# Bridging the Gap: Knowledge, Awareness, and Practices on Vitamin D Deficiency among Adolescent and Young Adults – A Cross-Sectional Study

Ali Elamin[1], Basem Almalki[1], Hamza Adam[1], Bhgah Adam[1], Reham Bakhsh[1], Ahmed Otudi[1], Eissa Alhadri[1], Mazen Homadi[1], Khalid Zain[1], Albaraa Zakri[1], Yahya Al-Sumayli[1], Siddig Ibrahim Abdelwahab[2], Ahmad Alharbi[3], Manal Mohamed Elhassan Taha[2] and Osama Albasheer[4,*]

[1]*Department of Public Health, College of Nursing and Health Sciences, Jazan University, Jazan, Saudi Arabia*

[2]*Health Research Centre, Jazan University, Jazan, Saudi Arabia*

[3]*ICU Department, Faculty of Medicine, Jazan University, Jazan, Saudi Arabia*

[4]*Family Medicine, Family and Community Medicine Department, College of Medicine, Jazan University, Jazan, Saudi Arabia*

**Abstract:** *Background*: Vitamin D deficiency is a significant public health issue, impacting bone health, immune function, and overall well-being. Despite abundant sunlight in Saudi Arabia, deficiency rates remain high, potentially due to limited sun exposure, cultural practices, and low dietary intake of vitamin D. University students are a key demographic for assessing public health awareness and behaviors related to vitamin D. This study aimed to assess the knowledge, attitudes, and practices (KAP) related to vitamin D deficiency among Jazan University students, and to identify demographic factors influencing these aspects.

*Methods*: A cross-sectional study was conducted among 429 students at Jazan University, Saudi Arabia, from March to June 2024. Data on KAP regarding vitamin D deficiency were collected via a validated bilingual online questionnaire. Statistical analysis was performed using SPSS version 26, employing descriptive statistics and multivariate logistic regression to evaluate demographic predictors of KAP scores.

*Results*: Among the participants, 47.3% exhibited high knowledge, 55% demonstrated high awareness, and 45.6% had high practice levels concerning vitamin D deficiency. Female students had significantly higher KAP scores than males ($p < 0.01$), and health college students showed greater knowledge and awareness than their non-health peers ($p < 0.05$). Multivariate analysis confirmed that gender was a significant predictor, with females displaying higher odds of better outcomes across all domains (Knowledge: AOR 2.66, 95% CI 1.73–4.07; Awareness: AOR 3.0, 95% CI 1.94–4.62; Practices: AOR 1.65, 95% CI 1.10–2.49).

*Conclusions*: The findings highlight a need for targeted educational programs and routine screening initiatives to address vitamin D deficiency among young adults. Public health strategies should prioritize awareness campaigns across all academic disciplines to improve vitamin D literacy and mitigate deficiency-related health risks.

**Keywords:** Vitamin D deficiency, knowledge-attitude-practice, university students, Saudi Arabia, Jazan.

## 1. INTRODUCTION

Vitamin D, a fat-soluble steroid hormone often referred to as the "sunshine vitamin," plays a crucial role in various physiological processes beyond its established importance in bone health [1]. The primary forms of vitamin D are vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol), with the latter being synthesized in the skin upon exposure to ultraviolet B (UVB) radiation and also found in limited dietary sources, such as fatty fish and fortified foods [2-4]. Vitamin D facilitates calcium absorption and is vital for bone mineralization and the maintenance of musculoskeletal health [5, 6]. Deficiency in vitamin D can result in conditions such as osteomalacia in adults and rickets in children, with a growing body of evidence linking it to adverse health outcomes, including osteoporosis, immune dysfunction, cardiovascular disease, and certain cancers [7-9].

Globally, vitamin D deficiency is a widespread issue, with studies estimating that 15.7% of the world's population has serum 25(OH)D levels below 30 nmol/L, considered deficient, while up to 47.9% exhibit insufficient levels (<50 nmol/L) [3, 10-12]. Even with abundant sunlight, the Middle East, particularly Saudi Arabia, reports high rates of vitamin D deficiency across age and gender groups, likely due to factors such as limited sun exposure, cultural practices, and inadequate dietary intake of vitamin D [13-19]. In the

*Address correspondence to this author at the Family Medicine, Family and Community Medicine Department, College of Medicine, Jazan University, Jazan, Saudi Arabia; Tel: 00966536827923; Fax: 0173297003;
E-mail: drosama802@gmail.com

Jazan region, deficiency rates are particularly concerning, affecting 50-60% of adults. Within specific subgroups, such as university students, the prevalence is even higher, with studies reporting deficiency rates of over 80% among female students and increased rates among those with conditions such as anxiety and depression [20, 21].

University students represent a critical demographic for assessing knowledge, attitudes, and practices (KAP) concerning vitamin D deficiency, given their potential to influence broader public health behaviors and awareness [19, 22-24]. Despite Saudi Arabia's natural advantage of high sunlight exposure, young adults may lack adequate knowledge of vitamin D sources, recommended levels, and the risks associated with deficiency. Existing literature indicates limited awareness among younger populations, compounded by lifestyle factors such as extended indoor activities and the use of clothing that limits skin exposure to sunlight [4, 13, 15, 20, 21]. While previous studies have explored vitamin D deficiency among various groups in Saudi Arabia, there remains a lack of specific data on the KAP of university students in the Jazan region.

This study aims to address this gap by assessing the KAP related to vitamin D deficiency among students at Jazan University. By identifying sociodemographic factors that influence these aspects, the study seeks to provide insights into potential areas for intervention, supporting the development of targeted educational programs and public health policies to improve vitamin D awareness and health outcomes.

## 2. MATERIALS AND METHODS

### 2.1. Study Area and Targeted Population

This cross-sectional study was conducted among students at Jazan University, located in the Jazan region of Saudi Arabia, from March to June 2024. Jazan, situated in southwestern Saudi Arabia, has a population of approximately 1.8 million and features diverse geographical zones, including highlands, coastal plains, and densely populated urban areas [25]. Given their potential impact on public health awareness, the study targeted university students across both health and non-health colleges. The study sample was chosen based on a convenience sampling method due to accessibility and logistical constraints.

### 2.2. Sample Size Calculation

The sample size was calculated to ensure adequate power to detect significant associations in knowledge, attitudes, and practices (KAP) regarding vitamin D deficiency. Using a 95% confidence level (Z = 1.96) and assuming a 50% prevalence for a balanced estimate, the required sample size was calculated based on the formula [26]:

$$N = \frac{Z^2(1-p)}{e^2}$$

Where N is the sample size, Z is the Z-score for the 95% confidence interval, p is the estimated proportion (0.5), and e is the margin of error (0.05). The final sample size comprised 429 students.

### 2.3. Data Collection and Measures

Data were gathered using a validated bilingual questionnaire available in Arabic and English, distributed via an online link shared through social media platforms like WhatsApp. Physical copies were also distributed within university premises to maximize reach and ensure a comprehensive response rate. The questionnaire included sections on demographic information (e.g., gender, age, college, and academic year) and KAP-related items concerning vitamin D deficiency. Content validity was ensured by consulting healthcare experts and conducting a literature review [4, 13, 15-17, 27, 28] on vitamin D-related knowledge, sources, recommended intake, and deficiency. The questionnaire comprised three main sections assessing knowledge, attitudes, and practices (KAP) related to vitamin D deficiency, with a total of 45 questions: 18 questions on knowledge, 20 on awareness, and 7 on practices. Each question in the KAP sections was scored to reflect participants' understanding and behaviors. Knowledge and awareness questions were scored on a correct/incorrect basis, with correct answers receiving 1 point and incorrect or “I don’t know” responses receiving 0 points. For practices, scores were based on frequency or adherence to recommended behaviors, with higher scores indicating better practices. The total KAP score was calculated by summing the scores for each section, with higher aggregate scores reflecting greater knowledge, awareness, and adherence to vitamin D practices.

### 2.4. Pilot Study

A pilot study was conducted with 32 students to test the questionnaire’s clarity and reliability. Based on feedback, minor modifications were made to enhance comprehension and question relevance. The pilot responses were excluded from the main analysis. Reliability was confirmed using the test-retest method,

yielding a Cronbach's alpha of 0.80, indicating good internal consistency [29].

### 2.5. Ethical Considerations

Ethical clearance and approval were obtained before commencing the study. Participants' consent was obtained, and the study proposals were submitted to the Standing Committee for Sabbatical Papers, Publication, and Research Ethics at Jazan University under the reference number HAPO-10-Z-001. Ethical approval was obtained from the Publishing Office within the College of Public Health and Tropical Medicine (approval number REC-45/11/1097), ensuring that the research adhered to established ethical guidelines and standards.

### 2.6. Data Analysis

After data extraction, the data were reviewed, encoded, and input into SPSS version 26 (IBM, Inc., Chicago, IL). All statistical analyses were conducted using two-tailed tests and ANOVA. Statistical significance was set at $p < 0.05$. A descriptive analysis utilizing the frequency and percentage distribution was conducted for all variables, encompassing the participants' demographics. The association between demographic factors and KAP measures was assessed using multivariate logistic regression (MLR). In this analysis, the dependent variable was derived using a transformation function in SPSS, with the mean value serving as the cut-off point. This methodology allowed for exploring how demographic variables related to the categorized KAP measures, providing valuable insights into the factors influencing knowledge, attitudes, and practices regarding the subject under study.

## 3. RESULTS

### 3.1. Demographic Characteristics

The demographic characteristics of the sample (N=429) in this study, with a response rate of 100%, are presented in Table **1**. The distribution by gender was 59.7% male and 40.3% female. In terms of age, the majority fell within the 21-25 age group (75.3%), followed by 17-20 (19.3%), and 25 and above (5.4%). Regarding educational background, 55.5% of the participants were from health colleges, while 44.5% were from non-health colleges. Academic year distribution varied across years: first year (6.8%), second year (17%), third year (21.9%), fourth year

**Table 1: Demographic Characteristics and KAP Scores for Vitamin D Deficiency**

| Characteristics | Frequency | % | Knowledge Score | Awareness Score | Practices Score |
|---|---|---|---|---|---|
| **Gender** | | | **Mean± SD** | | |
| Male | 256 | 59.7 | 7.57±3.3** | 8.97±4.0** | 3.98±1.4** |
| Female | 173 | 40.3 | 9.24±3.7 | 10.73±3.1 | 4.57±1.4 |
| **Age Group** | | | | | |
| 17-20 | 83 | 19.3 | 8.45±3.86 | 9.53±3.92 | 4.17±1.33 |
| 21-25 | 323 | 75.3 | 8.2±3.65 | 9.67±3.78 | 4.22±1.54 |
| 25 Above | 23 | 5.4 | 8.13±2.92 | 10.39±4.26 | 4.35±1.50 |
| **College Type** | | | | | |
| Health colleges | 238 | 55.5 | 8.82±3.7** | 10.06±3.8* | 4.23±1.4 |
| Non-health colleges | 191 | 44.5 | 7.52±3.4 | 9.21±3.7 | 4.2±1.5 |
| **Academic Year** | | | | | |
| First Year | 29 | 6.8 | 8.41±3.54 | 9.76±3.65 | 4.52±1.43 |
| Second Year | 73 | 17 | 7.82±3.88 | 9.26±4.03 | 3.96±1.46 |
| Third Year | 94 | 21.9 | 7.65±3.60 | 9.64±3.55 | 4.29±1.33 |
| Fourth Year | 132 | 30.8 | 8.8±3.46 | 10.02±3.55 | 4.34±1.63 |
| Fifth year | 52 | 12.1 | 7.79±3.21 | 9.06±4.56 | 4.15±1.74 |
| Trainee | 32 | 7.5 | 9.03±3.66 | 9.66±3.98 | 4.13±1.07 |
| Other | 17 | 4.0 | 8.5±3.22 | 10.75±4.21 | 3.81±1.51 |

*Significant at 0.05; **Significant at 0.01; Data were analyzed using T-test and One-way ANOVA techniques.

(30.8%), fifth year (12.1%), trainee (7.5%), and other (4.0%). These demographic insights provide a comprehensive overview of the sample composition.

### 3.2. Measures of Knowledge

Table **2** provides a comprehensive overview of the participants' responses regarding knowledge related to vitamin D deficiency. Key findings included that 85.3% knew about vitamin D deficiency prior, 42.2% had suffered from it, and 86.5% identified sunlight as a source of vitamin D. Additionally, 48.3% were aware of vitamin D supplements, with 24.5% recognizing D3 as the most common type. However, gaps existed as 50.3% of the participants were unsure of normal vitamin D levels, and 59.7% did not know the recommended daily intake. Moreover, 37.5% were uncertain about the best test for determining vitamin D status. Despite 72.7% acknowledging the importance of vitamin D for bone health, 13.7% were unsure of its overall functions and benefits.

**Table 2: Knowledge Measures on Vitamin D Deficiency among University Students**

| Measures of Knowledge | N | % |
|---|---|---|
| Did you know about vitamin D deficiency before? | | |
| Yes | 366 | 85.3 |
| No | 35 | 8.2 |
| I don't know | 28 | 6.5 |
| Have you suffered from a vitamin D deficiency in your life? | | |
| Yes | 181 | 42.2 |
| No | 133 | 31 |
| I don't know | 115 | 26.8 |
| Sources of Vitamin D ؟ (Multiple choices) | | |
| The Sunlight | 371 | 86.5 |
| Fatty fish (such as tuna and salmon) | 221 | 51.5 |
| Fruits | 127 | 29.6 |
| Cod liver oil | 126 | 29.4 |
| Egg yolks | 132 | 30.8 |
| Fortified foods like milk and cereals | 161 | 37.5 |
| I don't know | 0 | 0 |
| Others | 0 | 0 |
| Do you know the supplements for vitamin D (such as supplement D2 or D3)? | | |
| Yes | 207 | 48.3 |
| No | 137 | 31.9 |
| I don't know | 85 | 19.8 |
| Which of the following vitamin D supplements is the most common and widely used due to its effectiveness? (the correct answer is D3 cholecalciferol) | | |
| D2 (ergocalciferol) | 74 | 17.2 |
| D3 (cholecalciferol) | 105 | 24 |
| I don't know | 250 | 58.8 |
| The normal level of vitamin D (ng/mL)? (the correct answer is 20-50 ng/mL) | | |
| 5-10 ng/mL | 38 | 8.9 |
| 10-20 ng/mL | 83 | 19.3 |
| 20-50 ng/mL | 92 | 21.4 |
| I don't know | 216 | 50.3 |

| | | |
|---|---|---|
| What is the recommended daily intake of vitamin D (IU) for adults? (the correct answer is 600 IU) | | |
| 200 IU | 59 | 13.7 |
| 600 IU | 92 | 21.4 |
| 900 IU | 22 | 5.1 |
| I don't know | 256 | 59.7 |
| Other | 2 | 0.1 |
| Which of the following is the BEST test to determine vitamin D status? (the correct answer is hydroxyvitamin D [25(OH) serum 25(OH)D level) | | |
| (CBC) Complete blood count | 109 | 25.4 |
| hydroxyvitamin D [25(OH) serum 25(OH)D level] | 92 | 21.4 |
| Urine test for vitamin D metabolites | 34 | 7.9 |
| Bone density scan | 33 | 7.7 |
| I don't know | 161 | 37.5 |
| The functions and benefits of vitamin D? (Multiple choices) | | |
| Bones health | 312 | 72.7 |
| Skin health | 219 | 51 |
| Hair growth | 238 | 55.5 |
| Vision | 162 | 37.8 |
| Essential for muscle integrity | 189 | 44.1 |
| Protect against weakness and fatigue | 255 | 59.4 |
| I don't know | 59 | 13.7 |
| **Total** | **429** | **100** |

**Table 3: Awareness Measures on Vitamin D Deficiency among University Students**

| Measures of Awareness | N | % |
|---|---|---|
| Do you think vitamin D is an essential part of our daily diet? | | |
| Yes | 386 | 90 |
| No | 21 | 4.9 |
| I don't know | 22 | 5.1 |
| Do you think that vitamin D deficiency may cause bone disease? | | |
| Yes | 329 | 76.7 |
| No | 41 | 9.6 |
| I don't know | 59 | 13.8 |
| Diseases that are linked to vitamin D deficiency (Multiple choices) | | |
| Rickets | 144 | 33.6 |
| Osteomalacia | 217 | 50.6 |
| Diabetes | 50 | 11.7 |
| Alzheimer’s disease | 58 | 13.5 |
| Rheumatic arthritis | 146 | 34 |
| Hypertension | 55 | 12.8 |
| Coronary artery disease | 25 | 5.8 |
| Depression | 228 | 53.1 |
| Not all of the above | 9 | 2.1 |

| | | |
|---|---|---|
| I don't know | 76 | 17.7 |
| Others | 13 | 3.3 |
| How many minutes of exposure to the sun do you need per day to avoid vitamin D deficiency? (the correct answer is more than 10 minutes) | | |
| 1–2 minutes | 21 | 4.9 |
| 3-5 minutes | 76 | 17.7 |
| 6–10 minutes | 152 | 35.4 |
| more than 10 minutes | 93 | 21.7 |
| I don't know | 87 | 20.3 |
| What are the main causes of vitamin D deficiency? (Multiple choices) | | |
| Decreased exposure to sunlight | 345 | 80.4 |
| Decreased intake of foods rich in vitamin D | 313 | 73 |
| Kidney disease | 28 | 6.5 |
| Respiratory diseases | 25 | 5.8 |
| I don't know | 42 | 9.8 |
| Others | 6 | 1.4 |
| The symptom/s of vitamin D deficiency (Multiple choices) | | |
| Pain in joints and bones | 291 | 67.8 |
| Muscle pain | 154 | 35.9 |
| Hair Loss | 244 | 56.9 |
| Mood Changes | 262 | 61.1 |
| Fatigue | 264 | 61.5 |
| Changes in sleep patterns | 188 | 43.8 |
| I don't know | 44 | 10.3 |
| Others | 6 | 1.4 |
| Role of vitamin D deficiency in some chronic diseases | | |
| Yes | 363 | 84.6 |
| No | 66 | 15.4 |
| **Total** | **429** | **100** |

### 3.3. Measures of Awareness

A detailed snapshot of participant responses to various aspects of awareness of vitamin D deficiency is shown in Table **3**. Notably, 90% acknowledged vitamin D as an essential part of daily diets, with 76.7% recognizing its association with bone diseases. When asked about diseases associated with vitamin D deficiency, responses highlighted the awareness of conditions such as rickets (33.6%) and osteomalacia (50.6%). Understanding varied on sun exposure requirements, with 35.4% citing 6-10 minutes as sufficient and 21.7% recognizing the need for over 10 min. The causes of deficiency included decreased sunlight exposure (80.4%) and low intake of vitamin D-rich foods (73%). Symptoms such as joint pain (67.8%) and fatigue (61.5%) were well-recognized. Additionally, 84.6% of the participants acknowledged the role of vitamin D deficiency in chronic diseases.

### 3.4. Measures of Practices

In the practice survey, 79.5% reported relying on sun exposure, 54.5% on consuming vitamin D-rich foods, and 49.4% on vitamin D supplements to prevent deficiencies (Table **4**). A small proportion (8.6%) indicated doing nothing for prevention. Regarding vitamin D levels, 46.4% confirmed undergoing such tests. The majority (77.4%) admitted to wearing clothes covering most of their skin outdoors. Additionally, 76.7% stated that they consumed vitamin D-rich foods, 38% reported currently taking vitamin D supplements, and 62% did not.

**Table 4: Practices Measures on Vitamin D Deficiency among University Students**

| Measures of Practices | N | % |
|---|---|---|
| What are your usual practices to prevent vitamin D deficiency? (Multiple choices) | | |
| Sun exposure | 341 | 79.5 |
| Consumption of vitamin D supplement | 212 | 49.4 |
| Consumption of vitamin D-rich foods | 234 | 54.5 |
| Nothing | 37 | 8.6 |
| Examining vitamin D level? | | |
| Yes | 199 | 46.4 |
| No | 230 | 53.6 |
| Do you wear clothes that cover most of your skin when you are outside? | | |
| Yes | 322 | 77.4 |
| No | 97 | 22.6 |
| Do you consume foods rich in vitamin D, such as fatty fish or fortified dairy products? | | |
| Yes | 329 | 76.7 |
| No | 100 | 23.3 |
| Do you take any vitamin D supplements currently (such as supplement D2 or D3)? | | |
| Yes | 163 | 38 |
| No | 266 | 62 |

**Table 5: Summary Statistics of Knowledge, Awareness, and Practices (KAP) Scores for Vitamin D Deficiency**

| KAP | Mean | SD | CI (95%) | IQR |
|---|---|---|---|---|
| Knowledge Score | 8.24 | 3.655 | 7.9-8.59 | 6.0 |
| Awareness Score | 9.68 | 3.830 | 9.32-10.05 | 6.0 |
| Practices Score | 4.22 | 1.503 | 4.08-4.36 | 2.0 |

SD: standard deviation; CI: confidence intervals. IQR: interquartile range.

### 3.5. Overall Statistics of KAP

Table **5** presents the summary statistics for the KAP scores. The mean knowledge score was 8.24 (SD 3.655, CI 7.9-8.59, IQR 6.0), indicating an average understanding level. Awareness scored higher, with a mean of 9.68 (SD 3.830, CI 9.32-10.05, IQR 6.0). Practices had a mean of 4.22 (SD 1.503, CI 4.08-4.36, IQR 2.0), suggesting lower adherence. These values offer a snapshot of the distribution and variability of KAP scores in the study group. The percentages of low and high KAP levels were derived using a transformation function in SPSS, with the mean value serving as the cut-off point. In the study, 52.7% of the participants exhibited low knowledge levels, while 47.3% demonstrated high knowledge levels. Regarding awareness, 45% of the participants had low levels, while 55% showed high levels of awareness. In terms of practice, 54.4% of the participants displayed low levels, whereas 45.6% exhibited high levels of practice. The results are summarized in Figure **1**, which illustrates the distribution of low and high knowledge, awareness, and practice levels among the study participants.

### 3.6. Univariate Analysis

The analysis of KAP related to vitamin D deficiency among young adults (Table **1**) revealed that females (n=173, 40.3%) generally had higher scores than males (n=256, 59.7%) across all categories, with statistically significant differences at the 0.01 level. Females score 9.24±3.7 in knowledge, 10.73±3.1 in awareness, and 4.57±1.4 in practices, compared to males, who score 7.57±3.3 in knowledge, 8.97±4.0 in awareness, and 3.98±1.4 in practices, indicating that

females demonstrate greater knowledge, awareness, and better practices regarding vitamin D. Age shows no significant impact, with scores among age groups 17-20 (n=83, 19.3%), 21-25 (n=323, 75.3%), and above 25 (n=23, 5.4%) being relatively consistent: for example, 17-20-year-olds have knowledge scores of 8.45±3.86, while those above 25 scores 8.13±2.92. Academic year similarly does not significantly influence scores, although minor variations exist, such as third-year students (n=94, 21.9%) scoring 7.65±3.60 in knowledge. However, college type makes a notable difference: students in health-related colleges (n=238, 55.5%) have significantly higher knowledge (8.82±3.7) and awareness scores (10.06±3.8) compared to those in non-health colleges (n=191, 44.5%) with knowledge and awareness scores of 7.52±3.4 and 9.21±3.7, respectively, with p-values of 0.01 and 0.05. This highlights the impact of academic background on health-related understandings and attitudes. Overall, this study underscores the influence of sex and academic focus on health literacy concerning vitamin D, while age and year in college have minimal effects.

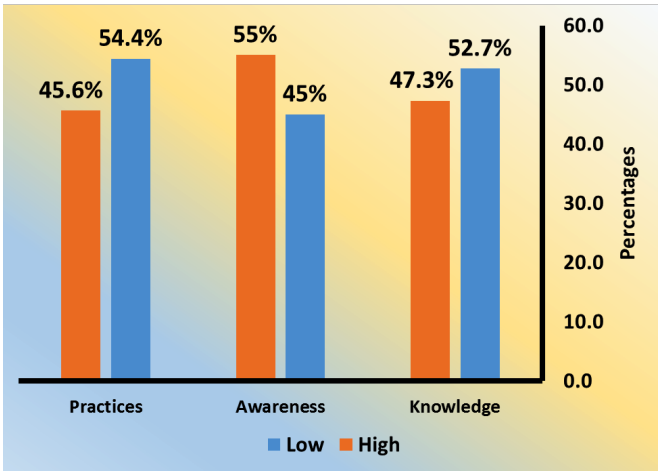


**Figure 1:** The distribution of low and high Knowledge, Awareness, and Practice levels among study participants. The percentages were derived using a transformation function in SPSS, with the mean value acting as the cut-off point. This analysis determined low and high levels based on the participants' scores compared to the mean value for each category. The figure provides a visual representation of the proportions of participants falling into low and high categories for Knowledge, Awareness, and Practices in the study sample.

### 3.7. Multivariate Analysis

Multivariate logistic regression analysis revealed associations between the demographic factors and KAP measures (Table **6**). Regarding knowledge, varying patterns were observed across academic years, and no significant associations were found (Table **5**). The Crude Odds Ratios (COR) suggested some trends, albeit not statistically significant. Similarly, age and college type did not show strong associations with the knowledge scores. However, gender exhibited a notable effect, with females displaying significantly higher odds of better knowledge scores than males (AOR 2.66, 95% CI 1.73-4.07), corroborating the trend observed in the COR. As indicated by COR and AOR, a similar trend was observed for awareness and practice, with no clear patterns emerging for academic year, age, or college type. Once again, gender stood out as a significant predictor, with females consistently demonstrating higher odds of better awareness and practice scores compared to males (Awareness: AOR 3.0, 95% CI 1.94-4.62; Practices: AOR 1.65, 95% CI 1.10-2.49), consistent with the trends seen in the COR values. These findings underscore the importance of sex as a key demographic factor influencing KAP measures in the study population.

## 4. DISCUSSION

Globally, vitamin D deficiency is regarded as a common avoidable ailment [5, 15, 26]. This implies that factors such as KAP's understanding of vitamin D levels among people and an assessment of any gaps in daily practices that could be detrimental to their vitamin D levels are very important. This purposeful cross-sectional study examined KAP regarding vitamin D deficiency in young adults in Saudi Arabia.

Our findings provide a nuanced perspective on the knowledge, awareness, and practices (KAP) regarding vitamin D deficiency among university students in Jazan, Saudi Arabia. Notably, female participants in our study demonstrated significantly higher KAP scores than their male counterparts. This outcome diverges from the prevailing literature that often highlights lower vitamin D levels among women in Saudi Arabia due to sociocultural factors, including limited sun exposure and the widespread use of body-covering clothing.

Several studies have examined the KAP for vitamin D deficiency in several categories of the Saudi community. Christie and Mason reported that, among female students, there is a shortage of knowledge concerning vitamin D deficiency due to factors such as intense heat and cultural practices of body covering [17]. Aljefree *et al*. emphasized disseminating knowledge and vitamin D supplementation as potential measures to reduce the severity of vitamin D deficiency

**Table 6: Multivariate Logistic Regression Analysis of Demographic Predictors of Knowledge, Awareness, and Practices Related to Vitamin D Deficiency.**

| Predictors | Categories | Knowledge | | Awareness | | Practices | |
|---|---|---|---|---|---|---|---|
| | | COR | AOR | COR | AOR | COR | AOR |
| Academic year | First Year (Reference) | | | | | | |
| | Second Year | 0.72(0.30-1.72) | 0.69(0.28-1.70) | 1.13(0.48-2.68) | 1.12(0.45-2.76) | 0.78(0.33-1.87) | 0.71(0.29-176) |
| | Third Year | 0.68(0.29-1.57) | 0.52(0.19-1.40) | 1.12(0.49-2.57) | 0.80(0.30-2.14) | 1.13(0.49-2.61) | 0.75(0.28-2.0) |
| | Fourth Year | 1.31(0.58-2.92) | 1.23(0.46-3.31) | 1.79(0.80-4.03) | 1.60(0.59-4.32) | 1.23(0.55-2.76) | 0.85(0.32-2.26) |
| | Fifth Year | 0.81(0.33-2.03) | 0.84(0.29-2.45) | 0.99(0.40-2.46) | 0.93(0.32-2.68) | 1.01(0.40-2.53) | 0.70(0.25-2.03) |
| | Trainee | 1.38(0.50-3.78) | 1.49(0.46-4.80) | 1.38(0.50-3.78) | 1.34(0.42-4.33) | 0.96(0.35-2.63) | 0.66(0.20-2.10) |
| | Other | 1.38(0.40-4.70) | 1.59(0.36-7.08) | 1.79(0.51-6.21) | 1.38(0.30-6.23) | 0.56(0.16-2.02) | 0.28(0.06-1.33) |
| Age | 17-20 (Reference) | | | | | | |
| | 21-25 | 1.11 (0.69-1.81) | 1.03(0.52-2.02) | 1.19(0.73-1.94) | 1.16(0.60-2.28) | 1.43(0.87-2.35) | 1.59(0.81-3.12) |
| | 25 Above | 1.12 (0.44-2.81) | 0.99(0.30-3.33) | 1.48(0.58-3.80) | 1.88(0.56-6.32) | 1.46(0.58-3.70) | 2.96(0.87-9.97) |
| College | Health colleges (Reference) | | | | | | |
| | Non-Health colleges | 0.70(0.48-1.03) | 0.72(0.47-1.94) | 0.76(0.52-1.12) | 0.75(0.50-1.14) | 0.85(0.58-1.25) | 0.83(0.55-1.24) |
| Gender | Male (Reference) | | | | | | |
| | Female | 2.20* (1.49-3.3) | 2.66*(1.73-4.07) | 2.622* (1.75-3.93) | 3.0*(1.94-4.62) | 1.605*(1.09-2.37) | 1.65(1.10-2.49) |

*Significant at 0.05. The association between demographic factors and the KAP measures was assessed using multivariate logistic regression (MLR). In this analysis, the dependent variable was derived using a transformation function in SPSS, with the mean value serving as the cut-off point. AOR: Adjusted odds ratio; COR: Crude odds ratio.

despite highlighting its high prevalence in cases with coronary heart disease compared to controls [16]. Alfayyadh *et al*. relied on the evidence of a weak understanding of vitamin D among medical students and its links to vitamin D deficiency [13]. Likewise, Zareef, Jackson, *et al*. researched premenopausal women in Jeddah and found vitamin D sufficiency status and poor knowledge of vitamin D sources, mainly low educational levels and negative attitudes towards sunlight exposure [15]. Kambal *et al*. explored vitamin D levels and the benefits of vitamin D among female students in one of the regions of Southwestern Saudi Arabia, which had limited results, and there were associations between knowledge level and some sociodemographic factors [4]. These studies conducted within the Kingdom of Saudi Arabia support the argument that there is a need for increased awareness campaigns and educational programs to tackle the issue of vitamin D deficiency.

Despite these persistent deficiencies, our study suggests that women are more knowledgeable and proactive in their approach to vitamin D health. This discrepancy might be explained by increased health awareness campaigns targeting women, particularly university students, who may have greater exposure to health-related information and resources than other demographics. Additionally, societal shifts emphasizing women's health could be fostering a greater awareness of vitamin D deficiency and its associated risks.

Furthermore, the higher KAP scores observed among female participants might indicate that awareness does not always correlate with optimal vitamin D levels. For instance, while women may be well-informed about dietary sources of vitamin D and the need for supplementation, cultural and environmental constraints may still hinder the practical realization of sufficient vitamin D levels through sun exposure.

Although this cohort included university students with access to the internet and health information, their understanding of vitamin D was inadequate. Inadequate awareness may stem from contradictory information on vitamin D levels and the absence of clear, localized guidance on sun exposure.

Comparable constraints regarding vitamin D knowledge have been documented in studies conducted in Bangladesh, the Middle East, Iran, Lebanon, and South Asian immigrants residing in Europe. Consistent with our findings, most studies indicate that participants are unable to recognize food and sunshine as essential sources of vitamin D [30, 31]. Nonetheless, our findings contradict those

observed in the UK, where individuals exhibited a commendable degree of awareness of vitamin D [28]. This may signify heightened public awareness and food fortification in wealthy nations. Comprehensive measures are necessary to evaluate public knowledge and awareness of vitamin D. Individuals must be provided with information in their native languages, which accurately represents the current understanding of vitamin D and its correlation with health, as well as explicit details on the sources of vitamin D [32]. National public health messages should be disseminated across several platforms (e.g., social media, health centers, colleges, and schools), particularly via the media, to enhance awareness across all demographic subgroups of the population [33].

According to Habib *et al*., medical university students in Riyadh have superior knowledge compared to non-medical university students; nevertheless, no differences were seen in attitudes or practices [27]. The current study revealed that students in health schools possess a greater degree of knowledge regarding health-related subjects, which is unsurprising. This is largely attributable to the increased exposure to health-related information and instruction that students at health schools receive compared to their counterparts in non-health colleges. Unsurprisingly, students in health institutions possess a heightened understanding of health-related concerns. This is probably because students in health colleges are more frequently exposed to health-related information and instructions beyond the classroom. It is remarkable that there is no disparity in health-related habits between students in health and non-health institutions. Students in health institutions are likely to possess a superior comprehension of the significance of healthy habits. The findings of this study align with prior research indicating that health college students typically exhibit a higher level of knowledge regarding vitamin D deficiency than non-health college students. For instance, Kambal *et al*. demonstrated that female medical students in Saudi Arabia had a mean knowledge score of 7.8 10, while female non-medical students scored an average of 6.2 out of 10 [4]. Similarly, Alfayyadh *et al*. reported that medical students in Saudi Arabia achieved a mean knowledge score of 9.53 out of 15, whereas non-medical students scored an average of 7.05 out of 15 [13]. These consistent findings across studies underscore the trend of higher knowledge levels among healthy college students compared with their non-health counterparts when it comes to understanding vitamin D deficiency. The involvement of healthcare practitioners in underscoring the significance of vitamin D testing and enhancing public awareness of vitamin D insufficiency is essential. A study including physicians and interns in Bangladesh [5] and the UK [14] revealed considerable knowledge deficiencies regarding the public health consequences of vitamin D insufficiency. Rectifying these deficiencies is crucial for the efficient prevention and management of associated health concerns.

It is also important to consider the demographic composition of our study. University students, especially those in health-related fields, are likely to exhibit higher baseline knowledge and awareness of health topics compared to the general population. This demographic specificity could partially explain why women in our study demonstrated better KAP scores relative to men despite broader national trends of higher deficiency rates among women.

Our findings highlight the critical need to incorporate routine vitamin D screenings as a cornerstone of public health initiatives. Despite high awareness and knowledge scores among certain demographics, such as health college students, gaps in practices—like insufficient testing and supplementation—underscore the importance of identifying individuals at risk of deficiency through systematic screening programs. Regular vitamin D screening could not only aid in early detection but also provide a tangible metric for assessing the effectiveness of public health interventions. This approach is particularly pertinent in regions like Saudi Arabia, where sociocultural factors significantly affect vitamin D status.

Targeted awareness campaigns are also imperative, especially for groups with lower KAP scores in health-related fields. Our study's results revealed that male students and those from non-health colleges displayed relatively weaker knowledge, awareness, and practices concerning vitamin D. Tailored educational initiatives should focus on these groups, utilizing culturally sensitive strategies to address specific barriers such as limited dietary knowledge, lack of supplementation practices, or misconceptions about sun exposure.

Leveraging digital platforms, university workshops, and collaboration with healthcare providers can amplify these efforts. For instance, campaigns designed for non-health college students could integrate interactive elements, such as mobile apps and gamified learning

modules, to engage this audience effectively. Additionally, emphasizing the broader health benefits of vitamin D beyond bone health—such as its role in immune function and chronic disease prevention—may motivate greater participation and adherence.

By integrating routine screenings and targeted campaigns, public health strategies can address the dual challenge of raising awareness and facilitating actionable practices, ultimately reducing the prevalence of vitamin D deficiency across diverse demographic groups.

Future studies should focus on longitudinal designs to track whether improved KAP translates into measurable improvements in vitamin D status to reconcile these findings with existing literature. Additionally, public health interventions should aim to bridge the gap between knowledge and actionable practices, particularly in overcoming cultural barriers that limit sun exposure among women.

## 5. LIMITATIONS

This study had multiple limitations, the foremost being that it utilized a convenience sample, which may introduce selection bias due to its execution within a specific academic context. Therefore, the results cannot be extrapolated to the Saudi population. This restricted age range further constrained our investigation. Subsequent research should authenticate this questionnaire for its application in a broader national investigation. The study was cross-sectional; therefore, it could not be used to determine causal relationships. This study relied on self-reported data, which may have been subject to bias. It is essential to collect blood 25-hydroxyvitamin D to evaluate the correlation between the KAP and vitamin D levels. Moreover, additional research should investigate how innovative communication channels such as social media might enhance public awareness and their effects through the diffusion of the innovation framework.

## 6. CONCLUSIONS

The study results on KAP related to vitamin D deficiency revealed a mixed level of understanding and actions among the respondents. While a significant proportion of participants reported awareness of the importance of vitamin D and its sources, gaps exist in knowledge regarding recommended daily intake and normal levels. There is a notable discrepancy in practice, with a high percentage relying on sun exposure but a lower proportion taking vitamin D supplements or examining their vitamin D levels. These findings also highlight the need for more education on the symptoms of vitamin D deficiency and its association with various diseases. Strategies to address these gaps could include promoting a balanced approach to obtaining vitamin D through sun exposure, diet, and supplements, coupled with regular monitoring of vitamin D levels, to ensure adequate intake and effectively prevent deficiencies.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study complied with the ethical principles outlined in the Declaration of Helsinki. Ethical clearance and approval were obtained before commencing the study. Verbal consent was obtained from the participants, and the study proposals were submitted to the Standing Committee for Sabbatical Papers, Publication, and Research Ethics at Jazan University under the reference number HAPO-10-Z-001.

## CONSENT FOR PUBLICATION

Not applicable.

## AVAILABILITY OF DATA AND MATERIAL

“Data is provided within the attached supplementary information file".

## COMPETING INTERESTS

The authors declare that they have no competing interests.

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## AUTHORS' CONTRIBUTIONS

A.E., B.A., and S.A. wrote the title and planned for the study. S.A., H.A., and B.A. wrote the methodology. A.Z., Y.A., A.E., M.T., and S.A. conducted the formal analysis and supervision. R.B., A.O., E.A., M.H., and K.Z. contributed to data curation, resources, funding acquisition, and project management. All authors involved in writing the main manuscript text. All authors reviewed and agreed to the published version of the manuscript.

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