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Assessment of vitamin d status among egyptian covid-19 patients

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Abstract

Background The COVID-19 outbreak has increased awareness of vitamin D's (Vit-D) potential advantages for both prevention and treatment. Adequate vitamin D levels are necessary for health of the immune system, which can help with cellular response and protection against the severity of microbial infection.

Purpose To evaluate Vit-D levels and their association with illness severity in Egyptian COVID-19-infected individuals.

Methods This case–control investigation was performed at the Alexandria Main University Hospital on 80 subjects divided into 2 groups: 40 COVID-19 patients and 40 healthy persons to measure the Vit-D levels of the Egyptian cohort.

Results There was a statistically insignificant difference in the Vit-D serum levels of the studied groups ($P=1.000$). The age of the Vit-D insufficient patients was significantly higher than that of Vit-D sufficient patients ($P=0.006$). There was a statistically insignificant rise in the CRP level in the Vit-D insufficient patients ($P=0.862$) compared to patients with sufficient Vit-D. Also, the D-dimer levels in Vit-D-insufficient patients were considerably higher ($P=0.015$). Patients with sufficient Vit-D exhibited significantly lower levels of IL-6 than Vit-D insufficient patients. ($P=0.037$). Patients in the Vit-D-insufficient subgroup needed substantially more breathing support than those in the Vit-D-sufficient group ($P=0.020$).

Conclusion Although there was no association between both levels of Vit-D and the COVID-19 infection risk, insufficiency of Vit-D was related to more severe infection.

Keywords COVID-19 infection, Vit-D status, Case–control study, Egyptian patients

Introduction

COVID-19 is the third and largest pandemic to occur. The first was the severe acute respiratory syndrome (SARS)-related SARS-CoV-pandemic, which started in China in 2002. The second coronavirus, known as the Middle East Respiratory Syndrome (MERS)-CoV pandemic, was first observed in 2012 [1, 2].

It has been demonstrated that Vit-D increases the anti-inflammatory cytokine expression by macrophages while reducing the pro-inflammatory Th1 cytokine production. It is critical to remember that COVID-19-infected patients have an inflammatory cytokine environment and that this "cytokine storm" might result in an acute syndrome of respiratory distress [3, 4].

Despite claims that low Vit-D levels encourage SARS-CoV-2 infection and a more severe disease course, the data on how Vit-D levels impact COVID-19 mortality or severity is lacking, highlighting the need for further research with larger cohorts to test this theory [5]. The

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study's objectives were to look at Vit-D levels among Egyptian patients who had COVID-19 infection as well as the correlation between disease severity and its level.

Subjects and methods

This work had been approved by the Research Ethics Review Committee of the Faculty of Medicine, Alexandria University on the 16th of December 2021, serial number: 0106992. All studied patients and controls gave informed consent, and the principles of the Helsinki Declaration were observed. A consent for publication was also taken from all the study participants.

A total count of 80 subjects were included in the study, they were divided into two groups, Group 1 included 40 confirmed COVID-19 patients from the Alexandria Main University Hospital and group 2 included 40 apparently healthy subjects matched for age and gender who served as controls particularly to measure Vit-D levels in the Egyptian cohort.

- Inclusion criteria:

1. All cases were chosen during the acute phase (1–2 weeks) of infection.
2. All studied participants were above 18 years old.
3. According to the Egyptian Protocol of COVID-19 July 2022: Confirmed case: a person with clinical manifestations of Covid-19 and laboratory confirmation (molecular testing PCR with deep nasal swab is the current test of choice).
4. Patients with no vitamin D intake at least 3 months prior to the study.

- Exclusion criteria:

1. Pregnancy.
2. Malignancy.
3. Drugs affecting vitamin D level: antibiotics as rifampicin and isoniazid, anti-seizure medications as phenobarbital, carbamazepine and phenytoin, anti-cancer agents as taxol, antifungal agents as clotrimazole and ketoconazole and lastly vitamin D supplements for at least 3 months before the study.

All patients were subjected to complete history taking, a thorough clinical examination and laboratory tests that were performed during the diagnosis.

Laboratory investigations

Peripheral venous blood samples (6 ml) were obtained. The following laboratory tests were measured including:

- Complete blood count (CBC) [6].
- Chemical tests: They included blood urea, serum creatinine, sodium, potassium, albumin, total bilirubin, liver enzymes, calcium and phosphorus [6–8].
- D-dimer [6].
- Inflammatory markers: They included CRP and IL-6 [6].
- Measurement of serum 25 (OH) vitamin D by ELISA Technique [9, 10].

Statistical data analysis

The IBM SPSS software application, version 20.0 (IBM Corp., New York's Armonk), was used to analyze computer-supplied data. Numbers and percentages were used to express qualitative data. The normality of data distribution was checked using the Shapiro–Wilk test. The range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR) were all used to represent quantitative data. Quantitative variables that were not normally distributed were compared using the Mann–Whitney test, and in order to compare two groups of categorical data the Chi-square test was used. The data significance was evaluated using the 5% level.

Results

Demographic data

This case–control study was conducted on 80 subjects divided into 2 groups:

Patients: Forty confirmed COVID-19 patients (19 females, 21 males).

Controls: Forty healthy subjects (19 females, 21 males). The mean age of the studied cases was 39.62 ± 19.42 years, and that of the studied controls was 38.60 ± 13.19 years. There was no statistically significant difference between the mean age of the two groups ($P = 0.547$).

Medical history

In the studied group of COVID-19 patients some had medical history of chronic diseases as shown in Table 1.

Clinical symptoms

In the studied group of COVID-19 patients, symptoms were as shown in Table 1. During the current study, some COVID-19 patients needed assisted ventilation in the form of nasal cannula (2 patients), oxygen mask (5 patients), and intubation (1 patient) during the course of the disease as shown in Table 1.

Laboratory investigations

Table 2 exhibits the laboratory investigations of the COVID-19 patients. It shows the following: the mean hemoglobin level was 12.35 ± 2.08 g/dl, the mean CRP level was 24.85 ± 42.34 mg/l, the mean D-dimer level was

Table 1 Medical history, symptoms and need for ventilation in the studied COVID-19 patients ($n=40$)

Medical History	No	%
HTN	8	20.0
DM	5	12.5
Cardiac Disease	4	10.0
Hepatic Disease	4	10.0
Chest Disease	3	7.5
CVS	1	2.5
SLE	2	5.0
Crohn's Disease	1	2.5
Symptoms		
Fever	32	80.0
Dry cough	13	32.5
Productive cough	8	20.0
Dyspnea	11	27.5
Bony aches	21	52.5
Sore throat	16	40.0
Anosmia	4	10.0
Rhinorrhea	3	7.5
GIT symptoms	11	27.5
Confusion	2	5.0
Assisted Ventilation		
No	32	80.0
Yes	8	20.0

CVS Cerebrovascular Stroke, *DM* Diabetes Mellitus, *HTN* Hypertension, *SLE* Systemic Lupus Erythematosus

1821.87 ± 3610.35 ug/l and the mean value of IL-6 was 26.56 ± 59.43 pg/ml.

Vitamin D level

The mean serum vitamin D was 64.45 ± 22.59 ng/ml in the COVID-19 patients, and 61.30 ± 19.14 ng/ml in the control group. There was no statistically significant difference between serum vitamin D of the two studied groups ($P=1.000$).

Neither the COVID-19 patients nor the controls had Vit-D deficiency (< 20 ng/dl). Thirty-three COVID-19 patients (82.5%) had sufficient Vit-D levels (> 30 ng/dl), compared to seven COVID-19 patients (7.5%) with insufficient levels of Vit-D levels (20–30 ng/dl) as shown in Table 3

Inflammatory markers and vitamin D status in COVID19 patients

The COVID-19 patients were further subdivided into two subgroups, patients who had sufficient Vit-D and those with insufficient levels of Vit-D. Subsequently, the age, medical history, requirement for assisted ventilation, and inflammatory markers were compared in each COVID-19 patient subgroup and presented in Table 4.

Patients with low serum Vit-D levels were significantly older than those with normal Vit-D levels ($P=0.006$). Vit-D insufficient COVID-19 patients did not show statistically significantly higher levels of CRP than those

Table 2 Laboratory investigations of COVID-19 patients ($n=40$)

Laboratory Test	Min. – Max	Mean ± SD	Median (IQR)
Hb (g/dl)	7.60 – 16.60	12.35 ± 2.08	12.45 (10.95–14.0)
Platelets ($\times 10^3$/Ul)	40.0 – 447.0	233.13 ± 89.99	225.5 (182.0 – 259.0)
TLC ($\times 10^3$/Ul) Lymphopenia in 29 patients	0.86 – 27.80	7.64 ± 5.50	5.65 (4.46 – 8.28)
Serum Creatinine (mg/dl)	0.30 – 3.50	0.81 ± 0.53	0.70 (0.50 – 0.90)
Blood Urea (mg/dl)	14.90 – 220.0	40.69 ± 44.45	27.0 (19.0 – 37.50)
Serum Sodium (mEq/l)	126.0 – 145.0	137.65 ± 3.74	138.0 (135.5 – 140)
Serum Potassium (mEq/l)	2.30 – 5.60	4.12 ± 0.60	4.20 (3.80 – 4.50)
Serum Albumin (g/dl)	2.20 – 5.0	3.51 ± 0.61	3.50 (3.0 – 3.95)
ALT (U/l)	6.0 – 487.0	40.43 ± 75.58	21.50 (17.50 – 39.0)
AST (U/l)	9.0 – 111.0	33.42 ± 16.24	33.0 (26.50 – 37.0)
Total Calcium (mg/dl)	5.60 – 10.10	8.05 ± 1.03	8.20 (7.40 – 8.75)
Serum Phosphorus (mg/dl)	1.10 – 4.40	3.06 ± 0.71	3.0 (2.75 – 3.50)
Total Bilirubin (mg/dl)	0.20 – 5.60	0.78 ± 0.87	0.70 (0.35 – 0.90)
CRP (mg/l)	0.50 – 150.0	24.85 ± 42.34	4.35 (2.15 – 13.70)
D-dimer (< 550 ug/l)	150.0 – 13,760.0	1821.87 ± 3610.35	295.0 (160 – 1060)
IL-6 (pg/ml)	1.50 – 306.30	26.56 ± 59.43	4.20 (2.76 – 9.05)

IQR Interquartile range, *SD* Standard deviation, *Hb* hemoglobin, *TLC* total leukocytic count, *ALT* alanine transaminase, *AST* aspartate aminotransferase, *CRP* C- reactive protein, *IL-6* interleukin-6

Table 3 The 25 hydroxy vitamin D levels in the two studied groups

25 (OH) vitamin-D (ng/ml)	COVID-19 Patients ($n=40$)		Controls ($n=40$)		Test of Sig	P
	No	%	No	%		
Deficient (< 20 ng/ml)	0	0.0	0	0.0	Chi-square test = 0.000	1.000
Insufficient (20–30 ng/ml)	7	17.5	7	17.5		
Sufficient (> 30 ng/ml)	33	82.5	33	82.5		
Min. – Max	23.0 – 96.0		23.0 – 93.0		Mann Whitney test = 693.50	0.305
Mean ± SD	64.45 ± 22.59 ng/ml		61.30 ± 19.14 ng/ml			
Median (IQR)	72.0 (50.50 – 81.50)		65.0 (53.50 – 74.0)			

IQR Interquartile range, *SD* Standard deviation, χ^2 Chi square test, *U* Mann Whitney test, *P* P value for comparing between the two studied groups

Table 4 Stratification of vitamin-D levels in COVID-19 patients ($n=40$) according to age, medical history, assisted ventilation, and inflammatory markers

	25 (OH) Vitamin-D (ng/ml)					
	Insufficient level (20 – 30 ng/ml) ($n=7$)		Sufficient level (> 30 ng/ml) ($n=33$)			
Age					**Mann Whitney test**	***P***
Mean ± SD	56.43 ± 13.07		36.06 ± 18.78		40.00*	0.006*
Median (Min. – Max.)	57.0 (42.0 – 80.0)		28.0 (19.0 – 90.0)			
Medical History	**No**	**%**	**No**	**%**	**Chi-square test**	**^{FE}P**
Hypertension	2	28.6	6	18.2	0.390	0.611
Diabetes Mellitus	1	14.3	4	12.1	0.025	1.000
Cardiac Disease	2	28.6	2	6.1	3.252	0.134
Hepatic Disease	2	28.6	2	6.1	3.252	0.134
Chest Disease	1	14.3	2	6.1	0.563	0.448
Cerebrovascular Stroke	0	0.0	1	3.0	0.218	1.000
Systemic Lupus Erythematosus	1	14.3	1	3.0	1.540	0.323
Crohn's Disease	0	0.0	1	3.0	0.218	1.000
Assisted Ventilation	**No**	**%**	**No**	**%**		**^{FE}P**
No	3	42.9	29	87.9	7.316*	0.020*
Yes	4	57.1	4	12.1		
Inflammatory Markers					**Mann Whitney test**	**P**
CRP (mg/l)						
Mean ± SD	23.32 ± 32.40		25.17 ± 44.57		110.50	0.862
Median (Min. – Max.)	3.0 (1.65 – 80.30)		4.50 (0.50 – 150.0)			
D-Dimer (ug/l)						
Mean ± SD	4432.4 ± 5293.2		1268.1 ± 2970.8		48.00*	0.015*
Median (Min. – Max.)	1700.0 (212.0 – 12,650.0)		227.0 (150.0 – 13,760.0)			
IL-6 (pg/ml)						
Mean ± SD	51.97 ± 68.01		21.17 ± 57.15		57.00*	0.037*
Median (Min. – Max.)	21.46 (2.01 – 165.3)		3.54 (1.50 – 306.3)			

COVID−19 patients were further stratified into a vitamin D sufficient subgroup and a vitamin D insufficient subgroup. Then age, medical history, need for assisted ventilation and inflammatory markers were compared in each subgroup of COVID−19 patients

SD Standard deviation, *U* Mann Whitney test, *P* P value for stratification of 25 (OH) vitamin D by inflammatory markers, * Statistically significant at $P \leq 0.05$

with sufficient vitamin D levels ($P=0.862$). Patients having insufficient Vit-D had significantly higher D-dimer levels than those with sufficient Vit-D serum levels ($P=0.015$). In comparison to Vit-D-insufficient patients, the serum IL-6 level was considerably lower in Vit-D-sufficient patients ($P=0.037$).

Four out of seven patients with insufficient vitamin D were advised to take diet rich in vitamin D and to have 20 min of sun exposure. The recommended dose for vitamin D supplementation was 50,000 (IU) per week for eight weeks. During that period of time, there was an improvement of the symptoms of cough, dyspnea, anosmia, and body aches. The clinical condition and serum levels of IL-6 were improved by active Vit-D treatment. While three patients out of seven patients with insufficient vitamin D had passed away.

Discussion

Vitamin D reduces the inflammatory reaction to SARS-CoV-2 infection [11], so it may protect against and reduce the severity of COVID-19 infection [12, 13]. During SARS-CoV-2 infection, there is a decrease in the expression of ACE2, which is thought to be a binding protein necessary for viral entry into host cells. Vitamin D can increase ACE2 expression and modulate the RAAS pathway, thus protecting against severe lung injury [14].

Some studies [5, 15–23] displayed a relationship between serum Vit-D levels and the incidence of COVID-19 in addition to the clinical course of the illness, while others have not shown any significant association between vitamin D deficiency and the risk of COVID-19 infection [24–28].

Moreover, numerous observational studies have assessed the correlation between COVID-19 outcome and vitamin D levels. Research has shown that a vitamin D deficit increases the risk of contracting COVID-19 infection [20, 29–31]. The majority of the studies revealed that low vitamin D levels in patients with COVID-19 infection are associated with increased risk of hospitalization, disease severity and mortality [32–37]. According to these findings, taking adequate vitamin D supplements may serve as an adjuvant treatment to reduce the risk of COVID-19. On the other hand, other clinical studies did not show any relation between vitamin D and COVID-19 infection [38–40]. The inconsistent results across many studies and trials could be attributed to a number of factors, including assays used to detect vitamin D status, sun exposure, acute critical illness, different ethnicity and variable vitamin D absorption.

In the current study, we did not find a significant difference as regards vitamin D level between COVID-19 patients and the control group ($P=1.000$).

According to a study conducted in a hospital in northern Italy, 347 patients who had previously been admitted there had their Vit-D levels checked. 25-hydroxyvitamin-D was used to indicate the Vit-D levels. Of these 128 were positive, whereas 219 had negative COVID-19 PCR results. A further 78.9% and 73.5% of patients in the COVID-19 positive and negative groups, respectively, had blood Vit-D levels that were lower than 30 ng/mL. The average Vit-D levels for the COVID-19 positive and negative groups were 21.8 ± 16.1 ng/mL and 22.8 ± 14.0 ng/mL, respectively ($P=0.39$) [24].

Furthermore, recent research of 1326 COVID-19 patients found no statistically significant association between season-adjusted 25-hydroxyVit-D status and positive COVID-19 outcomes in multivariate logistic regression models that included sex, age, and ethnicity [28].

On the contrary, in an Indonesian case series of confirmed COVID-19 cases, data were obtained from 10 participants. In this study, 90% of participants had 25(OH) Vit-D levels that were insufficient (20 ng/mL). Additionally, 10% of people had inadequate Vit-D levels (within 21 and 29 ng/mL) [16].

According to a study conducted in India, 89.1% of patients had Vit-D deficiencies (< 20 ng/mL) and insufficiencies (20 ng/mL–30 ng/mL) [17]. The criteria for Vit-D deficiency and insufficiency used in the Indian study were the same as those used in the current study. Among them, 30.2% had inadequate Vit-D, and 58.9% had insufficient Vit-D. An Algerian study also found that 75.1% of the patients had deficient levels of Vit-D (less than 20 ng/mL) or insufficient levels (between 20 and 30 ng/mL). Among this group, 59.9% of the patients had inadequate Vit-D levels [18].

According to D'Avolio et al., there was a direct correlation between levels of Vit-D and the risk of developing COVID-19 [19]. COVID-19 positive patients who tested negative for SARS-CoV-2 had statistically significantly lower Vit-D values. (11.1 ng/ml vs. 24.6 ng/ml, respectively).

In a recent Spanish retrospective case–control study, 216 hospitalized COVID-19 patients exhibited mean blood levels of 25(OH) Vit-D that were significantly lower than those of the 197 sex-matched control group (14 ± 7 vs. 20.9 ± 7.4 ng/mL, respectively) [15]. Contrary to the results of the current investigation, individuals infected with COVID-19 compared to controls, also had a higher incidence of Vit-D deficiency (82% vs. 47%).

These previously stated data are consistent with Ilie et al. [21] who focused on Vit-D mean levels as found in European countries. Vit-D levels were shown to be negatively correlated with COVID-19 cases and mortality incidence in the populations of the countries impacted.

Patients in the current study who had low Vit-D were noticeably older than those who had sufficient Vit-D ($P=0.006$).

Contrary to the data previously stated, Pereira et al. [32] found that a deficiency of Vit-D was correlated with the COVID-19 severity of infection, particularly in

elderly individuals with multiple chronic diseases that increase the COVID-19 infection severity.

The results of Biesalski showed that there was a relationship between vitamin D, body fat and age in COVID-19 patients. The ability of the skin to synthesize vitamin D declines with age. As vitamin D plays a significant role in the immune system and in the RAS, so sufficient vitamin D supply is important for reducing the risk of severe COVID-19 infection [41].

In the current study, the COVID-19 patients suffering from hypertension were 18.2% in the subgroup of Vit-D sufficient patients and 28.6% in the Vit-D insufficient patient subgroup. There was a statistically insignificant difference between the two study subgroups ($P=0.611$). The percentage of COVID-19 patients suffering from Diabetes mellitus was 12.1% in the Vit-D sufficient subgroup and 14.3% in the Vit-D insufficient subgroup. There was a statistically insignificant difference between the two studied subgroups ($P=1.00$).

In the current study, Vit-D sufficient patients had considerably lower IL-6 levels than those with Vit-D insufficient levels. ($P=0.037$).

A prospective study including 154 COVID-19 patients found that those who required ICU admission had substantially lower blood 25(OH) Vit-D concentrations than those who were asymptomatic. Individuals with COVID-19 and blood 25(OH)D levels < 20 ng/mL, on the other hand, showed greater levels of inflammatory-related responses, including IL-6, TNF-α, and ferritin [42].

Moreover, Gallelli et al. [43] also discovered that blood IL-6 levels among those with severe hypovitaminosis D did not rise significantly; however, among those with acute disease, the clinical condition and serum levels of IL-6 were improved by active Vit-D treatment.

According to observational systematic review and meta-analysis studies including more than 2 million individuals, a lack or deficiency of Vit-D may increase susceptibility to COVID-19 infection and its severity. Additionally, it has been noted that individuals with viral illnesses like COVID-19 who have systemic inflammation have decreased Vit-D levels. The Vit-D level begins to decline after the systemic inflammatory response onset [44].

The findings from the prior systemic evaluation are consistent with those that Xu et al. observed [45]. They found that Vit-D provides a number of antiviral mechanisms that either involve innate or adaptive immunity. Along with regulating cytokines like TNF-α, IL-1, IL-2, IL-6, IL-12, IL-23, IL-17, and IL-21 as well as suppressing the growth of both Th1 and Th17 cells, it is also able to regulate COVID-19.

The majority of research utilizing human immune cells revealed that Vit-D_3, especially the $1,25(OH)_2D_3$ and $25(OH)D_3$ forms, reduced the levels of inflammatory cytokines and reactive oxygen species (ROS) [46].

In the present study, there was a statistically insignificant difference in the CRP levels in both Vit-D sufficient and insufficient patients ($P=0.862$).

However, Adami et al. [47] found that in COVID-19 patients, Vit-D deficiency was linked to elevated CRP levels, a greater likelihood of a severe systemic inflammatory response, and respiratory failure.

These results are comparable to those of Daneshkhah et al. [48] who hypothesized that a 34% higher frequency of elevated CRP was observed in Vit-D deficient individuals aged 60 and beyond due to an increase in low-grade inflammation.

In the current study, the mean level of serum D-dimer in COVID-19 patients was 1268.1 ± 2970.8 ug/l among the Vit-D sufficient subgroup of patients and it was 4432.4 ± 5293.2 ug/l in the Vit-D insufficient subgroup of patients. Patients with Vit-D insufficiency exhibited considerably greater D-dimer levels compared to patients with sufficient Vit-D. ($P=0.015$).

The link between D-dimer levels and 25(OH) Vit-D was examined in a number of studies. The findings of the current study are consistent with a study of 91 COVID-19 patients by Giannini et al. [49], which discovered that D-dimer levels were greater in the presence of low levels of 25(OH) Vit-D.

In the present study, assisted breathing was necessary for 57.1% of COVID-19 patients with insufficient Vit-D levels, either noninvasive, such as a nasal cannula and oxygen mask, or invasive, such as mechanical ventilation. Only 12.1% of COVID-19 patients who were Vit-D adequate required assisted ventilation. Consequently, the Vit-D insufficient subgroup required assisted ventilation at much greater rates than did Vit-D sufficient patients. ($P=0.020$).

A study postulated by Ye et al. [50] came with findings similar to the present study, which reported a higher number of patients with severe/critical disease who needed assisted ventilation with insufficient and deficient Vit-D compared to mild/moderate disease.

Another study came in agreement with the findings of a study conducted by Panagiotou et al. [51] who reported that patients in critical condition who require assisted breathing have lower 25(OH) Vit-D levels (33.5 nmol/L ± 16.8 vs 48.1 nmol/L ± 38.2) than non-critical patients.

These prior conclusions are in line with the findings of the present study as well as a meta-analysis done by Munshi et al. [52] which discovered that Vit-D levels were lower in patients with bad prognoses than in those with excellent prognoses.

Another two studies showed the same findings like in the present study. They stated that low concentrations of Vit-D are linked significantly with poorer outcomes among those COVID-19 patients [53, 54].

In contrast, a recent prospective cohort study of patients with and without COVID-19 who were hospitalized and older than or having 65 years found that patients with Vit-D deficiency were much more likely to require noninvasive breathing assistance and be admitted to an intensive care unit with high dependency [36].

These earlier findings conflict with those of Jevalikar et al. [40] who came to the conclusion that among Indian patients hospitalized with COVID-19, neither the severity of the condition nor the mortality likelihood was correlated with Vit-D deficiency. These earlier findings also conflict with those of the current study.

Conclusion

Patients with low vitamin D levels are more likely to have severe COVID-19 than others with appropriate vitamin D levels, despite the fact that the vitamin D levels of the COVID-19 patients and the included controls were comparable.

In spite of the fact that there was no correlation between vitamin D levels and the chance of being susceptible to COVID-19, we came to the conclusion that insufficient vitamin D levels were linked to a more serious condition.

Abbreviations

CBC	Complete blood count
CRP	C reactive protein
ELIZA	Enzyme linked immunosorbent assay
IL6	Interleukin 6
IQR	Interquartile range
MERS	Middle East Respiratory Syndrome
ROS	Reactive oxygen species
SARS	Severe acute respiratory syndrome
SARS-CoV	Severe acute respiratory syndrome coronavirus
TH1	T helper 1
Vit-D	Vitamin D

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [M.A.S.A.] and [M.N.S.A.], [M.A.A.S.], [M.S.T.], [S.A.R.A.]. The first draft of the manuscript was written by [M.A.S.A.] and [M.A.AS.] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Approval was obtained from the Research Ethics Review Committee of the Faculty of Medicine, Alexandria University on the 16th of December 2021, serial number: 0106992. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Informed consent was obtained from all individual participants included in the study.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

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