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# Knowledge and behaviors of using vitamin D to boost immunity against COVID-19 pandemic

## A cross-sectional study in Saudi Arabia

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**Abstract**

The coronavirus 2019 (COVID-19) pandemic has globally impacted all aspects of life since its emergence and spread. There is a strong biological assumption and progressing epidemiological data supporting the role of vitamin D (VD) in COVID-19 infection. This study aims to determine the knowledge about VD supplements to boost immunity against COVID-19 and if participation in specific behaviors has increased the consumption of VD supplements during social distance restriction in Saudi Arabia (SA) in May 2021. This cross-sectional study used a structured online questionnaire for 2369 SA people, including demographic characteristics and knowledge about VD supplements to boost immunity against COVID-19 showed that there was a significant association between sex and vitamin D deficiency (VDD) ($P = .000$), and having VDD was strongly associated with having another vitamin deficiency ($P = .008$). Additionally, there was a statistically significant difference between VDD and cardiovascular ($P = .027$) and respiratory diseases ($P = .019$). Almost half of the participants used VD supplements to reduce or heal their COVID-19 symptoms. The adverse association between having VDD and understanding of COVID-19 symptoms was statistically significant ($P = .01$). Ginger is commonly used as an alternative medicine for the treatment of VD. The administration of VD is now known to be of physiological significance for general health, and evidence suggesting the beneficial role of VD in the prevention and/or treatment of diseases, particularly infectious diseases, such as COVID-19, is increasing.

**Abbreviations:** COVID-19 = The coronavirus 2019, FDA = The United States Food and Drug Administration, NVDD = non-vitamin D deficiency, SA = Saudi Arabia, VD = vitamin D, VDD = vitamin D deficiency.

**Keywords:** COVID-19, immunity booster, Respiratory infection, Saudi Arabia, Vitamin D

## 1. Introduction

The coronavirus 2019 (COVID-19) pandemic has globally impacted all aspects of life since its emergence and spread. It has caused approximately 13,135,129 confirmed cases and 573,304 deaths worldwide. In Saudi Arabia (SA), coronavirus cases were around 235,111, with 2243 (1%) deaths.[1] Health measures to reduce the risk of infection and mortality, as well as infection control measures and quarantine, are essential.

There is a strong biological assumption and progressive epidemiological data supporting the role of vitamin D (VD) in COVID-19 infection.[2] Recent studies have revealed that VD influences both the innate and adaptive immune systems through cytokines and the regulation of cell signaling pathways.[3] However, vitamin D deficiency (VDD) (25(OH) D < 30 ng/mL in the blood) is very common in the Saudi population.[4] VDD in SA is approximately 64.7% in adults (18–40 years), 45.7% in adults (> 40 years), 69.6% in women, and 49.3% in men.[5] Dietary deficiency in VD is likely an important contributing factor. Presumably, avoidance of sunlight and extensive covering of the skin by clothing provide an effective barrier to ultraviolet radiation, which leads to a high prevalence of VDD in the Saudi population.[4,6] The increased number of VDD could be an important factor contributing to the spread of COVID-19 among populations with low immunity.[7] There is a worldwide interest in the use of herbal medicine.[8] In SA, complementary and alternative medicines are commonly used alongside conventional drug therapy.[9] Saudi people use herbal and complementary medicine to boost immunity and treat a variety of diseases, such as cancer and diabetes.[10,11] Consequently, in situations such as the COVID-19 pandemic and quarantine, it is hypothesized that the use of complementary and alternative medicine will increase. Therefore, this study aimed to evaluate the knowledge, awareness, and use of VD to boost immunity against COVID-19 among the Saudi population, alongside herbal supplements and/or conventional medicinal supplements.

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*The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.*

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## 2. Methodology

This study had a cross-sectional design for SA people who were required to complete a survey in May 2021. A structured questionnaire, which took approximately 10 minutes to complete, was self-administered. The survey included basic demographic characteristics (age, education, sex, health status, and place of residence). It also measured the knowledge about VD supplements to boost immunity against COVID-19 and determined whether there was an increase in participation in specific behaviors (VD supplement consumption) during the lockdown in SA. The study was approved by the Institutional Review Board of the College of Medicine at King Saud University (SA Research project # E-20-5038).

### 2.1. Participants

The sample size calculation was based on existing literature.[12] The participants provided consent at the start of the survey before moving to the first question. A questionnaire, which was presented in English or translated into mother language (Arabic), was developed and self-administered. Translation was performed by different professional translators to verify the accuracy of both words and concepts. The participants were divided into 2 groups: one with VDD and one without VDD. A pilot study was conducted on 30 randomly selected participants. The data collected included demographic information, supplement used, and presence of VDD.

### 2.2. Statistical analysis

The collected data were coded, entered, and analyzed using IBM SPSS version 22 (SPSS Inc., Chicago, IL). Demographic characteristics were generated using a frequency analysis and percentages as descriptive statistics. To determine the significance of the association between VDD and independent variables such as demographic characteristics, including age, sex, location, occupation, health situation, supplement and herbal use, VD supplement use, and behaviors and attitudes towards COVID-19, Pearson's chi-square test ($\chi 2$) or Fisher's exact test was used as appropriate. Any variable with a *P*-value of $\leq 0.2$ will be included in the binary logistic model. For multivariable analysis that identified the predictive factors and associations between VD deficiencies and the use of herbs in participants with VDD and other variables, binary logistic regression analysis was used. Odds ratios (ORs) were calculated, and p-values $< 0.05$ were considered statistically significant.

## 3. Results

The demographic data of all respondents, including gender, location, occupation, marital status, educational level, and age group, are simplified in Fig. 1.

In total, 2368 respondents (94.76% response rate) were included in this study. Most respondents (57.1%) were between the ages of 30 and 51. Similarly, the majority of the respondents (76.4%) had a higher educational level, and only 6.9% of them were from the medical sector, which limited the bias in terms of medical information, as the sample represents a wider population.

Despite the highest percentage of respondents from the central region (55.8%) and western region (30.4%), there was no significant difference in terms of VDD between all regions in SA. Regarding the latest blood analysis that was conducted to measure the VD level, one third of the participants (34%) had been checked between 1 and 3 months ago, while 29.2% had measured VD between 6 and 9 months ago. The majority of the participants were female (n = 1580; 66.7%). This could

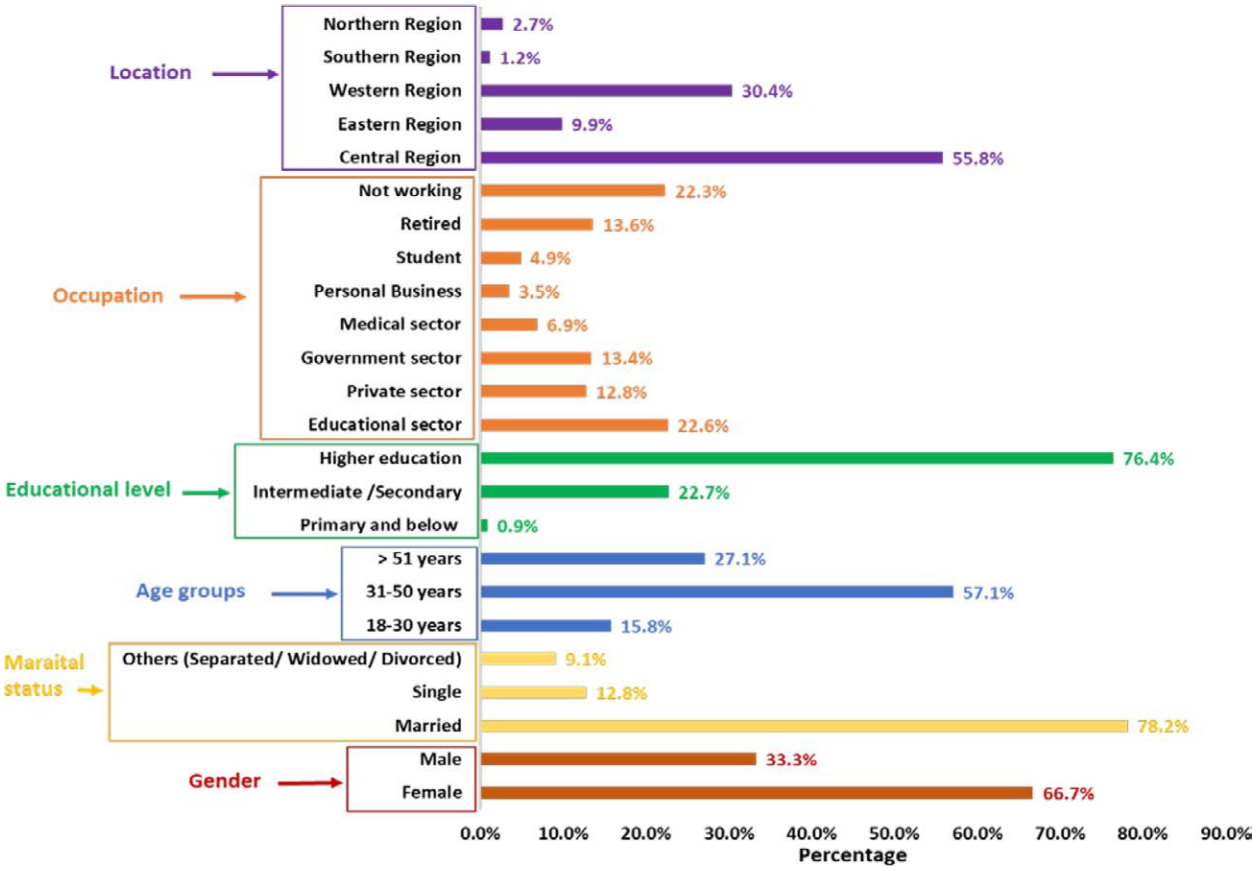


**Figure 1.** Demographic data analysis of all included respondent (n = 2368).

be explained by the results showing that female participation is higher than males in online surveys,[13] and there were 788 males (33.3%). The prevalence of VDD in this study was 29.9% (n = 708); 60% were female (n = 424), and 40% were male (n = 284). Interestingly, there was a significant association between VD level and sex. VDD was higher in males than in females (36% vs. 26.8%, $X^2$ (1, n = 2368) = 2.1, $P < .00$). The estimated risk for VDD was shown to be 0.6 times higher in male than in female. The demographic data of all the respondents are presented in Table 1.

The most common health problems were diabetes and cardiovascular, respiratory, and renal diseases, accounting for approximately 31% of all participants. Among these diseases, some participants had VDD (25.4%, diabetes; 25.3%, cardiovascular disease; 39.1%, respiratory disease; 42.9%, renal disease); almost 28.9% had prescribed medication related to their disease, and 31.8% used VD supplements. However, approximately 68.2% took VD supplements, although they did not have VDD. Interestingly, the opposite association between VDD and cardiovascular disease and diabetes was statistically significant ($X^2$ (1, n = 2368) = 3.894 and 3.010; $P = .027$ and $P = .047$, respectively), with estimated risks of 0.766 and 0.775, respectively. Additionally, there was a strong significant association between respiratory problems and VDD ($X^2$ (1, n = 2368) = 4.915, $P = .019$), as people with VDD might have a higher risk of respiratory problems (1.542 times) than those without (non-vitamin D deficiency (NVDD)). In addition, no statistically significant difference was found between the VDD and renal disease groups. Moreover, around 802 (34%) of the total participants implied using VD supplements during the quarantine; 31.8% had VDD, and the rest (68.2%) used supplements without VDD. However, the association between sex and supplement consumption was not statistically significant ($X^2$ (1, n = 2368) = 2.082; $P = .149$). In fact, 255 (31.8%) emphasized using VD supplements to boost their immunity against COVID-19 infection, while 453 (28.9%) stressed using VD as a general maintenance for their health and not to overcome COVID-19 in particular. Although there was no association between VDD and the timing of using VD supplements, 404 (30.1%) respondents highlighted that they used VD supplements before the COVID-19 pandemic and quarantine, while 45 (25.7%) of the participants stressed that they started using the supplement during quarantine to enhance their immunity against the infection.

All respondents were questioned regarding their source of knowledge about the advantages of using VD to overcome COVID-19 infection, as shown in Table 2.

Around 621 (26.2%) participants indicated that their knowledge about VD supplements was from healthcare specialists, as there was a significant association between having VDD and obtaining information about VD from healthcare practitioners ($X^2$ (1, n = 2368) = 3.981; $P = .03$). VDD people were 1.03 times more likely to get information from healthcare workers than NVDD people. However, the highest percentage

**Table 1**

**Health demographic data of respondents.**

| Variables | | VDD | NVDD | Total | *P* value |
|---|---|---|---|---|---|
| Gender | Female (n) % | (424) 26.8% | (1156) 73.2% | (1580) 100% | 0 |
| | Male (n) % | (284) 36% | (504) 64% | (788) 100% | |
| Respiratory problems | Yes (n) % | (45) 39.1% | (70) 60.9% | (115) 100% | .019 |
| | No (n) % | (663) 29.4% | (1590) 70.6% | (2253) 100% | |
| Diabetes | Yes (n) % | (69) 25.4% | (203) 74.6% | (272) 100% | .047 |
| | No (n) % | (639) 30.5% | (1457) 69.5% | (2096) 100% | |
| Cardiovascular disease | Yes (n) % | (84) 25.3% | (248) 74.7% | (332) 100% | .027 |
| | No (n) % | (624) 30.6% | (1412) 69.4% | (2036) 100% | |
| Renal disease | Yes (n) % | (6) 42.9% | (8) 57.1% | (14) 100% | .216 |
| | No (n) % | (702) 29.8% | (1652) 70.2% | (2354) 100% | |
| Having prescription | Yes (n) % | (248) 28.9% | (611) 71.1% | (859) 100% | .219 |
| | No (n) % | (460) 30.5% | (1049) 69.5% | (1509) 100% | |
| Last blood analysis | Last month (n) % | (57) 23.5% | (186) 76.5% | (243) 100% | .305 |
| | Last 3 months (n) % | (176) 31.3% | (386) 68.7% | (562) 100% | |
| | Last 6 months (n) % | (162) 30.6% | (368) 69.4% | (530) 100% | |
| | Last 9 month(n) % | (46) 28.6% | (115) 71.4% | (161) 100% | |
| | Last year (n) % | (131) 31.3% | (287) 68.7% | (418) 100% | |
| | I don't know (n) % | (136) 30% | (318) 70% | (454) 100% | |
| Having vitamin deficiency | Yes (n) % | (250) 28.1% | (641) 71.9% | (891) 100% | .008 |
| | No (n) % | (254) 34.2% | (488) 65.8% | (742) 100% | |
| | I don't know (n) % | (204) 27.8% | (531) 72.2% | (735) 100% | |

n = 2368. Analyzed with Pearson's chi-square, $P < .05$.
VDD = vitamin D deficiency; NVDD = non-vitamin D deficiency.

**Table 2**

**Source of knowledge about using VD supplements to overcome COVID-19 infection.**

| Source of information | | VDD | NVDD | Total | P-value |
|---|---|---|---|---|---|
| Health care practitioners | Yes (n) % | (205) 33% | (416) 67% | (621) 100% | 0.03 |
| | No (n) % | (503) 28.8% | (1244) 71.2% | (1747) 100% | |
| Media | Yes (n) % | (324) 31.9% | (691) 68.1% | (1015) 100% | 0.06 |
| | No (n) % | (384) 28.4% | (969) 71.6% | (1353) 100% | |
| Personal information | Yes (n) % | (155) 29.1% | (378) 70.9% | (533) 100% | 0.66 |
| | No (n) % | (553) 30.1% | (1282) 69.9% | (1835) 100% | |

n = 2368. Analyzed with Pearson's chi-square, $P < .05$.
VDD = vitamin D deficiency; NVDD = non-vitamin D deficiency.

(42.9%; n = 1015) of respondents implied that their source of information about VD is media, such as television or radio, or the Internet, such as social networking sites, while only 22.5% (n = 533) have gained information through personal experience and/or self-education. On the other hand, there was no association between having VDD and the source of knowledge about herbs either from the community around (as family, friends, or coworkers) to boost the immune system. Of the participants, 51% did not have knowledge of the herbal source of VD, while the other 49% identified some herbs that contained VD, and there was no significant difference between VDD and NVDD patients. Importantly, 53.1% of the participants revealed that they had no knowledge of COVID-19 symptoms and whether VD supplements had a healing effect, while only 12.8% of VDD patients specified different symptoms from their experience, which was cured or minimized by VD supplements. The adverse association between understanding of COVID-19 symptoms was statistically significant ($X^2$ (1, n = 2368) = 5.417; $P$ = .01), as the majority of VDD patients (32%) had no evidence of COVID-19 symptoms. In addition, participants revealed using VD supplements to reduce or heal sore throat (19.6%), cough (15.6%), fatigue (13.9%), loss of smell (2,2%), headache (8%), shortness of breath (7.2%), fever (7.1%), and other symptoms with lower responses, such as sneezing (9.2%), with no significant difference between VDD and NVDD participants. It was noted that there was a strong association between having VDD and identifying sneezing and diarrhea as major COVID-19 symptoms ($X^2$ (1, n = 2368) = 3.187 and $X^2$ (1, n = 2368) = 5.377; $P$ = .05 and $P$ = .01, respectively) as VDD patients understand sneezing and diarrhea as COVID-19 symptom 1.3 and 1.5 times more than NVDD participants, respectively. Associating the knowledge about using VD supplements to cure COVID-19 symptoms was analyzed, as shown in Table 3.

Table 4 presents the types of herbs Saudi people use as a source of VD, instead of using medical supplements, to boost their immunity. There was a significant difference in the use of ginger and honey between VDD patients and NVDD participants ($X^2$ (1, n = 2368) = 9.466 and $X^2$ (1, n = 2368) = 9.466, $P$ = .00, and $P$ = .04, respectively), as NVDD had a lower risk of having VDD by30% when using ginger and honey.

The responses demonstrated that 44% of the participants used herbs as a source of VD, whether because of their knowledge or beliefs based on scientific background or cultural myth. Approximately 16.6% used ginger as a source of VD, and lemons had the second highest score as a source of VD (9.4%). Moreover, 7.4% used honey as their source, of which 4% had

**Table 3**

**Knowledge and association between using VD supplements and curing COVID-19 symptoms.**

| COVID-19 symptoms | | VDD | NVDD | Total | P-value |
|---|---|---|---|---|---|
| Sneezing | Yes (n) % | (77) 35.2% | (142) 64.8% | (219) 100% | 0.05 |
| | No (n) % | (631) 29.4% | (1518) 70.6% | (2149) 100% | |
| Short breath | Yes (n) % | (58) 33.9% | (113) 66.1% | (171) 100% | 0.13 |
| | No (n) % | (650) 29.6% | (1547) 70.4% | (2197) 100% | |
| Cough | Yes (n) % | (124) 33.6% | (245) 66.4% | (369) 100% | 0.52 |
| | No (n) % | (584) 29.2% | (1415) 70.8% | (1999) 100% | |
| Fever | Yes (n) % | (57) 34.1% | (110) 65.9% | (167) 100% | 0.12 |
| | No (n) % | (651) 29.6% | (1550) 70.4% | (2201) 100% | |
| Headache | Yes (n) % | (63) 33.2% | (127) 66.8% | (190) 100% | 0.17 |
| | No (n) % | (645) 29.6% | (1533) 70.4% | (2178) 100% | |
| Sore throat | Yes (n) % | (150) 32.3% | (315) 67.7% | (465) 100% | 0.11 |
| | No (n) % | (558) 29.3% | (1345) 70.7% | (1903) 100% | |
| Diarrheoa | Yes (n) % | (52) 38.8% | (82) 38.8% | (134) 100% | 0.01 |
| | No (n) % | (656) 29.4% | (1578) 70.6% | (2234) 100% | |
| Loss of smell | Yes (n) % | (19) 29.4% | (32) 62.7% | (51) 100% | 0.15 |
| | No (n) % | (689) 29.7% | (1628) 70.3% | (2317) 100% | |
| Fatigue | Yes (n) % | (102) 31% | (227) 69% | (329) 100% | 0.34 |
| | No (n) % | (606) 29.7% | (1433) 70.3% | (2039) 100% | |
| Understanding the symptoms | Yes (n) % | (306) 27.6% | (804) 72.4% | (1110) 100% | 0.01 |
| | No (n) % | (402) 32% | (856) 68% | (1258) 100% | |

n = 2368. Analyzed with Pearson's chi-square, $P < .05$.
VDD = vitamin D deficiency; NVDD = non-vitamin D deficiency

**Table 4**

**Type of herbs used as a source of VD or that helps improve VD level.**

| Herbal used | | VDD | NVDD | Total | P-value |
|---|---|---|---|---|---|
| Ginger | Yes (n) % | (92) 23.4% | (301) 76.6% | (393) 100% | 0 |
| | No (n) % | (616) 31.2% | (1359) 68.8% | (1975) 100% | |
| Honey | Yes (n) % | (42) 23.9% | (134) 76.1% | (176) 100% | 0.04 |
| | No (n) % | (666) 30.4% | (1526) 69.6% | (2192) 100% | |
| Lemon | Yes (n) % | (66) 29.7% | (156) 70.3% | (222) 100% | 0.51 |
| | No (n) % | (642) 29.9% | (1504) 70.1% | (2146) 100% | |
| Garlic | Yes (n) % | (28) 28% | (72) 72% | (100) 100% | 0.38 |
| | No (n) % | (680) 30% | (1588) 70% | (2268) 100% | |
| Cardamom | Yes (n) % | (38) 25.7% | (110) 74.3% | (148) 100% | 0.14 |
| | No (n) % | (670) 30.2% | (1550) 69.8% | (2220) 100% | |

n = 2368. Analyzed with Pearson's chi-square, $P < .05$.
VDD = vitamin D deficiency; NVDD = non-vitamin D deficiency

known VDD, followed by curcumin with 6.3%, of which 3.7% had VDD, and finally, garlic (4.2%), of which 2.7% suffered from VDD. All the highlighted herbs had no statistically significant association with VDD, with a *P*-value > 0.05, except for ginger and honey. VDD was reviewed and tested as being possibly associated with variables such as gender and health demographic data, with the use of herbs, in addition to understanding COVID-19 symptoms (Table 5).

Logistic regression analysis showed that sex, respiratory problems, and cardiovascular disease presented a statistical association with VDD, with a *P*-value of ≤ 027 and odds ratio of 1.534, 1.655, and 0.738, respectively. However, there was a weak association between VDD and overall VD, and diarrhea as a COVID-19 symptom (*P* = .051 and *P* = .073, respectively). However, when subjected to multiple logistic regression analysis, only experience using ginger and understanding COVID-19 symptoms remained negatively correlated with VDD with a prevalence of *P* = .00, *P* = .005, and odds ratio of 0.582 and 0.767, respectively. However, the logistic regression model satisfied the goodness tests with the Hosmer–Lemeshow test (*P* = .7) and the logistic regression model (*P* = .00).

## 4. Discussion

During the COVID-19 pandemic and the applied quarantine, interest in VD as an adjuvant nutritional therapy for confirmed infected cases of COVID-19 has significantly increased.[14] Although there are many reports on different medications for treating COVID-19,[15] no biologics or drugs have been approved by the United States Food and Drug Administration (FDA) for the treatment of COVID-19.[15,16] Recent reports and studies have shown that VD supplements are effective and essential, and that VDD plays a significant role in the progression of COVID-19 disease state.[17]

In this study, the knowledge and behavior of SA people towards using VD supplements, whether they were screened for deficiency or not during the COVID-19 pandemic, were assessed using frequency analysis (percentage calculation) and descriptive statistics. Of the 2368 participants, 708 (29.9%) had VDD. Our findings highlighted a significant association between sex and VDD in terms of the proportion of VDD identified, with the estimated risk of females showing a lower risk of VDD, which could be attributed to the higher use of multivitamins and supplementation by females than males, which is consistent with previous studies.[18] VD levels were significantly reduced in both obese men and women. However, compared to women, serum VD levels were consistently lower in men, irrespective of obesity and type 2 diabetes.[19] Hence, a link among VD, sex, and COVID-risk should be considered, and VD supplements could be a valid adjuvant for the prevention of this severe infection, particularly in men.[20]

Therefore, there is a need to emphasize the implementation of appropriate nutritional care, such as VD supplementation, in COVID-19 disease management to guarantee adequate nutritional support to all populations, particularly those who have a high risk of concurrent diseases such as diabetes and cardiovascular, renal, and respiratory diseases, as it may be potentially beneficial to clinical outcomes and effective in reducing or preventing the harmful consequences of vitamin deficiencies in high risk population.[21–23] Our findings showed a significant association between VDD and respiratory problems, as VD works as an immunomodulator when the level is insufficient and could influence the disease pathophysiology, which is not completely understood.[24] Hence, for the treatment of people infected with COVID-19, higher VD3 doses might be useful.[14] Conversely, our findings showed an opposite significant association between having cardiovascular disease and VDD, which was supported by a recent meta-analysis, as it has been shown that VD supplementation was not associated with reduced major adverse cardiovascular events, individual CVD endpoints (myocardial infarction, stroke, CVD mortality), or all-cause mortality.[25] In addition, VD reduces inflammation, a major process in inducing insulin resistance.[26] Some studies strongly support the need to improve VD status for those who are at an increased risk of developing type 2 diabetes.[27,28] Previous studies have correlated with our findings, as our results showed a negative association between diabetes and VDD.

Several trials have also been published showing that VD supplementation has no effect on cardiovascular events, renal disease progression, and kidney stones, which is in line with our study, as our results showed no association between VDD and renal disease[29]; however, it might be due to the small number of renal samples (n = 14).

Despite the fact that SA is one of the sunniest parts of the world, VDD is common among Saudi people, which underlies the significance of screening for VDD in these populations.[4] VD status is likely already strongly impacted by the lockdown; the majority of VD is produced following sun exposure (which is often not compatible with the requirement to stay at home).[30]

Micronutrient deficiencies are associated with various adverse health outcomes, including a weakened immune system, leading to a higher risk of infection.[31] Our study showed significant positive association between VDD and vitamin deficiency. However, no systematic review has assessed the effects of micronutrient deficiency on respiratory infections, specifically the common cold in this population.[32] In addition, a meta-analysis showed that regular oral VD2/VD3 intake (in doses up to 2000 IU/d without an additional bolus) is safe and protective against acute

**Table 5**

**Binary logistic regression model.**

| | | | | | 95% CI for EXP(B) | |
|---|---|---|---|---|---|---|
| **Variable** | **Variable** | **Reference** | **Sig.** | **OR** | **Lower** | **Upper** |
| Gender | Male | Female | 0.000 | 1.53 | 1.266 | 1.859 |
| Respiratory problems | Yes | No | 0.012 | 1.66 | 1.115 | 2.458 |
| Cardiovascular | Yes | No | 0.027 | 0.74 | 0.564 | 0.966 |
| Having vitamin deficiency | Yes | Yes | 0.051 | | | |
| Having vitamin deficiency (1) | No | Yes | 0.130 | 1.19 | 0.951 | 1.477 |
| Having vitamin deficiency (2) | I don't know | Yes | 0.353 | 0.89 | 0.718 | 1.125 |
| Ginger | Yes | No | 0.000 | 0.58 | 0.448 | 0.756 |
| COVID-19 symptoms (diarrhea) | Yes | No | 0.073 | 1.41 | 0.968 | 2.043 |
| Understanding COVID-19 symptoms | No | Yes | 0.005 | 0.77 | 0.636 | 0.925 |
| Constant | | | 0.000 | 0.44 | | |

n = 2368, p < 0.05.

CI = confidence interval, OR = odds ratio.

respiratory tract infection, especially in subjects with VDD,[33] as preliminary observations support the hypothesis that VD supplementation can reduce the risk of influenza and COVID-19.[34] However, our results showed that there was no link between having VDD and the timing of taking supplements, as half of the participants used vitamins before and during the lockdown in SA; 453 (28.9%) stressed using VD as a general maintenance for their health and not to overcome COVID-19 in particular. Our findings are in agreement with a recent meta-analysis that found that VD supplementation reduces total mortality,[21,35] particularly in infectious diseases such as COVID-19.[17,21]

Many female participants, who were VD deficient, admitted that doctors had advised and suggested some methods to increase VD levels, including sun exposure, VD supplements, and the consumption of food rich in VD.[36] Our results showed that healthcare practitioners significantly played a role in educating VDD patients about VD, in addition to the role of media, as it was recommended that there should be more efforts from the media to increase VD awareness among the population and that doctors should explain to the patients the importance of VD by sharing medical information in media, as it has the highest percentage as a source of information, or by arranging awareness campaigns to the community.[37] This campaign could be helpful in educating VDD recipients on COVID-19 symptoms. Our analysis of the knowledge and behavior of Saudi people towards the use of VD during COVID-19 showed that most VDD participants did not know the exact COVID-19 symptoms in comparison with NVDD participants. Conversely, patients with VDD were significantly more aware of the association between using VD supplements to cure diarrhea and sneezing as a COVID-19 symptom, which is in line with previous findings.[21,22,35]

Another aspect of this study was the knowledge of Saudi people regarding the use of herbs as a source of VD, instead of medical supplements, which demonstrated that approximately 44% of the participants used herbs as a source of VD, whether because of their knowledge or beliefs based on scientific background or only cultural myth.[17] For example, our study demonstrated a significant inverse association between ginger use and VDD. This result was inconsistent with a study showed that ginger reduces pain and inflammatory factors in patients with back pain. It is recommended to prescribe ginger, which has fewer side effects, as an alternative to chemical drugs.[38] Although the consumption of garlic, ginger, and honey with warm water may provide symptomatic relief for the common cold, no evidence exists for these approaches in the treatment or prevention of COVID-19.[39] Our results showed no statistically significant association between the use of lemon, curcumin, and garlic and VDD ($P > .05$). The practice of using herbal and complementary medicine to heal or cure different diseases is well documented around the world[40] and in SA in particular.[8,9]

## 5. Study limitation

This study has some limitations. To avoid transmission, such as blood samples, due to COVID-19 precision. Voluntary participants agreed to share their recent biochemical blood results and used an online system. Therefore, the possibility of a bias should be considered.

## 6. Conclusion

VD is now known to be of physiological significance for health, and there is increasing evidence that it plays a role in the prevention and/or treatment of a wide range of diseases, particularly infectious diseases, such as COVID-19. Hence, it is recommended to use VD as a daily maintenance dose as a prophylactic against COVID-19 and any other respiratory infection.

## Author contributions

Both FSA and GS have made substantial contributions to conception and design, and work together in the survey and the analysis and interpretation of data. All authors contributed to the writing, editing, and reviewing of the final manuscript.
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**Formal analysis:** Ghalia Shamlan.
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## References


[1] Jiang S, Xia S, Ying T, et al. A novel coronavirus (2019-nCoV) causing pneumonia-associated respiratory syndrome. Cell Mol Immunol. 2020;17:554–554.
[2] Jolliffe DA, Griffiths CJ, Martineau AR. Vitamin D in the prevention of acute respiratory infection: systematic review of clinical studies. J Steroid Biochem Mol Biol. 2013;136:321–9.
[3] Vanherwegen A-S, Gysemans C, Mathieu C. Regulation of immune function by vitamin D and its use in diseases of immunity. Endocrinol Metabol Clin. 2017;46:1061–94.
[4] Alsuwadia A, Farag YM, Al Sayyari AA, et al. Prevalence of vitamin D deficiency in Saudi adults. Saudi Med J. 2013;34:814–8.
[5] Al-Daghri NM, Hussain SD, Ansari MG, et al. Decreasing prevalence of vitamin D deficiency in the central region of Saudi Arabia (2008-2017). J Steroid Biochem Mol Biol. 2021;212:105920.
[6] Sadat-Ali M, Al-Elq AH, Al-Shaikh IH, et al. "Assessment of low vitamin D among Saudi Arabians: did we overshoot the runway?" Saudi Med J. 2014;35:1243–9.
[7] Bakarman KA, Bajubair MA. A Meta-analysis study: Vitamin D deficiency in Saudi Arabia between 2009 and 2013. Saudi J Int Med. 2016;6:11–9.
[8] Alrowais NA, Alyousefi NA. The prevalence extent of Complementary and Alternative Medicine (CAM) use among Saudis. Saudi Pharmaceutical J. 2017;25:306–18.
[9] Suleiman A. Attitudes and beliefs of consumers of herbal medicines in Riyadh, Saudi Arabia. J Community Med Health Educ. 2014;4:269.
[10] Jazieh AR, Al Sudairy R, Abulkhair O, et al. Use of complementary and alternative medicine by patients with cancer in Saudi Arabia. J Altern Compl Med. 2012;18:1045–9.
[11] Jull AB, Cullum N, Dumville JC, et al. Honey as a topical treatment for wounds. Cochrane Database Syst Rev. 2015.
[12] Alhomoud FK, Basil M, Bondarev A. Knowledge, attitudes and practices (KAP) relating to dietary supplements among health sciences and non-health sciences students in one of the universities of United Arab Emirates (UAE). J Clin Diagn Res. 2016;10:JC05.
[13] Smith G. Does gender influence online survey participation?: A record-linkage analysis of university faculty online survey response behavior. ERIC Doc Reproduct Service no ED 501717. 2008.
[14] Grant WB, Lahore H, McDonnell SL, et al. Evidence that vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths. Nutrients. 2020;12:988.
[15] Boseley S. First trial for potential Covid-19 drug shows it has no effect. Guardian. 2020.
[16] Jean S-S, Hsueh P-R. Old and re-purposed drugs for the treatment of COVID-19. Expert Rev Anti Infect Ther. 2020. justaccepted.
[17] Lau FH, Majumder R, Torabi R, et al. Vitamin D insufficiency is prevalent in severe COVID-19. medRxiv. 2020.
[18] Archer SL, Stamler J, Moag-Stahlberg A, et al. Association of dietary supplement use with specific micronutrient intakes among middle-aged American men and women: the INTERMAP Study. J Am Diet Assoc. 2005;105:1106–14.
[19] Sanghera DK, Sapkota BR, Aston CE, et al. Vitamin D status, gender differences, and cardiometabolic health disparities. Ann Nutr Metab. 2017;70:79–87.
[20] La Vignera S, Cannarella R, Condorelli RA, et al. Sex-specific SARS-CoV-2 mortality: among hormone-modulated ACE2 expression, risk of venous thromboembolism and hypovitaminosis d. Int J Mol Sci . 2020;21:2948.

[21] Caccialanza R, Laviano A, Lobascio F, et al. Early nutritional supplementation in non-critically ill patients hospitalized for the 2019 novel coronavirus disease (COVID-19): Rationale and feasibility of a shared pragmatic protocol. Nutrition. 2020;110835.
[22] Arkin N, Krishnan K, Chang MG, et al. Nutrition in critically ill patients with COVID-19: Challenges and special considerations. Clin Nutr (Edinburgh, Scotland). 2020.
[23] Calder PC, Carr AC, Gombart AF, et al. Optimal nutritional status for a well-functioning immune system is an important factor to protect against viral infections. Nutrients. 2020;12:1181.
[24] Pulvirenti G, Parisi GF, Manti S, et al. The immunomodulatory role of Vitamin D in respiratory diseases. Curr Resp Med Rev. 2019;15:238–45.
[25] Barbarawi M, Kheiri B, Zayed Y, et al. Vitamin D supplementation and cardiovascular disease risks in more than 83 000 individuals in 21 randomized clinical trials: a meta-analysis. JAMA Cardiol. 2019;4:765–76.
[26] Berridge MJ. Vitamin D deficiency and diabetes. Biochem J. 2017;474:1321–32.
[27] Pittas AG, Dawson-Hughes B, Sheehan P, et al. Vitamin D supplementation and prevention of type 2 diabetes. N Engl J Med. 2019;381:520–30.
[28] Gröber U, Holick MF. Diabetes prevention: vitamin D supplementation may not provide any protection if there is no evidence of deficiency! Nutrients. 2019;11:26512651.
[29] Brogan M, Astor BC, Melamed ML. Vitamin D in chronic kidney disease: is there a role outside of PTH control? Curr Opin Nephrol Hypertens. 2020;29:243–7.
[30] Deschasaux-Tanguy M, Druesne-Pecollo N, Esseddik Y, et al. Diet and physical activity during the COVID-19 lockdown period (March-May 2020): results from the French NutriNet-Sante cohort study. medRxiv. 2020.
[31] Maggini S, Wintergerst ES, Beveridge S, et al. Selected vitamins and trace elements support immune function by strengthening epithelial barriers and cellular and humoral immune responses. Br J Nutr. 2007;98:S29–35.
[32] Wang MX, Koh J, Pang J. Association between micronutrient deficiency and acute respiratory infections in healthy adults: a systematic review of observational studies. Nutr J. 2019;18:80.
[33] Martineau AR, Jolliffe DA, Hooper RL, et al. Vitamin D supplementation to prevent acute respiratory tract infections: systematic review and meta-analysis of individual participant data. Bmj. 2017;356.
[34] Mattioli AV, Sciomer S, Cocchi C, et al. Quarantine during COVID-19 outbreak: changes in Diet and physical activity increase the risk of cardiovascular disease. Nutr Metab Cardiovasc Dis. 2020;30:1409–17.
[35] Kalantar-Zadeh K, Moore LW. Impact of nutrition and diet on COVID-19 infection and implications for kidney health and kidney disease management. J Ren Nutr. 2020;30:179–81.
[36] Aljefree N, Lee P, Ahmed F. Exploring knowledge and attitudes about vitamin D among adults in Saudi Arabia: a qualitative study. Paper presented at: Healthcare, 2017.
[37] Al-Agha AE, Alorabi SH, NoorSaeed S, et al. Awareness of vitamin D and its deficiency in Jeddah population, Saudi Arabia. J Commun Public Health Nurs. 2016;2.
[38] Hashemi M, Ghasemi M, Taheri M, et al. Comparing the effect of ginger and vitamin D3 supplement on inflammatory factors and pain severity in adults with low back pain. Electr J Gen Med. 2019;16.
[39] Bucher A, White N. Vitamin C in the prevention and treatment of the common cold. Am J Lifestyle Med. 2016;10:181–3.
[40] Marinac JS, Buchinger CL, Godfrey LA, et al. Herbal products and dietary supplements: a survey of use, attitudes, and knowledge among older adults. J Am Osteopath Assoc. 2007;107:13–20; quiz 21.