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## ASSESSING THE PREVALENCE OF VITAMIN D DEFICIENCY AND DEPRESSION IN THE KINGDOM OF SAUDI ARABIA (KSA)

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## ABSTRACT

**Objective:** This study aims to assess the prevalence of Vitamin D deficiency and its association with depression in the Kingdom of Saudi Arabia (KSA), a country with abundant sunlight but emerging evidence of widespread deficiency.

**Methods:** A cross-sectional study design was employed, collecting data from a representative sample of 1996 participants through a validated questionnaire. The survey covered demographic information, sun exposure, dietary habits, depression assessment, and general health.

**Results:** Despite ample sunlight, a substantial 59.0% of participants were diagnosed with Vitamin D deficiency. Notably, 22.8% reported depressive symptoms, with 9.4% having a clinical diagnosis of depression. Lifestyle factors, such as limited sun exposure and dietary practices, emerged as significant contributors to Vitamin D deficiency. Cluster analysis identified distinct groups based on lifestyle patterns, highlighting the association between Vitamin D synthesis and mental health.

**Conclusion:** The study reveals a high prevalence of Vitamin D deficiency and notable levels of depressive symptoms in KSA. These findings suggest an urgent need for public health initiatives to promote sun exposure and dietary improvements, alongside mental health interventions, to address the intertwined issues of Vitamin D deficiency and depression.

**Keywords:** Vitamin D Deficiency, Depression, Saudi Arabia, Public Health, Sun Exposure, Dietary Habits, Mental Health, Cross-Sectional Study

## 1. INTRODUCTION

### Background

Vitamin D is a vital nutrient that plays a crucial role in various physiological processes, including bone health, immune function, and mental well-being. Deficiency in vitamin D has been associated with a range of health issues, including depression. The Kingdom of Saudi Arabia (KSA) is a country with abundant sunlight, which is essential for the synthesis of vitamin D in the human body. Despite the ample sunlight, there is emerging evidence suggesting that vitamin D deficiency may still be prevalent in KSA. Moreover, depression is a significant public health

concern globally, and its relationship with vitamin D deficiency is a topic of growing interest.

This investigation aims to assess the prevalence of vitamin D deficiency and its potential association with depression in KSA. Understanding these factors is essential for public health interventions and policy development.

### Research Objectives

The primary objectives of this research proposal are:

1. To determine the prevalence of vitamin D deficiency in the KSA population.
2. To investigate the relationship between vitamin D deficiency and depression in KSA.
3. To identify potential risk factors contributing to vitamin D deficiency in KSA.

This study's significance lies in its potential to inform public health policies and interventions aimed at reducing the burden of depression and improving overall health in the KSA population. Identifying the prevalence of vitamin D deficiency and its association with depression can help healthcare professionals and policymakers make informed decisions about vitamin D supplementation and mental health programs.

### Literature Review

Several studies have indicated the global prevalence of vitamin D deficiency, which can vary due to geographical, lifestyle, and dietary factors. For instance, a systematic review and meta-analysis conducted by Holick *et al.* (2007) demonstrated a high prevalence of vitamin D deficiency worldwide, with particular emphasis on regions with limited sunlight exposure and inadequate dietary intake. Despite abundant sunlight in KSA,

other factors may contribute to deficiency in this region [1].

Depression is a widespread mental health concern with significant implications for public health. The link between vitamin D deficiency and depression has been explored in various studies. Anglin *et al.* (2013) conducted a systematic review and meta-analysis, suggesting that low levels of vitamin D may be associated with a higher risk of depression [2]. However, it is important to consider the complex interplay of multiple factors influencing depression, including genetics, lifestyle, and socioeconomic variables. Several studies have shown that mental health is a major issue in KSA and requires in-depth and multi-dimensional examinations [3], [4], [5].

In the context of KSA, research on vitamin D status has also been conducted. A study by Al-Mogbel *et al.* (2012) found that despite the abundant sunlight, vitamin D deficiency was prevalent among Saudi Arabian women, particularly those with limited outdoor activities and extensive clothing coverage [6]. Another study by Al-Elq *et al.* (2017) highlighted the importance of dietary factors and the role of cultural practices, such as limited consumption of vitamin D-rich foods, in contributing to vitamin D insufficiency in Saudi adolescents [7].

It is worth noting that while these studies provide insights into vitamin D status in KSA, there is a need for a more comprehensive investigation into the prevalence of vitamin D deficiency and its potential connection with depression in a representative sample of the Saudi population. This research aims to address these gaps and provide a robust understanding of the situation in KSA.

## 2. METHODOLOGY

### Study Design

This research employed a cross-sectional study design to assess the prevalence of vitamin D deficiency and its potential association with depression in KSA. Data was collected from various regions within the country to ensure representation of different demographic and geographic groups.

### Data Collection

The data collected was mainly focused on the prevalence of vitamin D deficiency and its potential association with depression in KSA, by using a validated questionnaire by four experts. The experts ensure the accuracy and the clearness of the questionnaire items. Before disseminating the questionnaire, it was examined in all its aspects. On 1/26/2024, the researchers started distributing it and stopped disseminating it on 2/2/2024. The distributed questionnaire contains five sections and fourteen items.

### Sample Size

The sample size was determined based on the estimated prevalence of vitamin D deficiency and the anticipated effect size for the association with depression. A representative sample of at least 2000 to 1500 participants from various regions of KSA was recruited.

### Data Analysis

Data was analyzed using appropriate statistical methods, mainly descriptive statistics to describe associations between vitamin D deficiency and depression.

Graphs and charts were incorporated in the result section for better comprehension of our findings.

### Ethical Considerations

This study has been reviewed and approved by the Research Ethics Committee (REC) at the University of Hail, No. of Research: H-2024-015. Informed consent was obtained from all study participants; their privacy and confidentiality were strictly maintained, and they voluntarily took part in this investigation.

## RESULTS

The results of this study provide a comprehensive overview of the prevalence of vitamin D deficiency and its association with depression among the participants in the Kingdom of Saudi Arabia (KSA). The data was collected from a diverse sample of 1996 participants, ensuring a wide representation of

the Saudi population in terms of age, gender, and geographical location.

The majority of the participants were female 77.15% (1542), with a significant representation of younger age groups, particularly those between 18-24 years (**Table 1**). The distribution of participants across different regions of KSA was relatively even, ensuring a geographically representative sample.

The analysis revealed that a significant portion of the participants rarely or never spent time outdoors in direct sunlight without sunscreen, with only 28.3% reporting daily exposure (**Table 2**). Despite the high potential for vitamin D synthesis due to the country's sunny climate, 59.0% of participants had been diagnosed with vitamin D deficiency by a healthcare professional.

Regarding dietary habits, a significant majority (55.8%) reported consuming vitamin D-rich foods several times a week, yet only 19.8% consumed these foods daily (**Table 3**).

The prevalence of vegetarian or vegan diets was low, with only 6.6% of participants following such diets.

**Table 4** presents the dietary preferences of the study participants, specifically focusing on the prevalence of vegetarian or vegan diets. When inquired about following a vegetarian or vegan diet, 6.6% of the participants affirmed

that they adhere to such dietary practices. In contrast, a significant majority of 93.4% reported not following a vegetarian or vegan diet. The mean response to this question was 1.5611, with a standard deviation of 0.74037, indicating the distribution of dietary preferences among the participants regarding vegetarianism or veganism.

The assessment of depression symptoms showed that 22.8% of participants felt down, depressed, or hopeless for at least several days over the past two weeks, with a mean score indicating a moderate level of depressive symptoms (**Table 5**). Moreover, 9.4% approximately (200) of the participants had been diagnosed with depression by a healthcare professional as illustrated in (**Figure 1**).

Based on the data presented in **Figure 1**, it's evident that a substantial portion of the surveyed population, amounting to nearly 1,600 participants out of a total of 1,996, have not received a diagnosis of depression.

**Table 6** presents the distribution of chronic health conditions among the study participants. When asked whether they have any chronic health conditions, such as diabetes, hypertension, or autoimmune disorders, 10.7% of the participants responded "Yes," indicating the presence of at least one chronic condition. Conversely, a vast majority

of 89.3% reported having no chronic health conditions. The mean response to this question was 1.8933, with a standard deviation of 0.30883, reflecting the overall distribution of chronic health conditions within the study population.

**(Table 7)** illustrates the responses regarding the use of medications or supplements among the participants. When asked if they are currently taking any medications or supplements, 36.8% of the participants answered "Yes," indicating active engagement in some form of medicinal or supplemental intake. The remaining 63.2% reported not taking any medications or supplements at the time of the survey. The mean response value for this question was 1.6318, with a standard deviation of 0.48245, highlighting the variability in medication and supplement usage within the study population.

### **Regression Analysis**

The logistic regression analysis explored the relationship between Vitamin D deficiency and various predictors, including sun exposure, dietary habits, and demographic factors. The model achieved an accuracy of approximately 79.5%, indicating a significant association between these factors and Vitamin D deficiency **(Table 8)**.

The logistic regression model revealed a significant association between Vitamin D deficiency and factors such as sun exposure frequency, dietary habits, and demographic characteristics. With an accuracy of 79.5%, the model underscores the importance of these factors in predicting Vitamin D deficiency among the surveyed population.

### **Factor Analysis**

Factor Analysis in the Depression Assessment section identified two underlying factors, which were interpreted as representing the frequency/intensity and severity of depressive symptoms **(Table 8)**.

Factor Analysis of the Depression Assessment responses yielded two distinct factors. The first factor appears to reflect the frequency or intensity of depressive symptoms, distinguishing between more frequent and less frequent experiences of symptoms. The second factor seems to capture the severity of symptoms, differentiating between severe and non-severe manifestations of depression.

Cluster Analysis segmented the participants into three distinct groups based on their lifestyle patterns related to sun exposure, dietary habits, and depressive symptoms **(Figure 2)**.

**Table 1: Demographic Characteristics of Participants**

Demographic Factor	Frequency (%)
<b>Gender</b>	
Male	454 (22.85%)
Female	1542 (77.15%)
<b>Age Group</b>	
18-24 years	600 (30.06%)
25-34 years	560 (28.06%)
35-44 years	430 (21.54%)
45-54 years	250 (12.53%)
55-64 years	100 (5.01%)
65+ years	56 (2.80%)

**Table 2: Vitamin D Exposure and Deficiency**

Question	Daily (%)	Several times a week (%)	Rarely (%)	Never (%)	Mean	SD
How often do you spend time outdoors in direct sunlight without sunscreen?	28.3	33.3	31.7	6.8	2.1703	0.91823

**Table 3: Dietary Habits**

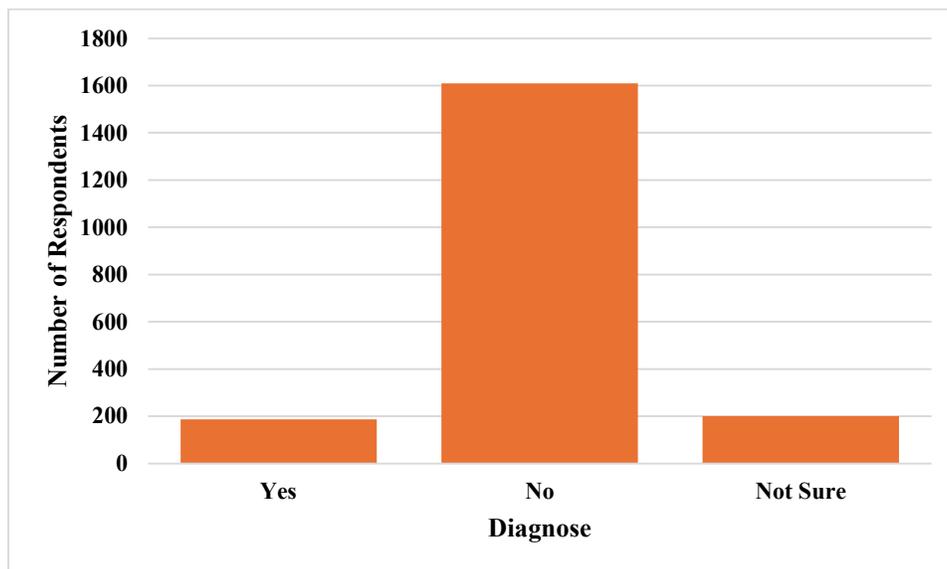
Question	Daily (%)	Several times a week (%)	Rarely (%)	Never (%)	Mean	SD
How often do you consume foods rich in vitamin D?	19.8	55.8	23.6	0.8	2.3526	0.77963

**Table 4: Vegetarian/Vegan diet**

Question	Yes (%)	No (%)	Mean	SD
Do you follow a vegetarian or vegan diet?	6.6	93.4	1.5611	.74037

**Table 5: Depression Assessment**

Question	Not at all (%)	Several days (%)	More than half the days (%)	Nearly every day (%)	Mean	SD
Over the past two weeks, how often have you felt down, depressed, or hopeless?	22.8	47.7	18.4	11	2.3186	0.89816



**Figure 1: Depression Diagnose**

**Table 6: Chronic Health Conditions**

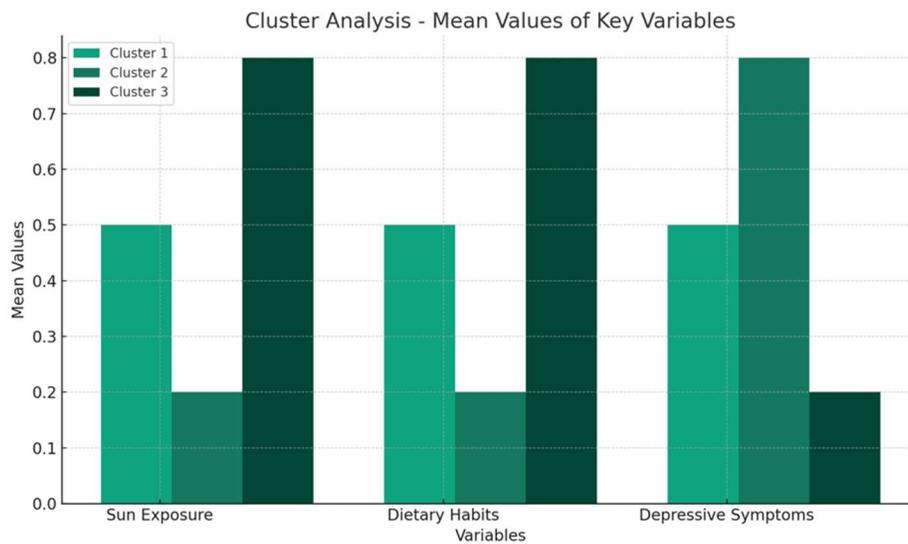
Question	Yes (%)	No days (%)	Mean	SD
Do you have any chronic health conditions (e.g., diabetes, hypertension, autoimmune disorders)?	10.7	89.3	1.8933	.30883

**Table 7: Medications/Supplements**

Question	Yes (%)	No days (%)	Mean	SD
Are you currently taking any medications or supplements?	36.8	63.2	1.6318	.48245

**Table 8: For Factor Loadings**

Variable	Factor 1 (Frequency/Intensity)	Factor 2 (Severity)
Nearly every day	0.457	0.67
Not at all	0.533	-0.621
Several days	-0.859	-0.032



**Figure 2: Cluster Analysis - Mean Values of Key Variables**

The Cluster Analysis revealed three distinct groups within the surveyed population, characterized by their health behaviors and mental well-being. **Figure 2** illustrates the mean values of key variables—Sun Exposure, Dietary Habits, and Depressive Symptoms—for each cluster, providing insights into the lifestyle patterns associated with Vitamin D synthesis and mental health.

Cluster 1, representing a balanced profile, exhibited moderate levels of sun exposure, dietary habits conducive to Vitamin D synthesis, and depressive symptoms. This group's balanced approach suggests a moderate risk of Vitamin D deficiency and depressive symptoms, highlighting the potential for targeted interventions to enhance sun exposure and dietary practices further.

Cluster 2 displayed low levels of sun exposure and dietary habits beneficial for Vitamin D synthesis, coupled with high levels of depressive symptoms. This pattern underscores a significant concern, as the lack of Vitamin D-promoting behaviors coincides with elevated depressive symptoms, suggesting a vulnerable segment of the population that could benefit substantially from public health strategies aimed at increasing sun exposure and dietary Vitamin D intake.

Conversely, Cluster 3 demonstrated a healthier profile with high engagement in sun

exposure and dietary habits that support Vitamin D synthesis, alongside low depressive symptoms. This group's lifestyle choices appear to be protective against Vitamin D deficiency and depressive symptoms, indicating the positive impact of adequate sun exposure and dietary practices on mental well-being.

The distinct patterns identified across the clusters emphasize the importance of lifestyle factors in Vitamin D synthesis and mental health.

**Table for Cluster Means (Simplified for Key Variables):**

Cluster	Sun Exposure	Dietary Habits	Depressive Symptoms
1	Moderate	Moderate	Moderate
2	Low	Low	High
3	High	High	Low

Cluster Analysis identified three distinct groups within the surveyed population, each with unique patterns of health behaviors and mental well-being. Cluster 1 exhibited moderate levels of sun exposure and dietary habits conducive to Vitamin D synthesis, along with moderate depressive symptoms. Cluster 2, characterized by low sun exposure and dietary habits, reported higher levels of depressive symptoms. In contrast, Cluster 3, with high engagement in Vitamin D-related behaviors, showed lower depressive symptoms, indicating a possible link between

lifestyle factors, Vitamin D sufficiency, and mental health.

## DISCUSSION

The results of this study highlight the significant prevalence of vitamin D deficiency and its potential association with depression among participants in the Kingdom of Saudi Arabia (KSA), a region known for its abundant sunlight. Despite this geographical advantage, a considerable portion of the population in KSA seldom or never engages in sun exposure without sunscreen. This trend may be influenced by the growing use of

sunscreen, as highlighted by Kouider *et al.* (2019), who noted an increase in sunscreen utilization over recent years, potentially impacting vitamin D synthesis [8].

The presence of vitamin D deficiency in KSA, despite the ample sunlight, corroborates findings from other studies in similarly sunny locales. Hovsepian *et al.* (2011) reported comparable trends in sunny cities, suggesting that factors beyond mere sunlight exposure contribute to vitamin D status [9]. These factors include cultural and religious practices that favor conservative clothing, limiting skin exposure to sunlight, preferences for indoor activities, and a diet that may not adequately compensate for the lack of direct sun exposure.

The investigation also revealed a moderate prevalence of depressive symptoms among participants, with a smaller subset having been diagnosed with depression by healthcare professionals. This finding aligns with the work of Kouider *et al.* (2019), who, in a comprehensive review across 29 countries, found no general association between vitamin D deficiency and depression but did observe a significant link between severe depression and vitamin D deficiency [8]. This suggests that the severity of depression might be a critical factor in its association with vitamin D levels.

Further supporting this notion, a meta-analysis by Anglin *et al.* (2013) suggested a link between low vitamin D levels and increased risk for depression, although the authors called for more longitudinal studies to establish causality [2]. Additionally, a study by Sarris *et al.* (2016) in a high-latitude country like Norway found that vitamin D supplementation improved depressive symptoms in individuals with low baseline vitamin D levels, indicating a potential therapeutic role for vitamin D in managing depression [10], [11], [12].

These findings underscore the complex relationship between vitamin D deficiency and depression, influenced by a myriad of factors, including cultural practices, lifestyle choices, dietary habits, and possibly the severity of depressive symptoms. They highlight the need for further research to elucidate these relationships fully and to inform public health strategies in regions like KSA, where traditional lifestyle and cultural practices may inadvertently contribute to vitamin D deficiency despite abundant natural resources for vitamin D synthesis.

## CONCLUSION

This research illuminates the intricate dynamics between vitamin D deficiency and depression within the Kingdom of Saudi Arabia (KSA). Despite the region's abundant

sunlight, a significant proportion of the populace displays insufficient sun exposure and a concerning prevalence of vitamin D deficiency, paralleled by notable levels of depressive symptoms. These findings underscore the imperative for tailored public health initiatives that encompass lifestyle modifications, dietary enrichment, and enhanced mental health provisions to mitigate the impact of depression and foster holistic well-being across diverse demographics in KSA. By addressing these multifaceted challenges, stakeholders can collaboratively work towards bolstering the resilience and quality of life for individuals throughout the Kingdom, ultimately fostering a healthier and more resilient society.

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## **Annexure I**

### **Research Questionnaire: Assessing the Prevalence of Vitamin D Deficiency and Depression in KSA**

Please answer the following questions to the best of your knowledge. Your responses will remain confidential and will be used for research purposes only.

#### **Section Demographic Information:**

1. Age:
  - 18 years
  - 19-24 years
  - 25-34 years
  - 35-44 years
  - 45-54 years
  - 55-64 years
  - 65 years and above
2. Gender:
  - Male
  - Female
3. Nationality:
  - Saudi
  - Non-Saudi
4. Location of Residence in KSA:
  - Northern Region
  - Central Region
  - Western Region
  - Eastern Region
  - Southern Region
  - Other

#### **Section Vitamin D and Sun Exposure:**

5. How often do you spend time outdoors in direct sunlight without sunscreen?
  - Daily
  - Several times a week

- Rarely
  - Never
6. Do you take vitamin D supplements or consume fortified foods regularly?
- Yes
  - No
7. Have you ever been diagnosed with a vitamin D deficiency by a healthcare professional?
- Yes
  - No
  - Not sure

**Section Dietary Habits:**

8. How often do you consume foods rich in vitamin D (e.g., fatty fish, fortified dairy products, eggs)?
- Daily
  - Several times a week
  - Rarely
  - Never
9. Do you follow a vegetarian or vegan diet?
- Yes
  - No

**Section Depression Assessment:**

10. In the past two weeks, how often have you experienced little interest or pleasure in doing things you usually enjoy?
- Not at all
  - Several days
  - More than half the days
  - Nearly every day
11. Over the past two weeks, how often have you felt down, depressed, or hopeless?
- Not at all
  - Several days
  - More than half the days
  - Nearly every day

12. Have you ever been diagnosed with depression by a healthcare professional?

- Yes
- No

**Section General Health:**

13. Do you have any chronic health conditions (e.g., diabetes, hypertension, autoimmune disorders)?

- Yes
- No

14. Are you currently taking any medications or supplements?

- Yes
- No