cases (20-29 ng/mL)	31.1% (14/45)	28.0% (7/25)	0.393	30.0% (21/70)

SD: Standard deviation; n: number of participants; pg/mL: picograms per milliliter; ng/mL: nanograms per milliliter; *: The difference is significant at the 0.05 level (2-tailed)

Correlation Analysis

Female Participants

Age, vitamin B12 level, and vitamin D level did not significantly correlate, according to correlation analysis among female participants (Table 5). The age and Vitamin B12 level had a Pearson correlation of -0.127 (p = 0.482), the age and Vitamin D level of 0.163 (p = 0.286), and the age and Vitamin B12 level of 0.078 (p = 0.666).

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Table 5. Correlation analysis between the following variables amongst females: age, vitamin B12 level, and vitamin D level

		Age	VB12 level	VD level
Age	Pearson Correlation	1	-.127	.163
	Sig. (2-tailed)		.482	.286
	N	45	33	45
VB12 level	Pearson Correlation	-.127	1	.078
	Sig. (2-tailed)	.482		.666
	N	33	33	33
VD level	Pearson Correlation	.163	.078	1
	Sig. (2-tailed)	.286	.666	
	N	45	33	45

Sig: Significant; N: number of participants; VB12: Vitamin B12; VD: Vitamin D.

Male Participants

Vitamin B12 and vitamin D levels showed a significant positive correlation (r = 0.448, p = 0.042) for male subjects (Table 6). Age and Vitamin B12 level (r = -0.180, p = 0.436), as well as age and Vitamin D level (r = -0.294, p = 0.154) did not show significant correlation.

Table 6. Correlation analysis between the following variables amongst males: age, vitamin B12 level, and vitamin D level

		Age	VB12 level	VD level
Age	Pearson Correlation	1	-.180	-.294
	Sig. (2-tailed)		.436	.154
	N	25	21	25
VB12 level	Pearson Correlation	-.180	1	.448*
	Sig. (2-tailed)	.436		.042
	N	21	21	21
VD level	Pearson Correlation	-.294	.448*	1
	Sig. (2-tailed)	.154	.042	
	N	25	21	25

Sig: Significant; N: number of participants; VB12: Vitamin B12; VD: Vitamin D; *: Correlation is significant at the 0.05 level (2-tailed)

All Participants (Sexes Pooled)

A significant positive correlation between vitamin B12 and vitamin D levels was discovered when the sexes were combined (Table 7; r = 0.316, p = 0.020). Gender and age (r = 0.189, p = 0.117), gender and vitamin B12 level (r = 0.102, p = 0.462), as well as gender and vitamin D level (r = 0.164, p = 0.176) did not significantly correlate.

A significant positive correlation was observed between vitamin B12 and vitamin D levels when data from both sexes were combined (Table 7; r = 0.316, p = 0.020). This finding suggests that as vitamin B12 levels decrease, vitamin D levels also tend to decline, indicating a potential relationship between these two vitamins.

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In contrast, the analysis revealed no significant correlations between gender and age (r = 0.189, p = 0.117), gender and vitamin B12 levels (r = 0.102, p = 0.462), and gender and vitamin D levels (r = 0.164, p = 0.176). The lack of significant correlation for gender and age may suggest that the distribution of ages in the sample was relatively uniform across genders, which could obscure any potential differences. Similarly, the absence of significant correlations between gender and the levels of either vitamin B12 or vitamin D indicates that these vitamin levels do not vary meaningfully between males and females in this population. Therefore, any observed variations in vitamin levels may be attributed more to individual health factors or dietary intake rather than gender differences.

Overall, the data show that although vitamin B12 and vitamin D levels did not differ significantly between males and females, there are noteworthy relationships between these vitamins, especially in males and the pooled sample. The study also shows a higher prevalence of Vitamin B12 insufficiency in males compared to females.

Table 7. Correlation analysis between the following variables all participants (sexes pooled): gender, age, vitamin B12 level, and vitamin D level

		Gender	Age	VB12 level	VD level
Gender	Pearson Correlation	1	.189	.102	.164
	Sig. (2-tailed)		.117	.462	.176
	N	70	70	54	70
Age	Pearson Correlation	.189	1	-.119	-.017
	Sig. (2-tailed)	.117		.390	.891
	N	70	70	54	70
VB12 level	Pearson Correlation	.102	-.119	1	.316*
	Sig. (2-tailed)	.462	.390		.020
	N	54	54	54	54
VD level	Pearson Correlation	.164	-.017	.316*	1
	Sig. (2-tailed)	.176	.891	.020	
	N	70	70	54	70

Sig: Significant; N: number of participants; VB12: Vitamin B12; VD: Vitamin D; *: Correlation is significant at the 0.05 level (2-tailed)

Discussion

Vitamin B12 Levels

In our study, the average levels of vitamin B12 were found to be 429.91 pg/mL in males and 388.10 pg/mL in females. While these levels fall within the normal range, the study highlighted that a significant proportion of males (9.5%) were deficient in vitamin B12. This finding aligns with recent literature indicating varying prevalence rates of vitamin B12 insufficiency across different demographics. For instance, a study conducted by Stabler et al. (2019) suggested that vitamin B12 deficiencies remain a prevalent issue, particularly in older populations where absorption may become impaired.

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Research from Kim et al. (2020) further supports the notion that vitamin B12 levels can vary significantly among diverse populations. Their investigation found that dietary habits and socio-economic factors significantly influenced the prevalence of B12 insufficiencies in different regions. In line with these observations, our study's finding that males had a higher likelihood of vitamin B12 deficiency echoes patterns reported in other global studies, which suggest that nutrition and socio-economic factors play crucial roles in these variations (Lau et al., 2022).

In the MENA region, studies have shown similar trends. For example, a study by Al-Musharaf et al. (2020) in Saudi Arabia found that vitamin B12 deficiency was prevalent among young adults, particularly in those with poor dietary habits. Similarly, a study in Egypt by El Sayed et al. (2021) reported that vitamin B12 deficiency was common among pregnant women, highlighting the need for targeted interventions in high-risk groups. These regional studies underscore the importance of considering local dietary patterns and socio-economic factors when addressing vitamin B12 deficiencies.

Vitamin D Levels

The average levels of vitamin D in our study were 25.44 ng/mL for males and 21.40 ng/mL for females, indicating a widespread issue of vitamin D insufficiency among the participants. Alarmingly, 40% of males and 46.7% of females demonstrated vitamin D deficiency, with levels falling below 20 ng/mL. These results are consistent with recent reports indicating a global epidemic of vitamin D deficiency, affecting approximately 1 billion individuals worldwide, as noted by Holick (2020).

When contextualized within the Middle Eastern region, our findings echo previous studies, such as the work by Al-Daghri et al. (2018), which reported similar rates of vitamin D deficiency among adults in Saudi Arabia. Other studies in Lebanon have revealed that 60% of teenagers have inadequate vitamin D levels, attributed to factors such as limited sun exposure and dietary inadequacy (Almoustafa et al., 2019). Such insights highlight the cultural and environmental factors contributing to high rates of vitamin D insufficiency across similar demographic settings.

Further reinforcing these findings, research by Mousa et al. (2021) in Iran revealed that 81% of participants had vitamin D levels below 20 ng/mL. Factors such as cultural dress practices, geographical location, and lifestyle choices continue to contribute significantly to the prevalence of vitamin D deficiency in the Middle East and South Asia (Mithal et al., 2021). A study in Morocco by El Maghraoui et al. (2020) also found that vitamin D deficiency was prevalent among postmenopausal women, further emphasizing the need for region-specific interventions. Understanding these dynamics is crucial for

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devising targeted public health strategies to combat vitamin D insufficiency, especially in populations with limited sun exposure and dietary diversity.

Correlation Between Vitamin B12 and Vitamin D Levels

Our study found a significant positive correlation ($r = 0.448$, $p = 0.042$) between vitamin B12 and vitamin D levels in males, and a correlation of ($r = 0.316$, $p = 0.020$) in the pooled sample. These findings suggest that individuals with higher levels of vitamin B12 often have higher levels of vitamin D as well. The mechanisms behind this correlation may involve shared dietary sources, as both vitamins are found in foods such as fish, dairy products, and fortified items. This dietary overlap suggests that individuals who maintain a nutritionally balanced diet may have better levels of both vitamins.

Studies conducted by Aaseth et al. (2021) support the notion that deficiencies in one vitamin frequently coexist with deficits in others, highlighting the interconnectedness of nutritional status. Further, a review by Mullen et al. (2020) emphasized how inadequate dietary intake and metabolic absorption issues can lead to both vitamin B12 and vitamin D deficiencies.

Moreover, genetic factors impacting vitamin metabolism also play a role in the observed relationship between these two vitamins, as described by Wang et al. (2020). They noted that genetic polymorphisms affecting vitamin D metabolism can subsequently influence vitamin B12 levels, suggesting a complex interplay between nutritional intake, lifestyle factors, and genetic predispositions.

In summary, the association between vitamin B12 and vitamin D levels appears to be influenced by multiple factors, including dietary intake, lifestyle choices, and genetic predispositions. Our findings underscore the need for comprehensive approaches to address vitamin deficiencies, including public health initiatives aimed at raising awareness, promoting sun exposure, and encouraging the consumption of vitamin-rich foods and supplements. Future research should continue to explore the multifaceted relationships between these essential nutrients to improve health outcomes in diverse populations.

Potential Confounding Factors

While this study identified a significant correlation between vitamin B12 and vitamin D levels, several confounding factors could have influenced the results. Dietary intake variations, genetic predispositions, and differences in sun exposure may have contributed to individual variations in vitamin levels. Additionally, underlying health conditions such as gastrointestinal disorders, renal dysfunction, and medication use (e.g., proton pump inhibitors or metformin) could impact vitamin B12 and vitamin D absorption and metabolism. Future studies should control for these factors through detailed

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dietary assessments, genetic screening, and consideration of medical history to strengthen the validity of findings.

Moreover, lifestyle habits, including physical activity levels and smoking status, may also influence vitamin levels. Physical inactivity and smoking have been associated with lower vitamin D levels, potentially affecting the overall correlation observed in this study. Further investigation into these factors will enhance the understanding of the interplay between lifestyle choices and vitamin deficiencies.

Clinical Significance

The observed correlation between vitamin B12 and vitamin D levels has important clinical implications. Vitamin B12 deficiency is associated with neurological dysfunction, anemia, and cardiovascular risks, while vitamin D deficiency is linked to bone disorders, immune dysfunction, and chronic diseases. The co-occurrence of deficiencies in these vitamins may exacerbate health risks, particularly among vulnerable populations such as the elderly, individuals with malabsorption syndromes, and those with dietary restrictions. Addressing these deficiencies through targeted nutritional interventions and supplementation programs could help mitigate associated health complications.

Implications for Public Health

This study's high rate of vitamin B12 and vitamin D deficiency highlights Jordan's need for focused public health initiatives. Among the methods to remedy these shortcomings are:

1. Public awareness campaigns: teaching the general public the value of getting enough vitamin D and B12 from their diets and supplements.
2. Nutritional Supplementation Programs: Putting in place initiatives to give supplements, especially to high-risk populations like the elderly, pregnant women, and people with limited sun exposure.
3. Dietary Modifications: Promoting the intake of foods rich in Vitamin B12 and Vitamin D, such as dairy, eggs, fish, and fortified cereals.
4. Sun Exposure Guidelines: While taking into account cultural and religious customs that restrict sun exposure, encouraging safe sun exposure practices to boost endogenous Vitamin D synthesis

Conclusion

This study highlights a significant positive correlation between vitamin B12 and vitamin D levels among Jordanian patients referred to a major medical center. The findings emphasize the clinical importance of addressing concurrent deficiencies to reduce the risk of associated health complications.

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To translate these findings into practice, policymakers and healthcare providers should consider implementing national screening programs for vitamin B12 and vitamin D deficiencies, particularly for high-risk populations. Additionally, educational campaigns promoting dietary sources rich in these vitamins, alongside fortification strategies, may help mitigate widespread insufficiencies. Future research should explore targeted interventions, including supplementation guidelines and lifestyle modifications, to enhance public health outcomes. Strengthening these efforts will be essential in reducing the burden of vitamin deficiencies and improving overall health in Jordan

Conflict of Interest: The authors reported no conflict of interest.

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Ethical statement: This study was approved by the Ethics Committee of the Royal Medical Services of the Jordan Armed Forces.

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