

## Vitamin D Deficiency and Insufficiency and their Role in Growing Levels of Depression and Anxiety in Saudi Arabia

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### Abstract

**Background:** Vitamin D deficiency is a rapidly growing endemic condition in Saudi Arabia, and it is known to be an underlying cause of various mental and physical illnesses. It is, therefore, important to assess the role of vitamin D in the regulation of mental health and the treatment of mental disorders. The primary objective of this study is to identify if regular medical check-ups clients with vitamin D deficiency (their vitamin D level is 10 ng/ml or less) have different levels of depression and anxiety than clients with vitamin D insufficiency (their vitamin D level is between 10.1 ng/ml to 30 ng/ml). The non-probability sample of this quantitative study comprises 246 participants with previously diagnosed vitamin D insufficiency or deficiency. The participants were clients from the Kingdom Hospital and Al-Borg Medical Laboratories in Riyadh, Saudi Arabia, and a structured questionnaire (developed by the current researcher) was administered to them.

**Results:** The study findings showed that although there are no significant differences between clients with vitamin D deficiency and clients with vitamin D insufficiency with regards to depression and anxiety levels, the means for depression and anxiety levels were higher in clients with vitamin D deficiency.

**Conclusion:** Clients suffering from low vitamin D levels, either a deficiency or insufficiency, may suffer from depression and anxiety; and as much as their vitamin D level is low as much as they are exposed to suffer from high levels of depression and anxiety.

**Keywords:** Vitamin D; Deficiency; Insufficiency; Mental disorder; Depression; Anxiety

### Background

Vitamin D, known as the 'sunshine vitamin', is one of the most important vitamins for good health and wellbeing. A number of studies have emphasised its role in the prevention of osteoporosis, cardiovascular heart disease, arterial hypertension, cerebrovascular disease, chronic kidney disease, type 1 diabetes, autoimmune diseases, and some cancers [1-3]. However, vitamin D deficiency has become a global epidemic which remains unrecognised and neglected as an issue that is responsible for increasing the healthcare burden worldwide [4]. This is clearly a problem in Saudi Arabia, where summer temperatures can reach 50°C, and UV levels are high, thus preventing people from venturing out in the sunlight, which is how the human body produces vitamin D [5]. Vitamin D deficiency does not just lead to physical health problems; it can also be an underlying cause of depression and anxiety [6-10].

Depression is "an emotional state of persistent dejection, ranging from relatively mild discouragement and gloominess to feelings of extreme despondency and despair" [11]. This mental disorder is considered a global crisis that affects more than 350 million people worldwide [12]. In 2001, depression was declared to be the fourth leading cause of premature death and disability among individuals. According to global statistics, depression is also common in Middle Eastern countries, particularly Saudi Arabia. It is estimated that the percentage of the Saudi population suffering from depression has risen to 7%, which is a relatively high percentage (ibid).

Anxiety is another common mental and psychological issue, which is defined as "a state of uneasiness, accompanied by dysphoria and somatic signs and symptoms of tension, focused on apprehension of possible failure, misfortune, or danger" [13]. It is one of the most troubling emotions and many people around the world suffer from excessive anxiety [14]; this is because anxiety encompasses emotions

such as worry and stress, as well as specific disorders such as panic disorder (PD), social phobia (SP) which is also known as social anxiety disorder (SAD), and post-traumatic stress disorder (PTSD) [15]. Baxter et al. analysed 87 studies across 44 countries to estimate the prevalence of anxiety disorders worldwide, and discovered that the existence prevalence of anxiety disorders in the world is ranged between 0.9% to 28.3% [16]. Alansari found that the population in Saudi Arabia, especially the female population, showed high levels of anxiety compared with their peers from other Arab countries [17].

In addition to the high prevalence of depression and anxiety among the Saudi Arabian population, vitamin D deficiency is also a common issue. Several studies have highlighted the low vitamin D levels in Saudi Arabia [5,7,18,19]; but none of these studies linked low vitamin D levels and both depression and anxiety. However, it could be argued that vitamin D deficiency and insufficiency may cause depression and anxiety. This is because it is suggested that vitamin D receptors are present in the neurons of the cortex and hippocampus and hence depletion of vitamin D could lead to neuronal and psychological changes [20,21]. In addition, a number of studies [21-23] have deduced that vitamin D is responsible for various brain functions including immunomodulation, neuroplasticity and brain development; and it has been proven that brain functions correlate with the mental and

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psychological status. In other words, it seems to be physiologically credible that vitamin D deficiency and insufficiency are influential in causing neurological changes, which can cause depression and anxiety.

In addition, the current researcher, an experienced psychotherapist, has encountered a wide range of clients showing moderate to severe symptoms of depression and/or anxiety with no definite aetiology; later, these clients were diagnosed with vitamin D deficiency or insufficiency. This demonstrates that low levels of vitamin D may cause not only physical health problems but also mental disorders such as depression and anxiety; however, this has not been investigated adequately yet. In other words, there is a gap in the body of knowledge linked to low levels of vitamin D, depression, and anxiety that need to be addressed. Therefore, this study aims to provide research-based evidence of the occurrence of depression and anxiety in clients with vitamin D deficiency and insufficiency in Saudi Arabia.

The current study tries to answer the following questions:

1. Are there differences in the levels of depression of clients with vitamin D deficiency, and clients with vitamin D insufficiency in Saudi Arabia?
2. Are there differences in the levels of anxiety of clients with vitamin D deficiency, and clients with vitamin D insufficiency in Saudi Arabia?

## Methodology

### Research design

This quantitative research adopts a cross-sectional methodology because it is the most appropriate approach where a researcher uses a self-completion questionnaire to study two or more variables in a large sample [24,25].

### Sampling

All the participants were clients – who are doing regular medical check-ups – at Kingdome Hospital and Al-Borg Medical Laboratories, which are both located in Riyadh, Saudi Arabia. This is a non-probability sample (convenience sample) because the researcher asked the managers at the hospital and the medical laboratories to ask these clients, who have been diagnosed with vitamin D deficiency (their vitamin D level is 10 ng/ml or less) or with vitamin D insufficiency (their vitamin D level is between 10.1 ng/ml to 30 ng/ml), to participate in this study. Highlighting the fact that these clients are not under any medication (psychiatric or other medication), are not under any treatment, and are not suffering from any chronic or other diseases. In other words, the participants suffer from vitamin D deficiency or insufficiency only.

The sample comprises 246 participants (136 males and 110 females). Their ages range from 14 to 80 years old;  $M=1.45$  and  $SD=0.49$ . The sample was divided into two groups regarding their vitamin D levels, group (1) has vitamin D deficiency ( $n=126$ , 50.8%), and group (2) has vitamin D insufficiency ( $n=120$ , 49.2%) (Table 1).

### Research instrument

In order to answer the research questions, the current researcher developed a self-completion questionnaire. Four primary sources were used to construct this method: the researcher experience as a psychotherapist for 16 years, ICD-10 [26], and DSM-4 and DSM-5 [27,28]. Highlighting that the questionnaire was developed in Arabic because it is the mother tongue of the participants. Hard copies were

	Clients with Vitamin D deficiency (group 1)	Clients with Vitamin D insufficiency (group 2)
Number (n)	126	120
Percentage (%)	50.80%	49.20%
Descriptive statistics	$M=1.45$ and $SD=0.49$	

Table 1: Shows the sample statistics.

given to the clients for completion. Pen-and-paper format was chosen because it produces a higher response rate than electronic forms [29,30].

This structured questionnaire, which is one page long, has two sections. The first section comprises demographical questions (age, sex, and vitamin D level). The second section includes 28 statements – closed-ended questions – that are statements 1-14 measuring depression and statements 15-28 measuring anxiety. Participants responded to all 28 statements using a five-point Likert scale (1=strongly disagree, 2=disagree, 3=sometimes agree, 4=agree, 5=strongly agree).

## Results

To answer the research questions, independent-samples t-test was used for both questions. Highlighting that the determined significant level is  $p<0.05$  and the confidence intervals (CI) 95% and also eta squared was used to determine the effect size; i.e. small effect size if eta squared = 0.01, medium effect size if eta squared = 0.06, and large effect size if eta squared = 0.138 [31].

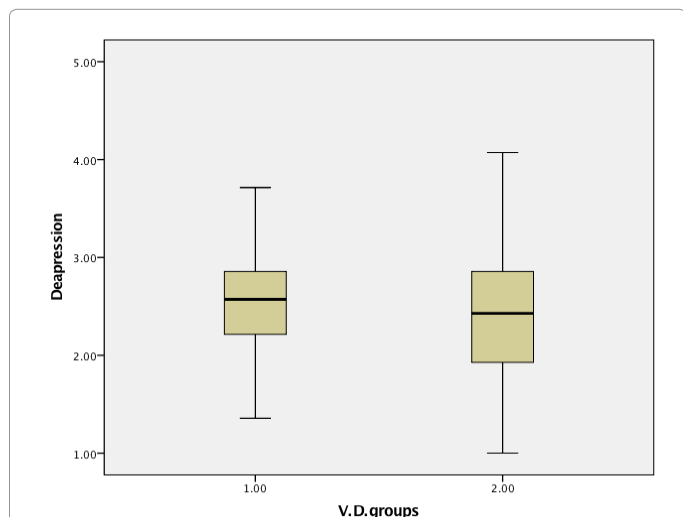
Regarding depression, an independent-samples t-test was conducted to compare the depression scores of clients with vitamin D deficiency (their vitamin D level is 10ng/ml or less) and clients with vitamin D insufficiency (their vitamin D level is between 10.1ng/ml to 30ng/ml). There was no significant difference between scores for clients with vitamin D deficiency ( $n=126$ ,  $M=2.59$ ,  $SD=0.66$ ) and clients with vitamin D insufficiency ( $n=120$ ,  $M=2.48$ ,  $SD=0.83$ ;  $t(226.71)= 1.167$ ,  $p=0.24$ , two-tailed. The differences in the means (mean difference =0.11, 95% CI: -0.30 to 0.07) was very small (eta squared= 0.005) (Table 2). Also, Figure 1 shows a boxplot of the differences in depression between the two groups (group 1 clients with vitamin D deficiency, and group 2 clients with vitamin D insufficiency) in the median. The median of group 1 is 2.64, the upper quartile is 2.86, and the lower quartile is 2.21. The median of group 2 is 2.43, the upper quartile is 2.96, and the lower quartile is 1.93.

Similarly, regarding anxiety, an independent-samples t-test was conducted to compare the anxiety scores of clients with vitamin D deficiency (their vitamin D level is 10ng/ml or less) and clients with vitamin D insufficiency (their vitamin D level is between 10.1ng/ml to 30ng/ml). There was no significant difference in the scores of clients with vitamin D deficiency ( $n=126$ ,  $M=2.67$ ,  $SD=0.74$ ) and clients with vitamin D insufficiency ( $n=120$ ,  $M=2.53$ ,  $SD=0.78$ ;  $t(244)= 1.480$ ,  $p=0.14$ , two-tailed. The differences in the means (mean difference =0.14, 95% CI: -0.33 to 0.04) was very small (eta squared= 0.009) (Table 3). Also, Figure 2 shows a boxplot of the differences in anxiety between the two groups (group 1 clients with vitamin D deficiency, and group 2 clients with vitamin D insufficiency) in the median. The median of group 1 is 2.71, the upper quartile is 3.14, and the lower quartile is 2.21. The median of group 2 is 2.5, the upper quartile is 2.95, and the lower quartile is 2.

However, it can be seen that the means of both depression and anxiety are higher in clients with vitamin D deficiency,  $M=2.59$ , and  $M=2.67$  respectively, than their peers who suffer from vitamin D

	Groups	n	M	SD	F	Sig.	t	Sig.
Depression	Vitamin D deficiency	126	2.59	0.66	6.62	0.01	1.167	0.24
	Vitamin D insufficiency	120	2.48	0.83				

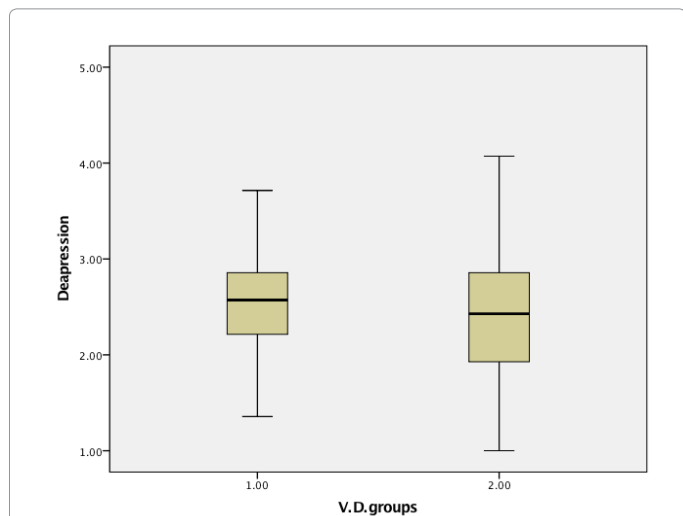
**Table 2:** Shows no significant difference in the levels of depression between scores for clients with vitamin D deficiency and clients with vitamin D insufficiency.



**Figure 1:** Shows a boxplot of the differences in depression between the two groups (group 1 clients with vitamin D deficiency, and group 2 clients with vitamin D insufficiency).

	Groups	n	M	SD	F	Sig.	t	Sig.
Anxiety	Vitamin D deficiency	126	2.67	0.74	0.47	0.49	1.48	0.14
	Vitamin D insufficiency	120	2.53	0.78				

**Table 3:** Shows no significant difference in the levels of anxiety between scores for clients with vitamin D deficiency and clients with vitamin D insufficiency.



**Figure 2:** Shows a boxplot of the differences in depression between the two groups (group 1 clients with vitamin D deficiency, and group 2 clients with vitamin D insufficiency).

insufficiency,  $M=2.48$ , and  $M=2.53$  respectively.

## Discussion

The current study found that although clients with vitamin D blood levels of 10 ng/ml or less are more likely to suffer from depression and anxiety than their peers with vitamin D blood levels of 10.1 ng/ml or higher, clients with vitamin D insufficiency may also suffer from depression and anxiety. This result is similar to other studies' findings such as Penckofer et al. revealed that vitamin D levels in clients with major depression are found to be less than 37.3 pg/ml [6]. Similarly, Anglin et al. carried out a survey study on a sample of 31,424 participants. The researchers discussed how low levels or a deficiency of vitamin D has the capability of affecting cerebral processes in a negative way [32]. The findings indicated that 95% of the participants were suffering from vitamin D deficiency as well as increased levels of depression. Anglin et al. study concluded that vitamin D deficiency is directly linked to an increased risk of depression among human beings, and vitamin D supplements can be used to address this depressive state effectively. All these findings are in line with the current research and other research outcomes [6-8,33] where the relationship between depression, anxiety, and/or low vitamin D levels has emphasised.

Therefore, treating vitamin D deficiency and insufficiency by modifying the vitamin levels may lead to a reduction in depression and anxiety. This can be achieved by using the main sources of vitamin D. For example, vitamin D supplements and serums [5,6,8,34], exposure to sunlight, and by having enough fish food-based [35]. These sources increase not only vitamin D levels but also decrease depression and anxiety levels.

## Study limitations

While the results of this study reveal that the depression and anxiety means of clients with vitamin D deficiency are slightly higher than their peers who suffer from vitamin D insufficiency, there are a few limitations to the present research. All the results produced by this study are based on self-completion questionnaires, i.e. the participants' answers are based on ready set of questions. In addition, this study was conducted on a non-probability sample from Kingdome Hospital and Al Borg Medical Laboratories, which are both located in Riyadh, Saudi Arabia, i.e. this sample may not be a representative sample and, therefore, more studies are needed in this field. Link to this, participants who are willing to participate were included in this study, which may reflect a volunteer bias. Furthermore, the close-ended questions (in the questionnaire) did not leave enough space for the participants to express their ideas and feelings regarding their low levels of vitamin D.

## Ethical considerations

This study followed the relevant ethical procedures. In other words, got the approval from both Kingdome Hospital and Al-Borg Medical Laboratories; and also, all the participants were asked to read and sign a Consent Form if they are willing to participate.

## Conclusion

The results of this study suggest that clients in Saudi Arabia with vitamin D deficiency and insufficiency are more likely to suffer from depression and anxiety. This is similar to other studies that consider vitamin D deficiency to be an underlying cause of depression and anxiety. As some studies have suggested, this deficiency among Saudi clients may be due to a lack of exposure to sunlight. Therefore, particular attention should be paid to finding methods, such as vitamin

D supplements and serums or exposure to sunlight that will raise clients' vitamin D levels and, therefore, reduce their depression and anxiety levels.

## Recommendations

Further research should be carried out to investigate the prevalence of vitamin D deficiency in Saudi Arabia and to estimate its relationship with other psychological disorders such as mood disorder, bipolar mood disorder, psychasthenic disorder, and sleep disorder. It is suggested that the use of a mixed methodology to obtain quantitative and qualitative data would give more depth to the collected data. Also, a large, randomly chosen sample should be used in order to generalise the findings. Furthermore, investigating the difference between males and females, and based on age, regarding their vitamin D levels, depression, and anxiety would enrich in the body of knowledge.

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