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Original article

A Detailed Comparison of the Use of Dietary Supplements Before and During the COVID-19 Pandemic

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Abstract. *Background and aim:* Considering the coronavirus disease 2019 (COVID-19) pandemic and the expectation that dietary supplements (DS) boost the immune system of individuals, the aim of this research was to evaluate the use of DS and related factors by comparing periods before and during the pandemic. *Methods:* A descriptive cross-sectional internet-based study was conducted with 1488 participants from the general public aged above 19 years. *Results:* The median age of participants was 33.0 (19-69) years and 88% of participants were women. A total of 48.9% of participants (50.2% of females, 39.9% of males) used DS before COVID-19, and DS use during COVID-19 was reported to be 57.9% (58.6% of females, 52.8% males). Independent variables of DS use before and during COVID-19 were sex, age, body mass index (BMI), education, income, vitamin/mineral deficiency (VMD), alcohol use, and medication use. Participants who had no VMD used more DS, mostly herbal supplements such as grape seed, gotu kola, ginseng, ginkgo biloba and green tea. Vitamin D and C were the most commonly-used DS among participants with vitamin/mineral deficiency, followed by zinc and multivitamins. The main reason for DS use (47.2%) during COVID-19 was to strengthen immunity. *Conclusions:* The current findings may help to understand the preferences of individuals about DS use during pandemics. Understanding factors associated with the use of DS and their claimed immune-boosting effects may support future studies aiming to provide accurate information and motivate individuals towards healthy use of supplements during pandemics.

Key words: the coronavirus disease 2019, COVID-19, dietary supplements, immunity, nutrition

Introduction

The coronavirus disease-2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which emerged in Wuhan, China at the end of December 2019 (1). Due to the rapid spread of COVID-19 globally, the World Health Organization declared a pandemic on 11 March 2020. As reported by the World Health Organization on 3 August 2021, Turkey ranked thirteenth with 5.7 million cases, and twenty-fifth with 51.4 thousand deaths. A total of 198.2 million cases and 4.2 million deaths were reported globally (2).

Current clinical management of COVID-19 consists of infection prevention and control measures and supportive care. To date, a combination of therapies such as anti-inflammatory, antiviral, and other medications were evaluated to prevent/treat COVID-19; however, limited medications are approved by the Food and Drug Administration (3,4). The use of social distancing, face masks and public/individual hygiene are the best prevention strategies for COVID-19 (5). Lack of preventive and curative medicine for COVID-19 puts a healthy immune system on the front line. The immune system has a major protective role against foreign bodies such as viruses (6). A number of vitamins and trace elements are essential for the immune system to sustain normal functions (7) and play key roles in reducing the risk of respiratory infection (8). Evidences show that dietary supplementation of some

essential nutrients may support the body's defenses and responses against infections (9). Vitamin A, D, C, high-dose zinc, selenium, omega 3 (6,7), several nutraceuticals (10) and probiotic (11) supplementation have enhancing effects on immunity against viral infections.

Since the early times of the COVID-19 pandemic, specific dietary supplement (DS) use was advised by television personalities, celebrities, wellness gurus, supplement companies and across social media to fight against SARS-CoV-2 and boost the immune system (12,13). There has been a constant increase in the use of DS over the last decades globally and 50–75% of the population use DS routinely (14). Data from the National Health and Nutrition Examination Survey shows that the use of DS in the United States (U.S.) increased from 48.4% in 2007-2008 to 56.1% in 2017-2018 (15). Sales of DS increased during the COVID-19 pandemic in most countries (14). For instance, sales of elderberry and zinc supplements increased remarkably by 255% and 415%, respectively, in only the first week of March, 2020 (12). The global DS market was valued at 101.38 billion USD in 2018, and 140.3 billion USD in 2020 and is expected to enlarge with compound annual growth rate of 8.6% from 2021 to 2028 (16). The Turkish DS market was valued at 122.5 million USD in 2018, 155.8 million USD in 2019, and 192 million USD in 2020 (17).

Rapid accessibility and interactive features of the internet give it an important role in obtaining information. In this confused and chaotic information environment, this infodemic involves consequences such as death, delayed treatment, wasted resources, and concerns (13). A Google Trends analysis reported that searches for phrases about 'immune boosting and the like' spiked in early February 2020, as concern about preventing or fighting COVID-19 increased (13,14). Turkish consumers were reported to focus on building immunity against COVID-19 and invested in joint and skin health with collagen supplements in 2020 (17). Despite the fact that a number of bioactive compounds have several anti-inflammatory, antioxidant, and antiviral benefits, the use of DS in COVID-19 treatment is not reported in any guidelines (14).

In this study, it has been hypothesized that the use of DS increased and factors related with DS use changed during the pandemic. Considering the high prevalence of DS use and easy access on the internet, the aim of this study is to compare and examine the frequency of DS use, most preferred DS, reasons for use, and preferences about accessibility and information channels before and during the COVID-19 pandemic with comparisons according to age, sex, education and similar factors. Additionally, another aim of this study is to gain a better understanding of attitudes and beliefs about consumers in relation to DS in pandemic times.

Materials and Methods

Definition of "Dietary Supplement"

The study definition of DS was placed at the beginning of the internet-based questionnaire and was based on the Dietary Supplement Health and Education Act of 1994 and the Food and Drug Administration definition (18). Dietary supplement was defined as non-tobacco products containing one or more vitamins, minerals, herbs or amino acids taken to support the diet, that may be found in many forms such as capsules, tablets, powders, or liquids which contain a wide range of vitamins, minerals, amino acids, essential fatty acids, fiber, various herbs and their extracts.

Participants and Procedure

A descriptive cross-sectional internet-based study was conducted during April-June 2021 among the general public aged above 19 years. Participants were reached through the researcher's social network and mostly via Instagram on social media. Online informed consent was obtained with the first question on the questionnaire for all participants. The study protocol was approved by the Research Ethics Review Board in accordance with the Helsinki Declaration (19), and participation was entirely voluntary. The questionnaire was anonymous and the privacy of the study participants was protected.

Internet-Based Study

An online questionnaire was designed for adult Turkish citizens to evaluate DS use before and after the first COVID-19 case reported in Turkey on 11th

March 2020. The questionnaire was based on previous studies (20-23) about the use of DS and it was modified for the present COVID-19 setting. Individuals under the age of 19 years (n = 20), pregnant females (n =8), and people with unknown, missing, inconsistent and duplicated data (n = 105) were excluded. Thus, the final analytic sample was 1488.

The questionnaire included four parts about demographics-general characteristics, DS use before (b-COVID-19) and during (d-COVID-19) COVID-19 pandemic, and attitudes and behaviors about DS use. Demographic and general characteristic data were collected, including age, sex, marital status, family type, education, income, profession, physical or online work, transportation, smoking and alcohol use, self-reported height and weight, diagnosis of COVID-19 infection, diagnosis of chronic disease, chronic drug use and vitamin and/or mineral deficiency (VMD). Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m^2), and classified according to the World Health Organization BMI classification (24).

The second and the third parts of the questionnaire were about the use of DS before and during COVID-19. Participants were asked to respond by considering DS in tablet/capsule/liquid/powder form, which they regularly took for at least one month; and they were informed that items such as spices, garlic, etc. used in food preparation are not DS to prevent misunderstanding. The questionnaire included a question about types of DS, including DS such as vitamins, minerals, probiotics, omega-3, and herbal supplements (vitamin D, vitamin K, folic acid, biotin, vitamin C, vitamin B6, vitamin B12, combination of vitamin B12+folic acid, coenzyme Q-10, biotin, multi-vitamin, calcium, zinc, magnesium, iron, multi-mineral, vitamin and mineral combinations, curcumin/turmeric, sambucus nigra+vitamin C+zinc, black seed oil, echinacea, ginko biloba, ginseng, gotu kola, garlic, St. john's wort, artichoke, cinnamon, grape seed, green tea, milk thistle, omega 3/fish oil, 5-hydroxytryptophan, prebiotic, probiotic, combinations of probiotic+prebiotic, yeast, yeast+probiotic, β-Glucan, bromelin, hyaluronic acid, collagen, hyaluronic acid+collagen+vitamin+mineral complexes, propolis, glucosamine/glucosamine chondroitin sulfate, glutamine, and other). Detailed information was collected about DS, who suggested the DS, where they got information about DS, purpose of DS use, and any adverse effects. Participants were allowed to give multiple responses. The last part contained 8 items about attitudes and behaviours related to the use of DS and was scored with a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Statistical analyses

Statistical analysis was performed with IBM SPSS Statistics for Windows, version 20.0 (25). Data for continuously measured variables are expressed as median value and minimum-maximum value. Data for categorical items including the percentage distributions for general characteristics, factors related to COVID-19 and health and anthropometric characteristics are presented according to the sex of participants. Group differences about the use and type of DS before and during COVID-19 were examined with the Wilcoxon and Mann-Whitney U test. Logistic regression models were used to investigate the independent variables of DS use in participants. The level of significance was accepted as $p < 0.05$ for all statistical analyses.

Results

The general characteristics of the participants are shown in Supplemental Table 1. The participants' median age was 33.0 (19-69) years with a high percentage in the 30-39 age group for both sexes. Eighty-eight percent of participants were women. Most of the participants were married, had a nuclear family, were non-smokers, had bachelor degree and income equal to expenses. A total of 48.9% of participants (50.2% of females, 39.9% of males, P=0.01) used DS b-COVID-19, and DS use d-COVID-19 was 57.9% (58.6% of females, 52.8% males, P=0.14). Female DS use was statistically higher than male use only b-COVID-19.

Health and anthropometric characteristics, and factors related to COVID-19 are shown

in Supplemental Table 2. The median BMI of the participants was 24.5 kg/m^2. While most females had normal weight, males had statistically higher pre-obesity and obesity rates than females (P=0.000). A total of 44.6% of the participants did not have any VMD; on the other hand, among the rest of the participants, females had higher VMD than males (P=0.000). A total of 79.0% of the participants were not diagnosed with COVID-19 but 30.6% had COVID-19 history in the family. The percentages of online or physical work types were statistically different between females and males (P=0.000). Most of the participants had other alternatives instead of public transportation.

Factors affecting DS use before and during the COVID-19 pandemic are seen in Supplemental Table 3. Factors such as sex, age, education, income, residence, job, presence of chronic disease, insulin resistance and digestive system diseases, medication use, VMD, and work type affected DS use between the groups b-COVID-19 and d-COVID-19 (P<0.05). A higher percentage of females (90.2%) reported DS use than males (9.8%) b-COVID-19, and DS use increased in males (10.9%) d-COVID-19. The use of DS was higher in the age group of 30-39. The age distribution of DS use changed d-COVID-19 and more participants older than 40 years old used DS compared to b-COVID-19. Participants who had a nuclear family and income equal to expenses reported higher DS use between and within the groups. The highest increase in DS use was among those with bachelor degrees compared to other educational levels. The percentage of DS use decreased in participants who had chronic disease, medication use and VMD d-COVID-19, while the number of users increased. In both periods, participants who worked in physical environments reported higher DS use than participants with other work types and the increase in DS use d-COVID-19 was statistically significant (P=0.01). The percentage of DS use among participants who did not work decreased d-COVID-19. Although there was an increasing number with DS use d-COVID-19, factors such as marital status, BMI, COVID-19 history, COVID-19 history in family, and transportation type did not change the DS use statistically due to the COVID-19 pandemic. In both periods, normal weight participants reported higher DS use and the distribution of DS use did not change d-COVID-19. When obesity increased, DS use decreased in both periods but the results were not statistically significant (P=0.21). Independent variables of DS use before and during COVID-19 are shown in Table 1.

Independent variables were sex, age, BMI, education, income, VMD, alcohol use, and medication use. Job was an independent variable for only students d-COVID-19.

Statistically significant differences between the type of DS taken before and during COVID-19 are seen in Supplementary Figure 1 A-B. Analysis applied for users without any VMD (n:664) is shown in A and for users with VMD (n:816) in B. Participants who had no VMD used more DS, mostly herbal supplements. The use of glutamine, grape seed, gotu kola, ginseng, ginkgo biloba, calcium and vitamin B6 increased and the others decreased, yet magnesium and green tea were the most-commonly used DS d-COVID-19. B, vitamin D and C were the most frequently used DS among participants with VMD, followed by zinc and multivitamins. B12 use decreased but still 41.5% of participants used B12. Curcumin, garlic, sambucus nigra, and propolis were the most commonly used herbal supplements d-COVID-19 in the VMD group. The top two (b-COVID-19) and three (d-COVID-19) types of DS used by participants were consistent among all age groups, except those 50 years and over (Figure 1). For 50 and younger, the top two DS were vitamin D (56.2-62.9%) and B12 (39.1-50%) b-COVID-19; the top there were vitamin D (64-74%), vitamin C (42.9-60.8%) and B12 (30.1-36.4%) d-COVID-19.

The purpose of DS use before and during COVID-19 pandemic are seen in Figure 2. Strengthening immunity was the main reason for DS use (47.2%) d-COVID-19. Strengthening immunity, maintaining/improving health, prevention of diseases, and dietary support were the reasons that increased most and weight loss, sports and beauty-related reasons decreased d-COVID-19.

The most frequent 5 responses for the source of information, suggestions about DS and the purpose of DS use among the participants were analyzed. Before COVID-19, DS were suggested by a doctor, themselves, pharmacist, dietitian, and close environment

Table 1. Logistic regression investigating independent variables of dietary supplement use in participants

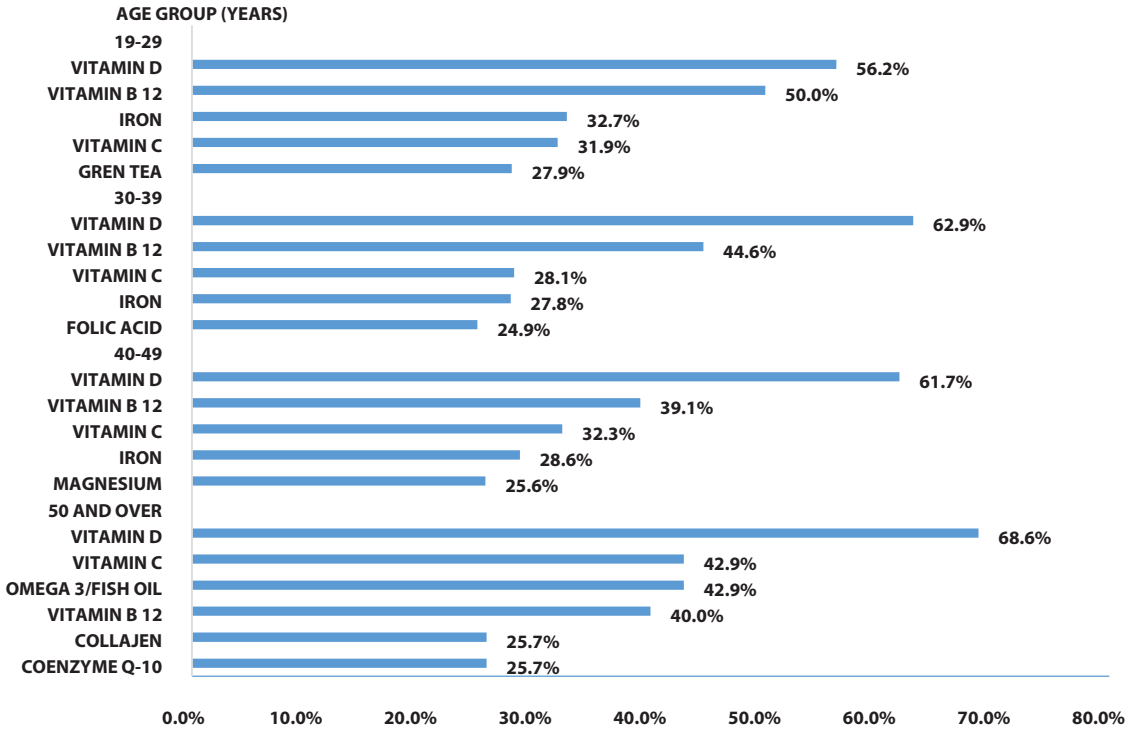
Variables	Before COVID-19		During COVID-19	
	ODDS Ratio (95% Cl)	*P*	ODDS Ratio (95% Cl)	*P*
Sex		0.000*		0.000*
Female	0.58 (0.39, 0.87)	0.008*	1.50 (1.01, 2.21)	0.04*
Male	1		1	
Age		0.000*		0.09
19-29	3.02 (1.55, 5.87)	0.001*	0.70 (0.52, 0.95)	0.02*
30-39	1.90 (1.01, 3.58	0.04*	0.69 (0.47, 1.0)	0.06
40-49	1.03 (0.53, 2.01	0.92	0.95 (0.52, 1.72)	0.85
50+	1		1	
BMI		0.17		0.02*
Underweight	0.47 (0.24, 0.92)	0.02*	2.15 (1.22, 3.81)	0.008*
Normal weight	0.79 (0.54, 1.16)	0.22	2.03 (1.12, 3.69)	0.02*
Pre-obesity	0.85 (0.58, 1.24)	0.39	2.77 (1.45, 5.32)	0.002*
Obese	1		1	
Education		0.03*		0.20
Primary	3.32 (1.30, 8.45)	0.01*	0.73 (0.29, 1.84)	0.51
Secondary	1.73 (1.09, 2.76)	0.02*	0.59 (0.24, 1.46)	0.25
Bachelor	1.23 (0.89, 1.70)	0.21	0.48 (1.19, 1.23)	0.12
Postgraduate	1		1	
Income		0.04*		0.04*
Income < Expenses	1.54 (1.11, 2.16)	0.01*	0.83 (0.63, 1.11)	0.21
Income = Expenses	1.25 (0.94, 1.65)	0.12	0.70 (0.84, 0.93)	0.01*
Income > Expenses	1		1	
Job		0.24		0.14
Housewife	1.32 (0.85, 2.06)	0.21	0.61 (0.33, 1.11)	0.10
Student	1.25 (0.74, 2.13)	0.40	0.54 (0.31, 0.94)	0.03*
Health workers	0.76 (0.52, 1.12)	0.16	0.69 (0.45, 1.07)	0.10
Others	1		1	
Work Type		0.74		0.29
Home/Online	0.78 (0.47, 1.29)	0.32	1.56 (0.93, 2.60)	0.09
Mix Type (online + physical)	0.72 (0.35, 1.48)	0.37	1.16 (0.83, 1.63)	0.38
At work/study place	0.83 (0.47, 1.47)	0.53	0.84 (0.51, 1.40)	0.49
Do not work	1		1	
Transportation		0.08		0.09
Public	1.19 (0.84, 1.69)	0.32	0.74 (0.41, 1.36)	0.33
Taxi	0.50 (0.26, 0.99)	0.05	1.29 (0.96, 1.73)	0.09
Private	0.97 (0.71, 1.33)	0.87	1.34 (0.95, 1.89)	0.09
Walking	1		1	

Table 1 (*Continued*)

Variables	Before COVID-19		During COVID-19	
	ODDS Ratio (95% Cl)	*P*	ODDS Ratio (95% Cl)	*P*
Residency		0.12		0.34
Alone	0.93 (0.45, 1.93)	0.85	1.12 (0.73, 1.71)	0.62
Nuclear family	0.98 (0.51, 1.90)	0.95	1.50 (0.90, 2.50)	0.12
Extended family	1.53 (0.74, 3.16)	0.25	1.32 (0.65, 2.70)	0.44
With a relative/roommate	1		1	
Vitamin & Mineral Deficiency		0.000*		0.000*
No	4.09 (2.52, 6.63)	0.000*	0.42 (0.33, 0.54)	0.000*
Only vitamin	1.88 (1.16, 3.06)	0.01*	0.29 (0.18, 0.46)	0.000*
Only mineral	1.72 (0.91, 3.25)	0.04*	0.33 (0.22, 0.51)	0.000*
Both	1		1	
Chronic Disease		0.08		0.39
Yes	0.76 (0,57, 1.02)	0.06	1.15 (0.87, 1.50)	0.33
None	1		1	
Smoking		0.19		0.42
Yes	1.36 (0.84, 2.20)	0.21	0.91 (0.69, 1.20)	0.51
None	1.50 (0.97, 2.35)	0.07	0.74 (0.47, 1.16)	0.19
Social Drinker	1		1	
Alcohol		0.001*		0.000*
Yes	1.77 (1.15, 2.73)	0.01*	1.05 (0.70, 1.57)	0.81
None	1.79 (1.31, 2.44)	0.000*	0.58 (0.38, 0.89)	0.01*
Social Smoker				
Medication		0.000*		0.000*
Yes	0.68 (0.52, 0.90)	0.006*	1.60 (1.24, 2.06)	0.000*
None	1		1	
COVID-19 History		0.20		0.76
Yes	0.71 (0.39, 1.27)	0.24	0.87 (0.63, 1.27)	0.53
No	0.99 (0.58, 1.70)	0.95	1.02 (0.58, 1.81)	0.93
Only suspicion	1		1	
Constant	0.13	0.005*	2.54	0.007*

*$P < 0.05$, COVID-19: The coronavirus disease 2019

mostly (33.1%, 18.1%, 9.1%, 7.8% and 5.9% respectively). During COVID-19, these answers changed to doctor, themselves, pharmacist, close environment, and dietitian (32.1%, 23.4%, 14.3%, 8.2% and 7.5% respectively). Among participants, 29% received information about DS from doctors, 20% from pharmacies, 19% from the internet, 15.6% from themselves and 8% from social media b-COVID-19. These values changed to 27.7% from doctor, 17.5% from pharmacies, 16.2% from the internet, 15.6% from themselves and 11.4% from social media d- COVID-19. Only 4.6% of participants who used DS b-COVID-19 experienced side effects. The most common responses were stomach upset/pain/indigestion at 1.6%, nausea/vomiting at 1.5%, diarrhea at 1.5%, constipation at 1.3% and fatigue/weakness at 1%. During the COVID-19 period,



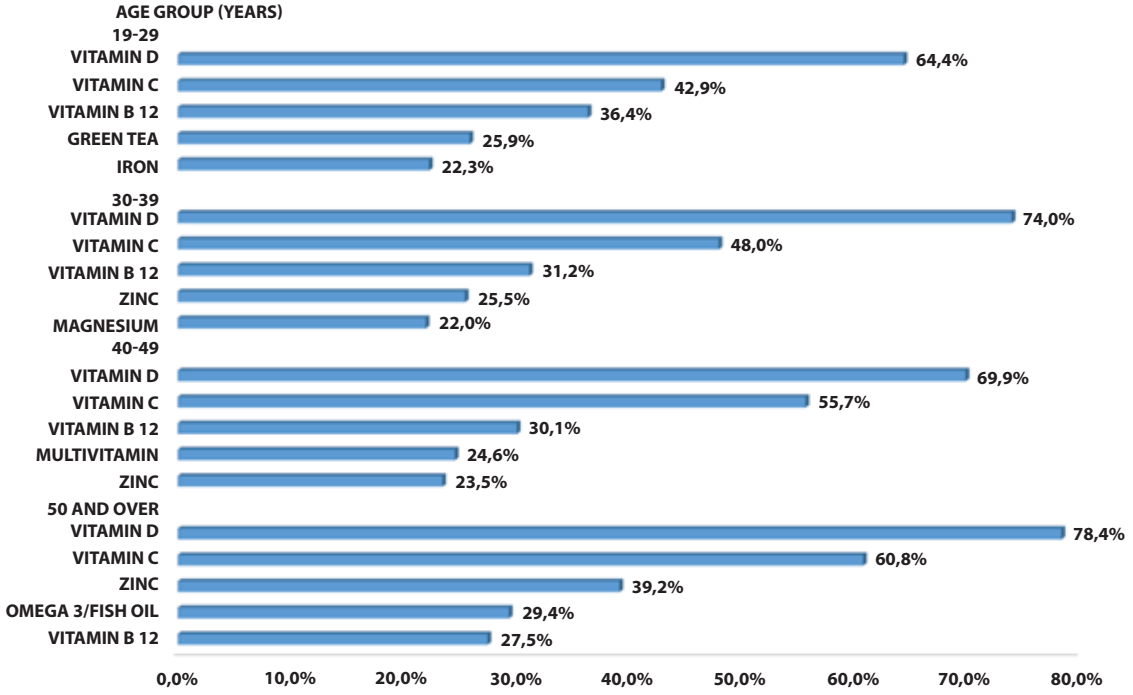


Figure 1. Most common types of dietary supplements used by participants before (A) and during (B) COVID-19. COVID-19: The coronavirus disease 2019

(A) – Before COVID-19

(B) – During COVID-19

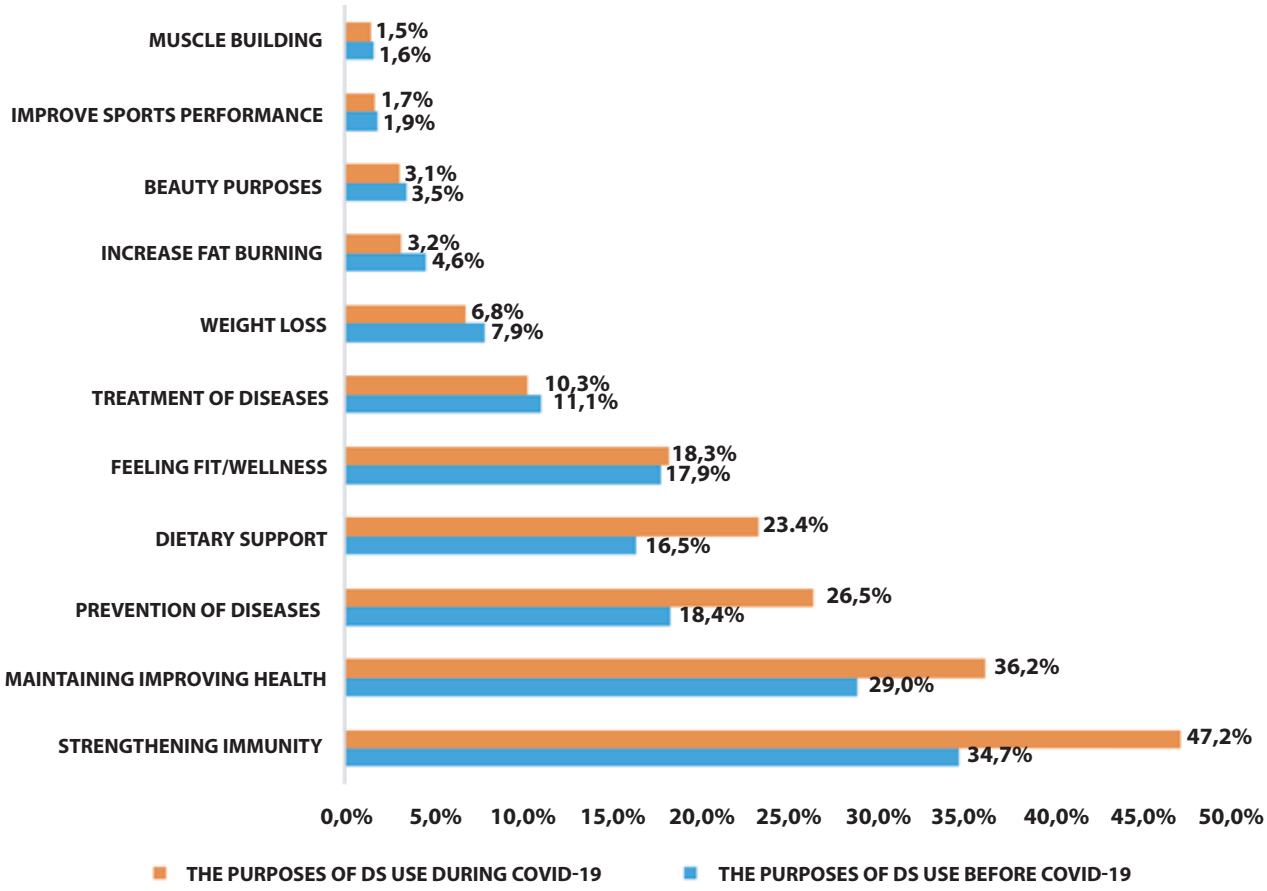


Figure 2. Percentages for reasons motivating DS use before and during COVID-19. COVID-19: The coronavirus disease 2019, DS: Dietary supplements

3.8% of DS users experienced side effects. The most common side effects were constipation at 1.5%, stomach upset/pain/indigestion at 1.3%, diarrhea at 1.3%, nausea/vomiting at 0.8% and headache at 0.6%.

Answers given by the participants to all statements about attitudes and behaviors on the use of DS in the last part of the study were in favor of "neither agree nor disagree" (Table 2). More female participants believed that DS are beneficial for health (P=0.03) and should be used under the control of a healthcare professional (P=0.04).

Discussion and Conclusion

The results of this study support the hypothesis that the use of DS increased and factors related with DS use changed during the COVID-19 pandemic. Of 1488 participants, 48.9% reported using DS b-COVID-19, and this increased to 57.9% d-COVID-19. In both periods, DS use was higher among women than men. The percentages of participants using DS were higher in the 30-39 age group, among those with bachelor degrees, income equal to expenses, who were married, normal weight and without COVID-19 infection history. The age distribution of DS use changed d-COVID-19, with more participants older than 40 years old using DS compared to b-COVID-19. DS use in different populations of several studies did not reflect the general population in Turkey b-COVID-19 with proportions of DS use ranging between 35.3-91% (26-28). The use of DS in healthy adults of five ethnicities in Hawaii and Los Angeles, California ranged from 44% to 75% (29). The National Health and Nutrition Examination Survey reported the age-adjusted DS use as 56.1% in

Table 2. Attitudes and behaviours about the use of dietary supplements according to sex

Statements		Female (*n*=1310)	Male (*n*=178)	Total Score	*P*
1	During the COVID-19 pandemic, my individual use of DS has increased.	2,93	2,92	2,93	0,90
2	My fear and anxiety of getting COVID-19 infection during the pandemic increased my individual use of DS.	2,81	2,75	2,80	0,54
3	The presence of those in my close environment who were infected with COVID-19 has increased my individual use of DS.	2,60	2,53	2,59	0,52
4	Deaths caused by COVID-19 infection increased my individual use of DS.	2,67	2,75	2,68	0,51
5	I think DS are beneficial for health.	3,42	3,17	3,39	0,03*
6	If the person's diet is healthy and sufficient, I think that they do not need DS.	3,12	3,12	3,12	0,98
7	I think that DS should be used under the control of a healthcare professional.	3,67	3,48	3,65	0,04*
8	I think that healthy people should also use DS.	3,01	2,96	3,00	0,77

Statistical analyses were conducted among sex. *P* values were calculated using the Mann-Whitney U test. *$P < 0.05$, DS: Dietary supplement, COVID-19: The coronavirus disease 2019

2017-2018 with a higher percentage of women than men. Among U.S. adults aged 20 and over, 57.6% used DS, and DS use increased with age, overall and in both sexes, and was highest among women aged 60 and over (80.2%) (15). Additionally, in a nationally representative sample of the Australian population, DS use in adults was 43% (35% of males and 50% of female), and independent predictors of DS use were female gender, increasing age, higher education level, healthy BMI, being physically active, and being a non-smoker (20).

The sales of DS for immune health increased in most countries after the COVID-19 outbreak because of the belief that these products might provide some protective effects against COVID-19 and help decrease disease severity (14,30). After the COVID-19 outbreak, a small number of studies in Turkey reported the proportion of DS use due to pandemic was 33% (31) and 48.9% (32). In a Polish study using Google Trends, DS use was 48% during the first wave and 79% during the second wave of the pandemic, and DS users were younger, better educated women living in more urbanized areas (14). In studies with large numbers of participants, the use of DS was 47.1% in the United Kingdom, 70.6% in the U.S., and 49% in Sweden during the pandemic (33). The Council for Responsible Nutrition reported that 43% of DS users changed their supplement routines due to COVID-19. Of those, 91% reported increasing their DS intake since the start of the pandemic (34). A European study showed that the belief in the importance of DS in overcoming infections became notably prominent during the COVID-19 pandemic (35). In a webpage research study in Canada and the U.S., the notion of immune boosting was described to help prevention of COVID-19 in 85.5% of webpages and supplements were mentioned as beneficial in 40% of the webpages. The top immune boosting strategies on websites were vitamin C (34.8%), diet (34.4%), sleep (34.4%), exercise (30.8%) and zinc (26.9%) (13).

Studies b-COVID-19 show that the most commonly reported types of DS used by all age groups were multivitamin and/or mineral supplements, followed by vitamin D and omega-3 fatty acid supplements (15,20,21,36-38). Several studies examined the type of DS used d-COVID-19. The use of DS ranged between 27-37% for vitamin C, 17.7-67% for vitamin D, 15-26.8% for omega-3 fatty acids, 12.4-17.8% for zinc, 41-58.3% for multivitamins, and 11.6-22.5% for probiotics (6,14,33). In a study with only dietitians in Turkey, the use of DS was reported as 19.4% for vitamin C, 39.4% for vitamin D, 81.9% for fish oil, 15.8% for zinc, 27.4% for multivitamins, 22.3% for probiotics and 17.4% for black elderberry (39). In the current study, DS use increased to 15.4% among health workers d-COVID-19. In a study with health workers b-COVID-19, 12.6% of individuals used herbal products, while 24.9% used vitamin-mineral supplements (22). Since VMD affects the type of DS used,

the type of DS was examined separately for those with and without VMD in the present study. The use of nearly 50 types of DS was questioned and only statistically significant changes were shown in the use of DS before and after the pandemic. Participants without VMD used more DS, mostly herbal supplements (Fig. A.1). Another study in Turkey d-COVID-19 identified the rate of starting to use vitamin D, C and zinc due to the pandemic as 56.9%, 50.4% and 27.6%, respectively (31). During the social isolation period in Turkey, the use of DS was 19.6% for vitamin C, 15.6% for vitamin D, 2.4% for zinc, 13.9% for multivitamin, 10.5% for probiotics-prebiotics, 4.0% for sambucus nigra complexes, and 1.7% for propolis (32). The use of DS increased compared to the pre-COVID-19 period and use increased since the beginning of COVID-19. Studies conducted b-COVID-19 about DS use in Turkey have inconsistent results. The use of DS were 1.6, 6.75 or 63.5% for vitamin C, 12.1 or 42.6% for vitamin D, 27 or 31.5% for fish oil, and 4.75, 17.8 or 28.4% for multivitamins (26-28).

Several reasons to use DS were reported such as wellness, prevention of illness, and improvement of dietary deficiencies (14,23). A decade before COVID-19, improving or maintaining overall health were the most important reasons to use DS, followed by boosting immunity (21,36). Currently, the reasons motivating DS use changed to helping the treatment and prevention of COVID-19. Among reasons for the use of DS d-COVID-19, improving immunity was stated most (60%), followed by improving overall health and wellness (57%), seasonal vitamin D or fish oil use (56%), and filling nutrient gaps in diet (53%) (14). In the current study, strengthening immunity was declared most often (47.2%), followed by maintaining/improving health (36.2%), prevention of diseases (26.5%), and dietary support (23.4%). Similarly in another study, strengthening immunity was the most important reason to use DS for 68.1% during the social isolation period in Turkey (32). In the present study, strengthening immunity was the main reason for DS use (34.7%) during one year b-COVID-19. Additionally, earlier than 2019, strengthening immunity was the main reason (30%) to use DS in Turkey (28).

The COVID-19 pandemic which is a new threat to public health, causes an important concern on human health with sudden lifestyle changes, and caused social and economic consequences. Optimizing public health during this pandemic requires of all human sciences related to lifestyle, social and behavioral studies, including dietary habits and lifestyle (40). Nutritional status is an important defense against the emergence of new viral pathogens (41). A diet with antioxidant and anti-inflammatory activities nutrients helps to reduce virulence of SARS-CoV-2 (42). Also facing continuously about the COVID-19 from media can be stressful. All these factor could direct individuals put more attention on immunity and the products, and led to a surge in the demand and supply of many complementary and alternative medicines. Recent studies have shown increasing complementary and alternative medicines information requests made to pharmacists and other healthcare professions from individuals of public and patients for prevention, symptoms relief or treatment of COVID-19 (43). Studies related with pandemic outcomes about dietary habits changes focus more on stress and eating, weight gain, lack of physical activity. Understanding behaviors towards immune related products consumption in pandemic time will be an important part. Also understanding the factors related with DS use will show a lot about individuals and public preferences.

This current study has some limitations. First, data were collected with a self-reported online questionnaire due to the COVID-19 precautions. Secondly, participants were mostly younger than forty years old. Another limitation was the skewness of sex, education, and income distributions of responders, which resulted in oversampling of women, those with a bachelor degree education level and income equal to expenses. Therefore, this may be a limitation for generalizing the results of this study to the whole population in Turkey.

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