



Shadows on the sunshine vitamin: Assessment of vitamin D knowledge among Bishkek's university students

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ABSTRACT

Vitamin D is critical in bone health, immunity, and mental well-being. Despite its importance, awareness and proper intake remain low in many regions, including central Asia. This cross-sectional study aimed to assess the awareness, sources of knowledge, lifestyle habits, and perceptions regarding vitamin D among 220 university students in Kyrgyzstan. A self-administered questionnaire was used to collect data on sun exposure, dietary habits, supplement use, and perceived health effects of vitamin D. Results indicated that although most participants had heard of vitamin D, a majority lacked regular sun exposure, rarely consumed vitamin D-rich foods, and were unaware of their vitamin D status. Only a minority had been tested for deficiency. The findings highlight a need for increased educational campaigns and routine screening for vitamin D levels among the youth in Kyrgyzstan.

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INTRODUCTION

Vitamin D, a fat-soluble secosteroid, is crucial for regulating calcium and phosphate balance, therefore facilitating bone mineralization and skeletal integrity (Holick, 2017). Vitamin D deficiency is a global issue despite its endogenous production, especially in areas with little sunlight, among the elderly, and among people with certain medical problems. It is now clear that vitamin D has important roles that go well beyond its well-known role in the metabolism of calcium and phosphorus. These roles include influencing cell growth, regulating immune responses, and even having an effect on mental health (Holick, 2017). In recent years, research on vitamin D has expanded significantly in the healthcare sector, highlighting its benefits, risks, and the consequences of deficiency and overdose in modern society. Globally, vitamin D deficiency has been recognized as a major public health concern, with some studies even referring to it as an epidemic due to its widespread impact on populations, particularly in Western and underdeveloped countries (Holick, 2007). Optimizing vitamin D levels may lower the incidence of falls and fractures, which is important in aging populations, according to recent research (Weaver *et al.*, 2016). It is well known that vitamin D has immunomodulatory properties that affect both innate and adaptive immunity. It increases the ability of monocytes, macrophages, and dendritic cells—all essential elements of the innate immune system—to combat pathogens. Additionally, vitamin D can affect how different cytokines are produced, which might lower inflammation and possibly stop overreactions from the immune system. Autoimmune conditions such as multiple sclerosis, rheumatoid arthritis, and type 1 diabetes have been connected to vitamin D insufficiency (Cantorna and Mahon, 2015).

Recent studies have suggested that vitamin D might also play a role in the prevention and management of viral infections, including respiratory infections and COVID-19. For instance, a study published in *Frontiers in Public Health*

indicated that vitamin D status is inversely related to the risk of COVID-19 infection, suggesting that sufficient vitamin D levels may mitigate the severity of the disease (Meltzer and Best, 2020). There is mounting evidence that mood problems and vitamin D deficiency are related. The hippocampus and amygdala, two parts of the brain involved in mood regulation, have vitamin D receptors. According to epidemiological research, those with low vitamin D levels are more likely to suffer from depression (Anglin *et al.*, 2013).

Several meta-analyses suggest that vitamin D supplementation may alleviate symptoms of depression, particularly in individuals with clinically low baseline levels (Berk *et al.*, 2013). Heart tissue contains receptors for vitamin D, and studies have demonstrated that the active form of vitamin D, calcitriol, affects inflammation, endothelial function, and blood pressure regulation (Zhao, 2013). Low vitamin D levels have been associated with a higher risk of heart failure, myocardial infarction, stroke, and hypertension (Zhao, 2013). Vitamin D supplementation lowered blood pressure in those with hypertension, according to a study published in *The American Journal of Clinical Nutrition* (Jeng and Hsu, 2012). Furthermore, vitamin D may help prevent arterial calcification, a major contributor to atherosclerosis, by regulating calcium deposition in vascular tissues (Mason *et al.*, 2012). Moreover, vitamin D deficiency has been linked to an increased risk of metabolic syndrome, a collection of conditions that increases the risk of heart disease, stroke, and type 2 diabetes (Forouhi and Luan, 2012). In developing nations such as Pakistan, India, and Bangladesh, a lack of public awareness and health education has contributed to a dramatic rise in vitamin D deficiency cases (Kollias and Beis, 2013). vitamin D deficiency in developing countries and explores the lack of awareness and the social and health impacts of deficiency, including its effects on the immune system and bone health (Ahn *et al.*, 2015). Vitamin D plays a crucial role in bone health by regulating calcium and phosphate metabolism, ensuring the proper development and maintenance

of bones, teeth, and muscles (Kendler and Tice, 2011). It facilitates calcium absorption in the intestines, preventing conditions such as rickets in children and osteomalacia in adults (Lips, 2001). Beyond musculoskeletal benefits, vitamin D is also vital for immune system function, aiding in infection resistance and inflammation control (Zhao, 2013).

Therefore, the goal of the current study is to assess the Kyrgyz population's public health awareness and knowledge surrounding vitamin D deficiency, with a focus on the significance of better understanding its causes, health implications, and the consequences of deficiency.

The study intends to close these gaps to provide more potent methods of preventing vitamin D insufficiency and enhancing public health outcomes.

MATERIALS AND METHODS

In the city of Bishkek, Kyrgyzstan, 220 university students participated in a descriptive cross-sectional study. In order to choose participants, convenience sampling was used. Data were recorded using a self-administered survey intended to measure knowledge and awareness of vitamin D. The survey included both multiple-choice and single-choice questions about belongings including food intake, supplement use, sun exposure habits, and opinions on the health advantages of vitamin D. Before the study conducted, informed consent was taken from every participant, and ethical endorsement was obtained from the institutional ethics board. To be eligible for the study, a person had to be at least eighteen years old, enrolled in college, and ready to take part.

Statistical analysis

All the data was entered in excel file and used for computation. Data were analyzed using descriptive statistics, and frequencies, percentages were calculated for categorical variables. Responses were analyzed using IBM SPSS Statistics for Windows, Version 27.0, ensuring comprehensive statistical evaluation and accurate interpretation of the results.

RESULTS

Distribution of survey participants by major

Among the 220 respondents, 115 were males, 105 were females, and the average age of participants was 20.33 years. The largest group consisted of Engineering students (90 participants, 40.9%), making up nearly half of the sample. Humanities (30 participants, 13.6%), Law (28 participants, 12.7%), and Business (25 participants, 11.4%) were also well represented. Social Sciences (24 participants, 10.9%) and Medicine/Health Sciences (11 participants, 5.0%) had fewer respondents. The least common majors were Computer Science (8 participants, 3.6%) and Pedagogy (4 participants, 1.8%) (Fig. 1).

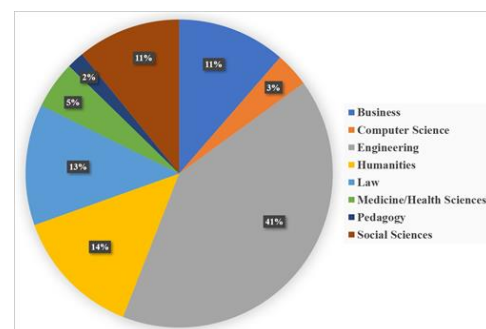


Fig. 1. Depiction of participants as per their major

Residential patterns of study participants

Among the 220 respondents, the majority (123 participants, 55.9%) reported living with family. Shared apartments were the second most common living arrangement, with 85 participants (38.6%). Only 12 respondents (5.5%) lived in dormitories, making it the least common housing option (Fig. 2).

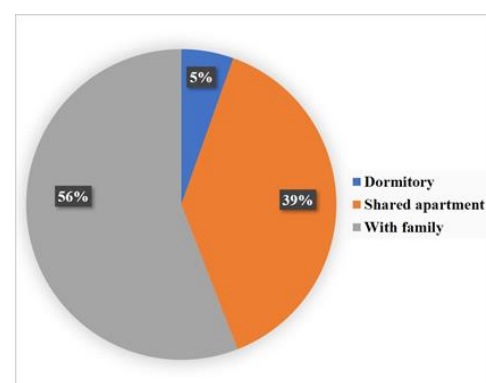


Fig. 2. Demonstration of the living style of study participants

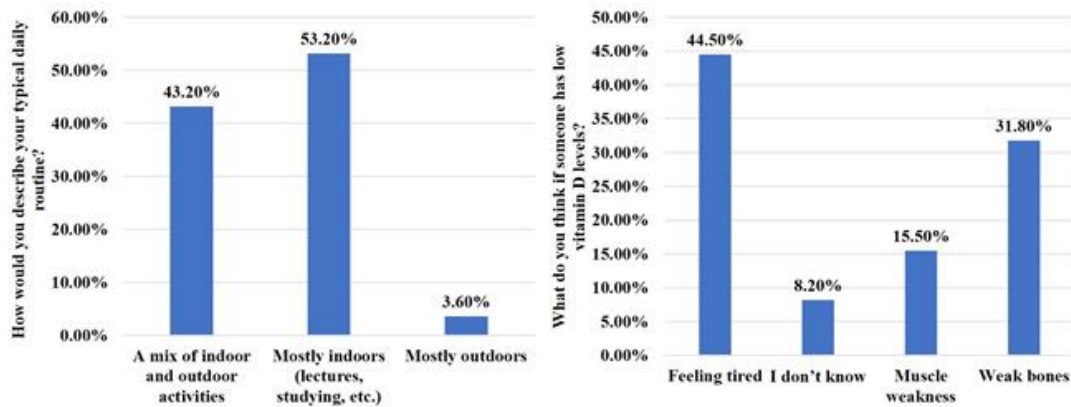


Fig. 3. Demonstration of daily routine and knowledge about vitamin D deficiency consequences

Daily routine of participants

Among the 220 respondents, the majority (117 participants, 53.2%) described their daily routine as mostly indoors, engaging in activities like lectures and studying. 95 participants (43.2%) reported a mix of indoor and outdoor activities, while only 8 respondents (3.6%) had a mostly outdoor routine, making it the least common lifestyle among the group. Among the 220 respondents, the most commonly recognized effect of low vitamin D levels was feeling tired or depressed, identified by 98 participants (44.5%). Weak bones (osteoporosis) were mentioned by 70 participants (31.8%), while muscle weakness was acknowledged by 34 respondents (15.5%). Notably, 18 participants (8.2%) admitted that they did not know the effects of vitamin D deficiency, indicating a gap in awareness (Fig. 3).

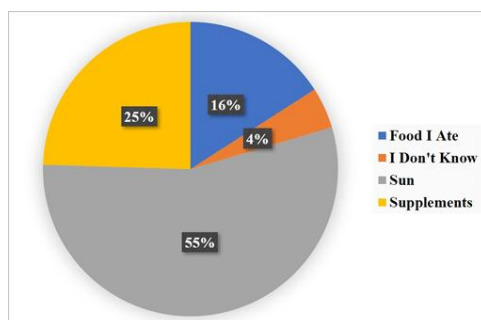


Fig. 4. Demonstration of knowledge of vitamin D sources among the participants

Familiarity of vitamin D source among respondents

Among the 220 respondents, the majority (121 participants, 55.0%) associated vitamin D with the

sun, making it the most recognized source. Supplements were mentioned by 54 participants (24.5%), while 35 respondents (15.9%) linked vitamin D to the food they ate. However, 10 participants (4.5%) stated that they did not know about vitamin D, highlighting a lack of awareness among a small portion of the group (Fig. 4).

Study participants' views on the importance of vitamin D

Among the 220 respondents, the most commonly recognized role of vitamin D was supporting the immune system, mentioned by 60 participants (27.3%). Strong bones and teeth were identified as the key benefit by 55 respondents (25.0%), while boosting mood and energy was noted by 36 participants (16.4%).

A smaller group (27 participants, 12.3%) acknowledged both immune support and mood enhancement, whereas 11 participants (5.0%) recognized all three benefits, bone health, immune support, and mood enhancement. Interestingly, 16 respondents (7.3%) admitted they were unsure about vitamin D's importance, indicating some gaps in knowledge (Fig. 5).

How often do you get sunlight exposure during the day

Among the 220 respondents, 66 participants (30.0%) reported getting 15-30 minutes of sunlight exposure daily, while an equal number (66 participants, 30.0%) spent 30-60 minutes in the

sun. 63 respondents (28.6%) had less than 15 minutes of daily sun exposure, indicating a potential risk for vitamin D deficiency. Only 25

participants (11.4%) reported getting more than an hour of sunlight each day, making it the least common exposure duration (Fig. 6).

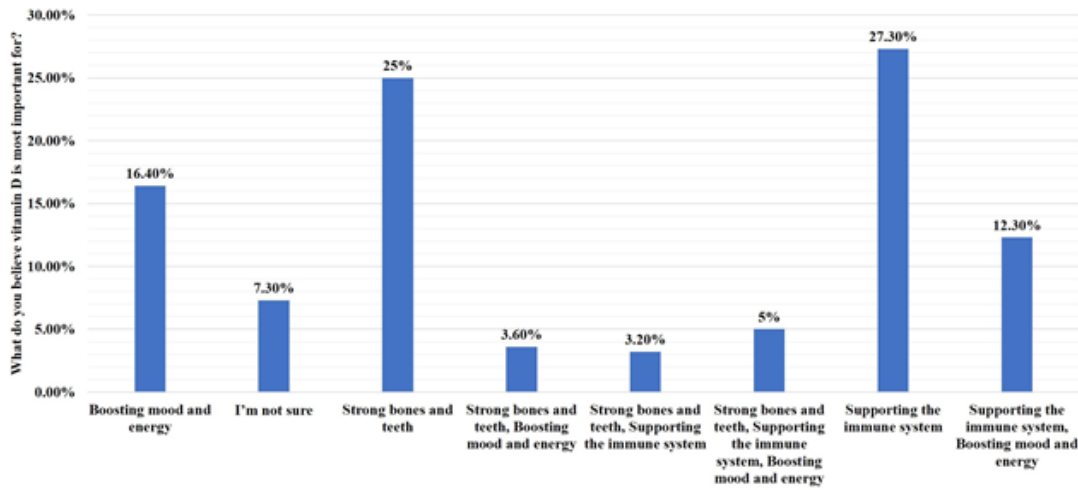


Fig. 5. Knowledge about the importance of vitamin D among the participants

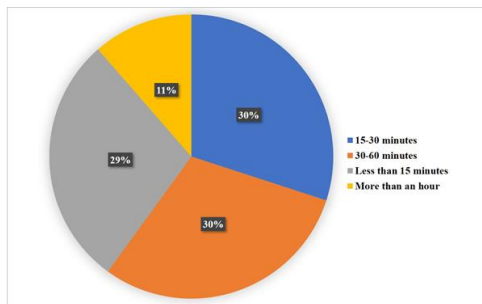


Fig. 6. Demonstration of sunlight exposure among the participants

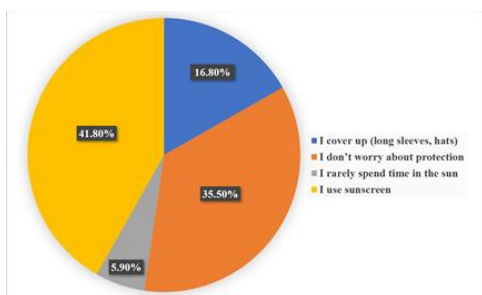


Fig. 7. Sun exposure habits and skin protection strategies among study participants

Participants' common practices for protecting skin from sun exposure

Among the 220 respondents, the most common form of sun protection was using sunscreen, chosen by 92 participants (41.8%). However, 78 respondents (35.5%) stated that they don't worry about protection, indicating

a lack of concern for sun exposure risks. 37 participants (16.8%) preferred to cover up with long sleeves or hats, while 13 respondents (5.9%) mentioned that they rarely spend time in the sun, making it the least common response (Fig. 7).

Participants' perceptions of whether their sunlight exposure is sufficient for health

Among the 220 respondents, 104 participants (47.3%) believed they probably need more sunlight for their health, indicating a concern about insufficient sun exposure. 88 respondents (40.0%) felt that the amount of sunlight they receive is enough to meet their health needs. Meanwhile, 28 participants (12.7%) were unsure, highlighting some uncertainty regarding the adequacy of their sun exposure (Fig. 8).

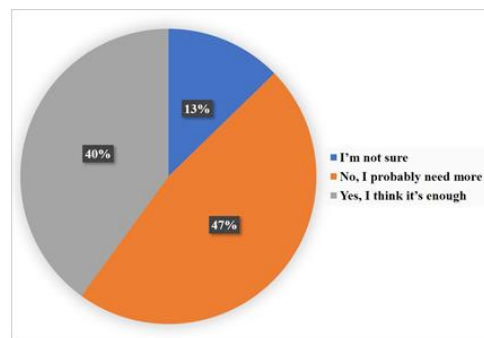


Fig. 8. Demonstration participants' perceptions of the sufficient health benefits of sunlight exposure

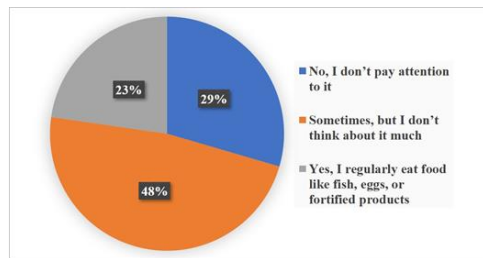


Fig. 9. Frequency of including vitamin D-rich foods in participants' diets

Do you actively try to include foods rich in vitamin D in your diet

Among the 220 respondents, 105 participants (47.7%) stated that they sometimes include vitamin D-rich foods in their diet but don't think about it much. 65 respondents (29.5%) admitted that they don't pay attention to vitamin D intake at all. Only 50 participants (22.7%) actively and regularly consume foods like fish, eggs, or fortified products, indicating that a majority do not consciously focus on maintaining adequate dietary vitamin D intake (Fig. 9).

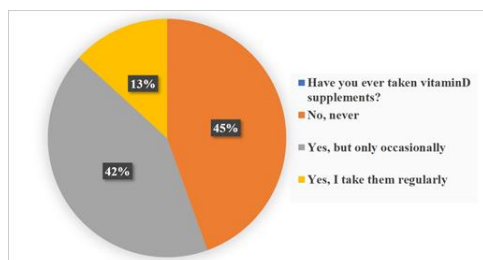


Fig. 10. Prevalence of vitamin D Supplement use in the study group

Have you ever taken vitamin D supplement

Out of 220 participants, 98 people (44.5%) reported that they have never taken vitamin D supplements. 93 participants (42.3%) indicated that they take vitamin D supplements only occasionally, while 29 participants (13.2%) take them regularly. This shows that a significant portion of the group either rarely or never uses vitamin D supplements (Fig. 10).

Do you think your diet alone provides you with enough vitamin D

Out of 220 participants, 52 people (23.6%) don't know if they get enough vitamin D from their diet alone. 99 participants (45.0%) believe that they might

need more vitamin D, indicating a potential deficiency in their diet. Meanwhile, 69 participants (31.4%) feel that their diet is sufficient for their vitamin D needs. This suggests that the majority of the group either needs more vitamin D or is uncertain about their intake (Fig. 11).

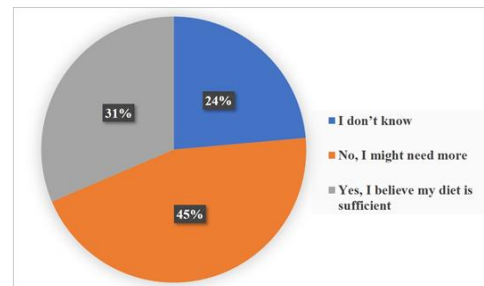


Fig. 11. Perceptions of participants regarding adequate vitamin D from dietary sources

Have you ever had your vitamin D levels checked through blood

Out of 220 participants, 153 people (69.5%) have never had their vitamin D levels checked through blood. 45 participants (20.5%) reported that they have had their vitamin D levels checked often, while 22 participants (10.0%) have had their levels checked sometimes. This suggests that the majority of participants have not regularly monitored their vitamin D levels through blood tests (Fig. 12).

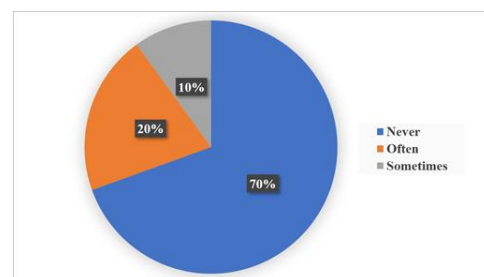


Fig. 12. Demonstration of vitamin D blood level testing incidence in the participants

Participants' experience with vitamin D testing and results

Out of 220 participants, 72 people (32.7%) reported that they were not told they had low vitamin D after a test. 107 participants (48.6%) indicated that the question did not apply to them, likely because they had not undergone a vitamin D test. Meanwhile, 41

participants (18.6%) stated that they were told they had low vitamin D levels. This suggests that a significant portion of the group has either never been tested or has not been diagnosed with low vitamin D (Fig. 13).

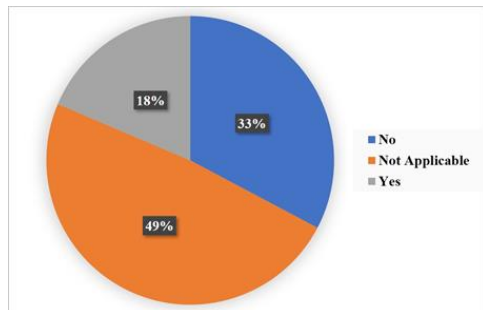


Fig. 13. History of vitamin D testing and communication of low levels among respondents

How likely do you think university students have vitamin D deficiency

Out of 220 participants, 32 people (14.5%) were unsure about whether university students have vitamin D deficiency. 53 participants (24.1%) believe that university students get enough sun and nutrients and are not likely to have a deficiency. However, 135 participants (61.4%) think that university students are likely to have vitamin D deficiency, especially because they spend a lot of time indoors. This indicates that the majority of participants perceive university students to be at risk for vitamin D deficiency (Fig. 14).

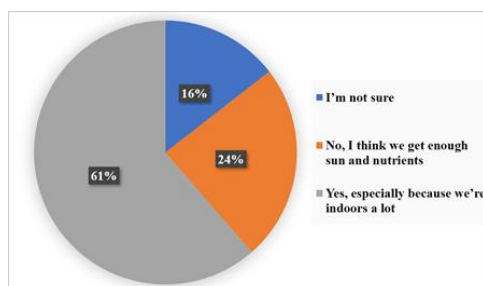


Fig. 14. Participants' perceptions of vitamin D deficiency likelihood among university students

How important participants consider vitamin D for their health

Out of 220 participants, 102 people (46.4%) consider vitamin D to be extremely important for overall health. 99 participants (45.0%) believe it is somewhat

important, while 19 participants (8.6%) feel it is not very important. This suggests that the majority of participants recognize the importance of vitamin D for overall health, with a large portion considering it extremely important (Fig. 15).

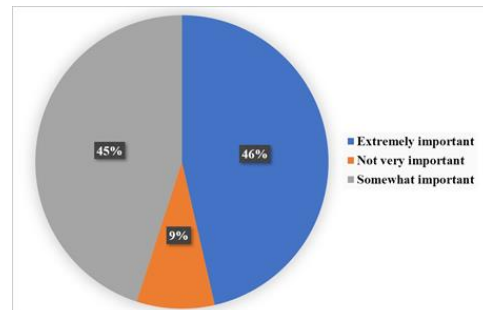


Fig. 15. Demonstration of participants' perceptions of the importance of vitamin D for overall health

Interest Levels in vitamin D education among participants

Out of 220 participants, 115 people (52.3%) expressed that they would be interested in learning more about vitamin D and its role in health. 85 participants (38.6%) said they might be interested if it is relevant to them, while 20 participants (9.1%) stated that they are not interested. This suggests that a majority of participants have a willingness to learn more about vitamin D, with over half expressing clear interest (Fig. 16).

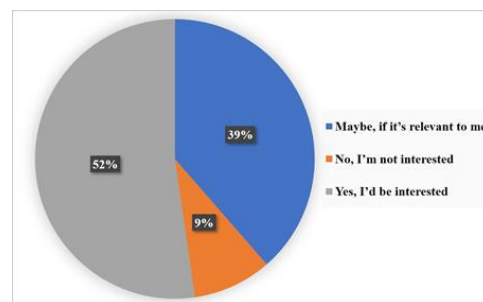


Fig. 16. Demonstration of interest in vitamin D and its health benefits among study participants

Sources of health and nutrition information among participants

Out of 220 participants, 107 people (48.6%) reported that they get health and nutrition information from both social media and healthcare professionals, making it the most common source. 45 participants (20.5%) rely on friends or family, while 43 participants (19.5%)

seek information directly from healthcare professionals. Only 6 participants (2.7%) engage in self-study, and 19 participants (8.6%) obtain information from university courses. This suggests that social media and healthcare professionals play a dominant role in shaping students' knowledge about health and nutrition (Fig. 17).

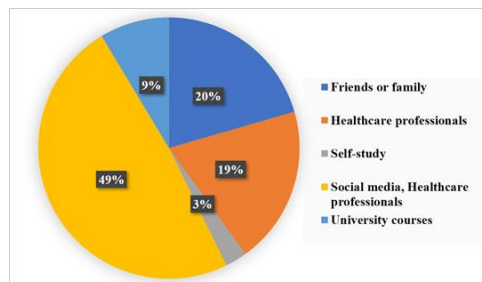


Fig. 17. Demonstration of common channels for health and nutrition information among study participants

Academic majors and their perceptions of vitamin D importance

In comparing students' majors, there was a significant difference in how important they consider vitamin D for their overall health ($\chi^2=24.83$, $df=14$, $p=0.03$) (Table 1).

Social Sciences and Pedagogy students were most likely to rate vitamin D as "extremely important" (>50%),

whereas Business students had the highest proportion considering it "not very important" (32%). Engineering—our largest group—was nearly evenly split between "extremely" and "somewhat important," suggesting varied views within that discipline.

Awareness of low vitamin D effects and interest in further information

Awareness of bone-related risks drove the greatest eagerness to learn more (70.6% "Yes"), whereas those uncertain of any consequence were least motivated (45.0% "Yes" and 50.0% "Maybe"). Although "tired/depressed" was the most cited effect, interest (61.5%) trailed that for osteoporosis, indicating stronger engagement when the health impact is concrete (Table 2).

Academic discipline and interest in learning more about vitamin D

Technical and education-focused majors (Computer Science, Pedagogy, Engineering) showed the highest interest (>67%), while Law and Social Sciences were more equivocal (~52–55% "Yes," ~38–35% "Maybe"). Business students also demonstrated slightly lower engagement. These differences suggest that academic background influences motivation to learn more about vitamin D ($p=0.03$) (Table 3).

Table 1. Demonstration of variation in perceived importance of vitamin D by major

Major	Total (N)	Extremely important N (%)	Somewhat important N (%)	Not very important N (%)
Engineering	90	43 (47.8)	43 (47.8)	4 (4.4)
Humanities	30	13 (43.3)	16 (53.3)	1 (3.3)
Law	28	13 (46.4)	11 (39.3)	4 (14.3)
Business	25	9 (36.0)	8 (32.0)	8 (32.0)
Social sciences	24	13 (54.2)	10 (41.7)	1 (4.2)
Medicine & health sciences	11	5 (45.5)	6 (54.5)	0 (0.0)
Computer science	8	4 (50.0)	3 (37.5)	1 (12.5)
Pedagogy	4	2 (50.0)	2 (50.0)	0 (0.0)

Table 2. Demonstration of perceived consequences of low vitamin D and interest in learning more

Perceived consequence	Total (N)	Yes interested N (%)	Maybe if relevant N (%)	No not interested N (%)
Feeling tired or depressed	104	64 (61.5)	35 (33.7)	5 (4.8)
Weak bones (osteoporosis)	85	60 (70.6)	22 (25.9)	3 (3.5)
Muscle weakness	31	19 (61.3)	11 (35.5)	1 (3.2)
I don't know	20	9 (45.0)	10 (50.0)	1 (5.0)

Table 3. Depiction of student majors and interest in learning about vitamin D

Major	Total (N)	Yes interested N (%)	Maybe if relevant N (%)	No not interested N (%)
Engineering	96	65 (67.7)	25 (26.0)	6 (6.3)
Medicine & health sciences	18	10 (55.6)	7 (38.9)	1 (5.6)
Humanities	25	15 (60.0)	8 (32.0)	2 (8.0)
Law	21	11 (52.4)	8 (38.1)	2 (9.5)
Social sciences	20	11 (55.0)	7 (35.0)	2 (10.0)
Business	21	12 (57.1)	7 (33.3)	2 (9.5)
Computer science	7	5 (71.4)	2 (28.6)	0 (0.0)
Pedagogy	4	3 (75.0)	1 (25.0)	0 (0.0)

DISCUSSION

According to this study, there is a moderate level of general understanding of vitamin D in Kyrgyzstan (68% of respondents indicated familiarity), but there is still a significant lack of detailed knowledge regarding its major source and recommended intake (41% and 22%, respectively).

These results are consistent with a worldwide trend: people generally acknowledge the value of vitamin D but are not well-informed about how to get and sustain optimal levels (Holick, 2007; Blebil *et al.*, 2019; Mithal *et al.*, 2009). Alwadei *et al.* (2018) found that whereas 89% of participants in Najran, Saudi Arabia, had heard of vitamin D, only 68.4% were able to identify its primary sources properly (Alwadei *et al.*, 2018).

Only 35% of adults in the Al-Qunfudhah governorate, Saudi Arabia, were able to name dietary sources of vitamin D, despite 80% of them acknowledging its importance for health (Alwadei *et al.*, 2018). This highlights ongoing deficiencies in nutritional literacy. While 93% of Jeddah people were aware of vitamin D, according to Alamoudi *et al.* (2019), while less than 60% identified sun exposure as the main source (Alamoudi *et al.*, 2019).

According to Tariq *et al.* (2020), 72% of people understood the need of vitamin D, but less than 40% could name foods high in the vitamin (Tariq *et al.*, 2020). A targeted survey of Pakistani engineering undergraduates confirmed these findings: Though just 22% were aware of the required daily intake, 56% had heard of vitamin D (Tariq *et al.*, 2020). According to Blebil *et al.* (2019), 82% of adults in Malaysia were aware of the connection between vitamin D and bone health, but only 28% routinely ate fatty fish or

fortified items, and only 20% were aware of toxicity symptoms (Blebil *et al.*, 2019). According to Kalivas *et al.* (2024), 85% of Greek adults were aware of vitamin D; yet, there were several common misunderstandings regarding the right amount (Kalivas *et al.*, 2024). O'Connor *et al.* (2018) discovered that while 99% of respondents in the UK acknowledged sunshine as the primary source of vitamin D, just 15% were able to name fortified food items (O'Connor *et al.*, 2018).

Adjei *et al.* (2025) showed that whereas 60% of adults in Ghana's Jaman South District were aware of vitamin D, only 25% connected it to immune function (Adjei *et al.*, 2025). This is in sub-Saharan Africa. Additionally, despite their official training, only 54% of Omani health-science undergraduates correctly recognized sunlight as the primary source of vitamin D (Al-Lawati *et al.*, 2022). Digital ads that make use of social media, Kyrgyzstan's top information channel (38%) can successfully provide concise, useful advice on appropriate sun exposure and food consumption (Zhumanazarova and Tursunov, 2023). Furthermore, like successful university interventions in Greece and the UK, incorporating standardized vitamin D teaching modules into secondary and tertiary curriculum may raise awareness and encourage healthier lifestyle choices (Kalivas *et al.*, 2024). In a cross-sectional survey of Saudi Arabia's general population, Algahtani *et al.* (2021) found that while people were moderately aware of vitamin D, they were not well-informed about its sources, health benefits, or recommended sun exposure. About 60% of participants were aware that sunlight is a source of Vitamin D. Only 40% correctly identified dietary sources like fish or fortified milk. Nearly 70% were unaware of the recommended duration of sun exposure for Vitamin D synthesis. Over 50% had misconceptions about

Vitamin D deficiency symptoms. Study underlined the necessity of improved public health initiatives to dispel myths and raise awareness, especially in areas where the frequency of deficiencies is high (Algahtani *et al.*, 2021).

Similarly, a multicultural Australian population's understanding of vitamin D was investigated by Dawodu and Wagner (2018). According to their research, immigrant populations, especially those from Asia and the Middle East, had a poorer knowledge of vitamin D and frequently confused it with other nutrients like calcium or vitamin C. Just 35% of those who were immigrants were able to accurately identify how vitamin D affects bone health. About 45% of people thought that vitamin D was the same as calcium or vitamin C. About 30% knew that sun exposure is essential for the creation of vitamin D (Dawodu and Wagner, 2018).

According to a study by Macdonald *et al.* (2020), public attitudes and knowledge on vitamin D have improved in the UK as a result of national health programs. Health campaigns raised public awareness of vitamin D from 40% to 65%. However, only half of ethnic minorities showed accurate understanding of the signs of deficiencies. About 60% were aware of the dietary sources of vitamin D. Nonetheless, there were still misconceptions regarding deficient symptoms, particularly among ethnic minorities and older persons (Macdonald *et al.*, 2020). Lee *et al.* (2022) evaluated pregnant women in the US for their awareness of vitamin D, focusing on a vulnerable population. The findings indicated that little was known about the importance of vitamin D during pregnancy, and many pregnant women were not aware of the need for food sources or supplements. Higher education levels and easier access to prenatal care were linked to increased awareness, Just 48% were aware of the importance of vitamin D during pregnancy. Approximately 35% knew of the necessity for supplements or food sources throughout pregnancy. The knowledge rate was 70% for women with higher education levels and 30% for those with lower education levels (Lee *et al.*, 2022).

CONCLUSION

This study highlights that while Kyrgyz university students are aware of vitamin D, actionable knowledge and preventive practices remain low. There is a strong need for health education, increased testing availability, and culturally appropriate interventions to promote vitamin D sufficiency in this population.

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