**International Journal of Biomedical and Clinical Sciences**
Vol. 6, No. 2, 2021, pp. 44-57
http://www.aiscience.org/journal/ijbcs

# Knowledge, Attitudes, Perceptions and Practice About Vitamin D, Its Deficiency, and Management Amongst Undergraduate Medical Students

**Shalini Krishnappan*, Azel Azam Nair, Sanjei Basker, Vinithaa Gunasagaran, Rhimaza Abdul Rishad**

Faculty of Medicine, Melaka-Manipal Medical College, Manipal Academy of Higher Education (MAHE), Melaka, Malaysia

## Abstract

We being medical students have a rudimentary understanding of the metabolism and functions of Vitamin D but how well can that be translated to everyday life. We aimed to find out the knowledge, attitude and perception about Vitamin D, its deficiency and management amongst undergraduate medical students. A cross-sectional study was conducted amongst fourth- and fifth-year clinical phase medical students of Melaka Manipal Medical College. An online questionnaire was distributed via google forms and a total of 110 total responses were collected. The data was then analyzed statistically using Epi info software version 7.2.4.0. Unpaired T-test, ANOVA, $X^2$ and logistic regression tests were used to analyze the data. The findings show that 82.73% of participants obtained a low knowledge score. A massive 91.82% participants obtain their Vitamin D information via university lecture classes. In regard to, to attitude, the majority of participants 67.27% have a poor attitude towards sunlight exposure. 71.82% of participants do not take a vitamin D supplement. This study shows that there is a significant association (P-value= 0.030) between race of participant and the attitude towards sunlight exposure. A significant positive association was established between the presence of a history of familial Vitamin D deficiency with the consumption of Vitamin D supplements (OR=16.23, 95% CI=2.96-88.93, P-value <0.001, $X^2$ value=14.97). However, there was no association between the year of study and the knowledge of participants. In summary, it is clear that both Knowledge and attitude of participants are clearly underwhelming. The perception of participants towards Vitamin D is very low. Thus, it is clear that we make the recommendation to the institute to emphasize and increase student participation in relation towards said students knowledge of Vitamin D and its deficiency so that when said students become practitioners of medicine they will not miss a diagnosis of Vitamin D deficiency.

## Keywords

Knowledge, Attitudes, Perception, Practice, Vitamin D Deficiency, Medical Students

Received: January 27, 2021 / Accepted: April 28, 2021 / Published online: May 15, 2021



## 1. Introduction

In the past few decades, Vitamin D has taken the spotlight when in regard to research regarding vitamins. [1] Understandably so because vitamin D has been shown to play a role in bone and calcium metabolism based on already established literature. [2-4] Rickets and osteomalacia are the classical clinical manifestations of Vitamin D deficiency but recently, non-musculoskeletal conditions such as metabolic syndrome, autoimmune disorders, and even cancer are attributable to vitamin D deficiency. [1] A deficiency of vitamin D is also seen to be related to the molecular mechanisms that lead to Diabetes and cardiovascular risk. [2] Globally it has been shown that Vitamin D deficiency is a global public health problem regardless of age group. [12]

* Corresponding author
E-mail address: shalini.1999@yahoo.com (S. Krishnappan)

There is a prevalence of Vitamin D deficiency in countries with low latitude, which was thought to have sufficient synthesis of Vitamin D by exposure of type B ultraviolet radiation that is present abundantly in sunlight exposure. [4-8] Low vitamin D levels have been detected in 1 billion people worldwide regardless of ethnicity or age group. [3] Malaysia is no exception to these numbers; the estimated value of Malaysia suffering from vitamin D deficiency (<20 ng/ml) is 67.4% of adults and a range of 47-75% for children. [3, 7, 9] A few major reasons for the worldwide spread of this nutritional disorder has been lack of awareness about the importance of vitamin D, its health benefits, and prevention of deficient states across populations. [9-11, 45]

Awareness about the importance of vitamin D in maintaining normal physiology as well as the effects of its deficiency is very essential to prevent the widespread of disorders that occur as a result of the deficiency. [13] Various efforts can be made in order to bring this awareness. For instance, in the community level, campaigns about vitamin D can be organized for both low and high-risk populations. [14] Besides that, the younger generation can be provided with primary education to cultivate positive health behaviors from a young age. [15]

Setting aside the awareness targeted towards the community and younger generations, there is no doubt that medical students, in other words, doctors of tomorrow play a crucial role in raising awareness about vitamin D deficiency. [16] These future doctors should be well informed and knowledgeable in order to be able to educate the general population who are not in the medical field. [6] The soon-to-be medical practitioners could influence the formation of beliefs and social norms about health, and behaviours that promote health as well as the progression of impending policy development and health education programs. [18] Thus, medical students should be the target for introducing such long-term changes. [17]

Previous research findings suggests that the rate of awareness amongst medical students has been overwhelmingly low. [16] Jain et al. (2011), found that less than 50% of the health visitors and even lesser midwives regularly advised vitamin D supplementation to their patients. [19] In addition, even general practitioners (GPs) were oblivious about different aspects of supplementation. [19] Moreover, common knowledge gaps were present in both the general population and healthcare professionals, and this was said to act as an obstacle in the prevention of the deficiency of vitamin D. [20]

In Malaysia, most researches focused on the prevalence and factors that alter vitamin D levels. [3, 21-25] Only two studies have been done regarding knowledge, attitude and perceptions of vitamin D deficiency and that too, the target population was the general public and Malay female office workers respectively. [26-27] It is important to have a better understanding of medical student's knowledge, attitudes and perceptions towards a healthy lifestyle in order to design constructive and targeted health promotion programs. [28-29] Thus, this study is an attempt to sensitize medical students early in their training and demonstrate gaps in basic knowledge related to the epidemic of vitamin D deficiency and its management. This study shall exhibit the relationship between the semester of the medical degree programme and knowledge about vitamin D.

# 2. Methodology

## 2.1. Study Design, Time, Setting & Study Population

An analytical type of cross-sectional study was conducted from December 2020 until January 2021. The study population consisted of 650 Malaysian and International undergraduate medical students who were studying in the clinical years in Melaka-Manipal Medical College (MMMC), Malaysia.

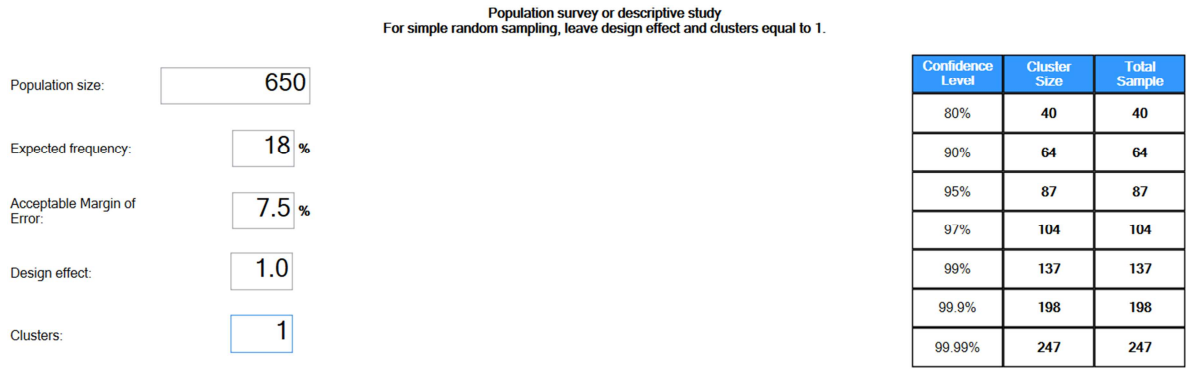


**Figure 1.** Calculation of minimal sample size.

## 2.2. Sample Size

After reviewing previous research regarding knowledge, attitude and perception of vitamin D of medical undergraduates in India, we arrived at an expected frequency

of 18%. In the Indian study, only 18% of the students were aware of the correct serum levels of vitamin D that indicate deficiency and insufficiency of vitamin D. [30] Using "Epi Info" version 7.2.4, taking into account our population of 650, confidence level at 95%, confidence limit at 7.5% and expected frequency of 18%, we got a sample size of 87.

After adjusting non-response of 20%, we then came to a final sample size of 109 using the formula below.

$$\text{n final} = \frac{\text{n population}}{1 - \text{non response\%}} = \frac{87}{1 - 0.2} = 108.75 = 109$$

## 2.3. Sampling

Purposive sampling was used. The inclusion criteria are students of Melaka Manipal Medical College who are pursuing bachelor of Medicine and Bachelor of Surgery (MBBS), these students must be in their clinical phase of the MBBS degree, above 18 years of age as well as participate voluntarily in this study and give their informed consent. The exclusion criteria are students who did not complete all compulsory questions, MBBS students who are in their preclinical phase, students of Bachelor of Dental Surgery degree (BDS) and Foundation of Science (FIS) students.

## 2.4. Data Collection

The data was collected through an online questionnaire for which Google form was used. The questionnaire had eight sections with a total of 35 questions. The first section embodied informed consent. Second section included demographic data such as age, gender, nationality, race and skin type based on the Fitzpatrick scale [31]. Third section had 15 questions to assess knowledge regarding vitamin D and its deficiency [30]. Section 4 contained 8 questions to assess the students' attitudes towards sun exposure [31]. The next section, section 5, was about attitudes towards vitamin D. The questions in this section assessed the concern of the patient regarding his or her own blood vitamin D levels [31]. Questions in section 6 focused on perceptions about food fortification and supplementation [31]. Section 7 and 8 had questions based on the answer to whether or not the student took a vitamin D supplement. Section 7 contained questions for students who took vitamin D supplements whereas section 8 contained questions for students who did not consume vitamin D supplements.

## 2.5. Data Processing & Data Analysis

The data was collected from the distributed questionnaires using Google forms and processed on Microsoft Excel. Qualitative data in our study included gender, nationality, race, semester, skin colour, source of vitamin D information, family history, past history of vitamin D levels being tested, consumption of vitamin D supplements by students and perceptions about vitamin D. These data were analyzed by deriving the frequency and percentage. Quantitative data in our study such as age, knowledge score and attitudes score were analyzed by calculating the mean and standard deviation (SD).

For the knowledge related questions, each correct response was scored "1" while each incorrect response was scored "0". The scores were then converted into percentage. The minimum possible score for the knowledge domain was 0 (0%) while the maximum possible score was 15 (100%). For the attitude related questions, the participants were scored 1, 2 and 3 respectively based on their response "disagree", "unsure" and "agree".

Level of significance was set at P=0.05. Unpaired t-test and ANOVA was used to assess the association between the independent variables (demographic variables and family history of vitamin D deficiency) and dependent variables (knowledge scores and attitude scores). Chi square was used to assess the association of the independent variables with the practice of vitamin D consumption. ANOVA was used to analyze the association between skin colour and attitude score about vitamin D. Lastly, Chi square was used to assess the association between skin colour and attitude when spending time outdoors in the sun. Odds ratio was then used to associate between the independent and dependent variables wherever applicable.

**Table 1.** Variables and statistical tests used in data analysis.

| Independent Variable | Dependant Variable | Statistical Test |
|---|---|---|
| Gender | Knowledge about Vitamin D, its Deficiency, and Management | Unpaired t-test |
| Nationality | Knowledge about Vitamin D, its Deficiency, and Management | Unpaired t-test |
| Race | Knowledge about Vitamin D, its Deficiency, and Management | ANOVA |
| Semester of MBBS Study | Knowledge about Vitamin D, its Deficiency, and Management | ANOVA |
| Family History of Vitamin D deficiency | Knowledge about Vitamin D, its Deficiency, and Management | Unpaired t-test |

| Independent Variable | Dependant Variable | Statistical Test |
|---|---|---|
| Gender | Attitudes towards Vitamin D | Unpaired t-test |
| Nationality | Attitudes towards Vitamin D | Unpaired t-test |
| Race | Attitudes towards Vitamin D | ANOVA |
| Semester of MBBS Study | Attitudes towards Vitamin D | ANOVA |
| Skin Colour | Attitudes towards Vitamin D | ANOVA |
| Family History of Vitamin D deficiency | Attitudes towards Vitamin D | ANOVA |

| Independent Variable | Dependant Variable | Statistical Test |
|---|---|---|
| Gender | Perceptions & Practice about Vitamin D | Chi Square test |
| Nationality | Perceptions & Practice about Vitamin D | Chi Square test |
| Race | Perceptions & Practice about Vitamin D | Chi Square test |
| Family History of Vitamin D deficiency | Perceptions & Practice about Vitamin D | Chi Square test |

| **Independent Variable** | **Dependant variable** | **Statistical test** |
|---|---|---|
| Knowledge about Vitamin D, its Deficiency, and Management | Practice about Vitamin D | Logistic Regression |

### 2.6. Ethical Consideration

All participants participated voluntarily after informed consent was obtained. Incentives were not offered to the participants of the study. The participants were allowed to withdraw at any time without providing any reason. Their identity was kept anonymous. All data collected was kept confidential. The research was conducted ethically after approval from the Research Ethics Committee, Faculty of Medicine, Melaka Manipal Medical College, Malaysia.

## 3. Results

A total of 110 valid responses were obtained by the end of the data collection period. The participants were aged between 21 to 26 years. Mean age was 22 years. 69 participants were female (62.73%) while 41 were male (32.27%). 90% of our participants were Malaysians while 10% were International participants. Most responses were obtained from Indian participants (42.73%) followed by Chinese participants (32.73%), others (16%) and lastly Malays (10%). Students from semester 6 and semester 7 most actively participated in our study. We received 40 responses from semester 6 students (36.36%) and 48 responses from semester 7 students (43.64%). 1 semester 8 student (0.91%), 12 semester 9 students (10.91%) and 9 semester 9 students (8.18%) also participated in our study. In terms of skin colour, most participants had medium, between white to moderate brown skin colour (40%). 4 participants had light or pale white skin colour (3.64%), 31 had white, fair skin colour (28.18%), 21 had moderate brown skin colour(19.09%), 8 had brown or dark brown skin colour (7.27%) and 2 had very dark brown to black, black skin colour (1.82%) respectively. The demographic details of the participants are summarized in table 2.

**Table 2.** Demographic details of the participants of the study (n=110).

| **Variables** | **Frequency (%)** |
|---|---|
| Age | |
| 21 - 23 | 97 (88.18) |
| 24 - 26 | 13 (11.82) |
| Gender | |
| Male | 41 (32.27) |
| Female | 69 (62.73) |
| Nationality | |
| Malaysian | 99 (90.00) |
| International | 11 (10.00) |
| Race | |
| Malay | 11 (10.00) |
| Chinese | 36 (32.73) |
| Indian | 47 (42.73) |
| Others | 16 (14.55) |
| Semester of MBBS Study | |
| Semester 6 | 40 (36.36) |
| Semester 7 | 48 (43.64) |
| Semester 8 | 1 (0.91) |
| Semester 9 | 12 (10.91) |
| Semester 10 | 9 (8.18) |
| Skin Colour based on Fitzpatrick Scale | |
| Light or pale white - Always burns, never tans | 4 (3.64) |
| White, fair - Usually burns, tans with difficulty | 31 (28.18) |
| Medium, between white to moderate brown - Moderately burns, moderately tans | 44 (40.00) |
| Moderate brown - Rarely burns, tans more than average | 21 (19.09) |
| Brown, dark brown - Rarely burns, tans very easily | 8 (7.27) |
| Very dark brown to black, black - Never burns, tans | 2 (1.82) |

**Table 3.** Knowledge of medical students about Vitamin D, its deficiency and management.

| Question | Correct Response frequency (%) |
|---|---|
| Status of vitamin D deficiency in Malaysia | 14 (12.73) |
| High risk groups for vitamin D deficiency | 67 (60.91) |
| Problems associated with vitamin D deficiency | 84 (76.36) |
| Sources of vitamin D | 15 (13.64) |
| Adequate sun exposure to achieve sufficient vitamin D levels in Malaysia | 32 (29.09) |
| Minimum amount of sun exposure required for synthesis of vitamin D in Malaysia | 55 (50) |
| Recommended Daily Allowance (RDA) of vitamin D for adults aged 19-50 | 60 (54.55) |
| Recommended form of vitamin D supplement for nutritional deficiency? | 56 (50.91) |
| Active biochemical form of vitamin D | 51 (46.36) |
| Indicate Vitamin D serum levels at their insufficiency and deficiency levels in an adult | 34 (30.91) |
| Dose regime of vitamin D3 recommended for treatment of vitamin D deficiency | 45 (40.91) |
| Biochemical form of vitamin D most commonly associated with hypercalcemia and hypervitaminosis | 74 (67.27) |
| Are calcium supplements required for all in treatment of vitamin D deficiency | 40 (36.36) |

Table 3 contains the percentage of correct responses received for each question that assessed vitamin D knowledge. When asked about the status of vitamin D deficiency in Malaysia, 12.73% of the participants responded correctly. When asked about high-risk groups for vitamin D deficiency, 60.91% responded correctly. For the problems associated with vitamin D deficiency, 76.36% answered correctly. For the sources of vitamin D, 13.64% of the participants answered correctly. When asked about the adequate sun exposure to achieve sufficient vitamin D levels in Malaysia, 29.09% of the participants answered correctly. 50% of the participants answered correctly when asked about the minimum amount of sun exposure required for synthesis of vitamin D in Malaysia. When asked about the recommended Daily Allowance (RDA) of vitamin D for adults aged 19-50, 54.55% answered correctly. 50.91% of the participants answered the recommended form of vitamin D supplement for nutritional deficiency correctly. When asked about the active biochemical form of Vitamin D, 46.36% got it right. When asked to choose the correct levels of Vitamin D serum levels which indicates insufficiency and deficiency levels in an adult from multiple options, 30.91% chose the right answer. For the question of the dose regime of vitamin D3 recommended for treatment of Vitamin D deficiency 40.91% choose the right answer. When asked about the biochemical form of Vitamin D which is most commonly associated with hypercalcemia and hypervitaminosis, 67.27% of the participants chose the right answer. For the question, "Are calcium supplements required for all in treatment of Vitamin D deficiency?", 36.36% chose the right answer.

**Table 4.** Summary of knowledge levels of medical students about Vitamin D, its deficiency and management.

| Variable | Frequency (%) |
|---|---|
| High | 0 (0) |
| Moderate | 19 (17.27) |
| Low | 91 (82.73) |

Table 4 contains the summary of knowledge levels of the medical students in our study. When the knowledge scores were grouped into 3 categories of low, moderate and high, 82.73% of the participants obtained low scores, 17.27% obtained moderate scores and no participants obtained high scores. The mean knowledge score of the participants who filled our questionnaire 43.85% with a standard deviation of 15.01%.

**Table 5.** Sources of Vitamin D Information & Family History of Vitamin D Intake.

| Variables | Frequency (%) |
|---|---|
| Source of Vitamin D Information [A] | |
| University lecture classes | 101 (91.82) |
| Health professionals (doctor, nurse, dietician, nutritionist) | 28 (25.45) |
| Media (TV, newspaper, radio, internet, magazine) | 49 (44.55) |
| Books | 30 (27.27) |
| People around | 2 (1.82) |
| Family History of Vitamin D Deficiency | |
| Present | 9 (8.18) |
| Absent | 62 (56.36) |
| Have you ever had your Vitamin D levels tested? | |
| Yes | 14 (11.9) |
| Unsure | 3 (2.5) |
| No | 101 (85.6) |
| Why did you get your Vitamin D levels tested? | |
| Healthcare professional advised me to | 20 (57.1) |
| Concerned about levels | 12 (34.3) |
| Friend or family advised it | 1 (2.9) |
| Others | 11 (31.40) |

[A] multiple response question

Table 5 contains the information about the source of vitamin D information of the participants and the presence or absence of family history of vitamin D deficiency. The participants had filled in multiple responses for the question about the source of vitamin D information. Out of 110 participants, 101 mentioned that they received the information from university lecture classes (91.82%). The second most common source of the information was media (44.55%). Students also mentioned that they received information from health professionals (24.45%), books (27.27%) and people around (1.82%)

Most participants claimed that there was no history of vitamin D deficiency in their family (56.56%). Only 9 participants had family history of the deficiency (8.18%) and

39 participants mentioned that their family members had never gotten their vitamin D levels checked in the past (8.18%). When questioned whether they had ever had their vitamin D levels tested, 85.8% did not, 11.9% said yes, and 2.5% were unsure. Of the 14 who mentioned that they had their vitamin D levels tested (11.9%), 57.1% did it because a healthcare professional advised them to, 34.3% were concerned about their Vitamin D levels, 31.4% chose others reasons and 2.9% did it because their friend or family advised them to.

**Table 6.** Attitudes towards sun exposure and attitudes towards vitamin D.

| Questions | Frequency (%) |
|---|---|
| Those with darker skin pigmentation are more at risk of Vitamin D insufficiency | |
| Agree | 35 (30.17) |
| Unsure | 36 (31.03) |
| Disagree | 45 (38.79) |
| Skin pigmentation affects Vitamin D status | |
| Agree | 65 (56.03) |
| Unsure | 34 (29.31) |
| Disagree | 17 (14.66) |
| If I regularly protect my skin from the sun, I may be in danger of not getting enough Vitamin D | |
| Agree | 41 (35.34) |
| Unsure | 45 (38.79) |
| Disagree | 30 (25.86) |
| Attitudes towards Vitamin D | |
| Are you concerned that your vitamin levels are too low? | |
| Agree | 24 (20.69) |
| Unsure | 22 (18.97) |
| Disagree | 70 (60.34) |

**Table 7.** Attitudes and practices related to sunlight exposure.

| Questions | Frequency (%) |
|---|---|
| When spending time outdoors in the sunlight do you usually | |
| Seek direct sun | 11 (9.91) |
| Shade | 58 (52.25) |
| Cover-up or wear clothing | 37 (33.33) |
| Do not go outside | 5 (4.50) |
| If you chose to cover up, how do you cover up | |
| Minimal coverage | 8 (11.94%) |
| Moderate coverage | 36 (53.73) |
| Maximal coverage | 23 (34.33) |
| Total coverage | 0 |
| When exposed to sunlight, how often do you wear sunscreen protection Never | 23 (22.12) |
| Rarely | 27 (25.96) |
| Usually | 22 (21.15) |
| Always | 22 (21.15) |
| Sometimes | 5 (4.81) |
| Only for planned exposure/tanning | 5(4.81) |
| How many days per week on average do you spend outdoors? | |
| 1-3 | 49 (44.14) |
| 4-6 | 41 (45.84) |
| 7 | 21 (18.92) |
| On these days of daylight exposure, how long on average would you spend outside each day | |
| <1 hour | 35 (31.53) |
| 1-3 hours | 67 (60.36 |
| 4-6 hours | 8(7.21) |
| >7 hours and more | 1 (0.9) |

Table 6 shows the attitude that the participants show towards sun exposure and Vitamin D among undergraduate medical students. There was an even spread of 30.17% for Agree, 31.03% Unsure and 38.79% for Disagree when the question of whether those with darker skin pigmentation are more at risk of Vitamin D insufficiency. When asked if skin pigmentation affects Vitamin D status most of the participants (56.03%) agreed, 29.31% were unsure and 14.66% disagreed. When asked if protecting their skin from the sun would endanger them to getting low vitamin D levels a majority were unsure (38.79%), whereas 35.54% agreed and 25.86% disagreed. When the participants were asked if they were concerned about their vitamin levels being too low, 60.34% said no, 20.69% chose yes and 18.97% were unsure.

**Table 8.** Perceptions to food fortification and supplementation.

| Questions | Frequency (%) |
|---|---|
| There is harm in taking fortified foods | |
| No | 60 (54.55) |
| Unsure | 30 (27.27) |
| Yes | 20 (18.18) |
| Reason why fortified food consumption is harmful [A] | |
| Fear of vitamin overdose | 11 (30.56) |
| Lack of choice | 11 (30.56) |
| Other | 14 (38.89) |
| Willingness to purchase/consume fortified foods | |
| Willing | 63 (57.27) |
| Not willing | 20 (18.18) |
| Unsure | 27 (24.55) |
| Consumption of vitamin D supplement | |
| No | 78 (71.82) |
| Yes | 31 (28.18) |

[A] multiple response question

Table 7 contains the data pertaining to the attitudes and practices to sunlight exposure. When asked about what they do when spending time outdoors in the sunlight, they replied with finding shade (52.25%), cover-up or wear clothing (33.33), seeking direct sun (9.91%) and not going outside (4.50%). Of the 33.33% who chose to cover up or wear clothing, 53.73% chose moderate coverage, 34.33% chose maximal coverage, 11.94% chose minimal coverage and nobody chose total coverage. when asked about the frequency of wearing sunscreen when exposed to sunlight, 25.96% stated they rarely wear sunscreen, 22.12% stated that they never wear sunscreen and there is an even distribution of 21.15% for both groups of Usually and Always wearing sunscreen. The same can be said for the groups of sometimes and only for planned exposure/tanning which is 4.81%. When asked about the number of days per week spent outdoors, 45.84% stated that they spend 4-6 days outdoors, 44.14% spent 1-3 days outdoors whereas 18.92% spent 7 days outdoors. To further expand on this question, we asked about the average duration spent outdoors each day under broad daylight. 60.36% stated that they spend 1-3 hours, 31.53% spent less than 1 hour, 7.21% spent 4-6 hours and 0.9%

spent 7 and more hours in daylight outside each day.

Table 8 contains data about the 4 questions about perceptions of food fortification and supplementation. Among 110 participants, 54.55% agree that there is no harm in taking fortified foods, 27.27% are unsure if taking fortified foods is harmful and 18.18% agree that taking fortified foods is harmful. 11 participants think that fortified food consumption is harmful because it could lead to vitamin D overdose while another 11 participants feel that there is a lack of choice. Apart from the suggested reasons in the questionnaire, 38.89% have selected the "other reasons" option for the same question. Most participants are willing to purchase or consume fortified foods (52.27%), 18.18% are not willing to purchase or consume fortified foods and 24.55% are unsure if they would or would not like to purchase or consume fortified foods. When asked if the participants consume vitamin D supplements, 71.82% mentioned that they do not consume the supplement while 28.18% mentioned that they do consume the supplement.

**Table 9.** Practice of incorporating Vitamin D into the diet.

| Questions | Frequency (%) |
|---|---|
| Reason for taking Vitamin D | |
| Friend and/or family advised me | 7 (19.36) |
| Good for my health | 28 (90.34) |
| I don't think I get enough from food | 14 (45.17) |
| Healthcare professional advised me too | 9 (29.04) |
| I don't think I get enough sun exposure | 15 (48.4) |
| Updated guidelines recommended me | 2 (6.46) |
| Type of vitamin D supplementation taken | |
| Cod liver oil | 10 (32.26) |
| Combined vitamin D | 5 (16.13) |
| Calcium tablet | 5 (12.9) |
| Multivitamin | 17 (54.84) |
| Vitamin D capsule | 3 (9.69) |
| Vitamin D oil | 12 (38.72) |
| Frequency of vitamin D supplement consumption | |
| Daily | 14 (45.16) |
| I don't know | 5 (16.13) |
| Less than weekly | 5 (16.13) |
| Weekly | 7 (22.58) |
| Awareness of vitamin D dosage from each supplement taken | |
| Yes | 23 (74.19) |
| No | 8 (25.81) |
| Specify dosage of vitamin D from the supplements | |
| 200 IU | 1 (20) |
| 1000 IU | 4 (80) |
| Reason for not taking Vitamin D | |
| I don't think it's important | 15 (18.48) |
| I don't know which one I should take | 15 (18.49) |
| I don't know how I can get them | 4 (4.92) |
| I think I get enough | 48 (59.24) |
| Too expensive | 4 (4.92) |
| Unaware of the benefits of taking them | 12 (14.79) |
| Others | 12 (14.81) |

Table 9 discusses the medical students' practices about incorporating vitamin D in their diet. 90.34% of participants know that vitamin D is good for their health. The lowest score for why Vitamin D is taken is due to the recommendation from the updated guidelines (6.46%). Following friends' or family's advice, 19.36% out of 110 participants take vitamin D. 29.04% of participants take it because of advise by health professionals. On the other hand, 48.4% of the participants take vitamin D because they think they lack sun exposure. The types of vitamin D supplementation that are taken often are multivitamins (54.84%) and vitamin D oil (38.72%). Following that, 32.26% of participants consume cod liver oil. Percentage of consumption of combined vitamin D is 16.13% whereas calcium tablets is 12.9%. Vitamin D capsule has the lowest percentage of consumption as compared to other vitamin D supplementations (9.69%). Consumption of vitamin D supplements daily has been noted to be the highest when asked about frequency of vitamin D consumption. In addition, 22.58% participants take vitamin D weekly; 16.13% of participants do not take vitamin D every week and the same percentage of participants do not know how frequently they consume vitamin D. Out of 110 participants, 74.19% are aware about the vitamin D dosage from each supplement taken while 25.81% are not aware of it. Most participants, (80%), chose 1000 IU as the dosage of vitamin D from supplement while 20% chose 800 IU as the dosage of vitamin D from supplement. About the reason for not taking vitamin D, a similar percentage of participants (18.48%) think vitamin D is not important and do not know which one to take. Similarly, 12% of participants are unaware of the benefits of taking them and a similar percentage of participants also have other reasons for not taking vitamin D. 4% of the participants do not know how to get them and 4% of the participants also think it is too expensive. The highest percentage of participants (59.24%) do not take vitamin D because they think they get enough.

**Table 10.** Association between gender, race, nationality, semester of study and family history of Vitamin D deficiency towards the knowledge score.

| Independent variables | Knowledge percentage mean (SD) | Mean difference (95% CI) | P-value |
|---|---|---|---|
| Gender | | | |
| Female | 44.59 (15.53) | 2.00 (-3.88, 7.89) | 0.501 |
| Male | 42.89 (14.19) | | |
| Race | | | |
| Chinese | 41.67 (12.52) | - | 0.709 |
| Indian | 44.52 (15.21) | | |
| Malay | 44.05 (12.91) | | |
| Others | 46.63 (20.73) | | |
| Nationality | | | |
| International | 44.06(22.05) | 0.23 (-9.26, 9.73) | 0.961 |
| Malaysian | 43.82(14.17) | | |
| Year | | | |
| Year 4 (semester 6 & 7) | 43.27 (15.18) | -2.88 (-9.99, 4.22) | 0.423 |
| Year 5 (semester 8, 9 & 10) | 46.15 (14.44) | | |
| Family history of vitamin d deficiency | | | |
| No | 41.81 (14.25) | -6.05 (-16.15, 4.05) | 0.236 |
| Yes | 47.86 (13.75) | | |

Table 10 shows the association between gender, race, nationality, semester of study and family history of Vitamin D deficiency towards knowledge (percent) on Vitamin D. Female participants got a mean score of 44.59% while male got a mean score of 42.89%. 95% CI is -3.88 to 7.89 in which null value is included. P-value is 0.501 which is >0.05, therefore it is not significant. For race, others managed to score the highest, with the mean score of 46.63%, followed by Indians with the mean score of 44.52%, Malays with the mean score of 44.05% and Chinese with the mean score of 41.67%. P-value is 0.709 which is >0.05, thus, it is not significant. For nationality, International students managed to get a mean score of 44.06% while Malaysians managed to score a mean of 43.82%. The mean difference between International and Malaysian participants is 0.23. 95% CI is -9.26 to 9.73 in which null value is included. P-value is 0.961 which is >0.05, thus, it is not significant. For the year of study, participants from Year 4 managed to get a mean score of 43.27% while participants from Year 5 managed to score a mean of 46.14%. The mean difference is -2.88. 95% CI is -9.99 to 4.22 in which null value is included. P-value for the year of study is 0.423 which is >0.05, thus, it is not significant. For family history of vitamin D deficiency, participants with no family history managed to get a mean score of 41.81% while participants with family history of the deficiency managed to get a mean score of 47.86%. The mean difference is -6.05. 95% CI is -16.15 to 4.05 in which null value is included. The p-value for family history with vitamin D deficiency is 0.236 which is >0.05, therefore it is not significant.

**Table 11.** Association between gender, race, nationality, year of study and family history of Vitamin D deficiency towards the attitude about Vitamin D as well as sun exposure.

| Independent variable | Cumulative attitude mean score (SD) | Mean difference (95% CI) | P-value |
|---|---|---|---|
| Gender | | | |
| Female | 7.92 (2.19) | 0.32 (-0.53,1.16) | 0.458 |
| Male | 7.60 (2.12) | | |
| Race | | | |
| Chinese | 7.56 (1.87) | - | 0.030 |
| Indian | 7.51 (2.04) | | |
| Malay | 7.27 (2.87) | | |
| Others | 9.63 (1.82) | | |
| Nationality | | | |
| International | 9.00 (1.73) | 1.32 (-0.02,2.27) | 0.053 |
| Malaysian | 7.68 (2.17) | | |
| Year of study | | | |
| Year 4 | 6.44 (1.91) | 0.13 (-0.78,1.04) | 0.787 |
| Year 5 | 6.32 (2.03) | | |
| Do any of your family members have Vitamin D deficiency | | | |
| No | 7.69 (1.98) | -0.75 (-2.1- 0.60) | 0.272 |
| Yes | 8.44 (1.13) | | |

Table 11 shows the association between gender, race, nationality, year of study and family history of Vitamin D deficiency towards the attitude of Vitamin D as well as sun exposure. When gender was compared, females had a higher mean score of 7.92 out of 12 whereas male participants have a mean attitude score of 7.60. The 95% confidence interval (CI) is -0.53 to 1.16 with a mean difference of 0.32 and P-value of 0.458. Thus, there is no significant association between gender and attitude towards Vitamin D and sun exposure. When comparing the difference in attitude and the races of participants, the mean attitude scores and standard deviation for each race is 7.56 (1.87), 7.51 (2.04), 7.27 (2.87) and 9.63 (1.82) respectively. The P-value is 0.03, thus there is a significant association between the race of the participant and the attitude towards Vitamin D.

When comparing nationality of students, international participants obtained a mean cumulative attitude score of 9.00 (SD= 1.73) whereas Malaysian participants obtained a mean score of 7.68 (SD=2.17). The mean difference of nationality is 1.32, with a CI of -0.02 to 2.27, with a P-value of 0.053. Thus, there is no significant association between nationality and attitude towards Vitamin d as well perception of sunlight. When asked about year of study those who chose year 4 had a mean cumulative attitude score of 7.82 (SD=2.14) whereas those who chose year 5 had a mean cumulative attitude score of 7.77 (SD=2.29). The mean difference is 0.05 with a 95% CI of -0.98 to 1.07 with a P-value of 0.930. Thus, there is no significant association between year of study and attitude towards vitamin D as well as perception towards sunlight exposure. When asked about past history of Vitamin D deficiency, the participants who answered no, had a mean score of 7.69 (SD=1.98) whereas participants who answered yes had a mean score of 8.44 (SD=1.13). The mean difference is 0.75, with a CI of -2.1 to -0.6, with a P-value of 0.272. Thus, there is no significant association between the history of Vitamin D deficiency in the family with attitudes towards Vitamin D and perception towards sunlight.

**Table 12.** Analysis of the association between social demographic profile of students and knowledge with their practice of vitamin D consumption.

| Independent variables | Practice | | Odds ratio (95% CI) | Chi-square | P-value |
|---|---|---|---|---|---|
| | Yes (%) | No (%) | | | |
| Gender | | | | | |
| Female | 20 (18.18) | 49 (44.55) | 1.11 (0.47 –2.64) | 0.06 | 0.808 |
| Male | 11 (10) | 30 (27.27) | | | |
| Race | | | | | |
| Malay (reference) | 2 (1.82) | 9 (8.18) | | | |
| Chinese | 9 (8.18) | 27 (24.55) | 1.50 (0.27-8.28) | 0.22 | 0.640 |
| Indian | 15 (13.64) | 32 (29.09) | 2.11 (0.40-10.99) | 0.81 | 0.368 |
| Others | 5 (4.55) | 11 (10) | 2.05 (0.32-13.16) | 0.58 | 0.446 |
| Nationality | | | | | |
| Malaysian | 28 (25.45) | 71(64.55) | 1.05 (0.26-4.25) | 0.005 | 0.944 |
| International | 3 (2.73) | 8 (7.27) | | | |
| Family history | | | | | |
| Yes | 7 (6.36) | 2 (1.82) | 16.23 (2.96-88.93) | 14.97 | 0.0001 |
| No | 11 (10) | 51 (46.36) | | | |
| Knowledge | - | | 0.9820 (0.9731-0.9909) | - | 0.0001 |

Table 12 shows the analysis of association between students' socio demographic profile and their practice of vitamin D consumption. There is a positive association between gender and practice of vitamin D consumption. Female students are 1.11 times more likely to consume vitamin D compared to male students. P-value is 0.808 which is > 0.05 (level of significance) and 95% CI for odds ratio is ranged from 0.47 to 2.64 in which null value is included. Thus, the association between gender and vitamin D consumption is not significant. When it comes to ethnicity, Chinese, Indians and others were 1.50 (95% CI for OR 0.27 to 8.286; P-value: 0.640), 2.11 (95% CI for OR 0.40 to 10.99; P-value:0.368) and 2.05 (95% CI is 0.32 to 13.16; P-value: 0.446) times more likely to have better practice than Malay respondents. In terms of nationality, Malaysian students were 6.76 times more likely to practice vitamin D consumption (95% CI is 1.67 to 27.34; P-value: 0.003). Those having a family history of vitamin D deficiency were 16.23 times more likely to practice vitamin D consumption. There is significant association because P-value is 0.0001 which is <0.05 (significance level). 95% CI for odds ratio is ranged from 2.96 to 88.93 in which null value is not included. It is also noticed that there is a negative association between knowledge and practice of vitamin D consumption. Students whose total scores ranged between 0 to 5 are 21% less likely to have the practice of vitamin D consumption. There is no significant association between knowledge and practice of vitamin D consumption. P-value for this association is 0.594 and this is more than 0.05 (level of significance). 95% CI for odds ratio is ranged from 0.34 to 1.85 in which null value 1 is included.

**Table 13.** Analysis of the association between skin colour of students and their total scores of attitudes towards sun exposure with regards to Vitamin D.

| Independent variable | Attitude mean (SD) | P-value |
|---|---|---|
| Skin Colour (Type) [B] | | |
| 1 & 2 | 6.49 (1.70) | |
| 3 & 4 | 6.03 (1.82) | 0.394 |
| 5 & 6 | 6.60 (2.22) | |

[B] Skin colour description:

Type 1 - Light or pale white - Always burns, never tans

Type 2 - White, fair - Usually burns, tans with difficulty

Type 3 - Medium, between white to moderate brown - Moderately burns, moderately tans

Type 4 - Moderate brown – Rarely burns, tans more than average

Type 5 - Brown, dark brown - Rarely burns, tans very easily

Type 6 - Very dark brown to black, black - Never burns, tans

Table 13 shows the association between skin colour and attitudes towards sun exposure. Students with skin colour type 1 and 2 got a mean attitude score of 6.49 (SD=1.70), students with skin colour type 3 and 4 got a mean attitude score of 6.03 (SD=1.82) while students with skin colour type 5 and 6 got a mean attitude score of 6.60 (SD=2.22). The P-value was 0.394 which is >0.05 (level of significance). Therefore, there is no significant difference in attitudes towards sun exposure between students of different skin colours.

**Table 14.** Analysis of the association between skin colour of students and their attitudes towards sun exposure when spending time outdoors.

| Independent variables | Attitude when spending time outdoors in the sun (%) | | Odds ratio (95% CI) | Chi-square | P-value |
|---|---|---|---|---|---|
| | Positive n (%) | Negative n (%) | | | |
| Skin colour [B] | | | | | |
| 1 & 2 (Reference) | 3 (8.57) | 32 (91.43) | | | |
| 3 & 4 | 6 (9.23) | 59 (90.77) | 1.08 (0.25-4.63) | 0.012 | 0.912 |
| 5 & 6 | 2 (20) | 8 (80) | 2.67 (0.38-18.74) | 1.029 | 0.310 |

[B] Skin colour description: Same skin colour description as in table 13.

Table 14 shows the association between skin colour of students and their attitudes towards sun exposure when spending time outdoors. For the purpose of Chi-square calculation, students who chose to seek direct sunlight when spending time outdoors in the sun were categorized as students with positive attitude while students who chose to get shade, to cover-up skin exposed areas or to abstain from going outdoors were categorized as students with negative attitude.

Students with skin colour type 3 and 4 were 1.08 times more likely to be willing to get exposed in the sun compared to students with skin colour type 1 & 2. P-value was 0.912 which is >0.05 (level of significance). 95% CI for Odds ratio was ranged from 0.25 to 4.63 in which the null value "1" is included. Chi-square value is 0.012 which is lesser than 3.841. Therefore, there is no significant association between skin colour type 5 and 6, and attitudes towards sun exposure when spending time outdoors.

Students with skin colour type 5 and 6 were 2.67 times more likely to be willing to get exposed in the sun compared to students with skin colour type 1 & 2. P-value is 0.310 which is >0.05 (level of significance). 95% CI for Odds ratio was ranged from 0.38 to 18.74 in which null value "1" is included. Chi-square value is 1.029 which is lesser than 3.841, thus, we accept null hypothesis. Therefore, there is no significant association between skin colour type 3 and 4, and attitudes towards sun exposure when spending time outdoors.

## 4. Discussion

The objectives for this study were to assess vitamin D knowledge among medical students and the relationship between the level of education and knowledge about Vitamin D. Majority of the participants in our study obtained low knowledge scores. Minimal levels of knowledge about vitamin D had also been reported in studies conducted in Pakistan, Iran, Middle East, Lebanon as well as amongst South Asians residing in Europe. [21] This could have occurred due to the presence of conflicting information about vitamin D and lack of emphasis about the role of sun exposure in preventing the deficiency. [21] However, our results contradict with the findings of a study conducted amongst medical students in India. The participants in that setting managed to obtain high marks in the knowledge section. [30] Despite the poor levels of knowledge, university lecture classes and media were the two commonest sources of Vitamin D knowledge in our sample. The source of vitamin D information in other researches varied based on the population in which the studies were conducted in. [26, 31] In our research, the questions where the students scored low marks were "Status of vitamin D deficiency in Malaysia" and "Sources of vitamin D. For both questions, the questions were multiple response questions where the selection of any one wrong option entitled them with 0 marks.

Studies about the prevalence of vitamin D deficiency amongst various cohorts in Malaysia prove that the number of cases of vitamin D deficiency in Malaysia is on par with epidemic proportions. [3, 21, 23-25] One of these studies which was conducted on permanent teachers of government secondary schools in Kuala Lumpur found that 67.4% of their participants had vitamin D deficiency. [3] In another study, 78.9% of the 13 year old participants from 15 schools in peninsular Malaysia were found to be deficient of vitamin D. [23] In our research, only 12.72% of the participants chose the correct response for the question about the status of vitamin D deficiency in Malaysia, and this suggests that the participants are unaware of the seriousness of vitamin D deficiency in Malaysia.

According to the report by the Ministry of Health of Malaysia, foods that naturally contain vitamin D include egg yolk, cod liver oil and fatty fish such as tuna, herring, salmon, sardine, and mackerel. [21, 36] Previous studies on university students in Pakistan showed that the participants were unable to identify food and non-food sources of vitamin D accurately. [21] In our study, 40.91% of the participants correctly identified egg yolk as a source, while 38.18% and 42.73% respectively thought green leafy vegetables and milk contain significant amounts of vitamin D. Those who thought that milk is a source of vitamin D are not entirely wrong, because although it is not a natural source, at present, milk is commercially being fortified with vitamin D. [36] Similar to the findings of our study, two other studies in Malaysia, found that 32.3% and 50.3% of the participants in each study respectively misidentified vegetables as a source of vitamin D. [26, 27] When it came to non-food sources of vitamin D, direct sunlight is a good source of vitamin D while sunlight that passes through a glass is not. [30, 37, 38] However, most participants (71.82%) in our study thought otherwise, highlighting the lack of knowledge.

Similar to the previous study, half of the participants of our study knew the minimum amount of sun exposure required for vitamin D synthesis. [30] In addition, most participants (95.45%) correctly identified bone and skeletal disorders as a problem associated with the deficiency just like in the study on Indian medical students. In the Indian study, the percentage of those who managed to identify diabetes mellitus, cardiovascular diseases and cancer was comparatively lesser than in our study. [30] The Recommended Daily Allowance (RDA) of vitamin D for adults aged 19 to 50 is 600IU per day. [36] In our study,

more than half of the participants knew the correct RDA of vitamin D, while only one-third of medical students in the Indian study correctly identified the RDA of vitamin D. [30] Majority of the students managed to correctly answer the biochemical form of vitamin D most commonly associated with hypercalcemia and hypervitaminosis similarly to the previous study.

When looking at the attitude of our participants, a majority of them disagreed with the statement that those with darker skin pigmentation are more at risk of Vitamin D insufficiency whereas the minority stated that they agreed, or they were unsure. This finding is similar to that of a previous study in Malaysia, where as low as 23.1% of the participants agreed that darker skin coloured individuals took longer time to synthesize vitamin D. [27] On the other hand, when the participants in our study were asked whether skin pigmentation affects Vitamin D status, most participants agreed whereas some disagreed. This shows the lack of clarity amongst the participants in our study regarding this matter. According to many previous studies, skin colour does affect vitamin D production and people with darker skin colour are at a higher risk of developing vitamin D deficiency. [11, 21, 30, 37, 38]

Furthermore, our findings about the presence or absence of concern of having low levels of vitamin D contradicts the findings of a study amongst university students in Pakistan. [21] Half the participants in the study conducted amongst adults in the United Kingdom expressed their concern about vitamin D levels as well. [31] Our participants were less concerned compared to the participants of both studies. Another study that was conducted in United Arab Emirates to assess Vitamin D deficiency and associated factors among university students also agrees with our results that the participants have unfavorable attitudes towards Vitamin D. [32] When looking at the attitudes of the participants towards sun exposure when outdoors, only 9.91% of our participants had positive attitudes and this was comparable with the findings in previous studies. [26, 39-42] It is to be noted that even if participants in some of the studies understood the health importance of vitamin D, they disliked getting exposed to the sun. The probable reason behind this is lifestyle changes due to modernization and the increased need to conform to the current cultural trend. [39, 41] In addition, awareness about harmful effects of prolonged sun exposure such as skin cancer and skin aging could have also contributed to such attitudes amongst the participants. [39, 43] Although our study found a significant association between race and attitudes towards vitamin D, several other studies in other countries found that diversity in ethnicity did not affect attitudes towards vitamin D. [40, 44]

Overall, only 28.18% of participants consume vitamin D supplement which is in contrast with the value obtained from a study conducted in the UK (43.5%). [31] The low proportion of subjects consuming vitamin D could have occurred because most of them (59.24%) perceive that they have sufficient amounts of Vitamin D. Unfortunately, they don't realize many other factors such age, skin colour, low fat diet, magnesium deficiency can contribute to vitamin D deficiencies. [34] In this study, we found no significant association between gender, race, nationality and vitamin D supplement consumption. In contrast, a study done in USA reported that females (30.1 %) were more likely than males (23.0 %) to take supplements containing vitamin D. [33] Previously, in the year 2015, a journal published that females were associated with lower vitamin D levels and independently associated with severe vitamin D deficiency. [35] Participants in the current study were found to have significant association between family history, knowledge and vitamin D supplementation. This may be because the subjects of our study are medical students and they surely have some amount of knowledge regarding vitamin D supplementation.

This study had some limitations. Firstly, the association between education level and knowledge about vitamin D could not be assessed appropriately because of lack of participation from students of semester 8, 9 and 10. When the knowledge aspect was assessed, most of the participants seemed to obtain poor knowledge scores (82.73%), however, this could have been attributable to the unequal number of participants from each semester. Most participants in our study were from semester 6 and 7 (80%). It is to be noted that there is a possibility that these students may acquire and retain more knowledge as they progress to the higher semesters of the degree program. The response rate of the semester 8, 9 and 10 students was low (20%) because they had examinations during the time of data collection. The findings in our study are true for semester 6 and 7 students who had the greatest number of participations. However, the findings were not conclusive for students of semester 8 till 10 who participated the least. Moreover, only students of one medical college, which is Melaka Manipal Medical College were asked to participate in the study, thus, the findings of this study may not be applicable to other medical colleges with students from various other backgrounds. Our study design was analytical cross sectional study, therefore, the study could only be done at one point of time making it impossible to establish a temporal relationship between the factors that affected the student's knowledge, attitudes and perceptions about vitamin D. The causal relationship could not be reflected.

The issue of poor knowledge about vitamin D, its deficiency and management amongst medical students must be addressed and curbed at the earliest. Since most students received information about the topic via university lecture classes and media, these platforms may be targeted to attract

students to expand their knowledge further. Quizzes, competitions, interactive sessions or workshops can be organised by the university in addition to the formal education the students already receive from lecture sessions and tutorials. Students can also be encouraged to organise health promotion programmes about vitamin D as these will indirectly create interest about the topic and get the students to read up more about the issue and spread awareness to the general population. Consequently, health awareness levels and the health status of the nation can be improved as well.

## 5. Conclusion

The solution of Vitamin D issues in the future depends on the understanding of Vitamin D and the perception of it. The knowledge about Vitamin D in MMMC is (43.85). There was no significant relationship between the independent variables and knowledge. Attitude towards sun exposure and fortified foods are about equally positive and negative. The perception on food fortification and supplementation are positive in MMMC. Vitamin D deficiency is still an issue and needs to be tackled by present and future physicians.

## Acknowledgements

The completion of this research would not have been possible without the continued support and assistance of many people who participated voluntarily in our study. We are truly fortunate to have received their support throughout the duration of our study. We would like to thank the Dean of Melaka-Manipal Medical College (MMMC) and Head of Department for Community Medicine MMMC, Professor Dr Adinegara Lufti Abas, our lecturers, Professor Dr Htoo Htoo Kyaw Soe, Associate Professor, Dr Sujata Khobragade and Assistant Professor, Dr Mila Nu Nu Htay from the Department of Community Medicine, MMMC Muar Campus for providing us their invaluable suggestions and guidance throughout the course of the research. Besides them, we would like to express our gratitude to each one of the respondents for their willingness and patience to participate in our study. Also, our sincere thanks to the Research Ethics Committee, Faculty of Medicine, Melaka Manipal Medical College, Malaysia for approving our research project. Last but not the least, we would like to express our gratitude to all our friends who supported and helped us complete this project successfully.

## References

[1] Ellison DL, Moran HR. Vitamin D: Vitamin or Hormone? Nurs Clin North Am. 2021 Mar;56(1):47-57. doi: 10.1016/j.cnur.2020.10.004. Epub 2020 Dec 28. PMID: 33549285.

[2] Latic N, Erben RG. Vitamin D and Cardiovascular Disease, with Emphasis on Hypertension, Atherosclerosis, and Heart Failure. Int J Mol Sci. 2020 Sep 4;21(18):6483. doi: 10.3390/ijms21186483. PMID: 32899880; PMCID: PMC7555466.

[3] Pereira M, Ribas de Farias Costa P, Miranda Pereira E, Russoni de Lima Lago I, Marlucia Oliveira A. Does vitamin D deficiency increase the risk of obesity in adults and the elderly? A systematic review of prospective cohort studies. Public Health. 2021 Jan;190:123-131. doi: 10.1016/j.puhe.2020.04.031. Epub 2021 Jan 13. PMID: 33453688.

[4] Grant WB, Holick MF. Benefits and requirements of vitamin D for optimal health: a review. Altern Med Rev. 2005 Jun; 10(2): 94-111. PMID: 15989379.

[5] Khan AW, Zadran N, Khan A, Ishaq M, Kumar J, Ibrar A, Tahir A. Vitamin D Levels and Bone Mineral Density in Premenopausal Women Compared to Postmenopausal Women: A Multi-Centre Study From Pakistan. Cureus. 2020 Nov 11;12(11):e11439. doi: 10.7759/cureus.11439. PMID: 33324522; PMCID: PMC7732786.

[6] Tabrizi R, Moosazadeh M, Akbari M, Dabbaghmanesh MH, Mohamadkhani M, Asemi Z, Heydari ST, Akbari M, Lankarani KB. High Prevalence of Vitamin D Deficiency among Iranian Population: A Systematic Review and Meta-Analysis. Iran J Med Sci. 2018 Mar;43(2):125-139. PMID: 29749981; PMCID: PMC5936844.

[7] Mendes MM, Hart KH, Lanham-New SA, Botelho PB. Exploring the Impact of Individual UVB Radiation Levels on Serum 25-Hydroxyvitamin D in Women Living in High Versus Low Latitudes: A Cross-Sectional Analysis from the D-SOL Study. Nutrients. 2020 Dec 11;12(12):3805. doi: 10.3390/nu12123805. PMID: 33322498; PMCID: PMC7764022.

[8] Al-Yatama FI, AlOtaibi F, Al-Bader MD, Al-Shoumer KA. The Effect of Clothing on Vitamin D Status, Bone Turnover Markers, and Bone Mineral Density in Young Kuwaiti Females. Int J Endocrinol. 2019 Jun 23;2019:6794837. doi: 10.1155/2019/6794837. PMID: 31341474; PMCID: PMC6612396.

[9] Alamoudi LH, Almuteeri RZ, Al-Otaibi ME, Alshaer DA, Fatani SK, Alghamdi MM, Safdar OY. Awareness of Vitamin D Deficiency among the General Population in Jeddah, Saudi Arabia. J Nutr Metab. 2019 Mar 3;2019:4138187. doi: 10.1155/2019/4138187. PMID: 30944738; PMCID: PMC6421804.

[10] Pettifor JM, Thandrayen K, Thacher TD. Vitamin D Deficiency and Nutritional Rickets in Children [Internet]. Vitamin D (Fourth Edition). Academic Press; 2017 [cited 2020Dec24]. Available from: https://www.sciencedirect.com/science/article/pii/B9780128099636000675?via=ihub

[11] Nowreen, Nida & Hameed, Reqaya. (2019). Awareness regarding the importance of vitamin D and prevention of its deficiency among female undergraduate medical students. International Journal of Basic & Clinical Pharmacology. 8. 10.18203/2319-2003.ijbcp20191563.

[12] Palacios C, Gonzalez L. Is vitamin D deficiency a major global public health problem? J Steroid Biochem Mol Biol. 2014 Oct; 144 Pt A: 138-45. doi: 10.1016/j.jsbmb.2013.11.003. Epub 2013 Nov 12. PMID: 24239505; PMCID: PMC4018438.

[13] Qureshi AZ, Zia Z, Gitay MN, Khan MU, Khan MS. Attitude of future healthcare provider towards vitamin D significance in relation to sunlight exposure. Saudi Pharmaceutical Journal: SPJ: the Official Publication of the Saudi Pharmaceutical Society. 2015 Oct; 23 (5): 523-527. DOI: 10.1016/j.jsps.2015.01.004.

[14] Bothmer MIKV, Fridlund BIKV. Gender differences in health habits and in motivation for a healthy lifestyle among Swedish university students [Internet]. Wiley Online Library. John Wiley & Sons, Ltd; 2005 [cited 2020Dec24]. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1442-2018.2005.00227.x

[15] Edmonds ET. Osteoporosis knowledge, beliefs, and behaviours of college students: utilization of the health belief model [dissertation], Abstracts International Section A: Humanities and Social Science. 70: 2908, 2009.

[16] Geddawy A, Al-Burayk AK, Almhaine AA, Al-Ayed YS, Bin-Hotan AS, Bahakim NO, Al-Ghamdi S. Response regarding the importance of vitamin D and calcium among undergraduate health sciences students in Al Kharj, Saudi Arabia. Arch Osteoporos. 2020 Jul 23; 15 (1): 114. doi: 10.1007/s11657-020-00790-9. PMID: 32705622; PMCID: PMC7376825.

[17] Von Ah D; Ebert S; Ngamvitroj A; Park N; Kang DH; Predictors of health behaviours in college students [Internet]. Journal of advanced nursing. U.S. National Library of Medicine; [cited 2020Dec24]. Available from: https://pubmed.ncbi.nlm.nih.gov/15533084/

[18] Haase A, Phil ASD, Sallis JF, Wardle J. Leisure-time physical activity in university students from 23 countries: associations with health beliefs, risk awareness, and national economic development. Preventive Medicine [Internet]. 2004 Jul; 39 (1): 182-190. Available from: https://www.sciencedirect.com/science/article/abs/pii/S009174350400060X Subscription required.

[19] Roth, D., Al., E., Author Affiliations From the Department of Pediatrics (D. E. R., Others, J., F. P. Polack and Others, & S. S. Abdool Karim and T. de Oliveira. (2018, November 08). Vitamin D supplementation in pregnancy and lactation and INFANT Growth: Nejm. Retrieved April 03, 2021, from https://www.nejm.org/doi/full/10.1056/NEJMoa1800927

[20] Tariq A, Khan SR, Basharat A. Assessment of knowledge, attitudes and practice towards Vitamin D among university students in Pakistan. BMC Public Health. 2020 Mar 18; 20 (1): 355. doi: 10.1186/s12889-020-8453-y. PMID: 32183774; PMCID: PMC7079348.

[21] Quah SW, Abdul Majid H, Al-Sadat N, Yahya A, Su TT, Jalaludin MY. Risk factors of vitamin D deficiency among 15-year-old adolescents participating in the Malaysian Health and Adolescents Longitudinal Research Team Study (MyHeARTs). PLoS ONE [Internet]. 2018 Jul 19; 13 (7): e0200736. Available from: https://doi.org/10.1371/journal.pone.0200736

[22] Woon FC, Chin YS, Ismail IH, Batterham M, Abdul Latiff AH, Gan WY, et al. (2019) Vitamin D deficiency during pregnancy and its associated factors among third trimester Malaysian pregnant women. PLoS ONE 14 (6): e0216439. https://doi.org/10.1371/journal.pone.0216439

[23] Al-Sadat N, Majid HA, Sim PY, Su TT, Dahlui M, Bakar MFA, et al. Vitamin D deficiency in Malaysian adolescents aged 13 years: findings from the Malaysian Health and Adolescents Longitudinal Research Team study (MyHeARTs). BMJ Open [Internet]. 2016 Aug; 6 (8): e010689. doi: 10.1136/bmjopen-2015-010689.

[24] Josh Mitteldorf. (2021, March 21). Weight and Aging: A Paradox, Part 2. Retrieved April 04, 2021, from https://joshmitteldorf.scienceblog.com/2021/03/21/weight-and-aging-a-paradox-part-2/

[25] Teixeira JS, Bull Ferreira Campos A, Cordeiro A, Pereira SE, Saboya CJ, Ramalho A. Vitamin D nutritional status and its relationship with metabolic changes in adolescents and adults with severe obesity. Nutr Hosp. 2018 Aug 2;35(4):847-853. doi: 10.20960/nh.1657. PMID: 30070873.

[26] Blebil AQ, Dujaili J, Teoh E, Wong PS. KC B. Assessment of Awareness, Knowledge, Attitude, and the Practice of Vitamin D among the General Public in Malaysia. Journal of Karnali Academy of Health Sciences. 2019 Dec 11; 2 (3): 171-180.

[27] Jamil NA, Shahudin NN, Abdul Aziz NS, et al. Knowledge, Attitude and Practice Related to Vitamin D and Its Relationship with Vitamin D Status among Malay Female Office Workers. Int J Environ Res Public Health. 2019 Nov 27; 16 (23): 4735. doi: 10.3390/ijerph16234735.

[28] Green LW and Kreuter MW, Health Program Planning: An Educational and Ecological Approach, McGraw-Hill, New York, NY, USA, 4th edition, 2005.

[29] Brewster, Amanda L.; Wilson, Traci L.; Curry, Leslie A. ; Kunkel, Suzanne R. ; Achieving Population Health impacts through Health Promotion Programs Offered by Community-based Organizations, Medical Care, Volume 59, Number 3, 11 March 2021, pp. 273-279 (7), Wolters Kluwer, DOI: https://doi.org/10.1097/MLR.0000000000001492

[30] Lhamo Y, Chugh PK, Gautam SR, Tripathi CD. Epidemic of Vitamin D Deficiency and Its Management: Awareness among Indian Medical Undergraduates. J Environ Public Health. 2017; 2017: 2517207. doi: 10.1155/2017/2517207. Epub 2017 Apr 3. PMID: 28473860; PMCID: PMC5394390.

[31] O'Connor C, Glatt D, White L, Iniesta RR. Knowledge, Attitudes and Perceptions towards Vitamin D in a UK Adult Population: A Cross-Sectional Study. Int. J. Environ. Res. Public Health [Internet]. 2018; 15 (11): 2387. Available from: https://www.mdpi.com/1660-4601/15/11/2387/htm#B15-ijerph-15-02387

[32] Alaa Al Amiry, Moyad Shahwan, Vitamin D deficiency and associated factors among Ajman university students, United Arab Emirates, Obesity Medicine, Volume 17, 2020, 100176, ISSN 2451-8476, https://doi.org/10.1016/j.obmed.2019.100176

[33] Moore CE, Radcliffe JD, Liu Y. (2013). Vitamin D intakes of adults differ by income, gender and race/ethnicity in the USA, 2007 to 2010. Public Health Nutrition, 17 (4), 756–763. https://doi.org/10.1017/s1368980013002929.

[34] The Causes of Vitamin D Deficiency are Probably NOT What You Think! (n.d.). Retrieved January 25, 2021, from https://www.easy-immune-health.com/Causes-of-Vitamin-D-Deficiency.html

[35] Verdoia M, Schaffer A, Barbieri L, Giovine G, Marino P, Suryapranata H, Luca G. (2015, February 07). Impact of gender difference on vitamin D status and its relationship with the extent of coronary artery disease. Retrieved January 25, 2021, from https://www.sciencedirect.com/science/article/abs/pii/S0939475315000277

[36] Ministry of Health Malaysia. RNI Recommended Nutrient Intakes for Malaysia. Putrajaya; 2017. Available from: https://expert.taylors.edu.my/file/rems/publication/107126_3033_1.pdf

[37] Chittari V. Harinarayan, Michael F, Holick, Upadrasta V, Prasad, Palavali S, Vani, Himabindu G. Vitamin D status and sun exposure in India. Dermato-Endocrinology. 2013; 5 (1) 130-141. Referenced in doi: 10.4161/derm.23873.

[38] Institute of Medicine (US) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium; Ross AC, Taylor CL, Yaktine AL, et al., editors. Dietary Reference Intakes for Calcium and Vitamin D. Washington (DC): National Academies Press (US); 2011. 5, Dietary Reference Intakes for Adequacy: Calcium and Vitamin D. Available from: https://www.ncbi.nlm.nih.gov/books/NBK56056/

[39] Soliman A. Vitamin D deficiency: A major global epidemic that requires effective strategy and guidelines for management. Indian J Endocrinol Metab. 2016; 0 (0): 0. Referenced in doi: 10.4103/2230-8210.194345

[40] Kotta S, Gadhvi D, Jakeways N, Saeed M, Sohanpal R, Hull S, Famakin O, Martineau A, Griffiths C. "Test me and treat me"--attitudes to vitamin D deficiency and supplementation: a qualitative study. BMJ Open. 2015 Jul 14; 5 (7): e007401. doi: 10.1136/bmjopen-2014-007401. PMID: 26173717; PMCID: PMC4513450. Deschasaux M, Souberbielle JC, Partula

[41] V, Lécuyer L, Gonzalez R, Srour B, Guinot C, Malvy D, Latino-Martel P, Druesne-Pecollo N, Galan P, Hercberg S, Kesse-Guyot E, Fassier P, Ezzedine K, Touvier M. What Do People Know and Believe about Vitamin D? Nutrients. 2016 Nov 11; 8 (11): 718. doi: 10.3390/nu8110718. PMID: 27845705; PMCID: PMC5133104.

[42] Salmanpour VA, Ibrahim HS, Salameh AG, Yahya AM, Debal BK. Vitamin D deficiency: knowledge and practices among the adult population in Sharjah, United Arab Emirates. Arch Osteoporos. 2016; 11: 15. doi: 10.1007/s11657-016-0269-0. Epub 2016 Mar 30. PMID: 27026018.

[43] Almuqati, R., Alamri, A., & Almuqati, N. (2019, January 23). Knowledge, attitude, and practices toward sun exposure and use of sun protection among non-medical, female, university students in Saudi Arabia: A cross-sectional study. Retrieved April 04, 2021, from https://www.sciencedirect.com/science/article/pii/S2352647518300728.

[44] Alzaman NS, Dawson-Hughes B, Nelson J, D'Alessio D, Pittas AG. Vitamin D status of black and white Americans and changes in vitamin D metabolites after varied doses of vitamin D supplementation. Am J Clin Nutr. 2016 Jul; 104 (1): 205-14. doi: 10.3945/ajcn.115.129478. Epub 2016 May 18. PMID: 27194308; PMCID: PMC4919528.

[45] Poh BK, Rojroongwasinkul N, Nguyen BK, Sandjaja, Ruzita AT, Yamborisut U, Hong TN, Ernawati F, Deurenberg P, Parikh P; SEANUTS Study Group. 25-hydroxy-vitamin D demography and the risk of vitamin D insufficiency in the South East Asian Nutrition Surveys (SEANUTS). Asia Pac J Clin Nutr. 2016; 25 (3): 538-48. doi: 10.6133/apjcn.092015.02. PMID: 27440689.