

Knowledge attitude and practices of university students to Vitamin D and Vitamin D supplements during times of low sun exposure and post lockdown

S.S. HABIB, H.B. ALHALABI, K.S. ALHARBI, O.S. ALGHAMDI, A.I. ALGHAMDI, M.A. AJAREM, M.A. ALOARNI

Department of Physiology, College of Medicine, King Saud University, Saudi Arabia

Abstract. – OBJECTIVE: Vitamin D deficiency is prevalent in Saudi Arabia. Inability to get sun exposure greatly influences Vitamin D levels. Getting enough Vitamin D during childhood and young adulthood can prevent possible future diseases.

We aim to estimate the level of knowledge of Saudi University students about Vitamin D and Vitamin D supplements, to correlate it with their attitudes and practices to sun exposure and Vitamin D supplements and to compare between males and females.

MATERIALS AND METHODS: This is an epidemiological cross-sectional KAP study conducted at King Saud University in Riyadh. A stratified random sampling technique was used where students were randomly selected from 3 colleges and stratified to males and females. N= 767 students completed the online survey used to assess the knowledge, attitudes, and practices of the students.

RESULTS: We found that the level of knowledge of university students was moderate to low (mean equivalent to 40%) where females had better knowledge. Also, their practices are not sufficient to maintain healthy Vitamin D levels as only 8.2% stay in the sun for more than an hour during weekdays. Only 10.2% of students take regular Vitamin D supplements, where females are the more likely users. 99.1% of students stay indoors during work.

CONCLUSIONS: The knowledge about Vitamin D is low among university students but slightly higher in females and medical students. Almost all participants work indoors and most of them wear a mask whenever going out. Few students take regular Vitamin D supplements. Females agreed more they have Vitamin D deficiency and take supplements more than males.

Key Words:

Vitamin D, College, Sun, Supplements, Knowledge.

Introduction

Vitamin D deficiency, as defined by low levels of 25(OH)D in blood, is prevalent worldwide. Vitamin D deficiency or insufficiency is documented among healthy individuals in large-scale studies from all parts of the world¹. Vitamin D deficiency is especially very common in Saudi Arabia. It is estimated that 60% of Saudi population have Vitamin D deficiency².

1,25(OH)₂D is the main form of Vitamin D, which produces most of its biologic actions such as Calcium absorption and bone formation³.

It is also suggested that Vitamin D has a positive immune modulating function, which induces anti-inflammatory and anti-fibrogenic pattern in the liver⁴.

The two main forms of Vitamin D are:

1. Vitamin D₂ or Ergocalciferol, obtained from Yeast and plants.
2. Vitamin D₃ or cholecalciferol, produced in the skin from 7-dehydrocholesterol under the influence of UV irradiation, which is considered the primary source⁵.

Other good sources of Vitamin D are fish, egg yolk, and offal such as liver. Some countries fortify milk and other food with Vitamin D as well⁶.

The flesh of fatty fish (such as salmon, tuna) and fish liver oils are considered as some of the best sources⁷.

According to the Saudi Arabian Ministry of Education, in 2017-2018 the number of university students in Saudi Arabia is about 2 million⁸.

Generally, the age range of university students is between (19-26)⁹.

At this Age, maintaining a healthy Vitamin D level is essential in the prevention of bone prob-

lems including future osteoporosis, Osteomalacia and low back pain^{10,11}. It is also essential in the prevention of the development and progression of Non-alcoholic fatty liver disease (NAFLD)¹², and Colon Cancer¹³. Also, at this age group, Peak Bone Mass (PBM) is reached, which is also very important in the prevention of osteoporosis¹⁴.

Vitamin D, Calcium intake and physical activity are all essential to obtain the highest possible PBM and the lack of Vitamin D will prevent the achievement of maximum bone mass¹⁵⁻¹⁷. One of the most important times when students get to increase their Vitamin D levels is during the summer, when sunlight is available for a long time and people tend to go out on vacation a lot.

That is why, there is a 30% increase in Vitamin D levels during summer^{18,19}.

While in winter, Vitamin D levels drop due to low sun availability and the tendency to stay home due to the cold weather^{15,19}.

On some occasions, the primary source of Vitamin D (sun exposure) can be unavailable like in winter or avoided like in lockdowns and during some pandemics where there are recommendations to stay at home.

During the summer vacation of 2020, most of the world's population including Saudi population experienced a lockdown due to a novel strand of Coronavirus SARS-CoV-2^{20,21}, which was officially considered a pandemic by the World Health Organization²².

During lockdowns and certain pandemics, people are obliged to stay at their homes and never go outside²³.

This caused scarce time of sun exposure, at one of the most important times when students tend to get enough sunlight and subsequently increase their Vitamin D to a healthy level¹⁹.

Even after the lockdown is over and until the date of this study, people are still advised not to leave their home frequently and not go out and gather unless necessary or if the group is vaccinated. Also, schools and universities provided all their lectures online without the need to go out to avoid gatherings of students, which leads to scarce time of sun exposure.

Despite the importance of Vitamin D at this age group as mentioned earlier, only few studies^{18,19,24} have been conducted on them in terms of their knowledge, attitudes and practices to Vitamin D, sun exposure and Vitamin D supplements.

That is why in this research we aim to learn more about the knowledge of this age group about Vitamin D and correlate that knowledge to their attitudes and practices to sun exposure and Vita-

min D supplements especially during times of low sun availability, lockdowns and pandemics.

This might prove that it is essential to increase the attention towards education about Vitamin D and its sources and the potential risks caused by Vitamin D deficiency especially in this particular age group.

Also, it will necessitate implying education to this age group to improve their sun exposure, the consumption of Vitamin D rich food and the use of Vitamin D supplements especially in times following low sun exposure, lockdowns and pandemics.

Materials and Methods

This is an epidemiological cross-sectional KAP study designed to assess knowledge attitude and practices of Vitamin D and Vitamin D supplements during times of low sun exposure and lockdowns. It was conducted at King Saud University in Riyadh, Saudi Arabia from October 2020 to March 2021. The study is targeting university students in Riyadh males and females with a sample size of 767 students which were enrolled in this study. Stratified random sampling was chosen to compare knowledge, attitude, and practices between males and females. In order to achieve that, university students were divided into two different strata (males and females) from 3 selected colleges: College of Medicine, College of Law and Political Science and College of Computer Science.

Subjects have been drawn randomly from each of the previously selected colleges. With the aim of each college and strata to represent respectively around 1/3 and 50% of the total sample size (767)²⁴.

Only healthy subjects with no history of cancers, calcium metabolic diseases, bone disease, ongoing Vitamin D supplementation, hypertension, heart disease, pregnancy, diabetes, epilepsy, and use of anabolic/systemic steroids were accepted on this study.

A validated questionnaire consisting of 34 items^{25,26}, arranged from two available literature was used to assess knowledge, attitudes and practices towards Vitamin D across range of dimensions, including the assessment of skin color type, sun exposure, dietary knowledge about Vitamin D etc. The questionnaire consisted of 5 questions about demographics which include: gender, college, skin color type of housing and other questions, 3 questions about knowledge in which participants were assessed on the factors that affect Vitamin D production and absorption in the body,

food sources of Vitamin D, and the health benefits of Vitamin D. 7 questions about attitudes, assessed by asking participants about their level of agreement with statements. These included (a) “From a health perspective, it is important to get Vitamin D regularly”; (b) “I am prone to Vitamin D deficiency if I did not get enough sunlight” and 17 questions about practices including questions about if participants were working indoor or outdoor, time spent outside in the sun during working days and weekends, parts of the body usually exposed to the sun, number of Vitamin D tests in a year and their supplementation intake (if any). Questions were also asked about dietary intake.

The scoring system for knowledge is as follows:

- Each question will have a maximum score of 2.
- Complete answer ensures full mark and incomplete answer will get half the marks while weak answer gets no marks.
- A final score of (5-6) means strong knowledge, (2-4) Moderate knowledge, (0-1) Weak knowledge.

All data were collected in the questionnaire using a translated Arabic version. It was collected during the second wave of COVID19²⁷.

Table I. General characteristic and frequency distribution of participants (N=767).

Variables	Frequency (%)
Gender	
Male	369 (48)
Female	398 (52)
College	
College of medicine	247 (32.2)
College of political science and law	238 (31)
College of computer science	282 (36.8)
Type of housing	
Vella	642 (83.6)
Apartment	54 (7.0)
Ground floor	48 (6.3)
Student housing	19 (2.5)
Others	3 (0.4)
Missing	1 (0.1)
Skin color	
Fair or pale	268 (34.9)
Fair to beige	388 (50.6)
Light brown (Olive)	100(13)
Very dark brown	8 (1)
Dark brown	3 (0.4)
Work	
Indoors	760 (99)
Outdoors	7 (1)
Have you done Vitamin D test in the past 3 months?	
Yes	182 (23.7)
No	585 (76.3)

A pilot study of 14 subjects with reliability test was done to ensure that the translated version is clear and easy to fill. An invitation message using social media platforms, and emails was sent to the respective participants with a link to the survey.

Data were analyzed using SPSS 26.0 (IBM, Armonk, NY, USA) version statistical software. Scores and number of responses were computed using Excel. Quantitative data were expressed as mean ± S.D, while qualitative data as frequencies and percentages. Bivariate statistical analysis was carried out using appropriate (chi-square) statistical test, based on the type of study and outcome variables. Numerical data were compared by independent Student’s *t*-test for two groups and ANOVA for more than two groups. For different categories of knowledge, attitude and practices, comparisons were made based on gender, skin color, type of housing and type of college. A *p*-value of <0.05 was used to report the statistical significance and precision of results.

Results

The total participants in this study were 767 college students from King Saud University, where males constituted 52% and females 48% of the responses. Of those, 32.2% were from College of Medicine, 31% from College of Political Science and Law and 36.8% from College of Computer Science. The vast majority (83.3%) lived in Vella. Almost half of the students (50.6%) had fair to beige skin color, where the other half had mostly fair or pale skin (34.9%). Only one quarter of the students (23.7%) did Vitamin D test in the past 3 months. Almost all students (99.1%) remained indoors during their work (Table I).

The outcome of the study contains the knowledge of university students about Vitamin D.

The questions include one question about Sources, one about health benefits, and one about factors affecting Vitamin D levels where more than one answer can be chosen.

Each question was scored out of 2 and the mean of the total score out of 6 for all 3 questions was measured for males and females, and for each College of Medicine, Political Science and Law and Computer Science, and the difference in the knowledge of the students about Vitamin D according to their Gender, college, attitudes and practices towards sun exposure and Vitamin D supplements is shown in (Table II). The mean knowledge score was considered moderate

Table II. Mean score and correlation of the level of knowledge with different variables including demographics, attitudes, and practices of participants.

Variable	Mean*	p-value**	95% Confidence interval of the difference	
			Upper	Lower
Gender				
Male	2.15	<0.001	-0.275	-0.698
Female	2.64			
College				
Medicine	3.15	<0.001	2.98	3.32
law and political science	1.87		2.03	2.37
Computer Science	2.20		1.70	2.05
Total	2.4			
It is important to get sun Exposure everyday				
Agree	2.5	<0.001	0.672	0.200
Do not agree	2.06			
I think I have Vitamin D deficiency				
Agree	2.37	0.333	0.120	-0.352
Do not agree	2.48			
Time spent outdoors during the weak				
More than an hour	1.97	0.021	-0.75	-0.876
Less than an hour	2.45			
Time spent outdoors during holidays				
More than an hour a day	2.20	0.084	0.033	-0.517
less than an hour a day	2.44			
Do you take Vitamin D supplements?				
always	2.73	0.041	0.712	0.015
never	2.37			

*Score of knowledge about Vitamin D with maximum score of 6. Q1/ What are the sources of Vitamin D? Q2/ What are the health benefits of Vitamin D? Q3/ What are the factors affecting Vitamin D? **A p -value of <0.05 is considered significant.

to low (mean score= 2.4). Female students have significantly better knowledge about Vitamin D (mean score= 2.64) compared to males (mean score=2.15) ($p<.001$). Students from College of Medicine had significantly better knowledge than other colleges ($p<.001$). Students who Agreed that “it’s important to get sun exposure everyday” had significantly better knowledge (mean score=2.5) compared to those who do not agree (mean score=2.06) ($p<.001$). There was no significant difference in knowledge between those who thought that “they have Vitamin D deficiency” or not ($p=0.333$). The knowledge of those who spent less than one hour in the sun during workdays was significantly higher than those who spent more than an hour in the sun during workdays ($p=0.02$) while there was no significant difference in knowledge between those who spent more than an hour in the sun during holidays and those who spent less than an hour in the sun during holidays ($p=0.08$). Students who always took Vitamin D supplements had significantly better knowledge

about Vitamin D in comparison to those who do not take Vitamin D supplements ($p=0.04$).

The association between participants demographics and attitudes and practices is summarized in (Table III). Female students agreed significantly more ($p<0.001$) than male students that they have Vitamin D deficiency. Students at college of computer sciences agreed the most ($p<0.001$) that they have Vitamin D deficiency. Vitamin D supplements were taken significantly more ($p=0.006$) among female students compared to males. 66 students (8.2%) agreed they stay in the sun for more than an hour during weekdays. 78 students (10.2%) stated that they are taking Vitamin D supplements.

In (Table IV) more practices of university students regarding sun exposure and Vitamin D consumption are shown. Nearly two thirds (62.8%, 66.6%) of the participants consume milk and eggs respectively on regular bases, and less than quarter of the participants (18.9%) consume fish on regular bases. Almost three quarters (71.8%) of the participants wear masks whenever they go

Table III. Association between student demographics and Vitamin D attitudes and practices.

Variables	No. of respondents	Q1	p-value	Q2	p-value	Q3	p-value	Q4	p-value	Q5	p-value	Q6	p-value
Gender													
Male	369	198 (37.9%)	<0.001	299 (50.1%)	0.040	366 (48.2%)	0.780	26 (33.3%)	0.006	34 (51.5%)	0.562	67 (55.8%)	0.65
Female	398	325 (62.1%)		298 (49.9%)		394 (51.8%)		52 (66.7%)		32 (48.5%)		53 (44.2%)	
College													
Medicine	247	145 (27.7%)	<0.001	204 (34.2%)	0.9	246 (32.4%)	0.303	31 (39.7%)	0.089	18 (27.3%)	0.112	37 (30.8%)	0.450
Law and political sciences	238	167 (31.9%)		214 (35.8%)		234 (30.8%)		16 (20.5%)		28 (42.4%)		43 (35.8%)	
Computer science	282	211 (40.3%)		179 (30%)		280 (36.8%)		31 (39.7%)		20 (30.3%)		40 (33.3%)	

Values under the question columns represent number and percentages of participants with a “agree response” for Q1 and Q2, “indoors” for Q3, “Yes” for Q4 and “more than an hour” for Q5 and Q6; Pearson chi-square represents *p*-value.

Q1: I think I have Vitamin d deficiency; Q2: It is important to get sun exposure every day; Q3: Where do you work; Q4: Do you take supplements; Q5: Time spent outdoors on weekdays; Q6: Time spent outdoors in weekends. Data was compared by Chi-square test.

out. More than three quarters of the participants mentioned that their reason for avoiding sun exposure is hot weather, and less than quarter of them (18.2%) mentioned that it is because of lockdown and the recommendations to stay at home.

Discussion

Vitamin D is one of the important hormones in the body that play an important role in many metabolic functions³.

Vitamin D deficiency is a very prevalent medical problem that many people suffer from¹.

There are many epidemiological surveys conducted about Vitamin D. Our study is one of the few studies that have been conducted in our region and to our knowledge, the only study in Saudi Arabia that tests all university students' knowledge, attitude and practices toward Vitamin D especially during and post lockdown as in (Covid-19).

We also aim to fill the shortage of information about this subject.

After analyzing the results, we found that 99% of the students stay indoors. So, they are deprived of sun exposure, which is considered the major source of Vitamin D^{28,29}.

We also found that 71.8% of the students use a mask due to the Covid-19 pandemic which also may contribute to Vitamin D deficiency.

We estimated the level of knowledge about Vitamin D and expected that the level of knowledge would be high but based on our result it was weak and significantly less than what we expected, and this is supported by a study conducted in Canada, which showed poor knowledge about Vitamin D among university students²⁴.

We also thought that females will have better knowledge than males and it was supported in our results as statistically significant.

The reasons that may contribute to these findings vary, the lack of education about Vitamin D during school may contribute the most. Also, not enough campaigns about Vitamin D are targeting university students, and social media lacks awareness about Vitamin D but awareness about Vitamin D among university students can still be raised by taking adequate measures.

We found that only 9.2% of the males get more than an hour of sun exposure during weekdays which was almost similar to females. This was supported by another study conducted in a nearby country²⁵, which showed that both males and fe-

males have the same duration of exposure to sun during weekdays.

Most of the student in college of Computer Sciences agreed that they have Vitamin D deficiency which we think is because they use computers indoors in most of their time, in addition to the lockdown.

Despite high concerns about being Vitamin D deficient, only 10.2% of the participants take Vitamin D supplements, but among those who reported taking it, female students were more likely the users of supplements. This can be due to the better knowledge about Vitamin D that females have compared to male.

University students are expected to be aware of Vitamin D importance, especially students at College of Medicine who had the highest level of knowledge among other colleges in our study. This is logically accepted as they probably have material concerning Vitamin D in their curriculum unlike other colleges.

Based on our findings only 23.7% did Vitamin D test during the past three months. This shows to be higher compared to another study conducted on medical students which showed that only 5.5% did recent Vitamin D test³⁰. This shows that students may have more attention about the risk of having Vitamin D deficiency following quarantine. Theoretically, that may indicate a good knowledge.

We hypothesized that half of the participants are not taking Vitamin D supplement.

In fact, our result is significantly below our estimation by a large margin, this can be attributed to the lack of knowledge and possibly avoiding visiting clinics during Covid-19 pandemic.

The low level of knowledge among university students can be an important factor explaining why more than 60% of Saudi population has Vitamin D deficiency². Our results highly support the association between knowledge toward Vitamin D and Vitamin D deficiency. We believe that the results obtained from our study are applicable to the general population, as more than two-thirds of the population in Saudi Arabia are of those below the age of (34)³¹, and since university students who are considered a highly educated part of the community showed a lack of knowledge about Vitamin D, we expect the general population to have an even further deficit in that regard which can be threatening to their health.

The association between participants' demographic and attitudes showed that females expect that they have a Vitamin D deficiency more than

Table IV. Number of subjects with dietary and lifestyle practices in population studied.

Questions of practice	No. of respondents (%)
Which of the following is part of your diet?	
Milk	482 (62.8)
Butter	127 (16.5)
Eggs	511 (66.6)
Oily fish (salmon, tuna, sardine)	115 (18.9)
Liver	76 (10.16)
Which of the following did you wear when going out?	
Wear a cap, scarf or hat	315 (41.1)
Wear a shirt with long sleeves	347 (45.2)
Wear sunglasses	272 (35.5)
Wear a mask	551 (71.8)
Use umbrella for sun protection	6 (0.8)
Why didn't you leave the house?	
Hot weather	603 (78.6)
Indoor lifestyle	309 (40.2)
Cosmetic reasons (e.g., to avoid skin tanning)	214 (27.9)
Fear of skin cancer	65 (8.5)
Lack of time	281 (36.6)
Lockdown	140 (18.2)

Values under responses column represent number and percentages of participants (percentages may not add to 100% since a participant may choose more than one option).

males. This is accepted in our society because of conservative female clothes.

Fish is an important source of Vitamin D yet participants documented low consumption of it, so it should be added to their diet as it also has a cardioprotective role³².

Many students still reported that the main reason that makes them refrain from leaving the house is hot weather even when responses were collected during autumn while only few mentioned recommendations to stay at home as a reason. This shows how much the weather is affecting the practices of Saudi population toward sun exposure therefore, Vitamin D supplements may be a good alternative in that population.

Conclusions

Our study concludes that the knowledge about Vitamin D is low among all university students but slightly higher in females and medical students. Almost all participants are working indoors and most of them even wear a mask whenever going out. Very few students take regular Vitamin D supplements. Females agreed more they have Vitamin D deficiency and take supplements more than males.

More education about Vitamin D should be provided to all students from elementary to university

students. Education through health campaigns, TV and social media about Vitamin D and Vitamin D supplements is also recommended to all as it will increase community awareness about health acts associated with Vitamin D. Students are urged to measure their Vitamin D levels and keep it at a healthy level by potentially using supplements especially following the lockdown period.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgment

This work was supported by the College of Medicine Research Center, Deanship of Scientific Research, King Saud University, Riyadh, Saudi Arabia.

Authors' Contributions

Conceptualization, Syed Shahid Habib, Hashem Alhalabi, Khalid Alharbi, Omar Alghamdi, Mohammad Ajarem, Abdullah Alghamdi and Mohammad Alqarni; Data curation, Hashem Alhalabi, Khalid Alharbi, Omar Alghamdi, Mohammad Ajarem, Abdullah Alghamdi and Mohammad Alqarni; Formal analysis, Syed Shahid Habib, Hashem Alhalabi, Omar Alghamdi, Mohammad Ajarem and Abdullah Alghamdi; Investigation, Hashem Alhalabi, Khalid Alharbi, Omar Alghamdi, Mohammad Ajarem, Abdullah Alghamdi and

Mohannad Alqarni; Methodology, Hashem Alhalabi and Khalid Alharbi; Project administration, Syed Shahid Habib; Software, Hashem Alhalabi, Khalid Alharbi, Omar Alghamdi, Mohammad Ajarem, Abdullah Alghamdi and Mohammad Alqarni; Supervision, Syed Shahid Habib; Visualization, Syed Shahid Habib; Writing – original draft, Hashem Alhalabi, Khalid Alharbi, Omar Alghamdi, Mohammad Ajarem, Abdullah Alghamdi and Mohammad Alqarni; Writing – review & editing, Syed Shahid Habib and Hashem Alhalabi.

References

- Shah D, Gupta P. Vitamin D deficiency: Is the pandemic for real? *Indian Journal of Community Medicine*. Medknow Publications 2015; 40: 215-217.
- Al-Alyani H, Al-Turki HA, Al-Essa ON, Alani FM, Sadaat-Ali M. Vitamin D deficiency in Saudi Arabians: A reality or simply hype: A meta-analysis (2008-2015). *J Family Community Med* 2018; 25: 1-4.
- Bikle D. Vitamin D: Production, Metabolism, and Mechanisms of Action. 2017 Aug 11. In: Feingold KR, Anawalt B, Boyce A, Chrousos G, de Herder WW, Dhatariya K, Dungan K, Grossman A, Hershman JM, Hofland J, Kalra S, Kaltsas G, Koch C, Kopp P, Korbonits M, Kovacs CS, Kuohung W, Laferrère B, McGee EA, McLachlan R, Morley JE, New M, Purnell J, Sahay R, Singer F, Stratakis CA, Trencle DL, Wilson DP, editors. *Endotext* [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. PMID: 25905172.
- Barchetta I, Cimini FA, Cavallo MG. Vitamin D supplementation and non-alcoholic fatty liver disease: Present and future. *Nutrients* 2017; 9: 1015
- Lips P. Vitamin D physiology. *Progress in Biophysics and Molecular Biology*. Pergamon 2006; 92: 4-8.
- Lamberg-Allardt C. Vitamin D in foods and as supplements. *Progress in Biophysics and Molecular Biology* 2006; 92: 33-38.
- Vitamin D - Health Professional Fact Sheet [Internet]. [cited 2020 Jul 19]. Available from: <https://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/>.
- Detailed education statistics [Internet]. [cited 2020 Jul 12]. Available from: <https://departments.moe.gov.sa/PlanningDevelopment/RelatedDepartments/Educationstatisticscenter/Education-DetailedReports/Pages/default.aspx>.
- Patterns in university students' numbers 2017. Available from: <https://www.ucas.com/file/135631/download?token=jwJ7Dg4S>.
- Weaver CM, Gordon CM, Janz KF, Kalkwarf HJ, Lappe JM, Lewis R, O'Karma M, Wallace TC, Zemel BS. The National Osteoporosis Foundation's position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. *Osteoporosis Int* 2016; 27: 1281-386.
- Zadro J, Shirley D, Ferreira M, Carvalho-Silva AP, Lamb SE, Cooper C, Ferreira PH. Systematic Review Mapping the Association between Vitamin D and Low Back Pain: A Systematic Review and Meta-Analysis of Observational Studies. *Pain Physician*. 2017; 20: 611-640.
- Eliades M, Spyrou E. Vitamin D: A new player in non-alcoholic fatty liver disease? *World J Gastroenterol*. 2015; 21: 1718-1727.
- Klampfer L. Vitamin D and colon cancer. *World J Gastrointest Oncol* 2014; 6: 430-437.
- Baxter-Jones AD, Faulkner RA, Forwood MR, Mirwald RL, Bailey DA. Bone mineral accrual from 8 to 30 years of age: An estimation of peak bone mass. *J Bone Miner Res* 2011; 26: 1729-1739.
- Cheng S, Lyytikäinen A, Kröger H, Lamberg-Allardt C, Alén M, Koistinen A, Wang QJ, Suuriniemi M, Suominen H, Mahonen A, Nicholson PH, Ivaska KK, Korpela R, Ohlsson C, Väänänen KH, Tylavsky F. Effects of calcium, dairy product, and vitamin D supplementation on bone mass accrual and body composition in 10-12-y-old. *Am J Clin Nutr* 2005; 82: 1115-1126.
- Nikander R, Sievänen H, Heinonen A, Daly RM, Uusi-Rasi K, Kannus P. Targeted exercise against osteoporosis: A systematic review and meta-analysis for optimising bone strength throughout life. *BMC Med* 2010; 8: 47.
- Stagi S, Cavalli L, Iurato C, Seminara S, Brandi ML, Martino M De. Bone metabolism in children and adolescents: Main characteristics of the determinants of peak bone mass. *Clin Cases Miner Bone Metab* 2013; 10: 172-179.
- Tangpricha V, Pearce EN, Chen TC, Holick MF. Vitamin D insufficiency among free-living healthy young adults. *Am J Med* 2002; 112: 659-662.
- Shakeri H, Pournaghi SJ, Hashemi J, Mohammad-Zadeh M, Akaberi A. Do sufficient Vitamin D levels at the end of summer in children and adolescents provide an assurance of Vitamin D sufficiency at the end of winter? A cohort study. *J Pediatr Endocrinol Metab* 2017; 30: 1041-1046.
- Custodian of the Two Holy Mosques Orders Extending Curfew to Curb Spread of Coronavirus Until Further Notice The official Saudi Press Agency [Internet]. [cited 2020 Jul 12]. Available from: <https://www.spa.gov.sa/viewstory.php?lang=en&news-id=2073705>.
- Al-Qahtani AA. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2): Emergence, history, basic and clinical aspects. *Saudi J Biol Sci* 2020; 27: 2531-2538.
- Coronavirus disease (COVID-19) [Internet]. [cited 2020 Jul 12]. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>.
- Arora S, Bhaukhandi KD, Mishra PK. Coronavirus lockdown helped the environment to bounce back. *Sci Total Environ* 2020; 742: 140573.
- Boland S, Irwin JD, Johnson AM. A Survey of University Students' Vitamin D-related knowledge. *J Nutr Educ Behav* 2015; 47: 99-103.
- Aljefree NM, Lee P, Ahmed F. Knowledge and attitudes about vitamin D, and behaviors related to vitamin D in adults with and without coronary heart disease in Saudi Arabia. *BMC Public Health* 2017; 17: 266.

- 26) Tariq A, Khan SR, Basharat A. Assessment of knowledge, attitudes and practice towards Vitamin D among university students in Pakistan. *BMC Public Health* 2020; 20: 355.
- 27) Saudi Press: Large Parts of World Are Witnessing a Second Wave of COVID-19 The official Saudi Press Agency [Internet]. [cited 2021 Mar 26]. Available from: <https://www.spa.gov.sa/viewfullstory.php?lang=en&newsid=2147810>.
- 28) Holick MF, Chen TC. Vitamin D deficiency: A worldwide problem with health consequences. *Am J Clin Nutr* 2008; 87: 1080-1086.
- 29) Coppeta L, Papa F, Magrini A. Are shiftwork and indoor work related to D3 Vitamin deficiency? A systematic review of current evidences. *J Environ Public Health* 2018; 2018: 8468742.
- 30) Binsaeed AA, Torchyan AA, Alomair BN, Alqadhib NS, Alsuwayeh FM, Monshi FM, Alrumaih FI, Alqahtani SA, Alyousefi N, Al-drees A. Determinants of vitamin D deficiency among undergraduate medical students in Saudi Arabia. *Eur J Clin Nutr* 2015; 69: 1151-1155.
- 31) General Authority for Statistics (GASTAT) [Internet]. [cited 2020 Aug 9]. Available from: <https://www.spa.gov.sa/viewfullstory.php?lang=en&newsid=2118758>.
- 32) Lu Z, Chen TC, Zhang A, Persons KS, Kohn N, Berkowitz R, Martinello S, Holick MF. An evaluation of the vitamin D3 content in fish: Is the vitamin D content adequate to satisfy the dietary requirement for vitamin D? *J Steroid Biochem Mol Biol* 2007; 103: 642-644.