

A Need for Improvement in the Knowledge, Attitudes and Practice Toward Vitamin D Among University Students

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Objective: The message delivered to the public regarding vitamin D is unclear, and contradictory; particularly regarding sun exposure; previous studies in Jordan have revealed high prevalence of low vitamin D among university students. The aim of this study was to investigate university students' knowledge, attitudes and practice regarding vitamin D.

Design: A web-based cross-sectional survey

Setting: The survey was completed by students at a Jordanian university in 2019.

Method: The survey collected sample characteristics data and information about university students' knowledge, attitudes, and practice toward vitamin D. The χ^2 test was used to assess the associations between the sample characteristics and their vitamin D knowledge and practices and to evaluate the association between participants' knowledge and practices. Binary logistic regression analysis was used to predict supplement use.

Results: 496 students completed the questionnaire. The mean knowledge score was 31.3 (\pm 11.3) out of 100. Women had significantly higher beliefs that vitamin D deficiency is an escalating health issue ($p < 0.01$). Negative practices regarding sun exposure were significantly higher in women than men ($p < 0.01$). The majority of participants recognized that insufficient sun exposure was a cause of vitamin D deficiency, but 50.7 % avoid sun exposure, and 67.6% expose only their face and hands. The consumption of fortified foods (OR 3.59; $p < 0.001$) was the only studied variable associated with vitamin D consumption.

Conclusion: There is a gap between knowledge, attitude, and practice regarding vitamin D which can be bridged by promoting Vitamin D related awareness.

Key words: Vitamin D, Supplements, Knowledge, Attitude, Practice

INTRODUCTION

Vitamin D deficiency is a widespread global condition[1]. Vitamin D is naturally present in relatively few foods, therefore diet is considered a poor source of vitamin D that accounts for only 10% of the intake of vitamin D; the rest is obtained by the exposure of unprotected skin to sunlight UVB radiation¹. Jordan is a sunny country having sunshine for an average of 10 hours per day during summer and 8 hours per day during winter². Therefore, exposure to UVB radiation should be sufficient for optimal vitamin D production¹. However, the rate of vitamin D deficiency in Jordan has an increasing trend in all ages and genders³. The high prevalence of vitamin D deficiency in sunny countries has also been reported in several other studies^{4,5}.

Vitamin D deficiency is often thought to be an exclusively elderly or hospitalized patient's problem. In contrast, many studies have found a higher prevalence of low vitamin D status among younger adults⁶. Strikingly high prevalence of low vitamin D status has been found in Saudi Arabia⁷ and Qatar⁸ (100% and 97.2 % respectively) among university students. In Jordan the prevalence of vitamin D deficiency among female university students was lower (31.2%) than Saudi Arabia and Qatar but still considered high².

University students are the potential future makers and they represent about 12% of the Jordanian population⁹. In addition, early health attitudes and beliefs are difficult to change in later life¹⁰. Furthermore, university students are reasonably healthy¹¹, which minimizes the bias related to the influence of illness on health behaviour¹².

Consequently, a thorough understanding of students' knowledge and attitudes toward vitamin D, the association between vitamin D and sun exposure and the consumption of vitamin D rich food or supplements, is essential before being able to create effective health promotion messaging and other intervention strategies. To date, no other studies have investigated the level of vitamin D knowledge, attitude and practice in Jordan. This study will assess knowledge, attitudes and practice of students regarding vitamin D, its association with sun exposure and the consumption of vitamin D food or supplementations among Jordanian university students drawn from non-health-related faculties.

METHODS AND MATERIALS

Study Design, Sitting and Participants: A cross-sectional web-based survey was designed using the Google survey tool (Google

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Forms), and the generated link was embedded in an invitation sent to all registered students during summer semester at Al-Zaytoonah University of Jordan (ZUJ) via email. Only students registered in the summer semester were recruited to avoid any potential recall bias when asked about sun exposure, as it is most importantly during the summer. An informed consent form included in the online questionnaire was completed by the participants. Ethical approval was obtained from ZUJ ethical committee (approval number: 28 /2017-2018) before the commencement of the study. All methods were carried out in accordance with Declaration of Helsinki.


The inclusion criteria for the study were current non-medical or para-medical students at ZUJ to avoid the influence of knowledge acquired during their study. The emails sent to the participants contained a personalized invitation that described the nature of the survey. The Google form was set to allow only one submission per participant and completing all questions was mandatory before submission. Three reminder emails were sent to ensure a reasonable participation rate. **Measures:** Due to the lack of a locally validated questionnaire on knowledge, attitude, and practice regarding vitamin D, we developed a new questionnaire (see Figure 1). The survey questions were adapted after an extensive and thorough review of the previously published literature and modified to be applicable to the Jordanian population.

Appendix 1: Research questionnaire


Demographic data

1. Age: ...
2. Sex: Male Female
3. Height: ...
4. Weight: ...
5. Do you have any chronic diseases? Yes No
6. Are you a smoker? Smoker Nonsmoker Ex-smoker
7. Marital status: Single Married
8. Household average monthly income
 - Less than 600 JOD
 - 600-1000 JOD
 - More than 1000 JOD
 - Prefer not to answer
9. Skin color: compare the color palette to your upper inner arm color


I




II




III




IV



V



VI



 - I
 - II
 - III
 - IV
 - V
 - VI
10. physical activity: How many you exercise to a sweat per week?
 - Three or more than three times per week
 - Less than three times per week

Knowledge, attitude, and practice about vitamin D

1. Have you ever heard of vitamin D? Yes No
2. What is the source of your information about vitamin D? (You can choose more than one answer)
 - Educational center school or university
 - Healthcare providers
 - Media
 - Websites and Facebook
 - Parents, relatives, or friends
 - Other sources
3. What are your preferred sources of information about vitamin D? (You can choose more than one answer)
 - Healthcare providers
 - Educational center school or university
 - Media and Internet
 - Parents, relatives, or friends
4. Do you agree that vitamin D deficiency is an escalating issue in the region? Yes Unsure No
5. Are you interested in getting more knowledge about vitamin D? Yes No
6. Are you concerned about your vitamin D levels? Yes No
7. What are the benefits of vitamin D? (You can choose more than one answer)
 - Essential for the bone's integrity
 - Prevention of osteoporosis
 - Prevention of rickets
 - Prevention of osteomalacia
 - Essential for the muscle's integrity
 - Protect against chronic diseases
 - Protect against weakness and fatigue
 - Unsure
8. Do you agree that vitamin D is important to maintain normal calcium levels? Yes No
9. In your opinion what are the causes of vitamin D deficiency? (You can choose more than one answer)
 - Insufficient sun exposure
 - Nutritional insufficiency
 - Dressing style
 - Aging
 - Pregnancy
 - Obesity
 - The sunscreen usage
 - Genetic variability
 - Gender differences
 - Physical inactivity
 - Soft drinks
 - Smoking
 - Extra water drinking
 - Unsure
10. In your opinion what are the sources of vitamin D?
 - Sun
 - Oily fish
 - Meat
 - Dairy products
 - Eggs
 - Fortified cereal
 - Olive oil
 - Mushroom
 - Vegetables
 - Unsure
11. Residency exposure to the sun
 - No exposure to the sun inside the residency
 - Sun exposure via glass only
 - Open area sun exposure with lack of privacy
 - Open area sun exposure with high privacy
12. How much time do you often spend outdoors per day on weekdays? (from 10 am to 4 pm)
 - Less than 30 min
 - 30-60 min
 - >60 min

13. How much time do you often spend outdoors per days on weekends? (from 10 am to 4 pm)
- Less than 30 min
 - 30-60 min
 - >60 min
14. At what times do you exposed to the sun usually? (You can choose more than one answer)
- Early morning
 - Before noon
 - Noon
 - Early afternoon
 - Late afternoon
15. What is the best time to be exposed to the sun in order to induce vitamin D synthesis?
- Early morning
 - Before noon
 - Noon
 - Early afternoon
 - Late afternoon
16. Which parts of your body are exposed to sun usually? (You can choose more than one answer)
- Face
 - Hands
 - Arms
 - Legs
 - Totally covered
17. Do you use sunscreen routinely? Yes No
18. Do you avoid sun exposure usually? Yes No
19. Do you agree that dark-skinned people are more prone to vitamin D deficiency? Yes No
20. How often do consume milk?
- Less than once weekly
 - Once weekly
 - More than once weekly
21. How often do consume butter?
- Less than once weekly
 - Once weekly
 - More than once weekly
22. How often do consume eggs?
- Less than once weekly
 - Once weekly
 - More than once weekly
23. How often do consume fish?
- Less than once weekly
 - Once weekly
 - More than once weekly
24. How often do consume meat?
- Less than once weekly
 - Once weekly
 - More than once weekly
25. Do you think that the nutritional sources of vitamin D are enough? Yes No
26. Do you take vitamin D supplements? Yes No
27. Do you agree that vitamin D consumption is important only when we sun exposure is limited? Yes No
28. Do you agree that vitamin D rich foods are costly? Yes No
29. Do you take vitamin D fortified foods? Yes Unsure No
30. Is flour in Jordan fortified? Yes No

Socio-Demographic Measures: Socio-demographic information was collected including age, gender, marital status, average household

income, and smoking habits. The Fitzpatrick skin type chart photo was included in the questionnaire to classify the participants' skin colour¹³. The colour palette used in the chart photo was adapted from (D'Orazio et al., 2013)¹⁴ and participants were asked to compare the colour palette to their upper inner arm.

Physical activity was assessed by asking the students how many times per week they exercise enough to work up a sweat. Students were classified as physically active if they exercise to a sweat three or more times per week. Exposure to the sun at home was classified into four categories: no exposure, sun exposure via window glass only, has an open area for sun exposure with lack of privacy and place of residence has an open area for sun exposure with high privacy.

As there is no local validated questionnaire for assessment of dietary vitamin D intake, vitamin D containing food items were obtained from a short validated questionnaire¹⁵ and the frequencies of intake were measured according to a Jordanian validated food frequency questionnaire¹⁶. The final version of the questionnaire includes four food items: oily fish, butter, egg, and meat, in addition to low vitamin D sources including olive oil and unfortified milk.

Knowledge, Attitude, and Practice: To assess knowledge we developed a questionnaire consisting of 30 questions. Knowledge score was calculated according Boland et al.¹⁷ (See Table 1). One point was added for each correct answer in questions that included one correct option, and for questions with multiple correct answers, one point was counted for each correct choice and one point was subtracted for each incorrect choice. The scores then were converted to percentages by dividing the scores by the highest possible score (30), then multiplied by 100. Regarding the question on the best time to be exposed to the sun to induce vitamin D synthesis, participants were provided with 5 answers; any student who answered one or more correct answer without choosing any incorrect answer was categorized as knowledgeable about the best time to be exposed to the sun. Additional questions that evaluated attitudes and practices about vitamin D and sun exposure were included in the questionnaire. To assess the consumption of vitamin D rich food, points were added based on the consumption frequencies (less than once weekly: 1 point, once weekly: 2 points, and more than once weekly: 3 points). Frequencies were transformed into percentages.

Table 1: Knowledge deterrents

	Answer (Correct: ✓, incorrect: X)	Frequency (%)
Sources of vitamin D (multiple answers)	Sun	✓ 376(75.65)
	Sea food	✓ 48(9.66)
	Meat	✓ 13(2.62)
	Dairy products	X 23(4.63)
	Eggs	✓ 14(2.82)
	Fortified cereals	✓ 3(0.60)
	Olive oil	X 3(0.60)
	Mushroom	✓ 2(0.40)
	Vegetables	X 5(1.01)
	Unsure	X 10(2.01)
Causes of vitamin D deficiency (multiple answers)	Insufficient sun exposure	✓ 408(82.1)
	Nutritional insufficiency	✓ 197(39.6)
	Dressing style	✓ 140(28.2)
	Aging	✓ 128(25.8)
	Pregnancy	✓ 61(12.3)

	Obesity	✓ 53(10.7)
	The sunscreen usage	✗ 100(20.1)
	Genetic variability	✓ 121(24.3)
	Gender differences	✗ 61(12.3)
	Physical inactivity	✓ 140(28.2)
	Soft drinks	✓ 64(12.9)
	Smoking	✓ 72(14.5)
	Extra water drinking	✗ 13(2.2)
	Unsure	✗ 11(2.2)
Benefits of vitamin D (multiple answers)	Essential for bones integrity	✓ 405(81.5)
	Prevention of osteoporosis	✓ 355(71.4)
	Prevention of rickets	✓ 272(54.7)
	Prevention of osteomalacia	✓ 0(0)
	Essential for the muscles integrity	✓ 161(32.4)
	Protect against chronic diseases	✓ 192(38.6)
	Protect against weakness and fatigue	✓ 261(52.5)
	Unsure	✗ 24(4.8)
	Do you think that the nutritional sources of vitamin D are enough?	Yes
No		✓ 262(52.7)
Vitamin D is important for calcium absorption	Yes	✓ 255(51.3)
	No	✗ 242(48.7)
Vitamin D consumption is important only when we have limited sun exposure	Yes	✗ 390(78.6)
	No	✓ 106(21.4)
Dark-skinned people are more prone to vitamin D deficiency	Yes	✓ 180(36.3)
	No	✗ 316(63.7)
Vitamin D rich food are costly	Yes	✗ 394(79.4)
	No	✓ 102(20.5)
Flour in Jordan is fortified	Yes	✓ 403(81.1)
	No	✗ 94(18.9)
Knowledge about best time to expose to sun	Knowledgeable*	✓ 121(24.4)
	Not knowledgeable**	✗ 375(75.6)

*Knowledgeable: if the student chose one or more correct answer without choosing any incorrect, ** Not knowledgeable: if the student chose any incorrect answer

Validation of the Questionnaire: The questionnaire content validity was evaluated by and expert panel composed of three experts. Formulated in English the questionnaire was translated to Arabic and

back translated by different translator, and then the two English versions were compared. Face validity of the Arabic version was conducted by interviewing 30 students and the questionnaire was modified according to their feedback. The responses from the pilot testing were excluded from the final analysis.

Statistical Analysis: Descriptive statistics were used to describe the study findings. Categorical variables were presented as frequencies (percentages) whereas continuous variables were presented as means (standard deviations). The χ^2 test was used to assess the associations between the sample characteristics and their vitamin D knowledge and practices and to evaluate the association between participants' knowledge and practices. Binary logistical regression was conducted to assess the contribution of different factors to the use of vitamin D supplements and the results of the regression were represented as odds ratios and 95% Confidence Interval (CI). P-values <0.05 were considered significant. IBM SPSS Statistics 25 was used to analyse the data.

RESULTS

The number of sent invitations was 2,150 (the number of eligible students who were registered in the summer semester). We received responses from 496. The response rate was 23%, which is higher than the minimum acceptable response rate¹⁸.

Socio-Demographic Characteristics: The socio-demographic characteristics of participants are shown in Table 2. Females made up 67.1% of the participants. The mean age of the participants was 23.52 ± 4.1 years. The skin colour of most of the participants ranged between Fitzpatrick skin type III (light brown) (41.1%) and type IV (moderate brown) (43.1%). Almost three-quarters of participants (74.6%) of the participants were physically inactive.

The largest group of the participants (46%) had access to an open area in their homes but without privacy, and only 2.8% reported that they had no kind of sun exposure in their home.

Table 2: Study Sample Demographics

Variable	M (SD) or N (%) (n=496)	
Age	23.52(4.10)	
Body Mass Index (BMI)	24.43(5.65)	
Sex	Female	333(67.1)
	Male	163(32.9)
Do you have any chronic illness?	Yes	27(5.4)
	No	469(94.6)
Smoking status	Smoker	74(14.9)
	Non smoker	404(81.5)
	Ex-smoker	18(3.6)
Marital status	Single	441(88.9)
	Married	55(11.1)
Average income (Jordanian dinars/month)	Low income (<600)	109(32.5)
	Moderate income(600-1000)	123(36.7)
	High income(>1000)	103(30.7)
Skin colour	White skin	16(3.2)
	Light brown skin	204(41.1)
	Moderate brown skin	214(43.1)
	Dark brown skin	62(12.5)
Physical activity	Physically active	125(25.4)
	Physically inactive	367(74.6)

Home exposure to the sun	No exposure to the sun inside the residence	14(2.8)
	Sun exposure via glass only	134(27)
	Open area sun exposure with lack of privacy	228(46.0)
	Open area sun exposure with high privacy	120(24.2)

Sources of Information About Vitamin D and Attitude Toward Vitamin D: As Table 2 shows, all participants had heard of vitamin D and the majority of the participants (78.8%) indicated that the primary source of information about vitamin D was from educational centres, followed by healthcare providers (42.9%). Likewise, the preferred source of information for more than half of them (53%) was educational centres followed by healthcare providers (38.5%). Most (79.4%) participants agreed that vitamin D deficiency is an escalating health issue in the region and all were interested in getting more knowledge about vitamin D. Nevertheless, 44.6% of participants were unconcerned about their vitamin D levels.

Knowledge and Attitudes Regarding Vitamin D Health Benefits and the Causes of its deficiency: Most participants knew that vitamin D is essential for bone integrity and for prevention of osteoporosis, but none knew that there is a role of vitamin D in prevention of osteomalacia (Table 2). Moreover, other essential benefits of vitamin D were less known; only a third (32.5%) of participants knew that vitamin D is important for the integrity of muscles. The primary cause of vitamin D deficiency according to participants was insufficient sun exposure (82.3%), followed by insufficient nutritional intake (39.7%) and the least mentioned cause was obesity (10.7%).

Knowledge and Attitude Regarding Nutritional Sources of Vitamin and Sun Exposure: As shown in Table 2, 52.8% of participants acknowledged that the nutritional sources of vitamin D are insufficient and most of them (75.8%) believed that the main source of vitamin D is the sun. Nevertheless, 75.6% did not know the best time to be exposed to the sun for cutaneous production of vitamin D and 36.3% of the participants were aware of the association between dark skin colour and vitamin D deficiency. Only 9.7% of the participants regarded oily fish as a source of vitamin D. The majority (78.6%) of respondents believed that vitamin D consumption is important only when sun exposure is limited and 79.4% believed that vitamin D rich foods are costly.

Participants' knowledge scores percentages mean (\pm SD) was 31.3% (\pm 11.25) and only 7% of the participants got a score of 50% and above. The highest score was 66.67%.

Table 3: Knowledge and Attitude about Vitamin D

Variable	N (%)	
Information sources about vitamin D	Educational centre, school, or university	391(78.8)
	Healthcare providers	213(42.9)
	Media	129(26.0)
	Websites and Facebook	155(31.1)
	Parents, relatives, or friends	162(32.7)
	Other sources	11(2.2)
Knowledge about best time to expose to sun	Knowledgeable*	121(24.4)
	Not knowledgeable**	375(75.6)

Benefits of vitamin D	Essential for the bone integrity	405(81.7)
	Prevention of osteoporosis	355(71.6)
	Prevention of rickets	272(54.8)
	Prevention of osteomalacia	0(0)
	Essential for muscle integrity	161(32.5)
Familiarity with vitamin D	Protect against chronic diseases	192(38.7)
	Protect against weakness and fatigue	261(52.6)
	Unsure	24(4.8)
Familiar	496(100)	
Interest in getting more knowledge about vitamin D	Interested	496(100)
	Healthcare providers	191(38.5)
Preferred source of information about vitamin D	Educational centres, school, or university	263(53.0)
	Media and Internet	32(6.5)
	Parents, relatives, or friends	9(1.8)
	Insufficient sun exposure	408(82.3)
Causes of vitamin D deficiency	Nutritional insufficiency	197(39.7)
	Dressing style	140(28.2)
	Aging	128(25.8)
	Pregnancy	61(12.3)
	Obesity	53(10.7)
	Sunscreen usage	100(20.2)
	Genetic variability	121(24.4)
	Gender differences	61(12.3)
	Physical inactivity	140(28.2)
	Soft drinks	64(12.9)
	Smoking	72(14.5)
	Extra water drinking	13(2.6)
	Unsure	11(2.2)
	Sources of vitamin D	Sun
Oily fish		48(9.7)
Meat		13(2.6)
Dairy products		23(4.6)
Eggs		14(2.8)
Fortified cereal		3(0.60)
Olive oil		3(0.60)
Mushroom		2(0.40)
Vegetables		5(1.0)
Unsure		10(2.0)
Is flour in Jordan fortified?	Yes	403(81.3)
	No	93(18.8)
Concerns about vitamin D levels	Concerned	275(55.4)
	Not concerned	221(44.6)
Vitamin D deficiency is an escalating health issue in the region	Yes	394(79.4)
	Unsure	76(15.3)
Do you agree with these sentences (Frequency (%) of agree)	No	26(5.2)
	Nutritional sources of vitamin D are adequate	234(47.2)
Vitamin D is important to maintain normal calcium levels	254(51.2)	
Vitamin D consumption is important only when sun exposure is limited	390(78.6)	
Dark-skinned people are more prone to vitamin D deficiency	180(36.3)	
Vitamin D rich foods are costly	394(79.4)	

*Knowledgeable: if the student chose one or more correct answers without choosing any incorrect, ** Not knowledgeable: if the student chose any incorrect answer

Sun Exposure Practice: As Table 3 shows 50.6% of the participants usually avoid exposure to the sun, and 57.9% routinely use sunscreen. From 10 am to 4 pm, 45.6% spend only less than 30 minutes outdoors during the weekdays and 62.3% of them spend less than 30 minutes outdoors during the weekends. Moreover, only 26.6% were exposed to the sun in the right time for vitamin D synthesis. The main sun-exposed body parts of the participants were face and hands (67.7%), legs were exposed in 6.7% of the participants. Totally covered body with no parts exposed to the sun was practiced by (2.2%) of the participants.

Vitamin D Containing Food, Fortified Food and Vitamin D Supplement, Consumption Practice: As indicated by the weekly frequency of vitamin D rich food consumption (Table 3), the least consumed food was oily fish, followed by butter, eggs. The most consumed was meat. A third of participants reported that they are taking vitamin D supplements. Regarding the consumption of vitamin D-fortified food, 34.5% of the participants reported consuming fortified food and 48.8% were unsure.

The consumption of vitamin D rich food percentages mean was 72.9% (± 14.7). Over 95% of participants got a score of 50% or more and the lowest reported percentage was 33.3%.

Table 4: Sun exposure and vitamin D consumption practices

Variable		N (%)
Time spent outdoors during weekdays (10 am to 4 pm)	Less than 30 min	226(45.6)
	30-60 min	120(24.2)
	>60 min	150(30.2)
Time spent outdoors during weekends (10 am to 4 pm)	Less than 30 min	309(62.3)
	30-60 min	70(14.1)
	>60 min	117(23.6)
Sunscreen usage	Use	287(57.9)
	Do not use	210(42.1)
Sun-exposed body parts	Face/hands/arms/legs	33(6.7)
	Face/hands/arms	92(18.5)
	Face/hands	336(67.7)
	Face	24(4.8)
Avoidance of sun	No parts are exposed to sun	11(2.2)
	Avoid usually	251(50.6)
	Do not avoid usually	245(49.4)
Participant exposure to the sun	At the right time*	132(26.6)
	Not at the right time	364(73.4)
Consumption of vitamin D fortified foods	Consume	171(34.5)
	Not sure	242(48.8)
	Do not consume	83(16.7)
Consumption of milk	Less than once weekly	171(34.5)
	Once weekly	96(19.4)
	More than once weekly	229(46.2)
Consumption of butter	Less than once weekly	286(57.7)
	Once weekly	59(11.9)
	More than once weekly	151(30.4)
Consumption of eggs	Less than once weekly	70(14.10)
	Once weekly	101(20.4)
	More than once weekly	325(65.5)
Consumption of oily fish	Less than once weekly	155(31.3)
	Once weekly	213(42.9)
	More than once weekly	128(25.8)

Consumption of meat	Less than once weekly	67(13.5)
	Once weekly	82(16.5)
	More than once weekly	347(70.0)
Use of vitamin D supplements	Use	196(39.5)
	Do not use	300(60.5)

*Right time: around the solar noon; before noon, noon, and early after noon

Association Between Sample Characteristics and Knowledge and Practices Related to Vitamin D: χ^2 test results show that females significantly higher beliefs that vitamin D deficiency is an escalating health issue (84.7%) than males. In addition, their negative practices regarding sun exposure was statistically significant compared to males (p-value <0.01), as they reported covering more of their bodies, exposing only face and hands (81.1%) and spend less than 30 minutes during 10 am-4pm time period of the day outside during weekends (64.6%). Significant differences between male and females were found in use of sunscreen and avoidance of sun exposure habits - only (6.7%) of males used sunscreen routinely compared to 82.9% of females, and 58% of females compared to 35.3% of males reported avoiding sun exposure.

Regarding the knowledge about the best time to be exposed to the sun for vitamin D synthesis (around the solar noon), 78.1% of females did not know the best time for vitamin D synthesis, which was reflected in their practice toward sun exposure as three-quarters of them (76%) reported being exposed to the sun during the time of day when little vitamin D synthesis might occur.

Association Between Vitamin D Knowledge and Beliefs with Practices: As indicated by χ^2 tests results, the participants who knew the best time for sun exposure for vitamin D synthesis had significantly higher sun exposure at the right time when compared with those who did not know (p<0.01). However, the beliefs of the sun as the best source of vitamin D, and insufficient sun exposure are the main cause of vitamin D deficiency did not have any significant effect on sun exposure time or duration of sun exposure during both weekdays and weekends. No significant association was found between the acknowledgment of a certain types of foods as a good source of vitamin D and their consumption.

Table 4 shows the results of the logistical regression of the factors that can contribute to vitamin D supplement use. The only significant contribution was found for the consumption of fortified foods which increased the odds of consuming vitamin D supplements.

DISCUSSION

Although Jordan is considered a sunny country², the prevalence of low vitamin D status is high in both genders, particularly among young adults of (18-39 years) compared to older age groups^{2,19}. This study aimed to evaluate the current knowledge, attitude, and practice towards vitamin D among young, educated, adults.

Knowledge Score: The mean of knowledge score of the participants in this study was 31.3%, which is close to previously reported scores in China²⁰ and Canada²¹ but significantly lower than that of undergraduate health science students in Saudi Arabia²².

Overall, participants demonstrated that the term, “vitamin D” had been heard, which is higher than an Australian study in which more than one-third of the participants had not heard of vitamin D²³, although the latter group were not university students as in the current study. Vitamin D – knowledge attitude and practice, regarding information

Table 5: Factors contributing to vitamin D supplementation use. A logistic regression predicting likelihood of supplement use on relevant factors (n =496)

	B	S.E.	Wald	Df	P	Odds-Ratio	95% CI of Odds-Ratio	
							Lower	Upper
Sex (Females compared to males)	0.37	0.39	0.91	1.00	0.34	1.45	.68	3.11
Household average monthly income (Moderate income group compared to low income group)	0.36	0.29	1.57	1.00	0.21	1.44	.81	2.53
Household average monthly income (High income group compared to low income)	0.16	0.30	0.27	1.00	0.60	1.17	0.65	2.12
Concerns about vitamin D deficiency (“Not Concerned” compared to “Concerned”)	-0.30	0.24	1.52	1.00	0.22	0.74	0.46	1.19
Taking vitamin D fortified food (“Not sure” compared “Do not take”)	0.72	0.36	4.12	1.00	0.04*	2.06	1.03	4.13
Taking vitamin D fortified food (“Take” compared to “Do not take”)	1.28	0.36	12.55	1.00	<0.01*	3.59	1.77	7.28
Physical activity (“Inactive” compared to “Active”)	-0.45	0.27	2.88	1.00	0.09	0.64	0.38	1.07
Sunscreen usage (“Do not use” compared to “Use”)	0.23	0.35	0.42	1.00	0.52	1.26	0.63	2.50
Avoidance of sun habits (“Avoid” compared to “Do not avoid”)	-0.24	0.24	0.94	1.00	0.33	0.79	0.49	1.27
Knowledge scores about vitamin D	-0.01	0.01	1.42	1.00	0.23	0.99	0.97	1.01
Scores of consumption of vitamin D rich food	0.03	0.07	0.20	1.00	0.65	1.03	0.90	1.19

Abbreviations: B coefficient (B), Standard Error (SE), Wald chi-square test (Wald), degrees of freedom (df), p-value (p), Confidence Interval (CI). * Significance taken at p < 0.05.

sources, food sources, health benefits, and causes of its deficiency.

Educational centres (schools and universities) were the most commonly reported and preferred source of information about vitamin D among the participants, followed by healthcare providers unlike other studies which found that healthcare providers²⁴ and the Internet¹⁷ were the main knowledge sources for participants. Therefore, healthcare providers must develop their role, since they were the second most preferred source of information for the current study participants.

The essential role of vitamin D in bone integrity was the most recognized benefit, in line with a similar study conducted in the United Kingdom¹⁷. The importance of vitamin D in maintaining normal calcium levels, and its role in muscle integrity were known by only half of participants. None of the participants knew of the role of vitamin D in the prevention of osteomalacia, which is an early sign of vitamin D deficiency²⁵. However, this could be due to the lack of a clear diagnostic criteria of osteomalacia²⁵, or unfamiliarity of the term, that may lead to the ambiguity of the term among the general population. Furthermore, less than 10% of participants identified oily fish as a source of vitamin D and low percentages were also reported for other nutritional sources. This indicates that the main nutritional sources of vitamin D and their essential role in health were not well-known by those surveyed, which suggests an unmet educational need regarding vitamin D deficiency and its related factors.

The escalating problem of vitamin D deficiency in the region was

perceived by more than two-thirds of participants, with females being significantly more aware of this issue, which is in line with previous a study²⁶. This emphasizes the need for better health education campaigns related to vitamin D that targets both males and females, especially because a previous Jordanian study indicated that the prevalence of low vitamin D status among males was low (54%)³.

While nutritional insufficiency was reported by (40%) of the participants as a possible cause of vitamin D deficiency, no significant associations were found between participants’ consumption of different vitamin D rich foods and their beliefs. However, their reported consumption of vitamin D rich food was better than the reported rates in a Sudanese study²⁷ which might contribute to the lower prevalence of vitamin D deficiency among Jordanian women than Sudanese women²⁸.

Knowledge, Attitude and Practice Regarding the Importance of Sun Exposure for Vitamin D Synthesis: High awareness of the relationship between insufficient sun exposure and vitamin D deficiency was observed among the participants. This was not observed in a Pakistani²⁹ study where only 36% of participants identified exposure to sunlight as a factor influencing vitamin D production. Nevertheless, consistent with a Chinese study²⁰, the high level of awareness in Jordanian participants did not improve their sun exposure practice. The relationship between attitude and practice of sun exposure reported among the participants is non-linear. This non-linear relationship could be better understood if the state of sun exposure at the participants’ home is investigated.

Clearly, there is a barrier for sun exposure among the participants as most did not have a private area for sun exposure at home. This means that participants, especially females, may be less comfortable exposing their body to the sun due to Jordanian cultural barriers. Consequently, the lack of privacy for sun exposure compelled a quarter of the participants to practice sun exposure via glass windows only, which filters out the UVB radiation required for vitamin D synthesis³⁰.

Moreover, many of the females in our study did not report exposure to the sun during right time for vitamin D synthesis³¹. In addition, compared to males, females during weekends had significantly lower duration (< 30 min) of sun exposure during the period from 10 am to 4 pm, in which effective vitamin D production could be achieved.

It is noteworthy to mention that the participants, who were well-informed about the right time for sun exposure for vitamin D synthesis, practiced significantly more sun exposure at that time than those who were unaware of this fact. Therefore, a more detailed message defining the correct time for sun exposure might enhance public sun exposure practice.

Furthermore, as reported in the present study, most of females in the conservative Jordanian society, cover most of their body parts sparing only their faces and hands, while the sun exposure of some of other body parts (eg back and legs)¹ is important for vitamin D synthesis. Similarly, males' exposure to sunlight did not differ much from the females' as 40.2% of the males exposed face/hands only.

Skin colour has an important effect on the sun-induced synthesis of vitamin D, as the darker the skin, the less vitamin D is synthesized by sun exposure³². In our study, participants' knowledge of this information was poor, which implies that there is a need to clarify the importance of skin colour for vitamin D synthesis, especially among those with darker skin. Use of sunscreen was significantly higher in females than males, something also reported by an Indian study³³. Although in India this may be due to cultural factors related to skin colour with greater value placed on lighter skin tones³⁴. It is now generally accepted that sunscreen usage is not associated with vitamin D deficiency in real-life setting³⁵ and this was found in the current study, as four-fifths of the participants felt that sunscreen usage would not lead to vitamin D deficiency.

Knowledge Attitudes, and Practice, Toward Vitamin D Supplementation: Despite the high prevalence of vitamin D deficiency and insufficiency among the Jordanian population³, 60.5% of the participants did not consume vitamin D supplements, despite these being one of the main sources of vitamin D. The results of the logistical regression showed that the only studied factor that significantly contributed to the vitamin D supplements use was the consumption of vitamin D fortified food, unlike other studies, that reported knowledge scores had the greatest influence^{17,21}.

It is worth reporting that milk was the second most consumed food among the participants, therefore milk fortification may help solve the vitamin D deficiency problem in Jordan as one glass containing about four cubic centimetres of fortified milk will contain about 100 IU of vitamin D which counts for 1/6 of the daily recommended intake (600 IU/day) of vitamin D for those between 1-70 years of age³⁶.

Many factors that may predispose to vitamin D deficiency like skin colour and cultural expectations of clothing are impossible or hard to modify. Therefore, more emphasis should be place on important

alternative modifiable factors including use of vitamin D supplement and food fortification, which might improve the low vitamin D status.

Strengths and Limitations: First, this study is the first that evaluate knowledge, attitude, and practice toward vitamin D among university students and in Jordanian population in general. Second, the sample size is larger than similar studies^{17,37}. Lastly, the study was conducted online, in a university with an infrastructure that allows free internet access for all students, where emails were sent to all of them, which eliminates coverage error, which led to a good response rate. However, there are several potential limitations of this study: first, the questionnaire based on self-reporting, which could lead to recall bias. Second, our results are limited in generalizability as the study population consisted mainly of Jordanian students. This educated population is likely to have led to an underestimation of the knowledge related to vitamin D in the wider Jordanian population. Third, a selection bias may have occurred, as the participation in this study is voluntary, those who participated in the study might had more interest in it than those who did not participate. Nevertheless, since the researchers have no knowledge regarding the views and the characteristics of those who choose not to respond, the reason for non-response cannot be accurately predicted.

Availability of Data and Materials: The datasets generated and/or analysed during the current study are available in the Zenodo repository. <https://doi.org/10.5281/zenodo.4141014>³⁸

CONCLUSION

A gap between participants' knowledge, attitudes and practices regarding vitamin D was observed. This gap which could be bridged through health policy makers adopting food-based strategies, and design effective campaigns to raise awareness of vitamin D, the importance of safe exposure to the sun expressed in unit of time, the use of vitamin D supplements, food fortification and the regular inclusion of oily fish such as salmon in their diet to improve vitamin D status among the Jordanian population. Our results, might give a hint for the explanation of the high prevalence of low vitamin D among younger adults in the sunny Jordan. While this conclusion may not be generalizable to the whole population as our sample were drawn from a single university, our study provides a baseline for further quantitative and qualitative studies regarding vitamin D knowledge, attitudes and practices within the wider population. Future studies could fruitfully explore this issue further by including vitamin D status as a proxy for vitamin D knowledge attitude and practice.

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