

## Use of Vitamin and Mineral Supplements in the Prevention and Treatment of COVID-19 in Tunisia

Halima Ben Hmad<sup>\*1,2</sup>, Eya Gara<sup>1</sup>, Sonia Ennaifer<sup>1</sup>, Mongi Hassouna<sup>1</sup> and Henda Jamoussi<sup>2</sup>

<sup>1</sup>Laboratory Asyllia Polla of Interdisciplinary Research in Health Sciences, body and health axis, Mahmoud El Materi University, Tunis, Tunisia

<sup>2</sup>University of Tunis El Manar, Faculty of Medicine of Tunis, 1007, Institute of Nutrition, Obesity: Etiopathogeny Pathophysiology and Therapeutic Management UR18ES01, Institute of Nutrition and food Technology, Tunis, Tunisia

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### Abstract

**Background:** Faced with a contagious virus such as Sars-CoV-2, Tunisians might be tempted to take dietary supplements (DS) to boost their immune systems and protect themselves from infection.

**Objectives:** The aim of this study was to evaluate the nutritional status of people who took DS either as a preventive or curative measure of COVID-19.

**Methods:** 160 patients were divided into 3 groups (G1: 83 people who had contracted COVID-19 and had taken DS during the attack, G2: 41 people who had been infected but had not taken DS, and G3: 36 people who had taken DS and had not contracted the virus. The dietary habits were assessed by a dietary history method and a validated food frequency questionnaire.

**Results:** Assessment of nutritional status showed the diet and DS did not adequately cover the requirements for some micronutrients. Intakes of magnesium, potassium, sodium, iron and vit B9 did not meet recommendations; however, intakes of vit C, vit D, vit B1 and zinc were excessive. The use of DS resulted in higher intakes of potassium, vitamin B9 and vitamin C in G1 than in G2. In addition, consumption of DS resulted in highly elevations ( $p < 0.001$ ) in vit B, magnesium, zinc, vit E, vit B9 and vit C in G1 compared to G3. Statistics also exposed highly differences ( $p < 0.001$ ) in intakes of potassium, vit B1, magnesium, zinc, vit E, vit B9, and vit C in G2 compared to G3.

**Conclusion:** The pandemic raises the stakes for DS consumers. But these products cannot replace a healthy, balanced diet, which is considered the basis for a well-functioning immune system.

**Keywords:** Covid-19, vitamin D, vitamin C, zinc, dietary supplements.

### Introduction

In Wuhan, Hubei region, an outbreak of pneumonia of unknown cause was reported in December 2019 [1] initially called "2019-nCoV" and after renamed COVID-19 by the World Health Organization (WHO) on February 11, 2020 [2]. Coronavirus disease "COVID-19" is a still active global epidemic, similar to a cold or flu in its mild form, it can be associated with many symptoms (runny nose, cough, fever...) but can also go unnoticed (asymptomatic). COVID-19 infection affects the immune system primarily and can cause fever, dry cough, fatigue, loss of taste and/or smell, severe pneumonia, and in some cases, death [3]. Elderly people and people with health problems, such as cardiovascular disease, diabetes, chronic respiratory disease, or cancer, are more likely to develop a severe form [4].

Very soon the scientific world has been aware that good nutrition plays a central role in the development and maintenance of the immune system of which a healthy and balanced diet is essential also to prevent the onset of chronic diseases that are classified as risk factors related to mortality of people infected with COVID-19 [5]. Therefore, adequate nutrition should be included in the prevention strategy of COVID-19 to improve the immune system of individuals [6]. Notably, the importance of several nutrients as modulators of immune defenses, such as vitamins A, C, D, E and some B groups, as well as the trace elements zinc, selenium, copper, magnesium and iron, whose daily dietary intake is hardly available to ensure all nutritional needs [5].

As a precautionary measure, especially since the emergence of the Sars-CoV-2 (COVID-19) coronavirus disease, individuals are more attentive to their health and resort to the use of dietary supplements to strengthen their immune systems [7]. Food supplements are based on plants, vitamins and minerals, or other concentrates of

\*Corresponding author's ORCID ID: 0000-0003-0816-4774

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substances with nutritional and physiological purposes. [8]. Food supplements in Tunisia do not require a medical prescription and they are available to everyone, either in pharmacies, drugstores or online sales, which facilitates the Tunisians self-prescription of these supplements. Self-medication has become an emerging phenomenon and increasingly threatening public health. According to the WHO, self-medication consists in the fact that an individual resorts to a drug, of his own initiative or that of a close relation, with the aim of curing affection or a symptom that he has himself identified, without having recourse to a health professional [9].

For the above-mentioned reasons, this work aims to objectify the enthusiasm of Tunisians for DS by highlighting the advantages and disadvantages of these products in order to discuss their place in the care pathway of patients in the fight against COVID 19. For that, this work will be interested on the one hand, to study the consumption of vitamin and mineral food supplements either as preventive or curative of COVID-19 in a group of Tunisians and on the other hand, to detect the beneficial effects and the possible undesirable effects related to the consumption of these products.

## Materials and Methods

### Study Population

We proceeded to a descriptive study using a questionnaire and a food survey among 160 people, during the period from February 18, 2021 to April 10, 2021.

All of the enrolled patients in the study, were randomly divided into three groups: Group 1: includes 83 people who caught Covid-19 and took dietary supplements (DS) during the reach, Group 2: consists of 41 people who have caught Covid-19 but did not take DS and Group 3: includes 36 people who are patients who took DS and did not contract the virus.

To conduct this survey, an entry and exit criteria were considered for all the participating subjects. Inclusion criteria to study were: adults of both sexes, aged over 18 years, people in recent post-Covid phase and people who use DS as a preventive or curative measure against Covid-19. Exclusion criteria were those patients who are carriers of chronic diseases, elderly people, pregnant and breastfeeding women.

### Questionnaire

The questionnaire is essentially composed of three parts: The first part is devoted to the identification of the participants: age, sex, place of residence, marital status, family situation, profession, socio-economic conditions, level of education, etc...The second part includes data on the COVID-19 disease (symptoms, duration of symptoms, sequelae after recovery). The third part is reserved to describe dietary supplements: (most consumed DS, daily

dose taken, duration of DS consumption, effect of DS on symptoms, knowledge, attitudes and use of DS). The distribution of the questionnaire was done at the Mahmoud El Materi University (Tunis, Tunisia). A call was made to people on social networks and the interrogation was done by phone. All participants were voluntarily brought to this survey

### Dietary assessment

The dietary survey is carried out over a period of 7 days to reflect the spontaneous dietary intake. All the data are reviewed and corrected, if necessary, by the dietician in the presence of the respondent in order to complete the information, verify the quantitative estimates and transform them into weights for the farm. The data from the questionnaire were analyzed by the "Bilnut" software which converts each food into micronutrients, vitamins, minerals and water and quantifies them either in grams, milligrams and as a percentage of the daily consumption. The analytical composition of these foods was based on the food composition table of the Tunisian National Institute of Statistics published in 1978. The daily intakes of vitamin D were calculated manually based on the composition tables of Ciquel 2012.

### Statistical analysis

Statistical analysis of the data was performed by using Student's t-test. A p value of 0.05 or less was considered as statistically significant.

### Ethical approval

Anonymity and confidentiality of data were respected throughout the study. The study has been approved by the Ethic Committee of the National Institute of Nutrition. The study protocol was conducted in accordance with the guidelines of the Declaration of Helsinki. Informed consent was obtained from all participants prior to their inclusion in the study.

## Results

The demographic characteristics and the clinical symptoms of the subjects were presented in (Table 1). The most affected aged groups are 18-30 years (57.3%) and 30-40 years (20.6%). 40.6% of the participants were male and 59.4% were female. The largest proportion of the participants was student (46.9%) and officers (40.6%). The COVID-19 infection rate was 77.5%. Most patients presented fever (59.7%), fatigue (83.1%), ageusia (66.1%), anosmia (70.2%), and a few patients showed signs of respiratory problem (26.6%). Other important clinical features included headaches (64.5%), myalgia (52.4%), and loss of appetite (39.5%). The most obvious aftermath of COVID-19 noticed more are fatigue (44.4%), shortness of breath (27.4%) and headaches (17.7%).

**Table 1 :** Demographic Characteristics and Clinical Symptoms of COVID-19 Patients

Characteristics	%	
<b>Gender</b>		
Female	59.4	
Male	40.6	
<b>Age (years)</b>		
18-30	57.5	
30-40	20.6	
40-50	13.1	
>50	8.8	
<b>Profession</b>		
Student	46.9	
Officers	40.6	
Unemployed	12.5	
<b>Covid 19 infection</b>		
Yes	77.5	
No	22.5	
<b>Symptoms</b>	<b>Yes</b>	<b>No</b>
Cough	26.6	73.4
Fatigue	83.1	16.9
Fever	59.7	40.3
Ageusia	66.1	33.1
Anosmia	70.2	29.8
Myalgia	52.4	47.6
Nausea/Vomiting	22.6	77.4
Diarrhea	21	79
Headaches	64.5	35.5
Loss of appetite	39.5	60.5
Shivering/Dizziness	29.8	70.2
Breathing problems	26.6	73.4
<b>Sequels after recovery</b>	<b>Yes</b>	<b>No</b>
Nothing to report	26.6	73.4
Headaches	17.7	82.3
Hairloss	10.5	89.5
Memory problems	1.6	98.4
Concentration problems	8.9	91.1
Shortness of breath	27.4	72.6
Diarrhea	7.3	92.7
Fatigue	44.4	55.6
Mood swings	15.3	84.7
Stimulated appetite	11.3	88.7

Data showed that the highest percentage of respondents (74.4 %) took DS for treating or preventing the infection. A greater percentage (58%) of respondents declared taking food supplements during the pandemic, while 30% consumed DS before the pandemic, and only 11.8% took DS before and during the pandemic. The respondents significantly more often answered that the most frequently chosen category of DS are vitamin C (60.5%), vitamin D (35.3%) and zinc (54.8%). The vast majority of respondents declared that they had noticed an improvement of some symptoms after taking DS such as fatigue (63.9%), headaches (32.5%) and myalgia (33.7%). 55% of respondents indicated that they had some knowledge about the preventive role of DS, and 53.8% know the healing process of DS. 47.9% % of patients reported that the primary source of information about DS

was health care professionals while a minority (23.5%) relied on either social media or family and friends. The majority of participants reported using feeling of improvement after taking DS (53.7% : yes, it seems to me and 19.5% : yes, clearly). Regarding the participants beliefs about the reasons for use of DS, 51.3% they think that they are helpful to treat COVID-19, 25.2% that the irregular consumption can prevent some diseases while for 10.9%, by out of curiosity. 73.9% of participants respect the daily dose. 21.3% of respondent's experience think that consuming DS can replace taking medication, 34.4% think it couldbe, while 25.5% think they do not replace medication (Table 2).

**Table 2 :** Using The Dietary Supplements During The Pandemic COVID-19

Dietary supplement habits	%	
<b>Using of dietary supplements</b>		
Yes	74.4	
No	25.6	
<b>Dietary habits</b>		
Before the pandemic	30	
Before and during the pandemic	11.8	
During the pandemic	58	
<b>Type of Dietary supplements</b>	<b>Yes</b>	<b>No</b>
Vitamin C	60.5	39.5
Zinc	54.8	45.2
Vitamin D	35.3	64.2
Multivitamins from synthetic sources	26.9	73.1
Multivitamins from natural sources	16	84
Magnesium	10.9	89.1
<b>Symptoms after consumption of dietary supplements</b>	<b>Yes</b>	<b>No</b>
Cough	10.8	89.2
Fatigue	63.9	36.1
Ageusia	21.7	78.3
Anosmia	18.1	81.9
Myalgia	33.7	66.3
Nausea/Vomiting	9.6	90.4
Diarrhea	8.4	91.6
Headaches	32.5	67.5
Loss of appetite	10.8	89.2
Shivering/Dizziness	15.7	84.3
Breathing problems	9.6	90.4
<b>Knowledge about the preventive role of dietary supplements</b>		
Yes	55	
No	45	
<b>Knowledge about the healing process of dietary supplements</b>		
Yes	53.8	
No	46.2	

<b>Who advised the use of dietary supplements ?</b>		<b>Could taking dietary replace taking medication ?</b>	
Health care practitioners	47.9	Yes	21.3
Social networking sites	23.5	No	25.5
Television/radio	9.2	It couldbe	34.4
Family/ close friends	23.5	I don't know	18.8
yourself	8.5		
<b>Feeling of improvement after taking dietary supplements</b>			
Yes, clearly	19.5		
Yes, it seems to me	53.7		
No, not at all	26.8		
<b>Reasons for the use of dietary supplements</b>			
Treating Covid19	51.3		
Improving a particular function	25.2		
Filling a deficiency	12.6		
Out of curiosity	10.9		
<b>Respect of the daily dose</b>			
Yes	73.9		
No	26.1		

According to Table 3, there was a significant difference ( $p < 0.001$ ) in potassium, vitamin B9 and vitamin C intakes in G1 compared to G2. DS intake cause dalso a highly significant increase ( $p < 0.001$ ) in vitamin B1, magnesium, zinc, vitamin E, vitamin B9 and vitamin C in G1 compared to G3. It should also be noted that the mean spontaneous vitamin C intakes in subjects who took DS were high compared with the recommendations. Futhermore, the intakes of potassium ( $p < 0.01$ ), vitamin B1, magnesium, zinc, vitamin E, vitamin B9, and vitamin C showed a highly significant difference ( $p < 0.001$ ) in G2 compared to G3. Moreover, the contribution in vitamin D were in excess in G1 and G2 when compared with the dietary reference intake. Regarding to the macro nutrient intakes, there were no significant differences between the 3 groups.

**Table 3 :** Mean Macro- And Micronutrient Intakes In Affected and Unaffected Subjects Or Not Dietary Supplements Taking

GROUPS	SPONTANEOUS INTAKES			DIETARY REFERENCE INTAKE
	G1	G2	G3	
PROTEIN (%)	12.60 ± 1.7	12.78 ± 1.71	12.79 ± 1.44	15 à 20
LIPIDS (%)	38.12 ± 6.81	38.96 ± 6.86	37.05 ± 7.88	35 à 40
CARBOHYDRATES (%)	49.26 ± 6.5	48.55 ± 6.42	50.2 ± 7.51	50 à 55
CALORIES (Kcal/d)	1815.30 ± 460.6	1811.60 ± 438.38	1778.66 ± 472.59	M : 2100 W : 1800
TOTAL WATER (ml/d)	2187.2 ± 633.51	2217.94 ± 587.53	2271 ± 598.43	1500
POTASSIUM (mg/d)	1261.68 ± 500.66	1132.3 ± 278.1 ***	1301.2 ± 462.77 ##	3500
SODIUM (mg/d)	1001.73 ± 548.36	917.11 ± 533.2	918 ± 511.97	2300
VITAMIN B1 (mg/d)	0.94 ± 0.75	1.04 ± 0.71	0.49 ± 0.18 ***###	0.1
MAGNESIUM (mg/d)	179.31 ± 108.8	204.7 ± 96.9	115.39 ± 44.16 ***###	M : 380 W : 300
IRON (mg/d)	9.6 ± 3.46	10.67 ± 4.27	10.07 ± 3.68	M : 11 W : 11-16
ZINC (mg/d)	9.6 ± 8.79	14.59 ± 6.53	4.39 ± 1.52 ***###	9,4 - 14
VITAMIN E (mg/d)	12.31 ± 8.01	13.92 ± 8.01	8.19 ± 4.39 ***###	M : 10 W : 9
CALCIUM (mg/d)	498.17 ± 224.15	510.78 ± 230.57	541.15 ± 228.68	950-1000
VITAMIN D (µg/d)	388.66 ± 102.82	357.14 ± 0	-	15
PHOSPHORUS (mg/d)	669.61 ± 352.04	698.89 ± 439.04	658.56 ± 316.82	550
VITAMIN B9 (µg/d)	176.57 ± 105.70	192.74 ± 118.78 *	10.88 ± 44.86 ***###	330
VITAMIN C (mg/d)	181.22 ± 131.93	306.49 ± 154.23 **	68.98 ± 45.18 ***###	110

\* :  $p < 0.05$  ; \*\* :  $p < 0.01$  ; \*\*\* :  $p < 0.001$  G1 vs G2 ; G1 vs G3 ; ## :  $p < 0.01$  ; ### :  $p < 0.001$  G2 vs G3 ; M : men ; W : women ; d : day.

G1 : 83 people who caught Covid-19 and took dietary supplements (DS) during the reach;

G2 : 41 people who have caught Covid-19 but did not take DS; G3 : 36 patients who took DS and did not contract the virus.

## Discussion

Coronaviruses are a large family of viruses, which cause diseases ranging from a simple cold to more severe pathologies such as MERS or SARS. The virus identified in January 2020 in China is a new Coronavirus [2]. Until February 2022, the World Health Organization (WHO) reported that there were 416 614 051 confirmed cases of people infected with the COVID virus worldwide [10]. According to the latest data announced by the Ministry of Public Health of Tunis (Tunisia), the number of cases of people affected by the COVID virus reported in Tunisia tends to 971,460 cases [11].

The population of the present study was selected from 160 adult patients aged between 18 to 60 years. There was a predominance of females with 59.4% of the cases and the sex ratio was 1.46. Current results were not consistent with the study of Wenham *et al*, who reported that women are less affected by the virus than men [12].

The Tunisian age group most affected by COVID-19 was the 18-30 year old who represented 57.5% of those infected. These results were in agreement with those of Abbasi (2020) who showed that the people most infected by this virus are children (0-19 years) and young adults (20-39 years) [13].

The results obtained in this study showed that 77.5% of our population has caught the virus. The symptoms most manifested in the infected persons are fatigue with 83%, anosmia with 70.2%, ageusia with 66.1%, headaches with 64.5%, fever with 59.7%, myalgia with 52.4% and diarrhea with 21%. The symptoms of COVID-19 can vary from one person to another. They may also vary according to age group. According to WHO, fever, fatigue and dry cough are the most common symptoms, while headaches, ageusia, anosmia, myalgia, and diarrhea are less common symptoms [14].

After COVID-19 infection, many people develop complications of varying duration. Indeed, our study showed that the sequelae related to the coronavirus contamination are multiple, namely fatigue (44.4%), hair loss (10.5%), concentration and memorization disorders (1.6%). Our results are in agreement with those of Logue *et al*, who studied the sequelae of COVID in adults. These researchers showed that fatigue, ageusia, and anosmia are the most frequent sequelae (13.6%) as well as brain fog (13.6%) [15].

In June 2020, the media carried the idea that vitamins and trace elements are effective in the prevention and treatment of Covid-19. As the pandemic situation worsened significantly, questions were raised about whether our dietary intakes of vitamins and micronutrients were sufficient and whether supplementation with these nutrients was really necessary as a means of combating the pandemic. Similarly, Alkhatib<sup>16</sup> showed that when vitamins (vitamins A, B6, B12, C, D, E and folates) and trace elements (zinc, iron, selenium, magnesium and copper) are deficient, viral infections will be easy to catch [16].

The results recorded in this study showed that the majority of our population (74.7%) consumed DS against (25.6%) who did not receive supplementation; this proves that since the beginning of the pandemic, Tunisians are much more health conscious and resort to the use of DS to treat COVID-19. Current results also showed that 58% of the people surveyed consumed DS during their COVID outbreak while a percentage of 30.3% took DS before the outbreak to protect themselves from COVID and strengthen their immune system. A percentage of 11.8% who consumed DS before and during the disease was recorded.

The modulation of the immune system by diet, i.e. macronutrients and micronutrients, has been widely demonstrated in humans. In this context, a retrospective study conducted in 2020 showed that the main risk factor in 201 patients with COVID-19 admitted to Wuhan Hospital in China was a low immune response. This is why, it is important to discuss the protective role of diet and DS intake in preventing seasonal infections namely SARS-CoV-2 (COVID-19) [17].

The results of undergoing survey showed that the DS most consumed by patients were: vitamin C (60.5%), zinc (54.8%), vitamin D (35.3%), multivitamins from synthetic sources (26.9%), multivitamins from natural sources (16%) and magnesium (10.9%). Our results are consistent with those of Adams *et al*, who showed that the most commonly used supplements for the prevention and/or treatment of COVID-19 are mainly vitamin C, vitamin D and zinc [17]. Similarly, Moscatelli *et al* [18] have shown that vitamin C, vitamin D and zinc play an important role in regulating the immune response, reducing the risk of infection and improving the health status of patients with COVID-19. For these researchers, the most robust micronutrients against COVID that boost the immune system are mainly vitamin C, vitamin D and zinc<sup>18</sup>. In this study we also reported the improvement of several symptoms such as fatigue 63.9%, myalgia 33.7% and headache 32.5%.

The results of the present study showed that the use of DS caused a significant increase in potassium ( $p < 0.05$ ) and vitamin C ( $p < 0.05$ ) intakes in G1 compared to G2. Vitamin and mineral self-medication also caused highly significant elevation ( $p < 0.001$ ) in vitamin B1, magnesium, zinc, vitamin E, vitamin B9, and vitamin C in G1 versus G3. Statistics also exposed highly significant differences in intakes of potassium ( $p < 0.05$ ), vitamin B1, magnesium, zinc, vitamin E, vitamin B9, and vitamin C in G2 versus G3 ( $p < 0.001$ ). In fact, in this period of COVID-19 pandemic, DS are supposed to boost immunity to fight against the coronavirus. Vitamins A, D, C, B as well as iron, copper, zinc and selenium contribute, each in their own way, to the proper functioning of the immune system, which helps to protect against infectious diseases and helps to recover quickly. According to the literature, the main micronutrients that help the body defend itself against COVID-19 are mainly vitamin D, vitamin C and zinc [19] which is consistent with results found in this study.

Although the adequacy of vitamin D intakes cannot be stated with certainty, usual intakes in the current study were found to be well below the suggested adequate intakes. In the literature, several data link vitamin D deficiency to susceptibility to acute respiratory infections [20]. Vitamin D is thought to be involved in the risk of infection through its effects on innate and adaptive immunity. Indeed, vitamin D inhibits pro-inflammatory mediators and stimulates the cells of the immune system, monocytes and macrophages, which use it in their fight against infectious processes. Berry *et al* [21] measured vitamin status, lung function and respiratory infections in British adults (over 45 years old). These authors showed a linear association between vitamin D status, seasonal infections and lung function. Each 10nmol/L increase in vitamin D was associated with a 7% lower risk of infection [21]. In the elderly, of whom 50% to 80% are vitamin D deficient, there is an increased susceptibility to developing severe complications of influenza. This is partly due to the weakening of the immune system, which becomes less effective in fighting infections with age. Each 10nmol/L increase in vitamin D was associated with a 7% lower risk of infection [22, 23]. However, the WHO does not recommend the use of vitamin D as a treatment for Covid-19 because it considers that there is insufficient evidence and recommends further research to determine the key role that vitamin D may play in the prevention and treatment of Covid-19 [24].

This study demonstrated that vitamin C intake was excessive for G1 and G2 but insufficient for G3. Vitamin C, or L-ascorbic acid, is an active organic substance present in the human body in usually low doses. Vitamin C has a virucidal activity, especially against the influenza virus of the seasonal flu. This effect has been demonstrated *in vitro*, but has yet to be demonstrated *in vivo*, especially with high doses [25, 26, 27]. Carr and Massini [28], Calder *et al* [29] and Carr [27] also report that it is often during the viral infection process that vitamin C plasma levels are at their lowest. It is therefore conceivable that rapid systematic supplementation of Covid-infected subjects would be beneficial in order to ensure a non-depressive evolution of the Covid pathology. High doses of vitamin C have already been recommended for the prevention of Sars-CoV2 infections by the Chinese Center for Disease Control and Prevention and the Chinese Nutrition Society. A large-scale clinical trial is under way to investigate the possible beneficial effects of vitamin C in patients with severe Covid disease [27].

Zinc intakes in our study appeared to be high in G1 ( $9.6 \pm 8.79$  mg/d) and G2 ( $14.59 \pm 6.53$  mg/d) but reduced in G3. Zinc is a trace element required for the function of more than 200 metalloenzymes and is a component or activator of many enzymes in protein, carbohydrate and lipid metabolism. Much scientific work over the past 50 years has shown that zinc is an important trace element in fighting bacterial and viral infections, including influenza viruses and coronaviruses. It functions as a

modulator of the immune response. Most of these studies have been done *in vitro*, but a review article from 2019 seems to confirm the value of zinc in preventing infection, but also in controlling the development of many viruses in humans. Wong *et al* [30] showed that zinc deficiency induces an increased inflammatory response in cells. Zinc deficiency actually causes insufficient activation of immune cells and dysregulation of a cytokine (interleukin-6), a protein that affects inflammation in the cell. Zinc is also an inhibitor of pro-inflammatory molecules, and as such could be an effective micronutrient support to limit the cytokine storm characteristic of Covid19. The role of zinc in the immune system is controversial [31], and in the hope of limiting the symptoms of Covid-19, or even avoiding severe forms of the disease, many treatments have been tested.

### Conclusion

Current study is one of the first in Tunisia to have assessed the prevalence, knowledge and practices of DS consumption of Tunisians to protect themselves or treat Sars-CoV2. Today, we still lack direct clinical data regarding the action of vitamin D, vitamin C, and zinc against COVID-19. Thus, additional studies are needed to elucidate the possible primary mechanisms of action of these micronutrients in combating these viral infections. In addition, consistent research is still needed to establish a cause-and-effect relationship to provide guidance on the supplementation needed to reduce the risk of acute respiratory viral infections, influenza and COVID-19.

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### Conflicts of interest

There are no conflicts of interest.

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