



Knowledge, Attitude, and Practice (KAP) towards Vitamin D Deficiency among Adult Population in Qassim, Saudi Arabia

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Abstract:

Background: Vitamin D deficiency is becoming a worrying problem in Saudi Arabia and worldwide. However, vitamin D, a fat-soluble vitamin, plays a vital role in bone health by enhancing calcium and phosphorus absorption and metabolism. Also, vitamin D deficiency is remarkably correlated with the development of neurodegenerative diseases, such as senile dementia, schizophrenia, and multiple sclerosis.

Objective: The objective of our study was to evaluate the vitamin D deficiency Knowledge, Attitude, and Practice (KAP) among the adult population in Qassim, Saudi Arabia.

Methods: A cross-sectional design study was conducted among the general population in the Qassim area from March 2022 to July 2022.

Results: About 99.1% of people had heard about vitamin D, and the majority were aware that sunlight is the primary source of this vitamin. Despite the fact that 72.9% of them exposed themselves to sunshine, only 46.4% of participants liked going outside in the sun. Only 13.7% of the participants believed that they receive adequate sun exposure. The majority of participants (93.1%) were aware of the significance of vitamin D for bone health, and 48.4% were aware that there is a link between vitamin D insufficiency and other disorders, such as diabetes, cardiovascular disease, and depression. Additionally, the majority of individuals (91.0%) stated sunlight to be the source of vitamin D.

Conclusion: The findings have revealed Saudis to have a basic understanding of vitamin D deficiency. However, they were not sufficiently informed on the consequences of vitamin D deficiency.

Keywords: Vitamin D deficiency, Knowledge, Practice, Adult population, Dementia, Schizophrenia.

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1. INTRODUCTION

Vitamin D deficiency is becoming a worrying problem in Saudi Arabia and worldwide [1, 2]. It has been recognized as an international public health problem because of its prominent role in the most common medical diseases related to the skeletal system [3, 4]. Vitamin D is a fat-soluble vitamin that is vital to bone health and

increases the absorption and metabolism of calcium and phosphorus. The primary role of vitamin D is to preserve the balance of calcium and phosphorus, which is essential for healthy bone mineralization. Hence, the most prevalent disorders linked to vitamin D deficiency include osteoporosis, osteomalacia, and rickets in children. It improves the small intestinal epithelial cells' capacity to

absorb calcium, controls how much phosphorus is absorbed from meals, and accelerates calcium reabsorption from the glomerular filtrate [5, 6]. Illnesses, such as multiple sclerosis, senile dementia, and schizophrenia, are strongly correlated with vitamin D insufficiency. Additionally, the renin-angiotensin-aldosterone pathway's stimulatory effects imply an association between a vitamin D deficit and the occurrence of cardiovascular diseases [7]. It should be highlighted that reduced incidence rates of colon, breast, ovarian, renal, pancreatic, and other cancers are significantly correlated with greater serum levels of 25-hydroxyvitamin D [8].

Many studies have reported that sunlight is the primary source of vitamin D [9, 10]. Despite this fact, vitamin D deficiency is unexpectedly higher in countries with a sunny climate, such as Saudi Arabia, Egypt, Oman, and the United Arab Emirates [11]. Babelghaith *et al.* [12] pointed out that although exposure to sunlight is a significant factor in the human body's production of vitamin D, vitamin D insufficiency is most common in some of the world's sunniest regions. Nevertheless, several reasons have led to Saudi Arabia's dangerously low vitamin D levels. The people of Saudi Arabia generally live indoors because of the country's extreme heat despite the belief that a deficiency in vitamin D is caused by Muslim communities' traditions of avoiding sun exposure.

Ghada reported that the risk factors for vitamin D deficiency include low socioeconomic level, female gender, multi-parity, season, conservative clothing style, and living in urban areas [2]. Siddiqui [13] assumed that sun exposure in Saudi Arabia is limited because women wear abaya, hiding them completely from head to toe. Christie *et al.* [14] reported, in their study, that students showed minimal awareness of vitamin D that it is crucial for the health of musculoskeletal development and that sunlight is beneficial.

As sunlight exposure is the main source of vitamin D, the efficiency of the conversion of 7-dehydrocholesterol to vitamin D₃ is dependent on many factors, like the time of the day, season of the year, nature, skin color, and age. Other sources of vitamin D have relatively little vitamin D levels and these are found in natural food, such as seafood, shrimp, mushrooms, egg yolk, and fortified milk [15]. Vitamin D is stored in fat cells and is transported to blood circulation by vitamin D-binding protein. Vitamin D₃ (cholecalciferol) is biologically inactive and should be metabolized to 25-(OH) D₃ in the liver and then to 1,25-dihydroxycholecalciferol in the kidney, which represents the biologically active form of vitamin [16, 17]. Assessing the knowledge, attitudes, and practices of the general population is essential to identify any gaps in their understanding and approach toward vitamin D deficiency status. The results obtained from the general population regarding knowledge and attitudes towards vitamin D could motivate policymakers to implement awareness programs or interventions to improve good practices and knowledge about vitamin D. This study aimed to assess knowledge, attitudes, and practices regarding vitamin D

deficiency among the general adult population in the Qassim region of Saudi Arabia.

2. METHODOLOGY

2.1. Study Design, Data Sources, and Sample Size Calculation

A cross-sectional study design was utilized to collect data through an online adapted questionnaire. The study was carried out from March 2022 until July 2022 in Qassim Province, Saudi Arabia.

An online questionnaire was used to evaluate the general population's knowledge about, attitude towards, and practice for vitamin D deficiency in the Qassim region. This questionnaire was adopted from a previous study in Riyadh, where we obtained approval from the authors Babelghaith *et al.* [12] in October 2021 to adapt or adopt their questionnaire.

For the purpose of calculating the sample size from the population, we used the Raosoft software (Sample Size Calculator; Raosoft, Inc., Seattle, WA, USA). We considered a 95% confidence level and a 5% margin of error, along with a standard response distribution of 50%. As a result, the calculated sample size was determined to be 377.

Ethical approval was obtained from the Committee of Research Ethics, Deanship of Scientific Research, Qassim University, on 13 March, 2022. Participation in the survey was strictly voluntary. Consent to take part in the study was assumed once participants responded to the online survey.

2.2. Study Population Participants and Questionnaire Administration

The targeted population of the study was both males and females of the general population living in the Qassim region. Individuals who agreed to fill out the questionnaire, aged 18 years old and above, were included in this research. Those who did not like to participate and were under eighteen years of age were excluded. The questionnaire was distributed using the social media platform WhatsApp® (Meta Platforms, Inc., Menlo Park, California, United States). In administering the survey, duplicate responses were avoided by limiting the response from the same device to only one response. Consent to take part in the study was assumed once the participants responded to the online survey. In this research, participation was completely voluntary, and no rewards were provided.

This questionnaire was pretested on 25 individuals different from the target population to check the understanding and clarity of the questionnaire. To test the reliability, the questionnaire was administered to the same participants. Cronbach's alpha test of internal consistency was 0.71. Questions asked were divided into four sections. The first part included questions on the demographic characteristics of the participants. The second part included questions on knowledge about vitamin D deficiency. Median scores were used as cutoff points to

assess KAP levels. A good knowledge level was considered if the individual achieved a median score of 2 or higher in the Knowledge-Benefit and Knowledge-Sources groups, and a score of 4 or higher in the overall Knowledge group (combining benefits and sources). Questions on attitude about vitamin D deficiency were included in the third part of the survey and questions on practice towards vitamin D deficiency in the fourth part.

2.3. Data Analysis

Statistical Package for Social Sciences software (SPSS, version 21, SPSS, Chicago, IL, USA) was used to analyze data. Descriptive analysis was used for the categorical variables. Associations between demographic data and

dependent variables were assessed using the Chi-square test. A *p*-value of <0.05 was considered statistically significant.

3. RESULTS

A total of 336 individuals from the targeted sample (n=377) responded to the survey, achieving a response rate of 89%. Table 1 shows the general characteristics of participants aged 18 to 60. The mean age in years of participants was 35.52 (13.54%). Approximately 95.8% of participants were Saudi, with the majority of participants (73.2%) being males and 26.8% being females. A bachelor's degree was held by slightly more than half of the participants (59.2%).

Table 1. Distribution of demographic data of participants (n = 336).

Variable	N (%)
Gender	-
Male	246 (73.2)
Female	90 (26.8)
Age in years	-
Mean (SD)	35.52 (13.54)
Median	33
Nationality	-
Saudi	322 (95.8)
Other nationality	14 (4.2)
Marital status	-
Single	148 (44)
Married	183 (54.5)
Divorced	3 (0.9)
Widow	2 (0.6)
Smoking	-
Yes	63 (18.8)
No	273 (81.2)
Education level	-
Elementary and Intermediate school	9 (2.7)
Secondary school	86 (25.6)
Bachelor	199 (59.2)
PhD/Master	28 (8.3)
Other	14 (4.2)

Table 2. Knowledge of vitamin D and sources of information (n = 336).

Items	Number (N)	Percent (%)
Heard of vitamin D	-	-
Yes	333	99.1
No	3	0.9
Source of information	-	-
Health staff	153	45.5
Newspapers, television, radio	74	22
Family and friends	90	26.8
Other	19	5.7

Table 3. Participants' knowledge of vitamin D's health benefits (n = 336).

Items	Number (N)	Percent (%)
Do you know that vitamin D is good for bone health?	-	-
Yes	296	88.1
No	13	3.9
Do not know	27	8
Could muscle pain be related to vitamin D deficiency?	-	-
Yes	253	75.3
No	11	3.3
Do not know	72	21.4
Do you think vitamin D deficiency is related to other diseases, such as heart, diabetes, depression, and cancer?	-	-
Yes	153	45.5
No	67	19.9
Do not know	116	34.6

3.1. Knowledge of Vitamin D and Sources of Information

99.1% of those surveyed responded that they had heard of vitamin D. As demonstrated in Table 2, the healthcare provider was the most common source of information about vitamin D (45.5%), followed by family and friends (26.8%) and the media (22%).

3.2. Knowledge of the Health Benefits of Vitamin D

Table 3 shows that most participants (88.1%) knew that vitamin D is necessary for healthy bones. Approximately 75.3% of the respondents indicated vitamin D deficiency to be associated with muscle pain. However, 45.5% of the respondents thought vitamin D deficiency and other illnesses, such as cancer, diabetes, heart disease, and depression, to be associated, compared to 19.9%, who thought that there was no association, and 34.6%, who were unaware of the association.

3.3. Knowledge of Vitamin D Sources

This study showed that only 4.16% of participants did not know the sources of vitamin D. The most reported vitamin D source was the sun (83.9%), followed by vitamin D supplements (80%), milk diary (26.78%), fatty fish (14.88%), and then eggs (30.95%), as shown in Table 4.

3.4. Vitamin D and Attitude towards Vitamin D and COVID-19 Disease

Only 30.7% of our subjects mentioned that vitamin D is not related to the prevention of COVID-19 disease, while 45.5% of our subjects said that they do not know whether vitamin D is related to the prevention of COVID-19 disease

or not. Table 5 shows that 31.3% of the participants thought that vitamin D supplementation protects against the deterioration of the health of patients with COVID-19, while 46.4% of participants reported that they do not know whether vitamin D supplementation protects against the deterioration of the health of patients with COVID-19 or not. However, only 22.3% reported that vitamin D supplementation does not protect against the deterioration of the health of patients with COVID-19. The majority of participants (89.6%) were ready to take a vitamin D test. Surprisingly, 84.8% of participants wanted to take a vitamin D supplement if they were deficient, as shown in Table 5.

3.5. Vitamin D and Sun Exposure Practice

As shown in Table 6, about 73% of participants reported that they like to go into the sun, and only 13.1% of them used an umbrella to shade from the sun, and the majority (86.9%) of them did not use an umbrella. Only 12.5% of participants used sunscreen products containing SPF > 15, and 3.9% of those used sunscreen daily. However, 87.5% did not use sunscreen products. A few participants (22.6%) believed that they have enough sun exposure.

Of those surveyed, over 40.2% reported having symptoms of vitamin D deficiency, while only 27.1% reported having no vitamin D deficiency. Of the respondents, about 32.7% reported that they were unsure if their complaints were due to indications of vitamin D deficiency. Furthermore, 44.9% of participants reported having pain in their muscles. Approximately 12.5% of participants reported using medication to treat muscle pain. Table 6 shows the responses received.

Table 4. Responses to knowledge of vitamin D sources (n = 336).

Resources	Frequency (N)	Percentage (%)
Fruit	112	33.3
Water	18	5.35
Vegetables	82	24.40
Vitamin D supplement	269	80
Sun	282	83.9

(Table 4) contd.....

Resources	Frequency (N)	Percentage (%)
Fatty fish	50	14.88
Eggs	104	30.95
Milk diary	90	26.78
Do not know	14	4.16

Table 5. Responses on participants' attitude towards vitamin D and COVID-19 disease.

Items	Number (N)	Percent (%)
Do you think vitamin D is related to preventing COVID-19 disease?	-	-
Yes	80	23.8
No	103	30.7
Do not know	153	45.5
Do you think vitamin D supplementation protects against the deterioration of health of patients with COVID-19?	-	-
Yes	105	31.3
No	75	22.3
Do not know	156	46.4
Are you ready to take a vitamin D test?	-	-
Yes	301	89.6
No	29	8.6
Do not know	6	1.8
If you are deficient in vitamin D, do you want to take a vitamin D supplement?	-	-
Yes	285	84.8
No	28	8.4
Do not know	23	6.8

Table 6. Responses of participants' practices related to vitamin D and sun exposure.

Items	Number (N)	Percent (%)
Do you like exposing yourself to sunlight?	-	-
Yes	245	72.9
No	88	26.2
Do not know	3	0.9
Do you often use an umbrella to protect yourself from the sun's rays?	-	-
Yes	44	13.1
No	292	86.9
Do you use sunscreen products with an SPF of more than 15?	-	-
Yes	42	12.5
No	294	87.5
How often do you use sunscreen?	-	-
Do not use	-	-
Every day	299	89
Two days/week or less	13	3.9
More than two days/week	14	4.1
Sunscreen products have an SPF of more than 15	10	3
Do you think you are getting enough exposure to sunlight?	-	-
Yes	76	22.6
No	227	67.6
Do not know	33	9.8
Do you suffer from symptoms of vitamin D deficiency?	-	-
Yes	135	40.2
No	91	27.1
Do not know	110	32.7
Do you suffer from muscle pain and fatigue?	-	-
Yes	151	44.9

(Table 6) contd....

Items	Number (N)	Percent (%)
No	167	49.7
Do not know	18	5.4
If you suffer, do you take treatment for muscle pain and fatigue?	-	-
Yes	42	12.5
No	294	87.5

Table 7. Relation of vitamin D to the prevention of COVID-19 disease (N= 336).

Question	Response	Variable	
Q1- Do you think vitamin D is related to preventing COVID-19 disease?	-	Male n (%)	Female n (%)
	Yes	162 (65.9)	71 (78.9)
	No	84 (34.1)	19 (21.1)
	-	School n (%)	University n (%)
	Yes	75 (78.9)	158 (65.6)
	No	20 (21.1)	83 (34.4)
Q2- Do you think vitamin D supplementation protects against the deterioration of patients' health with COVID-19?	-	Male n (%)	Female n (%)
	Yes	185 (75.2)	76 (84.4)
	No	61 (24.8)	14 (15.6)
	-	School n (%)	University n (%)
	Yes	82 (86.3)	179 (74.3)
	No	13 (13.7)	62 (25.7)

Table 8. Association between knowledge and age.

Variables	Knowledge-Benefit		*p value
Less than 33 years 33 years and more	Poor 29% 15.5%	Good 71% 84.5%	0.004
	Knowledge-Sources		p value
Sources Less than 33 years 33 years and more	Poor 21% 24.7%	Good 79% 25.3%	- 0.438
	Knowledge overall (benefits and sources)		p value
Overall Less than median (33) 33 years and more	Poor 30.2% 23%	Good 69.8% 77%	- 0.139

Note: * P-value <0.05 was considered statistically significant.

Table 7 shows that the responses of the males to Q1 and Q2 were better than the females' responses (34.1% versus 21.1% and 24.8% versus 15.6%, respectively). Also, participants' responses to Q1 and Q2 at the university level were better than those at the school level (34.4% versus 21.1% and 25.7% versus 13.7%, respectively).

Table 8 demonstrates that a significant association was found between the age variables and knowledge benefit (p = 0.004), whereas there are no significant associations between the age variables and the other knowledge sources and overall knowledge (benefits and sources) (p = 0.438 and p = 0.139). With regards to other variables, no significant associations were found.

4. DISCUSSION

Exposure to sunlight is a crucial source for obtaining

vitamin D. Various factors, including the aging process, having dark skin, and applying sunscreen, can diminish the skin's ability to produce vitamin D [9, 18-24]. Vitamin D can also be acquired through dietary sources, like egg yolk, fish, and liver. Certain foods, like milk and cereals, are also enriched in vitamin D [25]. During this study, an evaluation was conducted to gauge participants' practices concerning vitamin D intake and their sun exposure habits. The findings indicated that more than half of the participants exposed themselves to sunlight on a daily basis. This aligns with the outcomes of a cross-sectional study conducted among females in Jeddah city [21]. Our results demonstrated a higher percentage compared to a study carried out in Riyadh, which aimed to assess the general population's knowledge, practices, and attitudes regarding sun protection and its association with vitamin D deficiency. In that study, it was revealed that less than

half of the participants (46.4%) exposed themselves to sunlight daily [12].

In our study, we observed that a mere 12.5% of participants utilized sunscreen products with an SPF rate exceeding 15, and only 3.9% of this subgroup applied sunscreen on a daily basis. These outcomes are consistent with previous investigations conducted among females in Riyadh city [15]. Similarly, a study conducted by Christie [14] in Saudi Arabia, specifically among female students, revealed that the respondents exhibited insufficient knowledge regarding vitamin D. Furthermore, this study highlighted that the participants had restricted sun exposure, primarily because of the sweltering heat [14].

Vitamin D deficiency is known to be associated with various health conditions, including cancer, chronic diseases, and specific physical issues related to bone health. In our study, a substantial majority of participants (88.1%) recognized the crucial role of vitamin D in maintaining bone health. However, less than half of the participants (45.5%) believed that vitamin D deficiency could also contribute to other health problems, such as cardiovascular issues, diabetes, depression, and cancer. This finding aligns with a study conducted in Riyadh [12], which reported that only 48.4% of subjects were aware of this association. In a cross-sectional study conducted in the United States of America, researchers found evidence linking vitamin D deficiency to an elevated risk of cardiovascular disease [18]. Nevertheless, our study's awareness rate was higher than that of previous research, including one study conducted among Saudi females where approximately 25.6% provided the correct response regarding the significance of vitamin D [15]. Additionally, a study carried out in Australia indicated that 76% of subjects acknowledged vitamin D's role in maintaining bone health [20].

For most individuals, the primary source of vitamin D is exposure of the skin to Ultraviolet B (UVB) rays from sunlight. Additionally, vitamin D can be obtained through dietary sources, like eggs, fatty fish, and vegetables, or *via* supplementation [19]. In our study, a significant portion of respondents (83.9%) indicated that they meet their vitamin D requirements through sunlight exposure, followed closely by vitamin D supplements (80%). A smaller percentage reported obtaining vitamin D from dairy milk (26.78%), fatty fish (14.88%), and eggs (30.95%). These findings suggest that participants had a good level of knowledge and awareness regarding the importance of sunlight in obtaining vitamin D. However, it is worth noting that their actual sun exposure practices may not align with this knowledge, as they did not engage in sufficient sun exposure. These results are consistent with a previous study [12], where 91.5% of subjects identified sunlight as the primary source of vitamin D, followed by vitamin D supplements (73.4%). Similar findings were reported in a French study, where 72% of participants recognized sun exposure as the primary source of vitamin D [26]. However, in our study, only 22.6% thought that they were getting enough exposure to sunlight. This result is consistent with a study conducted

in Egypt [27], where only one-third of the participants were exposed to sunlight. This low percentage of people willing to get enough exposure to sunlight is vital since it raises the risk of vitamin D deficiency in them.

While a significant number of participants in our study correctly identified sunlight and vitamin D supplements as sources of vitamin D, a smaller percentage accurately recognized food sources of vitamin D. Specifically, our findings showed the primary sources of information about vitamin D to be healthcare providers (45.5%), followed by family and friends (26.8%), and media (22%). The influence of healthcare providers in imparting knowledge about vitamin D is noteworthy, as they play a crucial role in educating patients and the general public. This finding aligns with a similar study conducted in Riyadh, where less than half of the participants (44%) acknowledged healthcare professionals as the primary source of their knowledge about vitamin deficiency [12]. Contrary to our results, some other studies found social media as the main source of information among the general population group [28, 29].

The results presented in Table 5 indicate that participants had varying perceptions about the protective effects of vitamin D supplementation against the deterioration of health in COVID-19 patients. Specifically, 31.3% of respondents believed that vitamin D supplementation could offer protection in this context, while 46.4% admitted being uncertain about its efficacy. Only 22.3% of participants responded correctly and reported that vitamin D supplementation cannot protect against health deterioration in COVID-19 patients. Interestingly, these findings contrast with the results of a Mendelian randomization study, which unexpectedly revealed that vitamin D supplementation does not confer protection against the deterioration of health in COVID-19 patients [22]. This discrepancy between public perception and scientific evidence highlights the need for clear and accurate communication of research findings to the public to ensure informed decision-making regarding health practices and supplements.

A notable finding in our study was the significant association between knowledge of vitamin D benefits and age (categorized as less than median 33 years and 33 years and more) ($p = 0.004$). Interestingly, this result contradicts the findings of a study conducted by Alamoudi, *et al.* [30]. Conversely, we did not observe a significant association between knowledge sources and age, nor between overall knowledge (benefits and sources combined) and age ($p = 0.438$ and $p = 0.139$, respectively). Remarkably, these results align with the findings reported in the study by Alamoudi, L. H *et al.* [30], where no significant associations were found ($p = 0.62$ and $p = 0.63$, respectively).

These variations in findings between studies may be attributed to differences in sample characteristics, study methodologies, or cultural factors. Further research and exploration of these associations are warranted to understand better the relationship between age and knowledge of vitamin D benefits.

Despite that the current study primarily focused on the general population in the Qassim region and the sample size was acceptable, the males constituted the majority of the study sample, so we believe it to be one of the study's limitations. Also, the study was conducted in a limited area at a specific time, so the results could not be generalized to other populations. However, we recognize the importance of conducting further research on vitamin D deficiency to investigate potential gender differences.

CONCLUSION

The results of this study have revealed Saudis to have a basic understanding of vitamin D. However, they lack adequate awareness of vitamin D and its effects on the heart, diabetes, depression, and cancer, as well as poor sun exposure habits. The findings highlight the significance of implementing ongoing public education programs to raise awareness and information about the benefits of vitamin D.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The research ethics committee of Qassim University in Qassim, Saudi Arabia, approved the study. (approval date: 13 March 2022; number of certification of approval: 21-12-11).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee, and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

The survey was conducted *via* an online survey so the participation was voluntary, and all the participants could start filling the questionnaire only after their agreement to participate in the study.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The datasets used for this study will be available from the corresponding author [S.A] upon reasonable request.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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REFERENCES

- [1] Holick MF. The vitamin D epidemic and its health consequences. *J Nutr* 2005; 135(11): 2739S-48S.

- [2] El-Hajj Fuleihan G. Vitamin D deficiency in the Middle East and its health consequences for children and adults. *Clin Rev Bone Miner Metab* 2009; 7(1): 77-93. <http://dx.doi.org/10.1007/s12018-009-9027-9>
- [3] Masood SH, Iqbal MP. Prevalence of vitamin D deficiency in South Asia. *Angiogenesis* 2008; 11: 12.
- [4] Grant WB. An estimate of premature cancer mortality in the U.S. due to inadequate doses of solar ultraviolet-B radiation. *Cancer* 2002; 94(6): 1867-75. <http://dx.doi.org/10.1002/cncr.10427> PMID: 11920550
- [5] Hossein-nezhad A, Holick MF. Vitamin D for health: A global perspective. *Mayo Clin Proc* 2013; 88(7): 720-55. <http://dx.doi.org/10.1016/j.mayocp.2013.05.011> PMID: 23790560
- [6] Christakos S, Dhawan P, Verstuyf A, Verlinden L, Carmeliet G, Vitamin D. Metabolism, molecular mechanism of action, and pleiotropic effects. *Physiol Rev* 2016; 96(1): 365-408. <http://dx.doi.org/10.1152/physrev.00014.2015> PMID: 26681795
- [7] Burt M, Mangelsdorf B, Stranks S, Mangoni A. Relationship between Vitamin D status and autonomic nervous system activity. *Nutrients* 2016; 8(9): 565. <http://dx.doi.org/10.3390/nu8090565> PMID: 27649235
- [8] McDonnell SL, Baggerly C, French CB, *et al.* Serum 25-hydroxyvitamin d concentrations ≥ 40 ng/mL are associated with $>65\%$ lower cancer risk: Pooled analysis of randomized trial and prospective cohort study. *PLoS One* 2016; 11(4): e0152441. <http://dx.doi.org/10.1371/journal.pone.0152441> PMID: 27049526
- [9] Holick MF. Vitamin D deficiency. *N Engl J Med* 2007; 357(3): 266-81. <http://dx.doi.org/10.1056/NEJMra070553> PMID: 17634462
- [10] Vieth R, Kimball S. Vitamin D in congestive heart failure. *Am J Clin Nutr* 2006; 83(4): 731-2. <http://dx.doi.org/10.1093/ajcn/83.4.731> PMID: 16600920
- [11] Elshafie DE, Al-Khashan HI, Mishriky AM. Comparison of vitamin D deficiency in Saudi married couples. *Eur J Clin Nutr* 2012; 66(6): 742-5. <http://dx.doi.org/10.1038/ejcn.2012.29> PMID: 22415335
- [12] Babelghaith SD, Wajid S, Al-Zaaqi MA, *et al.* Knowledge and practice of vitamin d deficiency among people lives in riyadh, saudi arabia-a cross-sectional study. *Biomed Res* 2017; 28: 3114-8.
- [13] Siddiqui A, Kamfar H. Prevalence of vitamin D deficiency rickets in adolescent school girls in Western region, Saudi Arabia. *Saudi Med J* 2007; 28: 441-4.
- [14] Christie FTE, Mason L. Knowledge, attitude and practice regarding vitamin D deficiency among female students in Saudi Arabia: A qualitative exploration. *Int J Rheum Dis* 2011; 14(3): e22-9. <http://dx.doi.org/10.1111/j.1756-185X.2011.01624.x> PMID: 21816009
- [15] Habib FM, Al-Motairi WA, Al-Mutairi WM. Vitamin D deficiency: Knowledge and practice among adult Saudi females. *Glob Adv Res J Med Med Sci* 2014; 3: 95-101.
- [16] DeLuca HF. Overview of general physiologic features and functions of vitamin D. *Am J Clin Nutr* 2004; 80(6) (Suppl.): 1689S-96S. <http://dx.doi.org/10.1093/ajcn/80.6.1689S> PMID: 15585789
- [17] Champe PC, Harvey RA, Ferrier DR. Lippincott's illustrated reviews. *Biochemistry* 1994; 2: 78-85.
- [18] Judd SE, Tangpricha V. Vitamin D deficiency and risk for cardiovascular disease. *Am J Med Sci* 2009; 338(1): 40-4. <http://dx.doi.org/10.1097/MAJ.0b013e3181aaee91> PMID: 19593102
- [19] Ministry of Health and Cancer Society of New Zealand. Consensus Statement on Vitamin D and Sun Exposure in New Zealand. Wellington: Ministry of Health 2012.
- [20] Vu LH, van der Pols JC, Whiteman DC, Kimlin MG, Neale RE. Knowledge and attitudes about Vitamin D and impact on sun protection practices among urban office workers in Brisbane, Australia. *Cancer Epidemiol Biomarkers Prev* 2010; 19(7): 1784-9.

- <http://dx.doi.org/10.1158/1055-9965.EPI-10-0127> PMID: 20570906
- [21] Zareef TA, Jackson RT. Knowledge and attitudes about vitamin D and sunlight exposure in premenopausal women living in Jeddah, and their relationship with serum vitamin D levels. *J Health Popul Nutr* 2021; 40(1): 38.
<http://dx.doi.org/10.1186/s41043-021-00263-w> PMID: 34454622
- [22] Butler-Laporte G, Nakanishi T, Mooser V, *et al.* Vitamin D and COVID-19 susceptibility and severity in the COVID-19 host genetics initiative: A Mendelian randomization study. *PLoS Med* 2021; 18(6): e1003605.
<http://dx.doi.org/10.1371/journal.pmed.1003605> PMID: 34061844
- [23] Matsuoka L, Ide L, Wortsman J, MacLaughlin JA, Holick MF. Sunscreens suppress cutaneous vitamin D3 synthesis. *J Clin Endocrinol Metab* 1987; 64(6): 1165-8.
<http://dx.doi.org/10.1210/jcem-64-6-1165> PMID: 3033008
- [24] Clemens TL, Henderson SL, Adams JS, Holick MF. Increased skin pigment reduces the capacity of skin to synthesise vitamin D3. *Lancet* 1982; 319(8263): 74-6.
[http://dx.doi.org/10.1016/S0140-6736\(82\)90214-8](http://dx.doi.org/10.1016/S0140-6736(82)90214-8) PMID: 6119494
- [25] Lamberg-Allardt C. Vitamin D in foods and as supplements. *Prog Biophys Mol Biol* 2006; 92(1): 33-8.
<http://dx.doi.org/10.1016/j.pbiomolbio.2006.02.017> PMID: 16618499
- [26] Gupta AK, Jamwal V, Sakul MP, Malhotra P. Hypervitaminosis D and systemic manifestations: A comprehensive review. *JIMSA* 2014; 27: 236-7.
- [27] Alkalash SH, Shaheen HM, Tawfeek HM. Changes in maternal knowledge regarding vitamin D and its health importance after application of an educational program. *Menoufia Med J* 2021; 34(2): 538.
http://dx.doi.org/10.4103/mmj.mmj_343_20
- [28] Uzrail A, Abu Assab M, Alkalbani R, Al Kofahi R, Kadhim A. Knowledge, attitude and practice (KAP) towards vitamin D deficiency in the Jordanian adult population: A cross-sectional study. *Res J Med Sci* 2021; 15: 62-71.
<http://dx.doi.org/10.36478/rjmsci.2021.62.71>
- [29] Alkalash SH, Odah M, Alkenani HH, *et al.* Public knowledge, attitude, and practice toward vitamin D deficiency in Al-Qunfudhah governorate, Saudi Arabia. *Cureus* 2023; 15(1): e33756.
<http://dx.doi.org/10.7759/cureus.33756> PMID: 36793814
- [30] Alamoudi LH, Almuteeri RZ, Al-Otaibi ME, *et al.* Awareness of vitamin D deficiency among the general population in Jeddah, Saudi Arabia. *J Nutr Metab* 2019; 2019: 1-7.
<http://dx.doi.org/10.1155/2019/4138187> PMID: 30944738