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Assessment level of awareness of Vitamin D deficiency among the public residents of Al-Baha region; Saudi Arabia

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ABSTRACT

Background: Vitamin D deficiency is a common problem worldwide. One of the main reasons for the spread of this nutritional disorder is the lack of knowledge and understanding of the importance of vitamin D and its role in health and disease. *Objectives:* To assess the awareness and knowledge of vitamin D among the population of Al-Baha Region, Saudi Arabia. *Methods:* Data for this cross-sectional study were acquired using a structured electronic survey translated to Arabic that covered the sociodemographic profile and several awareness domains (knowledge, benefits, sources, and toxicity), using answers from participants over 18 years. This online survey was conducted for three months from December 2020 to obtain 410 total valid answers. *Results:* The study showed that 49.1% of females (opposed to 36.3% males) had a diagnosis of vitamin D deficiency; 69.8% believed rickets was treatable with vitamin D, while 60.7% agreed that vitamin D was essential for maintaining calcium and phosphate homeostasis. Moreover, 79% agreed that vitamin D was crucial for bone and teeth. 72% agreed that vitamin D enhanced immunity, 91.2% believed that sunlight exposure promoted vitamin D production, while only 13% of participants agreed that vitamin D content was higher in meat than in vegetables and fruits. 29.5% agreed that exposure to sunlight did not lead to vitamin D toxicity, while 11.5% agreed that people with darker skin were prone to vitamin D deficiency. *Conclusion:* Public awareness of vitamin D and its deficiency is low, particularly in the sources domain. Therefore, educational campaigns are needed to improve knowledge levels.

Keywords: vitamin d deficiency, knowledge, Al-Baha, Saudi Arabia

1. INTRODUCTION

Vitamin D considered a fat-soluble vitamin of significant physiologic importance. It plays a critical role in ensuring adequate calcium and phosphorus levels in the plasma and is also involved in many other

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physiological actions, including bone mineralization and neuromuscular transmission (Kumar et al., 2017). Moreover, vitamin D is crucial in preventing and treating bone diseases, such as rickets, osteomalacia, and tetany (Kumar et al., 2017). Vitamin D insufficiency is a common problem in many countries worldwide, involving both adults and children. Many studies have shown that vitamin D deficiency is strongly linked to an increased risk of various diseases, including osteoporosis, rickets, cardiovascular diseases, malignant tumors, and autoimmune diseases (Mithal et al., 2009; Hagenau et al., 2009; DeLuca, 2004; Alshahrani et al. 2020; Hassan et al. 2021).

Vitamin D deficiency is defined as a 25-hydroxyvitamin D concentration of less than 20 ng/ml (Bischofova et al., 2018; Poskitt et al., 1979; Holick, 2007). Serum 25-hydroxyvitamin D level is primarily determined by the dietary consumption of vitamin D and ultraviolet radiation exposure from sunlight, which provide the precursors of vitamin D (ergocalciferol from diet and cholecalciferol from sunlight). These precursors undergo a hydroxylation reaction (mediated by the 25-hydroxylase enzyme) in the liver to produce the primary form (25-hydroxyvitamin D). Natural sources of vitamin D are limited; these include egg yolks, meat and meat products, and milk and dairy products (Martins et al., 2007).Vitamin D receptors are present in most human cells and tissues; these receptors mediate enzymatic actions converting the primary circulating form of vitamin D (25-hydroxyvitamin D) to the active form (1,25-dihydroxyvitamin D) via a hydroxylation reaction by the 1α-hydroxylase enzyme, which occurs in the kidney.

Many studies have shown that the link between 25-hydroxyvitamin D levels in the serum and sunlight exposure is more significant than dietary intake, although vitamin D insufficiency is significant even in populations living in countries with low latitudes and adequate sunlight (Giovannucci, 2005). Despite the abundant sunlight for most of the year, North Africa and the Middle East (including Saudi Arabia) have unacceptably high degrees of vitamin D insufficiency (Alamoudi et al., 2019; Alsuwadia et al., 2013; Alshamsan & Bin-Abbas, 2016; Bischoff-Ferrari et al., 2006). In Saudi Arabia, vitamin D deficiency has become a problem in most regions. In the past few decades, evidence from other studies has shown that vitamin D insufficiency is high due to insufficient dietary vitamin D intake and lack of sun exposure (Alamoudi et al., 2019; Alsuwadia et al., 2013; Tuffaha et al., 2015; Kaddam et al., 2017; Al-Alyani et al., 2018). This finding highlights the need for awareness in the population. One of the main reasons for the spread of this nutritional disorder worldwide is the lack of knowledge and understanding of the significance of vitamin D and its role in health and disease (Palacios & Gonzalez, 2014; Alemu & Varnam, 2012).

Vitamin D deficiency has generated substantial interest in healthcare. Many studies have been conducted worldwide to determine vitamin D awareness (sources, benefits, and deficiency) associated with the rising of vitamin D insufficiency prevalent (Alamoudi et al., 2019; Alshamsan & Bin-Abbas, 2016; Palacios & Gonzalez, 2014; Siddiqui & Kamfar, 2007). Nevertheless, vitamin D deficiency awareness has rarely been studied directly in Al-Baha population. Given the scarcity of literature and vitamin D insufficiency adverse effects, a better understanding and data on awareness among Al-Baha population are necessary. Therefore, this study was conducted to determine the knowledge and awareness of vitamin D in Al-Baha region.

We also evaluated the population's demographic characteristics associated with awareness levels. This study will help develop more sophisticated and tailored methods to raise awareness of vitamin D benefits and consequences of a deficiency in Al-Baha population and compare the knowledge gap among people of Saudi Arabia.

2. METHODS

Study Setting

This study was conducted on a cross-sectional basis from December 2020 to February 2020 and included 410 residents of Al-Baha region, considered the southern province's capital in Saudi Arabia. Al-Baha region is characterized by cloudy, cold weather. It is 2200 m above sea level with a surface area of 9,921 km2 and more than 487,000 people. It is not a coastal region.

Sampling Method

The study used the Survey Systems' sample size calculator to determine the minimum required sample size (www.surveysystem.com/sscalc.htm). The minimum required sample size was 384, based on the population of Al-Baha region (487108) with a 5% margin of error and a confidence interval of 95%. This sample size was acceptable to assess the awareness of vitamin D insufficiency among Al-Baha public residents. Ethical approval for the work within this study was provided by Al-Baha University, Faculty of Medicine, Scientific Research & Ethics Committee.

Data Collection

We used a structured survey in an electronic form for data collection. Participants were informed of the study's aims before enrollment. The questionnaire was developed based on a previous study (Alamoudi et al., 2019). The questionnaire covered the

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sociodemographic profile and awareness domains of vitamin D (knowledge, benefits, sources, and toxicity). We examined the associations between the awareness status of vitamin D insufficiency and sociodemographic variables. We designed an easy-to-answer questionnaire, including questions translated to Arabic, and participants could quit the questionnaire at any time. Participants who were younger than 18 years or lived outside Al-Baha region were not included in the study. Participants who had not completed the questionnaire were also excluded.

Questionnaire Development and Testing

Before using the questionnaire in the actual study, a pilot study was conducted with a sample of 64 participants. It yielded good reliability, with the overall Cronbach's alpha of all 16 items calculated as $\alpha = 0.711$. The questionnaire was divided into two parts. The first part consisted of sociodemographic questions, while the second part comprised 16 questions measuring the level of awareness of vitamin D in different domains (knowledge, benefits, sources, and toxicity). Participants had to answer the first two questions with "yes" or "no" options and "yes," "no," or "do not know" options for the remaining questions. A correct answer was assigned a score of one, and wrong answers were assigned a zero; the total maximum possible score was 16.

For each participant, the awareness score for each domain of vitamin D was measured as the sum of correct answers from a question set. Higher scores indicated better awareness in a particular domain. The awareness level of knowledge, benefits, sources, and toxicity domains was measured using a set of two, five, eight, and one questions.

Study Variables

The sociodemographic characteristics were included in this study: gender, age, nationality, educational level, employment status, homeownership status, marital status, and parental status. The nationality of the participants was divided into Saudi and non-Saudi groups. Participants were placed into four groups according to age: 18-28 years, 29-39 years, 40-49 years, and over 50 years. The highest formal education completed was classified as elementary, intermediate, high school, and university degrees to assess education levels.

For the employment status, four general categories were used: student, health-field worker, non-health-field worker, and unemployed. We assessed homeownership status based on whether the participant owned or rented a home. There were four categories for marital status: married, single, divorced, and widowed. Parental status was assessed by asking the participants (who were not single) if they had children or not.

Statistical Analysis

Data was entered, managed, and coded using Microsoft Excel 16.0. Statistical analyses were conducted using the IBM SPSS 25.0 (Statistical Package for the Social Sciences, Inc, Chicago, IL, United States) and presented as tables. The statistical approach used in our study has been published in a previous study (Alamoudi et al., 2019). For each domain, we summed the correct answers to obtain a total possible score of 2, 5, 8, and 1 in the domains of knowledge, benefits, sources, and toxicity. Categorical variables were presented as numbers and percentages. For the quantitative variables, the data were provided as mean ± SD, minimums, and maximums. We analyzed the differences in the mean score of awareness for vitamin D domains between independent variable groups to identify differences in data relating to characteristics between groups using the Independent-Sample t-test and Analysis of Variance (ANOVA). A p-value <0.05 was considered statistically significant.

3. RESULTS

Initially, we calculated Cronbach's alpha to assess the internal consistency of the questionnaire items. A total of 64 participants were included in this pilot study. Cronbach's alpha value was 0.711 for the entire questionnaire, which is considered acceptable. A total of 422 have participated, 12 were excluded. Finally, we selected 410 participants; 401 (97%) had Saudi ethnicity, 207 (50.5%) participants were 18-28 years, 315 (76.8%) had a university degree, and 90 participants (22%) completed high school. Two hundred-three (49.5%) were married, and 187 (45.6%) had children (Table 1).

Table 1 Sociodemographic characteristics of participants.

Variables		*N*	%
Gender	Male	237	57.8%
	Female	173	42.2%
Nationality	Saudi	401	97.8%

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	Non-Saudi	9	2.2%
Age	18-28	207	50.5%
	29-39	89	21.7%
	40-49	76	18.5%
	>50	38	9.3%
Educational level	Elementary	1	0.2%
	Intermediate	4	1.0%
	High school	90	22.0%
	University degree	315	76.8%
Occupation	Student	140	34.1%
	Health-field worker	33	8.0%
	Non-health-field worker	131	32.0%
	Unemployed	106	25.9%
Homeownership	Owned	317	77.3%
	Rented	93	22.7%
Marital status	Married	203	49.5%
	Single	203	49.5%
	Divorced	2	0.5%
	Widowed	2	0.5%
Parental status	A parent	187	45.6%
	Not a parent	223	54.4%

The awareness scores on knowledge of vitamin D are shown in Table 2. The majority of participants (96.8%) had been familiar of vitamin D, and 41.7% had a diagnosis of vitamin D deficiency. A remarkable proportion of female participants (49.1%) had a diagnosis of vitamin D deficiency compared to male participants (36.3%) (p-value=0.009). Regarding vitamin D's advantages, more than two-thirds (69.8%) of participants believed that vitamin D could treat rickets, 60.7% agreed that vitamin D was essential in maintaining calcium and phosphate levels, and 79% agreed that vitamin D was crucial for bone and teeth.

Table 2 Vitamin D knowledge scores.

		N	%
Have you ever heard of vitamin D?	Yes	397	96.8%
	No	13	3.2%
Have you ever been told that you have vitamin D deficiency?	Yes	171	41.7%
	No	239	58.3%

The majority of participants (72%) believed vitamin D enhances immunity, while 23% were unaware of its role in improving immunity. Approximately half of the participants (53.2%) agreed that vitamin D helps strengthen muscles, and 35.9% had no knowledge. The majority agreed that vitamin D was essential in maintaining bone and teeth (79%). Regarding Vitamin D sources, a total of 374 (91.2%) participants believed that sunlight exposure promotes vitamin D production in the skin, and 241 (58.8%) thought that residents who live in cloudy areas are more prone to vitamin D deficiency. Only 13% of the participants agreed that vitamin D content was higher in animal meat than in vegetables and fruits, while 43.2% did not know. Approximately 29.5 % believed that sun exposure did not cause vitamin D poisoning, and 11.5% agreed that those with darker skin were more likely to suffer from vitamin D deficiency than people with lighter skin.

Regarding vitamin D toxicity, approximately half of the participants (49.3%) were aware that high calcium levels in the blood could be associated with several medical conditions, while 40.5% were unaware. Table 3 shows the mean score of awareness. The overall mean awareness score was 7.74±2.95. The mean awareness score was 1.4±0.5 for knowledge, 3.35±1.5 for benefits, 2.51±1.63 for sources, and 0.49±0.50 for toxicity. Figure 1 shows that the highest score was in the knowledge domain (69.5%) followed by the benefits (67%), while the least score was for the sources domain (31.4%).

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Table 3 Awareness scores in 4 domains.

Variables	Mean ± SD	Range (Min-Max)	*Total*	%
Knowledge	1.39±0.54	2 (0-2)	2	69.5%
Benefits	3.35±1.53	5 (0-5)	5	67%
Sources	2.51±1.63	8 (0-8)	8	31.4%
Toxicity	0.49±0.50	1 (0-1)	1	49%
Overall	7.74±2.95	16 (0-16)	16	48.4%

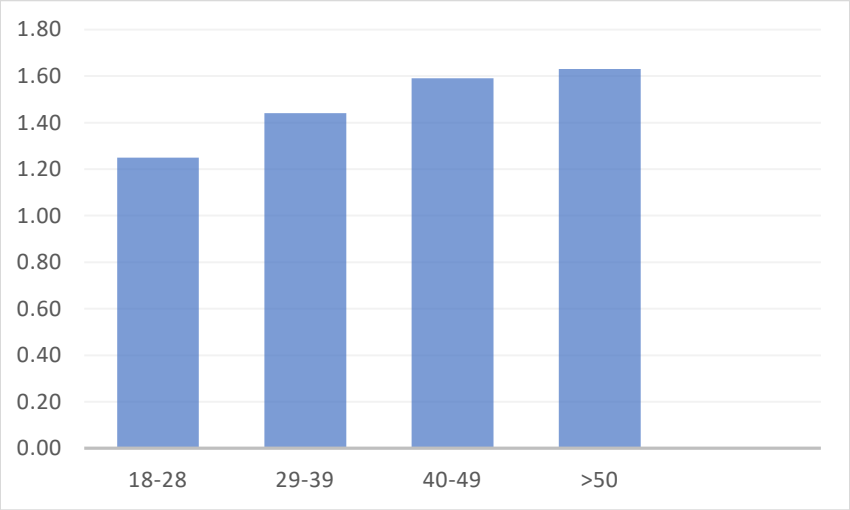

Figure 1 Percentage representation of awareness domains scores.

A comparison of age groups showed a statistically significant difference across age groups for nearly all awareness domains, except toxicity, where there was no discernible difference (Table 4). Figure 2 shows higher awareness score in participants aged 40-49 years in benefits, sources, and toxicity domains, while participants aged 18-28 achieved the least scores in three domains. A comparison of education level groups showed no significant difference for all domains of awareness scores. A comparison of gender groups showed a significant difference for knowledge, benefits, and toxicity domains (p-value=0.04, p-value=0.022, and p-value=0.003, respectively). Females had higher awareness scores among all vitamin D domains than males (Table 5).

Table 4 Awareness level by age

Variables		Mean ± SD	*p* value
Knowledge	18-28	1.25±0.54	.000
	29-39	1.44±0.52	
	40-49	1.59±0.49	
	>50	1.63±0.49	
	Total	1.39±0.54	
Benefits	18-28	3.12±1.50	.005
	29-39	3.40±1.60	
	40-49	3.84±1.39	
	>50	3.45±1.57	
	Total	3.35±1.53	
Sources	18-28	2.27±1.57	.004
	29-39	2.66±1.49	
	40-49	3.04±1.96	
	>50	2.47±1.33	
	Total	2.51±1.64	
Toxicity	18-28	0.49±0.50	.569

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	29-39	0.47±0.50	
	40-49	0.55±0.50	
	>50	0.42±0.50	
	Total	0.49±0.50	
Overall	18-28	7.13±2.89	.000
	29-39	7.98±2.82	
	40-49	9.03±3.05	
	>50	7.97±2.53	
	Total	7.74±2.95	

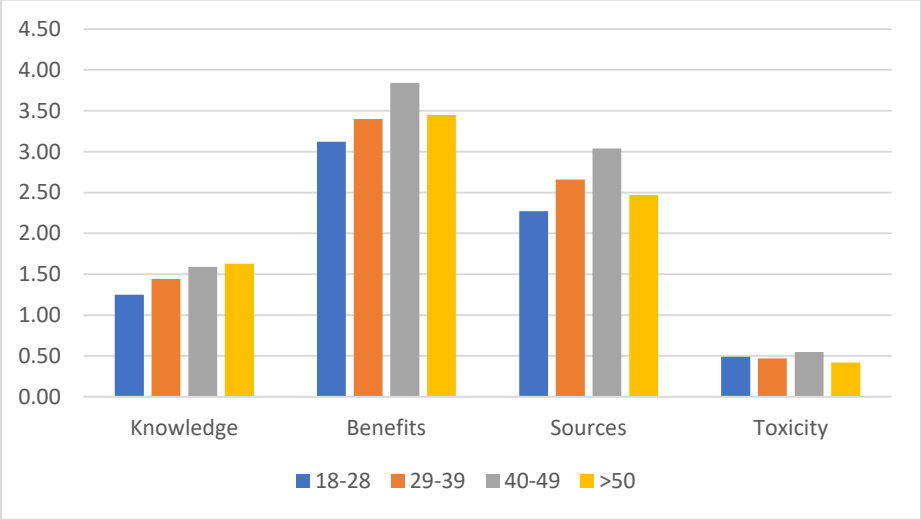

Figure 2 Comparison of awareness domains scores between age groups.

Table 5 Awareness level by gender

Variables		Mean ± SD	*p* value
Knowledge	Male	1.32±0.54	.004
	Female	1.48±0.52	
Benefits	Male	3.20±1.61	.022
	Female	3.55±1.39	
Sources	Male	2.56±1.73	.463
	Female	2.44±1.50	
Toxicity	Male	0.43±0.50	.003
	Female	0.58±0.50	
Overall	Male	7.52±3.17	.071
	Female	8.05±2.60	

A comparison of employment status groups showed a significant difference for the knowledge and sources domains (p-value=0.002 and p-value=0.001, respectively). A comparison of marital status groups showed that married participants had higher awareness scores than single participants. Also, there was a significant difference across the knowledge, benefits, and sources domains, with no significant difference for the toxicity domain (Table 6).

On comparing whether or not a participant had children, the results revealed a significant difference in the knowledge domain only (p-value=0.009).

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Table 6 Awareness level by marital status

Variables		Mean ± SD	*p* value
Knowledge	Married	1.54±0.51	.000
	Single	1.24±0.53	
	Divorced	2.00±0.00	
	Widowed	1.50±0.70	
	Total	1.39±0.54	
Benefits	Married	3.60±1.46	.006
	Single	3.09±1.55	
	Divorced	4.50±0.70	
	Widowed	3.00±2.83	
	Total	3.35±1.53	
Sources	Married	2.79±1.67	.007
	Single	2.25±1.57	
	Divorced	1.50±0.70	
	Widowed	2.00±0.00	
	Total	2.51±1.64	
Toxicity	Married	0.49±0.50	1.000
	Single	0.49±0.50	
	Divorced	0.50±0.70	
	Widowed	0.50±0.70	
	Total	0.49±0.50	
Overall	Married	8.42±2.79	.000
	Single	7.07±2.98	
	Divorced	7.00±0.70	
	Widowed	7.00±4.24	
	Total	7.24±2.95	

4. DISCUSSION

Vitamin D deficiency has become a problem worldwide. Many studies have been conducted to determine awareness of vitamin D (sources, benefits, and deficiency) associated with the rising of vitamin D insufficiency prevalent (Alamoudi et al., 2019; Alshamsan & Bin-Abbas, 2016; Palacios & Gonzalez, 2014; Siddiqui & Kamfar, 2007). However, awareness of vitamin D deficiency has rarely been studied directly in Al-Baha population. The current study results showed that 69.5% of the participants had an adequate level of knowledge domain for vitamin D, and 67% showed vitamin D benefit domain. A similar study in Jeddah showed that two-thirds of the participants had an adequate level of information on vitamin D benefits (Alamoudi et al., 2019). Exposure to sunlight is a crucial source of vitamin D. Vitamin D's natural sources is limited; these include egg yolks, meat and meat products, and milk and dairy products. Many studies have shown that the link between 25-hydroxyvitamin D levels in the serum and sunlight exposure is more significant than dietary intake (Giovannucci, 2005). Vitamin D production in the skin could be impaired in some situations, such as darker skin and sunscreen use (Libon et al., 2013; Matsuoka et al., 1987; Samarkandy et al. 2020).

The current study revealed that 41.7% of participants had a diagnosis of vitamin D insufficiency (female > male) (49.1% vs. 36.3%). A UAE study showed a higher prevalence of vitamin D insufficiency in females than in males (83% vs. 42%); study results showed that 60% of female participants spent less than one hour outdoors, and 55% used sunscreen daily (Ibrahim et al., 2019). Another study conducted in the United Kingdom for high-risk people showed that 45% of women and 61% of men were unaware of the link between vitamin D insufficiency and its symptoms (Alemu &Varnam, 2012). Furthermore, a recent study on Makkah (KSA) school children found a higher incidence of vitamin D insufficiency in females, primarily caused by restricted sunlight exposure (Kensara et al., 2015). Another study involving the female population in China showed that 62.3% of participants did not like sun exposure (Kung & Lee, 2006).

Our study showed that over two-thirds of the participants had proper awareness of vitamin D and its benefits. The majority agreed that vitamin D helped maintain teeth and bone, enhance immunity, and improve muscle strength. A comparison of the current state of knowledge regarding vitamin D sources showed that only 31.4% of the participants had adequate information. The

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current study revealed that low information levels were not associated with education levels; there were no discernible difference in knowledge scores for education level groups. Our findings correspond with the findings of a study in Jeddah that found no association between education levels and vitamin D information (Al-Agha et al., 2016).

A study in Belgium on the association between skin color and vitamin D synthesis found that skin pigmentation (dark skin) adversely affects vitamin D production (Matsuoka et al., 1987). Only 11.5 % of the present study's participants agreed that people with dark skin were more prone to vitamin D deficiency.

5. CONCLUSION

This study highlights the awareness of vitamin D (sources, benefits, and deficiency) in Al-Baha population. Participants had limited understanding regarding vitamin D sources. Further, the number of female participants diagnosed with vitamin D deficiency was higher than males, mainly due to restricted sunlight exposure and lifestyle differences. Most participants had adequate knowledge of vitamin D benefits and its effects on maintaining teeth and bone, enhancing immunity, and improving muscle strength. However, the majority were unaware of the nutritional sources of vitamin D, which should be addressed in the future.

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Author Contributions

All authors contributed evenly with regards to development of study design, data collection and analysis, interpretation of data, drafting the manuscript, and critical revision.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Ethical approval

This study was approved by the Research Ethics Committee in Faculty of Medicine, Al-Baha University with the ethical approval number (REC/PAT/BU-FM/2020/0095).

Conflicts of interest

The authors declare that they have no conflict of interest.

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Data and materials availability

All data associated with this study are present in the paper.

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