


Assessment of vitamin D-related knowledge, attitudes and practices among Sultan Qaboos University students in Oman: a cross-sectional study

Rahma Said Al Hadhrami ^{1,2}, Rehab Al Kaabi,² Hajer Juma Al Shuaibi,³ Rawan Salim Al Abdulsalam³

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ABSTRACT

Background Vitamin D deficiency, a circulating level of 25-hydroxyvitamin D <30 nmol/L, has become an emerging public health issue in recent years. Despite being a sun-rich country, vitamin D deficiency is widespread in Oman (87.5%).

Aim This study aimed to evaluate knowledge, attitudes and practices regarding vitamin D among university students in Oman to assess the need for additional awareness campaigns.

Methods and sitting This descriptive, cross-sectional study was conducted from September to December 2022 and involved 399 students enrolled in various degree programmes at the Sultan Qaboos University (SQU) in Muscat, Oman, using self-administered, 38-item vitamin D-related KAP (D-KAP-38) questionnaire to collect information regarding the participants' vitamin D-related general knowledge, nutritional knowledge, attitudes and practices.

Results Of the 399 college students, 384 (96.2%) were Omani nationals, 283 (70.9%) were women and 255 (64.1%) were between the ages of 20 and 26 years. Overall, the participants demonstrated moderate general knowledge (mean D-KAP-38 score: 77.3), poor nutritional knowledge (mean D-KAP-38 score: 45.1), moderate attitudes (mean D-KAP-38 score: 64.4) and average practices (mean D-KAP-38 score: 60.0). In general, female students demonstrated greater general knowledge ($p=0.004$) and more positive attitudes ($p=0.007$) compared with males; however, males more frequently reported better practices ($p<0.001$). In addition, participants who lived off-campus reported better practices compared with those living on-campus ($p<0.001$).

Conclusions University students in Oman demonstrated moderate vitamin D-related general knowledge, attitudes and practices, while nutritional knowledge was poor.

INTRODUCTION

Vitamin D deficiency is a significant and costly public health issue affecting individuals of all ages worldwide.^{1 2} An insufficient circulating

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Several studies have highlighted the limited awareness of vitamin D within this geographical area. Despite the prevalent deficiency of vitamin D in Oman, there has been a dearth of published literature addressing the knowledge, attitudes and practices related to vitamin D.

WHAT THIS STUDY ADDS

⇒ The study's findings revealed that participants exhibited moderate general knowledge, inadequate nutritional knowledge, moderate attitudes and average practices regarding vitamin D.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The research findings indicate the need for appropriate health education programmes to improve nutritional knowledge in this segment to help combat the high prevalence of vitamin D insufficiency in the local population. Publicly sponsored vitamin D-level testing for high-risk communities may also be a successful way to raise awareness and counteract the high prevalence of vitamin D deficiency and insufficiency in the local population.



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¹Family Medicine and Public Health, Sultan Qaboos University Hospital, Muscat, Oman

²College of Medicine and Health Sciences, Sultan Qaboos University, Muscat, Oman

³Family Medicine Program, Oman Medical Speciality Board, Muscat, Oman

Correspondence to

Dr Rahma Said Al Hadhrami; rahmasaid@squ.edu.om

level of 25-hydroxyvitamin D is characterised by a range of 30–50 nmol/L, while vitamin D deficiency is indicated when the level falls below 30 nmol/L. Vitamin D is required for the intestinal absorption of dietary calcium and phosphorus; as such, a lack of vitamin D can result in hypocalcaemia, hypophosphataemia and elevated parathyroid hormone, all of which can increase compensatory calcium absorption from bone, resulting in a variety of bone disorders.³ Moreover, because vitamin D receptors are found in various other body tissues, vitamin D insufficiency is linked to many extraskelatal conditions, including type

1 diabetes, Crohn's disease, multiple sclerosis, arthritis, hypertension, coronary heart disease, many common malignancies and certain psychiatric disorders like schizophrenia and depression.^{3,4}

The main source of vitamin D is exposure to sunlight, particularly ultraviolet-B (UVB) radiation.⁴ As UVB light enters the skin, it transforms 7-dehydrocholesterol into pre-vitamin D₃, which is then transformed into vitamin D₃.⁵ Therefore, daily physical activity and time spent outdoors are factors associated with high serum levels of vitamin D.⁶ In turn, vitamin D deficiency or insufficiency is more prevalent in certain groups, including individuals with darker skin due to the role of melanin in inhibiting vitamin D synthesis, older individuals as a result of age-mediated declining vitamin D production in the skin, breastfeeding women likely as a result of the loss of vitamin D via breast milk and those who wear concealing clothing due to lack of exposure to sunlight.^{7–10}

Several studies have reported a high prevalence of vitamin D insufficiency in Middle Eastern nations, often necessitating food fortification and public health initiatives.^{11–12} The prevalence of vitamin D deficiency was found to be significant in Pakistan, with 53.5% found to be vitamin D-deficient and 31.2% vitamin D-insufficient.¹³ In Saudi Arabia, the prevalence of vitamin D deficiency was reported to be 78.1% in women and 72.4% in men, while the prevalence in Oman has been reported to be as high as 87.5%.^{14,15} One of the primary hypotheses behind the high prevalence of vitamin D deficiency in sunshine-rich countries like those in the Middle East is the insufficient consumption of foods high in vitamin D, such as liver oil, egg yolks, fatty fish and supplemented dairy products.⁶

Furthermore, various studies have reported limited public awareness of vitamin D in this region of the world.^{16,17} For instance, only 9% of university students in Pakistan correctly identified food sources of vitamin D, although 36% were aware of the importance of sunlight exposure.¹⁶ However, despite the high prevalence of vitamin D deficiency in Oman, no published literature has thus far focused on vitamin D-related knowledge, attitudes and practices. One study conducted in 2020 to assess overall nutritional knowledge, dietary habits and nutrient intake reported that only 20% of Omani university students of both genders had adequate knowledge of their daily energy needs, while fewer than 6% were aware of macronutrient requirements.¹⁸ The researchers emphasised the importance of appropriate nutrition education programmes to enhance the dietary practices and overall health status of university students in Oman.¹⁸ Thus, Oman, situated in tropical regions with year-round sunshine, paradoxically exhibits a significant prevalence of vitamin D deficiency. Consequently, this study aims to evaluate the knowledge, attitudes and practices regarding vitamin D among university students in Oman, aiming to discern the necessity for further awareness campaigns on this subject. Furthermore, the study explores the factors affecting the differences in responses.

METHODS

Study design and population

This descriptive, cross-sectional study was conducted from September to December 2022 at Sultan Qaboos University (SQU), one of two public universities in Oman. A total of 399 students of both genders attending various degree programmes at SQU from nine different colleges at different study years were enrolled in the study.

Sample size

Using a sample size calculator, the ideal sample size was determined to be 377. This calculation was performed under the assumption that there were 18000 students enrolled at SQU as a whole, with a 95% CI and a 5% margin of error.

Data collection tool

Data were collected from the participants using the 38-item vitamin D-related KAP (D-KAP-38) questionnaire, a self-administered, valid and reliable questionnaire developed by researchers in Tehran, Iran.¹⁹ Assessment of the psychometric properties of the questionnaire confirmed that it exceeded the minimum Cronbach's alpha reliability standard of 0.60.¹⁹ For the purposes of the present study, the questionnaire was translated into Arabic as per the WHO's translation guidelines.²⁰ A convenience sample was gathered by approaching students within their college environments, including libraries and campuses. Those students who agreed to participate signed a consent form and completed a questionnaire. Approximately 450 questionnaires were distributed, and 399 were collected, resulting in a response rate of 89%. The D-KAP-38 questionnaire is divided into two main parts, in which the first part gathers information regarding the participants' socio-demographic characteristics, including age, gender, age, educational attainment, cohort, place of residence, marital status and previous vitamin D supplementation use. Part 2 includes 38 questions covering four dimensions of vitamin D-related data: (1) general knowledge; (2) nutritional knowledge; (3) attitudes; and (4) practices.

Section A includes 11 questions relating to general knowledge of vitamin D. Participants can give responses of 'yes', 'no' or 'I don't know', scored as 2, 0 or 1, respectively, with total scores for this section ranging from 0 to 22. Section B comprises five questions related to nutritional knowledge, with possible responses of 'yes', 'no' or 'I don't know' scored as 0, 2 or 1, respectively, except for item 12 which is inversely scored, resulting in a total score range of 0–10. Section C consists of 12 questions assessing vitamin D-related attitudes on a 5-Likert scale, with possible responses ranging from 'strongly disagree' to 'strongly agree' allocated scores of 1–5, respectively, for a total score range of 12–60. Finally, section D includes 10 questions relating to the frequency of various vitamin D-related practices, with possible responses of 'never', 'rarely', 'sometimes', 'often' or 'always' scored on a 5-point Likert scale from 1 to 5, with four items scored

inversely, for a total score range of 10–50. For each section, the total score was proportionately transformed to a range of 0–100.

For the purposes of the present study, per cent scores of $\geq 80\%$ indicate adequate level of knowledge, positive attitude ($\geq 90\%$) and good prevention practice ($\geq 75\%$) in line with Bloom's cut-off values for evidence-based medicine.²¹

Data collection

The researchers employed a convenience sampling method, approaching students within their college environments, such as libraries and campuses. The data was collected between September and December 2022. Those who agreed to take part signed a consent form and completed a questionnaire, which typically required approximately 10 min to fill out.

Patient and public involvement

The participants solely completed the questionnaire and had no involvement in its design or any other process in the study.

Data analysis

The Statistical Package for the Social Sciences (SPSS) software, V.23 (IBM, Armonk, New York, USA) was used to analyse collected data. Data related to the demographic characteristics, knowledge, attitudes and practices of the participants were presented using descriptive statistics (ie, frequencies and percentages). Means and SDs were used to present continuous variables. Comparisons of quantitative and categorical variables were conducted using a Mann-Whitney U test. The level of statistical significance was set at $p \leq 0.05$.

RESULTS

Demographic characteristics

Of the 399 university students who participated in this study, there were notably more female ($n=283$; 70.9%) than male participants ($n=116$; 29.1%). In addition, most participants were aged 20–26 years ($n=255$; 64.1%), were of Omani nationality ($n=384$; 96.2%) and were single ($n=347$; 87.0%). The most frequently attended college was the College of Medicine and Health Sciences ($n=119$; 29.8%), followed by the College of Education ($n=58$; 14.8%) and the College of Science ($n=57$; 14.3%). Only seven students (1.8%) were enrolled in the College of Nursing. There was a greater proportion of fourth-year students ($n=121$; 30.3%) compared with students in other years of study, with few second-year students ($n=42$; 10.5%). Overall, 152 participants (38.1%) lived on the SQU campus, whereas 133 (33.3%) lived with their families and 114 (28.6%) lived off-campus (table 1).

General and nutritional knowledge

A total of 272 participants (68.2%) agreed that most required vitamin D is produced when the skin is directly exposed to the sun and 332 (83.2%) correctly identified

Table 1 Characteristics of students attending Sultan Qaboos University, Muscat, Oman (N=399)

Characteristic	n	%
Gender		
Female	283	70.9
Male	116	29.1
Age (years)		
20–26	255	64.1
>26	144	35.9
Nationality		
Omani	384	96.2
Non-Omani	15	3.8
College		
Medicine and Health Sciences	119	29.8
Education	59	14.8
Science	57	14.3
Agricultural and Marine Sciences	46	11.5
Economics and Political Science	35	8.8
Arts and Social Sciences	33	8.3
Engineering	28	7.0
Law	15	3.8
Nursing	7	1.8
Year of study		
1	60	15.04
2	42	10.52
3	57	14.29
4	121	30.33
5	48	12.03
≥ 6	71	17.79
Marital status		
Single	347	87.0
Married	46	11.5
Divorced	6	1.5
Place of residence		
On campus	152	38.1
Off campus	114	28.6
With family	133	33.3

the link between bone pain and vitamin D deficiency. In addition, most participants were aware that people who work indoors are at high risk of vitamin D deficiency ($n=294$; 73.7%) and that a vitamin D intake greater than dietary recommendations could be harmful ($n=317$; 79.4%) (table 2). However, in terms of nutritional knowledge, only 232 students (58.1%) identified fatty fish as one of the main dietary sources of vitamin D; although only 33 (8.3%) disagreed with this statement outright, 134 (33.6%) reported not knowing one way or another. Less than half of the cohort ($n=196$; 49.1%) knew that dairy products represent another main source of vitamin

Table 2 Correct responses to Vitamin D knowledge questions among students attending Sultan Qaboos University, Muscat, Oman (N=399)

No.	Questions	Correct response, n (%)*
1	People, who work indoors, are at high risk of vitamin D deficiency.	294 (73.7)
2	Vitamin D intake more than dietary recommendations could be harmful.	317 (79.4)
3	Elderly people are at high risk of vitamin D deficiency.	241 (60.4)
4	Inappropriate dietary intakes are related to vitamin D deficiency.	218 (54.6)
5	Vitamin D supplement intake requirements differ for different age groups.	304 (76.2)
6	Pregnant and lactating women are at high risk of vitamin D deficiency.	211 (52.9)
7	Most of the vitamin D required is produced when the skin is directly exposed to the sun.	272 (68.2)
8	Currently, vitamin D deficiency is one of the most important health issues in our country.	176 (44.1)
9	Bone pain and fatigue are among the vitamin D deficiency symptoms.	332 (83.2)
10	Vitamin D supplement intake requirements differ in various seasons of the year.	116 (29.1)
11	Both men and women are at risk of vitamin D deficiency.	354 (88.7)

*Percentages calculated out of the total number of responses per variable.

D due to food fortification programs. The fact is the same the eggs as the main source of vitamin D (n=179; (44.9%) (table 3).

The mean D-KAP-38 scores for the general and nutritional knowledge sections of the questionnaire were 77.3±14.1 and 45.1±18.6, respectively. Female students reported significantly higher mean general knowledge scores compared with males (78.5 vs 74.1; p=0.004) (figure 1). Furthermore, both mean general and nutritional knowledge scores were significantly higher among students aged 20–26 years (p=0.001 and 0.017, respectively) (figure 2). Students enrolled in science-based colleges had significantly better mean general knowledge scores compared with those in non-science-based colleges (78.2 vs 73.8; p=0.005); although students in non-science-based colleges had slightly higher mean nutritional knowledge scores, this difference was not statistically significant (46.5 vs 44.7; p=0.564) (figure 3). There was no significant difference in mean general or nutritional knowledge scores between students living on-campus or off-campus (table 4).

Attitudes

Most students (n=292; 73.2%) strongly agreed that existing education regarding the benefits of sun exposure

for the production of required vitamin D was insufficient. Additionally, 142 students (35.6%) strongly agreed that the undesirable taste of seafood was a barrier to their consumption of dietary sources of vitamin D, although 126 (31.6%) disagreed with this statement. A total of 102 (25.6%) and 181 (45.4%) students strongly agreed and disagreed, respectively, with the statement that using sunscreen on the face, neck and hands prevents sun exposure necessary for the production of vitamin D (table 5). The mean D-KAP-38 score for the attitude section of the questionnaire was 64.4±11.1. Overall, female students reported significantly higher mean attitude scores compared with male students (65.7 vs 61.2; p=0.007) (figure 1). No other significant differences in mean attitude scores were observed based on age, type of college or place of residence (table 4).

Practices

With regards to vitamin D-related practices, only 29 participants (7.3%) reported that they always consumed fish at least twice a week. Furthermore, less than one-third of the students (n=108; 27.1%) reported that they always walked outdoors daily to ensure that they had sufficient exposure to sunlight. The majority of the cohort (n=254; 63.7%) indicated that they never took vitamin D

Table 3 Correct responses to nutrition knowledge questions among students attending Sultan Qaboos University, Muscat, Oman (N=399)

No.	Questions	Correct response, n (%)*
12	Fatty fishes are one of the main dietary sources of vitamin D.	232 (58.1)
13	Dairy products are one of the main dietary sources of vitamin D.	196 (49.1)
14	Eggs are one of the main dietary sources of vitamin D.	179 (44.9)
15	Meat and poultry are the main dietary sources of vitamin D.	109 (27.3)
16	Fruits are one of the main dietary sources of vitamin D.	76 (19)

*Percentages calculated out of the total number of responses per variable.

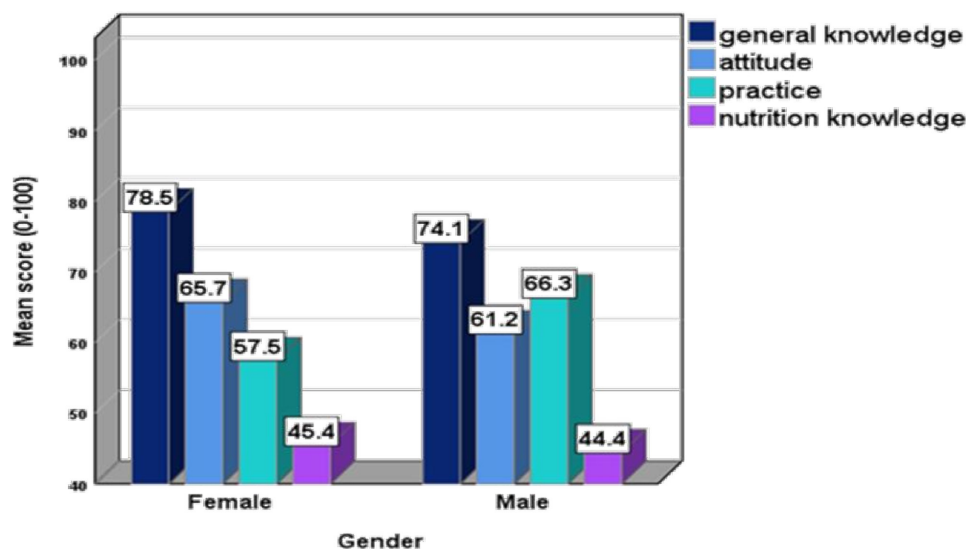


Figure 1 Comparison of mean subscale scores for vitamin D-related general and nutritional knowledge, attitudes and practices* by gender among students attending Sultan Qaboos University, Muscat, Oman (N=399). *Assessed using an Arabic version of the self-administered, 38-item vitamin D-related KAP questionnaire.

supplements, with only 25 students (6.3%) always taking them. A total of 165 students (41.4%) reported always using sunscreen on their face, of which the vast majority were women (n=160; 97.0%). (table 6). For the practices section of the questionnaire, the mean D-KAP-38 score was 60.0 ± 10.4 . Male students had significantly higher mean practice scores compared with females (66.3 vs 57.5; $p < 0.001$) (figure 1). Moreover, participants living off-campus reported significantly better mean scores compared with those residing on-campus (63.7 vs 57.7; $p < 0.001$) (table 4).

DISCUSSION

To the best of the authors' knowledge, this is the first study to evaluate university students' vitamin D-related knowledge, attitudes and practices in Oman, an important topic in light of the local population's extremely high prevalence of vitamin D insufficiency.¹⁵ With a mean subscale score of 77.3, the findings indicated that SQU students generally possessed a moderate degree of vitamin D-related general knowledge; however, nutritional knowledge related to dietary sources of vitamin D was poor, with a mean subscale score of 45.1. In turn, the

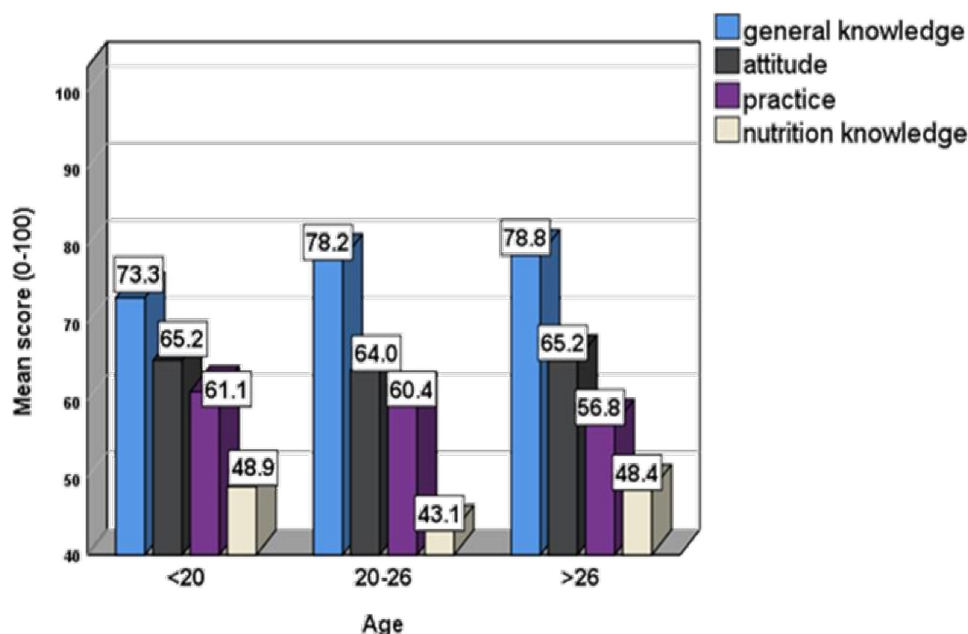


Figure 2 Comparison of mean subscale scores for vitamin D-related general and nutritional knowledge, attitudes and practices* by age group among students attending Sultan Qaboos University, Muscat, Oman (N=399). *Assessed using an Arabic version of the self-administered, 38-item vitamin D-related KAP questionnaire.

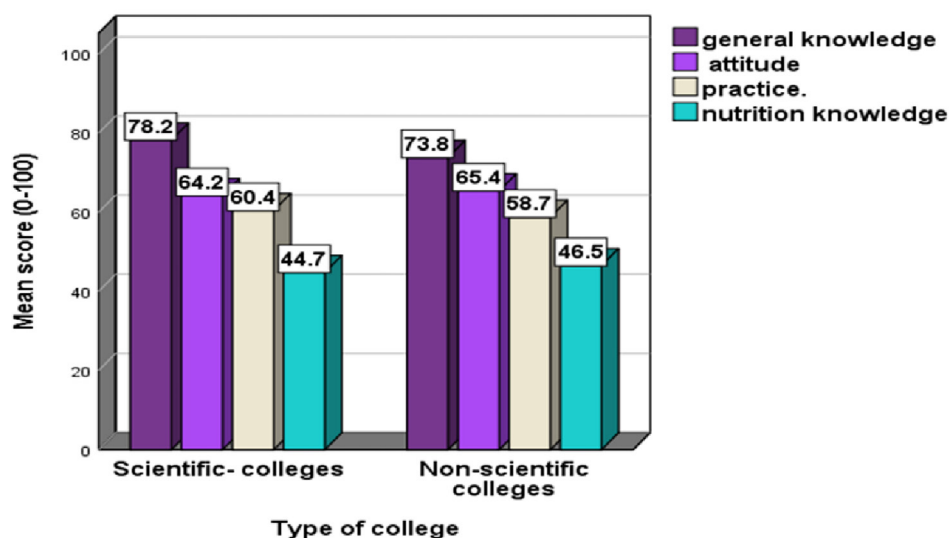


Figure 3 Comparison of mean subscale scores for vitamin D-related general and nutritional knowledge, attitudes and practices* by college type among students attending Sultan Qaboos University, Muscat, Oman (N=399). *Assessed using an Arabic version of the self-administered, 38-item vitamin D-related KAP questionnaire.

students demonstrated moderate attitudes and average practices, as indicated by mean subscale scores of 64.4 and 60.0, respectively. In terms of socio-demographic associations, female students reported significantly better general knowledge and attitude scores compared with males, while the latter had better practice scores, as did students who lived off-campus. Students enrolled in science-based colleges also showed significantly better general knowledge scores compared with those in non-science-based colleges.

Overall, our respondents demonstrated a moderate level of general knowledge, a finding consistent with the results of a similar survey conducted among female adults recruited from public healthcare centres in Iran.¹⁹ On the other hand, better general knowledge scores were reported by a sample of adults in the UK.²² Specifically, 68.2% of SQU students correctly stated that the majority of necessary vitamin D is created when the skin is directly exposed to the sun; however, only 40.1% were

aware that vitamin D insufficiency is a significant health problem in Oman. A good proportion of students knew that elderly, pregnant and lactating women are at risk of vitamin D deficiency. Furthermore, 83.2% correctly indicated that bone pain and fatigue are symptoms related to vitamin D deficiency; in contrast, only 53.5% of patients attending a primary care centre in Kuwait were aware of this fact.²³ This discrepancy in findings could be due to the high number of students enrolled in medical degree programmes in the current study. However, only 29% of students agreed that vitamin D supplement intake requirements differ throughout the year because of seasonal variations,^{24 25} although 76.1% knew that such requirements differ according to age group.

Besides sunlight, certain foods such as fortified milk, oily fish and egg yolks represent important dietary sources of vitamin D.⁶ However, the surveyed SQU students demonstrated a distinct lack of nutritional knowledge relating to vitamin D. For instance, only 58.2% correctly identified

Table 4 Significance of associations between selected characteristics and vitamin D-related general knowledge, nutritional knowledge, attitudes and practices using Mann-Whitney test* among students attending Sultan Qaboos University, Muscat, Oman (N=399)

Characteristic	P value			
	General knowledge	Nutritional knowledge	Attitudes	Practices
Gender	0.004†	0.733	0.007†	<0.001†
Age group	0.001†	0.017†	0.360	0.566
Type of college‡	0.005†	0.564	0.613	0.152
Place of residence§	0.080	0.329	0.727	<0.001†

*Assessed using an Arabic version of the self-administered, 38-item vitamin D-related KAP questionnaire.

†Statistically significant at $p < 0.05$.

‡Colleges involved in the study include Medicine and Health Sciences, Education, Science, Agricultural and Marine Sciences, Economics and Political Science, Arts and Social Sciences, Engineering, Law and Nursing.

§Place of residency: on campus, off campus and with family.

Table 5 Agreement with vitamin D-related attitude statements

No.	Questions	Agree/strongly agree, n (%) [*]
17	Urbanisation prevents sun exposure and production of required vitamin D.	168 (42.1)
18	A shortage of public places for outdoor activities prevents the sun exposure required for production of vitamin D.	266 (66.7)
19	Full-time indoor occupation prevents the sun exposure required for production of vitamin D.	278 (68.7)
20	Inefficient education regarding benefits of sun exposure prevents production of required vitamin D through sun exposure.	292 (73.2)
21	The undesirable taste of sea foods for Omanis is one of the barriers to their consumption of dietary sources of vitamin D.	142 (35.6)
22	In vitamin D deficiency, supplement intake is more effective compared with dietary intake and sun exposure.	157 (39.3)
23	Taking vitamin D supplement, unless recommended by physicians is wrong.	261 (65.4)
24	Unwillingness of individuals to take vitamin D supplement is one of the barriers of providing this nutrient.	202 (50.6)
25	Taking supplements is necessary for treatment of vitamin D deficiency but not for its prevention.	253 (63.4)
26	Permanent using of sunscreens on face, neck and hands prevents the sun exposure required for production of vitamin D.	102 (25.6)
27	Taking supplement is only necessary in case of lack of exposure to sunlight.	148 (37.1)
28	A high expense of dietary sources of vitamin D is one of the barriers of providing this nutrient.	205 (51.4)

^{*}Percentages calculated out of the total number of responses per variable.

fatty fish as one of the key dietary sources of vitamin D, while 33.6% were unsure. Moreover, half of the students either did not know if fruits represent one of the main dietary sources of vitamin D or not, and answered the question incorrectly. Comparable results were reported from studies of adults in Iran and university students in Pakistan.^{16 19} Moreover, our study showed that the frequency of actual consumption of vitamin D-rich foods was low; for instance, only 23.3% and 10% of the surveyed students always consumed fortified milk and fish at least twice a week. Other studies involving Chinese and Pakistani university students have reported similar results.^{26 27}

Despite living in a coastal country with a robust fishing industry, 35.6% of SQU students in the present study reported that they avoided eating seafood because of its undesirable taste, representing a considerable barrier to the consumption of this particular vitamin D food source. In addition, 51.4% of the students also reported being hindered by the expense of dietary sources of vitamin D. In general, the majority (63.7%) indicated that they never took vitamin D supplements; according to a survey of Chinese university students, only 5.6% used vitamin D supplements.²⁷ Researchers have indicated that female university students may be more likely to

Table 6 Agreement with vitamin D-related practice statements

No.	Questions	Often/always, n (%) [*]
29	For sufficient exposure to sunlight, I regularly engage in outdoor physical activities.	148 (37.1)
30	To be vitamin D sufficient, I consume fortified milk.	110 (27.6)
31	In order to be vitamin D sufficient, I consume fish at least twice a week.	209 (52.4)
32	For sufficient exposure to sunlight I walk outdoors daily.	216 (54.1)
33	I use caps/hats to avoid severe sun exposure.	95 (23.8)
34	To be vitamin D sufficient, I take vitamin D supplements.	52 (13)
35	I use sunscreen on my hands.	120 (30.1)
36	During the day I am directly exposed to sunlight (outdoors).	233 (58.4)
37	During the day I am indirectly exposed to sunlight (through glass).	192 (48.1)
38	I use sunscreen on my face.	240 (60.2)

^{*}Percentages calculated out of the total number of responses per variable.

supplement vitamin D pills than male students.¹⁶ These findings highlight the necessity of creating appropriate nutrition education programmes for university students in Oman, particularly in light of previous research showing that SQU students have poor nutritional knowledge in general, especially concerning macronutrient requirements.¹⁸

On the whole, university students in the present study demonstrated moderate attitudes towards vitamin D, with female students reporting significantly more positive attitudes compared with male students. Despite this, female students had significantly lower practice scores compared with male students. A study of 340 students attending a medical college in Pakistan indicated that only 33% had positive attitudes towards vitamin D, with female students similarly demonstrating better attitudes than male students.²⁶ In general, research indicates that women may be more health-conscious than men, a factor which may partially explain such findings.²⁸ In contrast, the same study in Pakistan indicated that female students had better practices.²⁶ Age was not found to significantly affect attitude or practice scores in the present study; in contrast, the study of Pakistani medical students indicated that attitudes were better among students aged 24 years and older.²⁶ This discrepancy is likely due to variations in study methodology and population.

Crucially, 73.2% of students in our study reported that education regarding the benefits of sun exposure was suboptimal. Although 68.2% agreed that most of the vitamin D required is produced when the skin is directly exposed to the sun, only 27.1% always walked outdoors daily. Similar findings have been reported in studies from the UK and China^{22, 27}; in particular, most Chinese students avoided sun exposure as they were worried about getting tanned, with 82.7% using sunscreen on a daily basis.²⁷ In the current study, 41.4% of students always used sunscreen on their face, although 25.5% believed that permanent sunscreen use on the face, neck and hands prevents the sun exposure required to produce vitamin D. As expected, the vast majority of SQU students practicing daily sunscreen use were women, a finding in line with previous research.²⁹ Among university students in Iran, the mean concentration of blood 25-hydroxyvitamin D₃ (25-OH-D) was significantly lower in female compared with male students (27.46 ± 10.37 vs 49.29 ± 12.87 nmol/L; $p=0.001$), likely as a result of the greater use of sun-protective measures like sunscreen and covering clothing.³⁰

Theoretically, sunscreen use is thought to reduce the production of 25-OH-D because it prevents the absorption of UVB rays.³¹ However, there is conflicting research regarding whether sunscreen truly prevents vitamin D production in real-life settings, as well as whether the benefit of sun exposure for vitamin D production outweighs the potential risk of skin cancer.^{32, 33} Nonetheless, 42.1% and 66.7%, respectively, of SQU students also identified urbanisation and the shortage of public places for outdoor activities as additional barriers hindering

sun exposure required for the production of vitamin D. Indeed, only 10% of the students regularly engaged in outdoor physical activities, possibly due to the yearlong hot, desert climate of Oman. In addition, we found that students who lived outside of the SQU campus demonstrated better practice scores than those who lived on campus; this might be because such students had more opportunities to participate in outdoor activities. Such findings support the need for a public awareness campaign to highlight the benefits of spending 10–30 min outdoors every day with uncovered skin, ideally in the morning or mid-afternoon to reduce the risk of sunburn.³⁴

Limitations and recommendations

Due to the convenience sampling strategy used and the fact that the research took place at a single university and specific age group, there is a possibility that the findings may be affected by selection bias. This might explain the failure to detect statistically significant differences between some of the studied variables. Moreover, these limitations hinder the generalisability of the findings to other population groups, including students attending educational institutions outside of SQU and nationwide larger study participants of different age groups. In the future, this limitation could be overcome by increasing the number of students participating in the study and including those attending other universities or colleges. Another restriction that could have contributed to missing data and non-responses was the length of the questionnaire. Moreover, approximately 30% of the sample was drawn from the College of Medicine and Health Sciences, and individuals who invest more time in their studies, potentially affecting the outcomes due to their educational background. It is recommended that future research consider these limitations to improve the accuracy and relevance of the findings. Crucially, quantitative measure of the students' serum 25-OH-D levels would be particularly useful in order to be able to correlate attitudes, knowledge and practices with actual rates of vitamin D insufficiency and deficiency.

CONCLUSION

In summary, our research revealed a notable deficiency in awareness among surveyed university students regarding the benefits of vitamin D and its specific dietary sources. Consequently, there is a crucial need to enhance public understanding and recognition of the significance of vitamin D in maintaining health. To achieve this, it is recommended to implement additional public health awareness campaigns through diverse channels such as hospitals, social media and educational institutions. Furthermore, integrating vitamin D education into the curriculum of colleges and public schools would contribute to broader awareness. Additionally, conducting publicly sponsored vitamin D-level testing for high-risk communities could prove effective in addressing

and mitigating the widespread prevalence of vitamin D deficiency in the local population.

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ORCID ID

Rahma Said Al Hadhrami <http://orcid.org/0000-0001-5512-1780>

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