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ORIGINAL ARTICLE / ARAŞTIRMA YAZISI

Nutrition and Dietetics / Beslenme ve Diyetetik

Evaluation of Gastrointestinal Life Quality and Food Consumption and Choices in Recovered Covid-19 Patients

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ABSTRACT

Background/Objectives: This study explores how gastrointestinal symptoms affect patients' nutrition, food choices, consumption, and gastrointestinal quality of life index (GIQLI) scores after recovering from COVID-19.

Subjects/Methods: A questionnaire-based cross-sectional study was conducted among patients aged 18 and older who recovered from COVID-19 between 15th May 2020 and 15th June 2020. The researchers sent 594 patients a questionnaire via e-mail, which included demographical information and questions related to supplement use, food choices, and a survey for GIQLI. Seventy-six patients who responded and consented to take the questionnaire were included in the final analysis.

Results: Weight loss post-COVID was significant for both male and female genders (-5.1± 4.0 vs. -1.5 ± 2.4; p-value:0.001). The length of hospitalization, the loss of appetite, and the loss of smell were significantly higher in male participants (P<0,05). The mean GIQLI score was significantly higher in males compared to females (102.2± 14.6 vs. 89.5 ± 23.2; p=0.003). Gender and regular probiotic use before and after hospitalization were correlated with the total GIQLI score (R = 0.646; R2 = 0.417)

Conclusion: COVID-19 affects the Gastrointestinal system (GIS) and appetite. Therefore, healthy nutrition, well adapted to the body's needs and the current level of physical activity, becomes particularly important during and post-COVID. In addition, the treatment of gut dysbiosis involving an adequate intake of pre and probiotics could be a beneficial instrument for modulating the immune system in COVID-19 patients and prophylactically pre-infection. Therefore, we recommend integrating probiotic use into current COVID-19 nutritional guidelines.

Keywords: COVID-19, Food, Infection, Diarrhea, Nutrition, Probiotic

İyileşen Covid-19 Hastalarında Gastrointestinal Yaşam Kalitesi, Besin Tüketimi ve Tercihlerinin Değerlendirilmesi

ÖZET

Amaç: Bu çalışma, COVID-19 geçirip iyileştikten sonra gastrointestinal semptomların; hastaların beslenmesini, besin tercihlerini, tüketimini ve gastrointestinal yaşam kalitesi indeksi (GIQLI) puanlarını nasıl etkilediğini araştırmaktadır.

Konu/ Yöntemler: 15 Mayıs 2020 ile 15 Haziran 2020 tarihleri arasında COVID-19 geçirip iyileşen 18 yaş ve üstü hastalar arasında anket tabanlı bir kesitsel çalışma yapıldı. Araştırmacılar, demografik bilgiler, takviye kullanımı, besin tercihleri ve GIQLI için sorular içeren bir anketi 594 hastaya e-posta yoluyla gönderdiler. Anketi yanıtlayan ve onaylayan 76 hasta son analize dahil edildi.

Bulgular: COVID-19 sonrası ağırlık kaybı erkek ve kadın bireyler için istatistiksel olarak anlamlıydı (-5.1± 4.0 vs. -1.5 ± 2.4; p-değeri: 0.001)). Hastanede kalma süresi, iştah kaybı ve koku kaybı erkek katılımcılarda önemli ölçüde daha yüksekti (p<0,05). Ortalama GIQLI puanı, erkeklerde kadınlara göre anlamlı ölçüde yüksekti (102.2± 14.6 vs. 89.5 ± 23.2; p=0.003). Cinsiyet ve hastaneye yatış öncesi ve sonrası düzenli probiyotik kullanımı, toplam GIQLI puanı ile ilişkiliydi (R = 0,646; R2 = 0,417).

Sonuç: COVID-19, gastrointestinal sistem (GIS) ve iştahı etkiler. Bu nedenle, vücudun ihtiyaçlarına ve mevcut fiziksel aktivite düzeyine uygun sağlıklı beslenme, özellikle COVID-19 sırasında ve sonrasında önemlidir. Ayrıca, bağırsak disbiyozunun tedavisi, uygun miktarda prebiyotik ve probiyotik alımını içeren, COVID-19 hastalarında bağışıklık sistemi modülasyonu için faydalı olabilir ve önleyici olarak enfeksiyondan önce kullanılabilir. Bu nedenle, probiyotik kullanımının mevcut COVID-19 beslenme yönergelerine entegre edilmesini öneriyoruz.

Anahtar Kelimeler: COVID-19, Besin, Enfeksiyon, Diyare, Beslenme, Probiyotik

Main Points

Seventy percent of immune system cells reside in GIS, and there is a strong relationship between gut cells, immunity, and dietary habits.

The digestive system may have been the main target organ of COVID-19. Probiotic supplementation may reduce the severity or shorten the duration of infection.

Probiotic use prior to COVID-19 is associated with higher total GIQLI scores. Therefore, healthy nutrition, well adapted to the body's needs and the current level of physical activity, becomes particularly important during and post-COVID.

Introduction

Patients experience gastrointestinal symptoms in the early stages of the COVID-19 infection, as in severe acute respiratory syndrome (SARS-CoV) and the Middle East respiratory syndrome (MERS-CoV) (1). In a cohort study conducted with 1099 patients in China, researchers observed vomiting or nausea symptoms in 5% of the patients and diarrhea in 3.8% of all patients (2). The coronavirus virus (SARS-CoV-2) has a 79.6% similarity to the SARS-CoV virus, and it codes and synthesizes the proteins that can attach to angiotensin-converting enzyme 2(ACE2) to be able to penetrate human cell (3). ACE2 receptors in type 2 alveolar cells are also synthesized in copious amounts in the small and large intestines (4). The detection of SARS-CoV-2 in fecal samples of 50% of patients and the presence of SARS-CoV-2 in the intestinal mucosa of patients with COVID-19 implies that invaded enterocytes expressing ACE2 lead to intestinal symptoms (5).

It is largely unknown how COVID-19 manages to evade the immune system. Studies show a relationship between disease severity, the level of proinflammatory cytokines, and the subgroups of immune cells. During the acute phase of infection, the dysregulation of the immune system and the elevated level of proinflammatory cytokines may lead to tissue damage (6). To mitigate potential damage, a balanced diet, physical activity, and healthy sleep patterns are among the most effective ways of disease prevention and strengthening the immune system (7, 8). In addition, the body's energy requirements soar due to an increased metabolism during an active immune system. Thus, it is essential to supply energy, macro, and micronutrients to support immune cells and create an efficient and rapid response to pathogens for the best immunologic results. If exogenous sources such as diet are not enough, the requirements of the immune system for energy, macro, and micronutrients are met from endogenous sources such as body storage (7).

Macro and micronutrients have specific roles in developing and maintaining a lifelong potent immune system. Zinc (Zn), manganese (Mn), copper (Cu), iron (Fe), selenium (Se), folate, and vitamins B6, B2, and B12 comprise the micronutrients required for an effective immune response. Antioxidant vitamins, such as vitamins E, C, and A, carotenoids, and flavonoids, also positively affect the immune system and cytokines, protect us from oxidative stress, and generate proliferative responses (8). Seventy percent of immune system cells primarily reside in GIS. The latest scientific studies revealed a strong relationship between gut cells, immunity, and dietary habits. In this context, probiotics such as yogurt, kefir, homemade pickle, and cheese and prebiotics such as banana, apple, strawberry, grapes, artichoke, celery, asparagus, onion, garlic, leek, legumes, whole grains, flaxseed, almond, walnut supply the necessary ingredients to the body for the integrity of the intestinal immune system (9). The World Health Organization recommended daily consumption of adequate water and fresh and unprocessed foods to supply the body's vitamins, minerals, dietary fiber, protein, and antioxidants during the pandemic. Recent studies advise against the consumption of excessive amounts of sugar, salt, and fat as they may suppress the immune system (10).

In this study, we explored how gastrointestinal symptoms of recovered hospitalized COVID-19 patients affected their nutrition and food preferences. Moreover, we analyzed the relationship between patient's food choices and consumption, body weight change, and how these affect GIS health as potential risk factors. The studies examining changes in food choices and consumption are limited to the general population during the lockdown period (11).

Our study is unique in the literature because it explores the GIQLI and food choices in recovered patients.

Methods

The researchers screened 3513 patients aged 18 years and older who underwent inpatient COVID-19 treatment between 15th May 2020 to 15th June 2020. The study coordinators sent a questionnaire to patients whose e-mail was in the patient registry system (n=594), of whom 13% (n=76) responded and consented to participate. While those who had COVID-19 and recovered were included in the study, those with cancer, pregnant-lactating, digestive system diseases were not included. The first part of the questionnaire included demographic information and questions related to alcohol, tobacco, supplement use, level of exercise, and food choices. The second part contained GIQLI, a 36-question survey querying symptoms, physical status, emotions, social dysfunction, and effects of medical treatment. Every question is scored from zero to four points (0–4), and a higher value represents a better outcome. The maximum score on this scale is 144 (12). The usual range of scores is between 118-126 (13). Appetite, taste, smell, intestinal gas and bloating were evaluated with a 1-10 mm Visual Analog Scale (VAS). Before conducting this study, we obtained ethics approval from the Medical Research Ethics Board of Acibadem University. The data were analyzed with descriptive statistics and univariate analyses (Student's t-test and Mann–Whitney U Test) to identify variables associated with total GIQLI scores using SPSS version 22.0. First, we performed a Shapiro-Wilk normality test to confirm data normality. Next, we used Cronbach's alpha to measure internal consistency and reliability. Finally, cross-tabulation and the chi-square tests investigated associations among the variables, and multiple linear regression analyses helped identify the predictors of total GIQLI scores. All calculations were two-tailed with an alpha set at 0.05.

Results

Socioeconomic demographics, comorbidities, pre, and post-COVID alcohol and tobacco consumption, and exercise levels of the recovered cases are presented in Table 1. Among the study participants, 52.6% (n=40) were female, and 47.4% (n=36) were male. Most female (72.5%) and male participants (63.9%) held a higher education degree. In addition, 26.3% (n=20) of the sample were current smokers when they were infected, and the percentage of smokers decreased by 7.9% (n=6) after COVID recovery. Only 36.8% (n=28) of the participants did not consume alcohol. The rate of social-alcohol consumption, defined as one or two glasses of alcohol a couple of times a month, was 63.2% (n=48) before COVID infection, which decreased to 39.5% (n=30) after recovery. The percentage of patients diagnosed with chronic diseases such as diabetes and hypertension was 38.2% (n=29). Table 2 shows the means and standard deviations for variables of recovered cases based on gender. The participants' ages ranged from 21 to 74 years, with a mean (±SD) age of 42.7± 12.3 years and a mean weight of 77.9±16.8 kg (89.9±11.1 kg for males and 67.1±13.3 kg for females pre-COVID. Weight change in discharged patients was -1.5±2.4 kg in females and -5.1±4.0 kg in males ($p<0.001$). In addition, the hospitalization length in male participants was significantly higher than in female participants ($p<0.001$). Females experienced a significantly higher loss of appetite and smell than male participants ($p<0.05$). Male participants (102.2±14.6) scored significantly higher on the GIQLI than their female counterparts (89.5±23.2) ($p<0.05$). There were no significant differences in GIQLI subscales scores between the two genders ($p<0.05$). Table 3 lists the participants' most frequently consumed vitamins and supplements pre-COVID-19 as vitamins C, D, B12, and probiotics. After recovery, vitamin C (68.4%), probiotics (48.7%), and combination multivitamin & mineral (53.9%) supplements were popular among patients. Table 4 indicates the changes in food consumption quantities in recovered patients. Post COVID-19 infection, fresh vegetables (59.2%), fresh fruits (51.3%), nuts (32.9%), yogurt (28.9%), herbal tea (32.9%) and water (75.0%) consumption increased. Meanwhile, patients decreased the amount of white bread (40.8%), bakery products (27.6%), carbonated (31.6%), and lightly carbonated beverages (27.6%) in their post-COVID diet. Multiple linear regression analyses showed a significant correlation between gender, regular probiotic use and GIQLI total scores pre and post COVID-19 infection ($p<0.001$; $R= 0.646$, $R^2 = 0.417$) (See Table 5).

Table 1.Socioeconomic demographic, smoking, alcohol use and exercise levels

Variables	Male		Female		Total		Chi-Square	*p*-value
	n	%	n	%	n	%		
Educational level								
Elementary or secondary school	2	5.6	-	-	2	2.6	5.291	0.259
High school	4	11.1	6	15.0	10	13.2		
University	23	63.9	29	72.5	52	68.4		
Postgraduate	7	19.4	5	12.5	12	15.8		
Marital status								
Married	31	86.1	22	55.5	53	69.7	12.619	0.006
Single	5	13.9	18	44.5	23	30.3		
Smoking status before infection								
Yes	10	27.8	10	25.0	20	26.3	0.1	0.494
No	26	72.2	30	75.0	56	73.7		
Smoking status after infection								
Yes	2	5.6	4	10,0	6	7.9	0.515	0.389
No	34	94.4	39	90.0	70	92.1		
Alcohol consumption before infection								
Yes	24	66.7	24	60.0	48	63.2	0.362	0.359
No	12	33.3	16	40.0	28	36.8		
Alcohol consumption after infection								
Yes	12	33.3	10	25.0	30	39.5	1.719	0.141
No	24	66.7	30	75.0	46	60.5		
Exercise before infection (at least 150 minute / per week)								
Yes	12	33.3	10	25.0	22	28.9	0.324	0.370
No	24	66.7	30	75.0	54	71.1		
Exercise after infection (at least 150 minute / per week)								
Yes	15	41.7	8	20.0	23	30.3	0.071	0.486
No	21	58.3	32	80.0	53	69.7		
Diagnosed disease before infection								
Yes	16	44.4	13	32.5	29	38.2	1.146	0.202
No	20	55.6	27	67.5	47	61.8		

*$p < 0.05$.

Table 2. Means and standard deviations for the variables of participants

Variables	Male		Female		Total		*p*-value
	Mean	SD	Mean	SD	Mean	SD	
Age (year)	45.9	11.2	39.8	12.6	42.7	12.3	**0.031**
Weight in pre-infection (kg)	89.9	11.1	67.1	13.3	77.9	16.8	**0.000**
Weight in discharged (kg)	84.8	11.1	65.6	13.1	74.7	15.5	**0.000**
Weight differences (kg)	-5.1	4.0	-1.5	2.4	-3.2	3.7	**0.000**
BMI in pre-infection (kg/m^2)	28.1	3.2	25.0	4.9	26.5	4.4	**0.002**
BMI discharged (kg/m^2)	26.5	3.0	24.5	4.9	25.5	4.2	**0.037**
Current BMI (kg/m^2)	27.2	2.7	25.5	5.6	26.3	4.5	0.114
Hospitalization day	12.8	7.3	7.8	5.0	10.1	6.6	**0.001**
Changes post-infection?							
Appetite	6.2	2.2	5.4	2.1	5.8	2.1	0.107
Sense of taste	6.4	2.1	5.0	3.1	5.7	2.7	**0.032**
Sense of smell	6.5	2.2	4.9	3.1	5.7	2.8	**0.017**
Intestinal gas	6.3	1.8	6.4	2.5	6.4	2.2	0.856
Abdominal bloating	5.3	2.0	6.5	2.9	5.9	2.6	0.052
GIQLI Total Score	102.2	14.6	89.5	23.2	95.5	20.5	**0.030**
Core symtpom score	28.3	6.0	23.7	8.1	25.9	7.5	0.059
Psychological symptom score	14.6	3.7	13.5	4.8	14.0	4.3	0.105
Physical sypmtom score	14.3	4.4	12.6	4.5	13.4	4.5	0,122
Social sypmtom score	8.1	3.0	7.4	2.6	7.7	2.8	0.093
Diseases-specific symptom score	36.9	3.2	32.3	6.7	34.5	6.0	0.055

BMI; Body mass index, GIQLI; Gastrointestinal quality of life index
*Data are presented as mean ± SD. Independent t-test were performed. *p < 0.05.*

Tablo 3. The frequency of food supplements use by participants in pre and post-COVID19 Infection

Food Sumpplements	Use of food supplements pre-COVID19 infection		Use of food supplements after recovered COVID-19		Chi-Square	*p*-value
	n	%	n	%		
Vitamin C	44	57.9	52	68.4	8.681	0.004
Vitamin D	35	46.1	34	44.7	18.696	0.000
Zinc	17	22.4	23	30.3	28.154	0.000
Curcumin	17	22.4	17	22.4	29.322	0.000
Propolis	15	19.7	20	26.3	35.104	0.000
Probiotic	31	40.8	37	48.7	1.339	0.177
Sambucus nigra	18	23.7	16	21.1	11.169	0.004
Iron	14	18.4	11	14.5	37.157	0.000
Calcium	12	15.8	7	9.2	41.127	0.000
Magnesium	13	17.1	9	11.8	26.504	0.000
Selenium	7	9.2	8	10.5	30.364	0.000
Vitamin E	7	9.2	5	6.6	32.073	0.000
Omega-3	7	9.2	21	27.6	49.851	0.000
Vitamin B12	28	36.8	18	23.7	9.016	0.004

**p < 0.05 (χ^2-test) for the difference in proportions between pre and after COVID-19*

Table 4. The frequency of changing food consumption preferences after infection in patients with COVID-19 infection

Foods	Changing food consumption preferences after recovered COVID-19					
	Increased		Decreased		Unchanged	
	n	%	n	%	n	%
Milk	5	6.6	3	3.9	68	89.5
Yoghurt	22	28.9	1	1.3	53	69.7
Kefir	13	17.1	-	-	63	83.9
Cheese	7	9.2	4	5.3	65	85.5
Pickles	6	7.9	7	9.2	63	82.9
Fruits (fresh)	39	51.3	-	-	37	48.7
Fruits (dried, frozen)	1	1.3	11	14.5	64	84.2
Vegetables (fresh)	45	59.2	1	1.3	30	39.5
Vegetables (frozen, can)	4	5.3	9	11.8	63	82.9
Legumes	22	28.9	4	5.3	50	65.8
Bread (white)	2	2.6	31	40.8	43	56.6
Bread (whole grain)	19	25.0	3	3.9	54	71.1
Bakery foods	9	11.8	21	27.6	46	60.5
Whole grains	13	17.1	6	7.9	57	75.0
Red Meat	17	22,4	7	9.2	52	68.4
Poultry	6	7,9	7	9.2	63	82.9
Fish and sea foods	14	18.4	8	10.5	54	71.1
Bone broth	10	13.2	3	3.9	63	82.9
Carbonated beverages (with sugar)	2	2.6	24	31.6	50	65.8
Carbonated beverages (light)	-	-	21	27.6	55	72.9
Herbal tea	25	32.9	6	7.9	45	59.2
Black tea	9	11.8	6	7.9	61	80.3
Green tea	8	10.5	4	5.3	64	84.2
Coffee	7	9.2	12	15.8	57	75.0
Spicy	10	13.2	6	7.9	60	78.9
Water	57	75.0	3	3.9	16	21.1
Ginger	16	21.1	4	5.3	56	73.7
Turmeric	11	14.5	3	3.9	62	81.6
Olive oil	10	13.2	-	-	66	86.8
Butter	16	21.1	1	1.3	59	77.6
Milky desserts	12	15.8	4	5.3	60	78.9
Pastries	3	3.9	16	21.1	57	75.0
Nuts	25	32.9	3	3.9	48	63.2
Seeds	8	10.5	10	13.2	58	76.3

Discussion

At the time of this publication, COVID-19 has affected more than 216 million people globally and over six million in Turkey. Previous reports about GIS symptoms in SARS-CoV-2 are varied, and it is estimated that they occur in 5 to 50% of people (2). Subsequently, less common manifestations, such as abdominal discomfort, nausea, vomiting, and diarrhea, present significant differences among various study populations, along with an early onset and mild symptoms usually followed by respiratory manifestations (14). Data from previous studies suggested that the enteric tropism of SARS coronavirus (SARS-CoV) was confirmed by viral detection in stool and biopsy specimens, even in discharged patients. This finding may partly explain the GIS signs and symptoms, potential relapse, and transmission of SARS via the continuous fecal shedding of the virus (15). Other reports specified the percentage of COVID-19 patients with GIS symptoms as 2 to 10%, and the main symptoms listed were diarrhea and vomiting (14). In our study, almost half of the hospitalized patients did not experience any GIS issues, and among those who did, the most common complaints were nausea, anorexia, and diarrhea. The gastrointestinal system may be a target organ of COVID-19, and in these patients, the amount of virus in feces poses minimal risk. Research by Wang et al. reported that patients who were positive for COVID-19 in their stool samples presented gastrointestinal symptoms such as changes in bowel habits and diarrhea. They were re-admitted after respiratory samples had negative test results and upon resolution of the previous chest computed tomography findings (16). In our study, participants reported the following GIS symptoms post-COVID; gas: 29%, nausea: 17.1%, abdominal pain: 11.8%, constipation: 9.2%; diarrhea: 7.9%, and acid reflux:7.9%. In addition, we evaluated patients' appetite, smell, taste, abdominal gas, and bloating perceptions with a visual analog scale. Following discharge, appetite, smell, and taste in males were more affected than in females, while abdominal gas and bloating were the more common symptoms in females. Pan et al. found 103 patients who reported digestive-system-related symptoms, such as lack of appetite, diarrhea, vomiting, and abdominal pain, in COVID-19 patients (17). However, we did not find any publication in the literature investigating above GIS symptoms in post-COVID-19 patients.

Table 5. Multiple regression analyses on gastrointestinal quality of life index (GIQLI) score in the overall sample

	B	SE	β	t	95% CI		p
Age (years)	0.335	0.171	0.201	1.964	-0.005	0.676	0.054
Gender[1]	11.503	5.426	0.282	2.120	0.676	22.331	**0.038**
Weight before infection (kg)	-0.073	0.159	-0.060	-0.460	-0.391	0.244	0.647
Length of hospitalization(day)	-0.363	0.326	-0.118	-1.114	-1.015	0.288	0.269
Comorbidities[2]	-1.230	4.629	-0.029	-0.266	-10.468	8.008	0.791
Regular probiotic use pre-Covid-19[3]	-9.252	4.531	-0.223	-2.042	-18.293	-0.211	**0.045**
Regular probiotic use post Covid-19[4]	-16.976	4.788	-0.417	-3.546	-26.530	-7.422	**0.001**

B = beta coefficient; SE = Standard error; β = Standardized beta coefficient; CI: Confidence Interval
[1]1=female; 2=male, [3]0=no; 1=yes, [4]0=no; 1=yes,

According to a study by Nguyen et al., males had a longer length of hospital stay than females and a higher death rate across all age, race and ethnicity groups, and preexisting comorbidities (18). Similarly, in a retrospective study, higher age (70+), male sex, and individual comorbidities were all significantly associated with in-hospital stay and mortality (19). Our study illustrates similar results with a higher mean hospital stay for males vs. females.

Various vitamins and trace elements are essential for the normal functioning of the immune system. However, one should note that supplements do not have a protective effect on COVID-19. A healthy immune system is essential where no effective preventive and curative medicine exists. A recent review by Jayawardena et al. reported that vitamins A, D, and E, and some trace elements, such as zinc and selenium, have shown favorable immune results in viral respiratory infections (20). Also, many nutraceuticals and probiotics demonstrated immune-promoting effects for preventing or treating viral infections. However, good nutrition is essential during and after illness, so a healthy diet is necessary for supporting the immune system (21). In our study, participants reported using supplements with immune supportive effects, such as vitamin C, D, B12, multivitamins, minerals, and probiotics pre and post-COVID (Table 3). The most preferred supplements were vitamin C, D, multivitamins, minerals, and probiotics.

In addition, post-COVID 19, most patients reported increased consumption of vegetables, fruits, nuts, yogurt, water, and herbal teas. Unfortunately, to our knowledge, the studies in the literature examining the change in patients' food preferences pre- and post-COVID are limited to the general population during the lockdown period (22). Schmulson et al. reported that GIS symptoms in patients with COVID-19 seem equally distributed between male and female genders (23). Our study results align with these findings. At the time of this publication, we could not find data about gastrointestinal complaints and gender relationships post-COVID-19 infection in the literature. In our study, female patients with COVID-19 had significantly lower GIQLI scores than males post-infection. Therefore, we suspect women with COVID-19 may experience more intense GIS complaints after discharge. However, further studies are needed in this area.

Probiotics offer a wide range of health benefits. A meta-analysis by Lee et al. revealed that probiotics had a moderate impact on reducing the common cold (24). Furthermore, several studies suggested that probiotic supplementation either reduced the severity of infection or shortened its duration. These studies also indicated the efficacy of Lactobacillus for viral-originated respiratory tract infection treatment (25). Researchers emphasized the significant association between Bifidobacterium and improved immune function and intestinal microbiota in the elderly (26). Many clinical trials and meta-analyses explored the benefits of probiotics for common gastrointestinal illnesses such as irritable bowel syndrome (27), Helicobacter Pylori infection (28), Necrotizing Enterocolitis (29), antibiotic-associated diarrhea (30), infectious diarrhea, and traveler's diarrhea (31). All these studies revealed that probiotic bacteria have notable effects on preventing and treating gastrointestinal illnesses (31). In a recent review, Dhar and Mohanty expressed that gut microbiota has a role in affecting lung disease (32). The meta-analyses held in developed countries in a health-care setting established that respiratory virus infection disturbs the gut microbiota (32).

Nutrition, environment, and genetics play an essential role in forming gut microbiota which can affect immunity. The diversity of intestinal microbiota declines with age, and COVID-19 has been fatal in older patients, highlighting the gut microbiota's role in diseases. Research suggests that enhancing gut microbiota with personalized nutrition and supplementation improves immunity and may help reduce symptom burden in the elderly and immune-compromised people.

In our study, 40.8% of patients reported using probiotic supplements (mostly Bifidobacterium spp.) pre-infection and 48.7% post-infection (mostly Saccharomyces boulardii). We conducted a multiple linear regression analysis to ascertain the independent effects of probiotic use before and after COVID-19 on the GIQLI total score. In summary, we found that GIS complaints persisted at least two weeks after discharge in one-fifth of patients with COVID-19. Almost half of the patients used one or more dietary supplements after release, especially vitamin C, vitamin D, multivitamins, minerals, and probiotics. In addition, patients increased their consumption of fresh vegetables, fresh fruit, nut, water, and herbal tea post-COVID. Patients who used probiotic supplements before and after infection had a better gastrointestinal quality of life. In conclusion, respiratory system symptoms drive the criteria for diagnosis and discharge of COVID-19; however, some patients may primarily show digestive symptoms due to infection of the gastrointestinal tract by SARS-CoV-2.

COVID-19 affects GIS. Hence, healthy nutrition, well adapted to the body's needs and the current level of physical activity, becomes particularly important during and post-COVID. In addition, the treatment of gut dysbiosis involving an adequate intake of pre and probiotics could be a beneficial instrument for modulating the immune system in COVID-19 patients and prophylactically pre-infection. Therefore, we recommend integrating probiotic use into current COVID-19 nutritional guidelines.

Declarations

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Conflict of Interest

The authors declare no potential conflicts of interest.

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