Cukurova Medical Journal
ÇUKUROVA ÜNİVERSİTESİ TIP FAKÜLTESİ

Cukurova Med J 2025;50(2):328-340
DOI: 10.17826/cumj.1619283

RESEARCH

Cognitive impairments, depression and quality of life 1 year after COVID-19 hospital discharge

COVID-19 sonrası taburculuğun birinci yılında bilişsel bozukluklar, depresyon ve yaşam kalitesi

Cana Aksoy Poyraz[1], Büşra Uçar Bostan, Elif Burcu Ersungur Çelik, İrem Hacısalihoğlu Aydın[1], Mehmet Murat Kırpınar[1], Burç Çağrı Poyraz[1], Ömer Faruk Demirel[1], Rıdvan Karaali[2]

[1]Istanbul University-Cerrahpaşa, Istanbul, Türkiye

Abstract

Purpose: Following the acute stage of COVID-19, many patients have experienced persistent physical and neuropsychiatric symptoms, regardless of the severity of the illness. Key concerns like fatigue, depressive symptoms, and cognitive impairments have a detrimental effect on psychosocial functioning and quality of life. This study aims to explore cognitive impairments and depression one year after discharge from the hospital for COVID-19, along with implications for quality of life.

Materials and Methods: Patients hospitalized with COVID-19 with mild-moderate disease severity were asked to participate in a 12-month follow-up evaluation. A total of 60 individuals who had recovered from COVID-19 were examined for cognitive functions, depressive symptoms, and quality of life. They were then compared to a healthy comparison group, matched for age and education, who had not been infected with COVID-19.

Results: After 1 year following discharge, cognitive impairment was noted in 21.7% of COVID-19 patients, based on The Montreal Cognitive Assessment, while only 3.3% of the non-COVID-19 control group exhibited the same. Quality of life domains were largely comparable across groups. Depressive symptoms were identified as the main factor affecting quality of life domains in COVID-19 patients.

Conclusion: Despite the potential for cognitive impairment to last for up to a year following hospital discharge, it does not seem to have a negative effect on the quality of life in our group of patients with mild-to-moderate disease severity. However, depressive symptoms were found to be the key indicators of quality of life.

Keywords:. cognitive impairment, COVID-19, quality of life, depression

Öz

Amaç: COVID-19'un akut evresini takiben, hastalığın şiddet düzeyinden bağımsız olarak birçok hastada uzun süreli fiziksel ve nöropsikiyatrik semptomlar ortaya çıkmıştır. Yorgunluk, depresif semptomlar ve bilişsel bozukluklar gibi temel sorunlar, psikososyal işlevsellik ve yaşam kalitesi üzerinde olumsuz etkilere neden olmaktadır. Bu çalışma, COVID-19 nedeniyle hastaneden taburcu edilen bireylerde, bir yıl sonrasında bilişsel bozukluklar ve depresyonun varlığını ve bunların yaşam kalitesi üzerindeki etkilerini araştırmayı amaçlamaktadır.

Gereç ve Yöntem: COVID-19 nedeniyle hafif-orta şiddette hastalık geçiren ve hastanede yatarak tedavi gören hastalardan, taburculuktan 12 ay sonra değerlendirmeye katılmaları istenildi. COVID-19'dan iyileşmiş toplam 60 birey, bilişsel işlevler, depresif semptomlar ve yaşam kalitesi açısından değerlendirilmiş ve yaş ve eğitim düzeyine göre eşleştirilmiş, COVID19 enfeksiyonu geçirmemiş sağlıklı bir kontrol grubu ile karşılaştırılmıştır.

Bulgular: Taburculuktan 1 yıl sonra, Montreal Bilişsel Değerlendirme ölçeğine göre COVID-19 hastalarının %21,7'sinde bilişsel bozukluk tespit edilmiştir, buna karşın kontrol grubunda bu oran yalnızca %3,3'tür. Yaşam kalitesi alanları genel olarak gruplar arasında benzerdir. Depresif semptomlar, COVID-19 hastalarında yaşam kalitesi alanlarını etkileyen ana faktör olarak belirlenmiştir.

Sonuç: Taburculuk sonrası bir yıl boyunca bilişsel bozukluklar devam edebilse de, hafif-orta şiddette hastalık geçiren hasta grubunda yaşam kalitesi üzerinde olumsuz bir etkisi bulunmamıştır. Ancak depresif semptomlar, yaşam kalitesinin temel göstergeleri olarak tespit edilmiştir.

Anahtar kelimeler: bilişsel bozukluk, COVID-19, yaşam kalitesi, depresyon

Address for Correspondence: Büşra Uçar Bostan, Department of Psychiatry, İstanbul University-Cerrahpaşa, Cerrahpaşa School of Medicine, Istanbul, Türkiye E-mail: busraucarbostan@gmail.com
Received: 15.01.2025 Accepted: 15.05.2025

INTRODUCTION

The COVID-19 pandemic has brought about unprecedented challenges in terms of physical health and mental well-being. The health status of patients who were hospitalized with COVID-19 was still worse than that in the control population even a year after their initial diagnosis[1]. Fatigue, cognitive impairment, and depression are frequently reported as the most common and disabling aspects of 'long-COVID' or 'post-COVID syndrome', which involves lingering symptoms lasting 12 weeks or more after the resolution of acute illness[2]. A greater risk of long-term COVID-19 is associated with severe COVID-19 illness[3,4], advanced age, increased comorbidities, and female sex[5].

Long-term cognitive sequelae of COVID-19 generally describe memory or concentration difficulties. Several studies have indicated that cognitive impairments are frequently seen in individuals in the months following their hospitalization for COVID-19[6,7], although some studies have reported lower rates of cognitive dysfunction [8,9]. Research has shown that cognitive impairment can vary from 15 to 80% [10], with deficiencies in attention, memory, verbal fluency, executive functions, and processing speed[8-10]. Cognitive impairment was found to have a pooled proportion of 22% in a meta-analysis of 43 studies[5]. This meta-analysis includes studies that examined cognitive impairment following COVID-19 using various methodologies and assessment tools. The methodologies used in these studies vary significantly, with some employing validated cognitive assessments like the Montreal Cognitive Assessment (MoCA), the Screen for Cognitive Impairment for Psychiatry (SCIP), and the Brief Repeatable Battery of Neuropsychological Tests (BRB-NT), while others rely on self-reported cognitive complaints through questionnaires. Many studies have taken a longitudinal approach, assessing cognitive function at different time points post-infection, from three months to over a year, to track the progression of cognitive decline or recovery. Additionally, factors such as disease severity, inflammatory markers, hospitalization history, and psychological conditions (e.g., depression, anxiety) have been examined as potential contributors to cognitive impairment. However, inconsistencies in study designs, heterogeneous populations, and varied neuropsychological tests have led to differing conclusions regarding the exact nature and persistence of COVID-19-related cognitive dysfunction[5].

Despite the limited data on long-term cognitive deficits in survivors of COVID-19, several longitudinal cohort studies have demonstrated that cognitive impairment can persist at 6 months and 1 year post-recovery in hospitalized patients[7,11-13]. However, the trajectories of cognitive impairment can vary greatly. Some studies show that cognitive impairment does not improve at 1 year[12]. In contrast, others indicate that the prevalence of cognitive impairment decreases within 1 year of hospitalization, suggesting that many patients recover during this time[13].

Improvements in cognitive domains such as verbal fluency, attention, processing speed, executive functions, psychomotor coordination, working memory, and verbal memory have been observed between 3 and 6 months, particularly in connection with mood enhancement, as assessed through standardized neuropsychological tests including phonemic and semantic fluency tests, the Symbol Coding Test, the Tower of London Test, the Token Motor Task, the Digit Sequencing Task, and list-learning paradigms[11].

The prevalence of clinically significant depressive symptoms among COVID-19 survivors ranged from 21% to 45% [14,15]. The quality of life of COVID-19 survivors was found to be significantly impacted by an interaction between depression and cognitive functions at the 6-month follow-up after hospital discharge[11]. The COVID-19 psychiatric consequences are thought to be linked to the immune inflammatory response to the viral infection and the potential neuroinflammation that follows along with psychosocial stress [16,17]. Comprehending these mechanisms is vital for crafting impactful interventions that truly make a difference.

Quality of life is a multidimensional concept that measures the well-being of individuals, considering several aspects, such as physical and mental health. Several studies have shown that COVID-19 patients experience a decrease in at least one aspect of their quality of life compared to their pre-infection status, non-COVID subjects, or population norms 12 weeks or more after diagnosis[5]. Although some long-term studies show improvement in various aspects of quality of life[18], it is important to note that in most studies, quality of life remains below population

norms[19]. A recent systematic review revealed that approximately one-third of survivors of critical cases of COVID-19 experienced a decline in their functional status and health-related quality of life[20]. It is worth noting that patients who required mechanical ventilation and stayed in the intensive care unit (ICU) tended to have poorer outcomes[20,21].

Despite the growing evidence, a notable research gap persists in our understanding of the complex interplay between depression and cognitive impairments in individuals who have survived COVID-19. This gap limits our insight into how these two factors interact and jointly influence these survivors' overall quality of life. Exploring this relationship is crucial, as it can shed light on the challenges faced by these individuals and inform approaches for improving their well-being.

This study enhances the existing literature on the long-term cognitive effects of COVID-19 by investigating cognitive functioning one year after hospital discharge and its correlation with depressive symptoms and quality of life. We hypothesized that individuals hospitalized for COVID-19 would demonstrate substantial cognitive impairments one year after discharge and that these impairments would correlate with depressive symptoms and diminished quality of life.

MATERIALS AND METHODS

Participants and procedure

This case-control study examines all patients treated at the COVID-19 services at Istanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, between February 1 and October 1, 2021. This is a tertiary care academic hospital with standardized diagnostic and treatment protocols. Clinical data were extracted from electronic medical records and cross-checked by a secondary reviewer to ensure accuracy.

Diagnosis of COVID-19 was confirmed by a positive polymerase chain reaction (PCR) test for severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2) from the upper respiratory tract. Out of the 545 individuals who had inpatient treatment during this period, 121 died. Subsequently, the remaining cohort of 424 patients was contacted by phone for assessment; however, 142 individuals could not be reached, 29 consented but did not attend, and the rest declined participation for various reasons, resulting in 61 individuals who ultimately took part in the study.

Two psychiatrists conducted a face-to-face psychiatric evaluation. Interviews were performed 12 months after the patients' discharge from the hospital. The study included literate people between the ages of 18 and 60 who were treated in the hospital with the diagnosis of COVID-19. Those with alcohol and drug abuse, previously known cognitive disorders, psychotic disorders, bipolar disorder, intellectual disability, or primary neurological diseases were excluded from the study. After face-to-face evaluation with 61 people who agreed to participate in the study, 1 person was excluded from the study because he was followed up with a diagnosis of schizophrenia. A total of 60 people constituted the patient group. The control group was selected from the relatives of hospital staff who agreed to participate in the study. The history of COVID-19 infection was assessed by reviewing records from the National Medical Registry and verifying with patient-reported information. The patient group was matched with the control group by decades for age and four-year education intervals. Those with a history of COVID-19, current alcohol and drug use disorders, previously known cognitive disorders, psychotic disorders, bipolar disorder, intellectual disability, or primary neurological diseases were not included in the study.

The investigators explained the objectives and methods of the study to the participants and filled in the sociodemographic and clinical data forms. The investigators administered the Standardized Montreal Cognitive Assessment Scale (MoCA) to the participants. Patients were then asked to complete self-reported tests consisting of the World Health Organization Quality of Life ScaleShort Form-Tr (WHOQOL-BREF-TR), Pittsburgh Sleep Quality Index, Beck Depression Scale, and Cognitive Failures Scale Questionnaire (CFQ).

All assessments were conducted by trained research assistants under the supervision of experienced psychiatrists specialized in clinical practice. The assessors had prior experience with the instruments used in the study.

Ethics approval was obtained from the Istanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine Ethics Committee, with decision number 380358 on May 10, 2022. The study procedure was fully explained, and written consent was obtained from all participants. This study was conducted in accordance with the Helsinki Declaration.

Measures

Sociodemographic and clinical data form:

The sociodemographic form included questions related to age, sex, marital status, level of education, employment status, prior chronic illnesses, history of COVID-19 infection, alcohol and substance use, smoking status, and family income. Patients' medical records were reviewed to assess COVID-19 severity based on WHO's Use of Chest Imaging in COVID-19: A Rapid Advice Guide (2020)[22]. WHO guidelines categorize cases as asymptomatic, mild, moderate, severe, or critical. Clinical symptoms, oxygen saturation levels, respiratory distress, and the presence of pneumonia or multi-organ failure determined severity classification. Additional parameters were recorded, including the lowest SpO_2 levels, need for supplemental oxygen, hospital stay duration, ICU admission, and administered treatments. Chest imaging findings, when available, were evaluated according to WHO's guidelines to support disease classification. During COVID-19 hospitalization, blood tests, including d-dimer, C-reactive protein (CRP), and ferritin, were taken to evaluate the immune response.

Montreal Cognitive Assessment Scale (MoCA)

The Montreal Cognitive Assessment was used to assess cognitive performance. It is a cognitive screening instrument to detect mild cognitive impairment created by Nasreddine et al.[23] and validated in Turkish by Ozdilek et al.[24]. In the Turkish adaptation of the Montreal Cognitive Assessment (MoCA), cutoff scores were adjusted according to educational level, with scores of <18 for primary school graduates, <21 for middle or high school graduates, and <23 for university graduates, thereby enhancing the test's validity across different educational backgrounds[24]. The original scale had a Cronbach's alpha 0.83, while the Turkish version showed a Cronbach's alpha of 0.664. [23,24]. The MoCA measures eight cognitive domains (executive functions, visual-spatial skills, memory, attention, concentration, working memory, language, and orientation), contemplating various tasks in each domain (delayed recall, cube drawing, clock drawing, trail-making test, phonemic verbal fluency, verbal abstraction, cancelation, subtraction, digit span, naming, sentence repetition, and orientation to time and space) scored within a range of 0–30 in which higher scores indicating better cognitive performance. The MoCA is an interviewer-administered instrument, and in the current study, it was administrated by a well-trained psychiatrist.

World Health Organization Quality of Life Scale-Short Form-TR

It is a 26-question scale **comprising** four dimensions in total: physical well-being, spiritual well-being, social relations, and environmental dimensions[25]. Additionally, it provides a score for overall QoL and general health. The Cronbach's Alpha coefficient for the original WHOQOL-BREF was reported as 0.68-0.82[25]. In the Turkish version of the WHOQOL-BREF, a 27th question addressing social pressure specific to Turkey has been added and is evaluated within the environmental domain. The validity and reliability study of the Turkish version reported values ranging from 0.53 to 0.83[26]. As a self-reported measure, the patients directly completed this scale, reflecting their subjective assessment of quality of life. Higher scores indicate a better quality of life.

Pittsburgh Sleep Quality Index

The scale consists of seven subcomponents that evaluate subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleeping pill use, and daytime dysfunction. Each response is scored between 0-3 according to symptom frequency. The total score obtained varies between 0-21, and higher values indicate poor sleep quality and sleep disturbance[27,28]. The original scale had a Cronbach's alpha of 0.83, while the Turkish version showed a Cronbach's alpha of 0.80.[27,28]. This self-reported scale was filled out directly by the patients.

Beck Depression Scale

The scale was created as a four-point Likert-type self-report scale consisting of twenty-one items to evaluate depression-specific behavior.[29,30] The items in the scale do not have an etiological value but are related to symptoms specific to depression. The standard cut-off scores were as follows: 0–9: minimal depression; 10–18: mild depression; 19–29: moderate depression; 30– 63:severe depression[31]. The original scale had a Cronbach's alpha of 0.86, while the Turkish version showed a Cronbach's alpha of 0.80[29,30]. Since this is a self-reported scale, the responses reflect the patients' assessments of their depressive symptoms.

Cognitive Failures Questionnaire

It is a self-report scale that assesses subjective

cognitive functions in daily life. The scale consists of 25 questions evaluated on a 4-point scale ranging from "never" to "always. Total scores are obtained by summing the scores of the items, giving a result between 0-75. The total score shows the frequency of cognitive failures, with a higher score indicating greater cognitive impairment[32,33]. A higher score indicates a tendency to cognitive failure. The original scale had a Cronbach's alpha of 0.89, while the Turkish version showed a Cronbach's alpha of 0.91[32,33]. A high CFQ score is defined as a score ≥38 (mean of the controls plus one standard deviation)[32].

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics version 22.0 (IBM SPSS Inc. Chicago, Illinois). The normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Categorical variables were reported as frequencies and percentages. Continuous variables were presented as means ± standard deviation (SD) for normally distributed data or medians and interquartile ranges (IQR) for non-normally distributed data. Comparisons between the COVID-19 patients and matched healthy controls were conducted using paired sample t-tests for normally distributed variables (e.g., MoCA total score, PHQ-9 total score, WHOQOL domain scores) and Wilcoxon signed-rank tests for non-normally distributed variables. Pearson's correlation coefficients were used to evaluate associations between normally distributed continuous variables (e.g., MoCA and WHOQOL scores), while Spearman's rho was used for non-parametric correlations. A multiple linear regression analysis was performed to assess the predictive relationship between WHOQOL domain scores (as dependent variables) and independent variables such as age, sex, PHQ-9 scores, and MoCA scores. All statistical tests were two-tailed, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

The final sample included 60 patients and 60 controls. Table 1 displays patients' demographic and clinical characteristics and demographic characteristics of the age and education-matched healthy control (HC) group (n = 60). An analysis of smoking status in the patient group revealed that 13.3% were current smokers, 21.7% had a history of smoking but had quit, and 65% reported never having smoked. An analysis of alcohol consumption in the patient group revealed that 5% were current alcohol users, 13.3 % had a history of alcohol use but had quit, and 81.7% reported never having consumed alcohol.

An analysis of substance use in the patient group revealed that 100% reported never having used any substances. It was found that 3.3% of the patient group's family income was below 3000 TRY (Turkish Lira), 26.7% between 3000 and 6000 TRY, 35% between 6000 and 9000 TRY, and 35% above 9000 TRY.

The patient group had a significantly higher number of male patients compared to the control group (p=0.006; X2=7.5). The number of comorbid illnesses in the patient group was significantly higher than in the control group (p=0.015). The frequency of main comorbidities, hypertension (p=0.018, X2=5.5, df=1), diabetes (p=0.08, X2=3.06, df=1), respiratory diseases (p=0.17, X2=1.88, df=1), were higher than the control group.

In the patient group, hypertension (n=13), diabetes (n=12), cancer (n=6), organ transplantation history (n=7), chronic kidney disease (n=8), cardiac disease (n=9), and respiratory disease (n=4) were observed. In the control group, the corresponding numbers were hypertension (n=4), diabetes (n=6), chronic kidney disease (n=1), cardiac disease (n=1), and respiratory disease (n=1).

The sample consisted of hospitalized patients with mild-to-moderate disease severity, and 57.4% did not need oxygen therapy during their hospital stay. The patients included corresponded to categories 3 (hospitalized, no oxygen therapy) and 4 (hospitalized, oxygen mask or nasal prongs) of the WHO ordinal scale clinical improvement[34]. The patient group's lowest oxygen saturation levels on pulse oximetry had a median of 94% (IQR: 89%–96%). The median length of hospital stay for the patient group was 7.5 (6.0–11.0) days. It was observed that 13.3% of the patients required intensive care.

When evaluating the medication use in the patient group, 3.3% used hydroxychloroquine, 13.3% used tocilizumab, 83.3% used favipiravir, 68.3% used corticosteroids, 1.7% used azithromycin, and 98.3% received anticoagulation therapy (Table 2).

The maximum ferritin value in the patient group had a median of 535 ng/mL, with an interquartile range (IQR) of 312 to 1121 ng/mL. The maximum

fibrinogen value was 573 mg/dL (IQR: 479692 mg/dL), while the maximum CRP value had a median of 80.3 mg/L (IQR: 34.8-147 mg/L). Lastly, the maximum d-dimer value was 1.27 μg/mL, with an IQR of 0.743-2.29 μg/mL (Table 2).

Table 2. Inflammatory Markers and Clinical Characteristics of the Patient Group

Parameter	Value
Length of Hospital Stay (days, median [IQR]	7.5 [6.0–11.0]
Intensive Care Unit Admission, n (%)	8 (13.3%)
COVID Severity WHO Ordinal Scale (%) Stage 3	34 (57.4)
Stage 4	26 (42.6)
Therapeutic Agents Used During Hospitalization Hydroxychloroquine, n (%)	2 (3.3%)
Tocilizumab, n (%)	8 (13.3%)
Favipiravir, n (%)	50 (83.3%)
Corticosteroids, n (%)	41 (68.3%)
Azithromycin, n (%)	1 (1.7%)
Anticoagulant Therapy, n (%)	59 (98.3%)
Inflammatory Markers Ferritin (ng/mL, median [IQR])	535 [312–1121]
Fibrinogen (mg/dL, median [IQR])	573 [479–692]
C-Reactive Protein (CRP) (mg/L, median [IQR])	80.3 [34.8–147]
D-dimer (μg/mL, median [IQR])	1.27 [0.743–2.29]

IQR: interquartile range

Using cut-off score adjusted according to the level of education in the Turkish population (for primary education, scored <18; for secondary or high school, <21, and for university <23); for the MoCA test, 21.7 % of patients had some cognitive impairment, whereas 3.3 % of the control group had cognitive impairment. A Wilcoxon signed rank test showed that the difference in MoCA total score between patients and control was statistically significant (p=0.013, X2=2.49, df=1). The median score was 24 (%80) in the patient group compared to 26 (%87) in the control.

No significant difference was found in subjective cognitive complaints (CFQ Total scores) between patients and controls (Table 1).

No significant difference was found in Beck Depression Scale total scores between groups; both groups showed mild depressive symptoms (median=11, p=0.9). Using the Beck Depression Scale cut-off scores, 57.4% of the patient group had minimal depression, 23% mild depression, 16.4% moderate depression, and 1.6% severe depression, whereas, in the control group, 56.7% of the individuals had minimal depression, 16.7% mild depression, whereas 15% moderate and 11.7% severe depression.

WHOQOL-BREF-TR subscales scores were not significantly different between groups except for the environmental health domain. Environmental health scores were significantly lower in the control group compared to the patient group. (Table 1)

At the 12-month evaluation, a substantial proportion of patients reported dyspnea on exertion (41.7%), fatigue (31.7%), myalgia (15%), and cough (30%).

The Pittsburgh Sleep Quality Index (PSQI) median (IQR) for the patient group was 6 (3.75), while for the control group, it was 5 (5.5), with no statistically significant difference between the groups (p = 0.32). (Table 1).

Table 1. Demographics and clinical characteristics at the 12 months follow-up assessment after hospitalisation with COVID-19

	Patients(n=60)	Controls(n=60)	Test value	p
Demographic Characteristics Age(years), median (IQR)	48.5 (13.5)	47(15)		0.8
Sex, no.of females (%)	22 (36.7)	37(61.7)	X2=7.5 df=1	**0.006**
Years of education, median (IQR)	12 (6.75)	12 (6)		0.9
Work status, employed (%)	32 (53.3)	30(50.8)	X2=0.07 df=1	0.8
Marital status (married) (%)	42 (70)	44(74.6)	X2=0.31 df=1	0.58
Clinical characteristics Number of comorbid illness, median (IQR)	1 (1.75)	0 (1)	165	**0.015**
WHOQOL-BREF-TR, mean (SD) Physical	14.74 (2.85)	14.27 (2.34)	t=0.97 df=54	0.34
Psychological	14.41 (2.25)	14.06 (2.57)	t=1.46 df=54	0.15
Social	14.12 (3.42)	13.67 (3.32)	t=0.67 df=54	0.51
Environmental	14.08 (1.84)	13.22 (2.16)	t=2.08 df=54	**0.04**
Pittsburg Sleep Index, median(IQR)	6 (3.75)	5 (5.5)	-0.98	0.32
Cognitive Failure Questionnaire, median(IQR)	21 (15.75)	22 (17.75)	0.66	0.51
MoCA total,median (IQR)	24 (4)	26 (4)	X2 =2.49 df=1	**0.013**
Beck Depression Scale,median (IQR)	11 (9.5)	11.5 (14)	0.105	0.9

SD:standard deviation, IQR:interquartile range, df: degrees of freedom X_2:Chi square value

A few patients, 15%, had severe subjective cognitive difficulties in daily life, whereas, among healthy controls, 11% of participants reported experiencing severe cognitive difficulties (CFQ scores ≥38).

In the patient group, subjective cognitive complaints (CFQ Total scores) (Pearson's correlation; r = 0.334, p = 0.009) and MoCA total (r=-0.4, p=0.008) correlated significantly with Beck Depression total scores. WHOQOL-BREF-TR subscales scores, physical health (Pearson's correlation; r = −0.44, p = 0.001), psychological health (r=-0.6, p=0.000), environmental health (r=-0.35, p=0.009) and social relationships (r=-0.5, p=0.000) correlated significantly Beck Depression total scores. No significant correlations were obtained between the MoCA total score and WHOQOL-BREF-TR subscales scores, physical health (Pearson's correlation; r = −0.16, p =0.224), psychological health (r=0.13, p=0.35), environmental health (r=1, p=0.46) and social relationships (r=0.009, p=0.95).

No significant correlation was found between MoCA total score and Beck Depression Scale score and length of hospital stay, need for high-flow nasal oxygen during hospitalization, or maximum levels of the following acute illness severity markers: CRP, ferritin, d-dimer, and fibrinogen.

No significant correlation was found between MoCA total score and max CRP value (Spearman's correlation r = 0.0, p = 1), max fibrinogen value (rho = 0.17, p = 0.19), or maximum d-dimer value (rho = -0.14, p = 0.27). A weak significant negative correlation was found between the MoCA total score and the maximum ferritin value (rho = -0.27, p = 0.03), as well as a weak negative correlation with the length of hospital stay (rho = -0.336, p = 0.09). No significant correlation was found between the MoCA score and the need for high-flow nasal oxygen (rho = -0.25, p = 0.85).

No significant correlation was found between the Beck Depression Scale and the maximum CRP value (Spearman's correlation rho = -0.1, p = 0.44), max

fibrinogen value (rho = -0.2, p = 0.051), max d-dimer value (rho = 0.01, p = 0.91), or max ferritin value (rho = 0.009, p = 0.94). No significant correlation was found between the Beck Depression Inventory score and length of hospital stay (rho = 0.031, p = 0.814), or between the Beck Depression Inventory score and the need for high-flow nasal oxygen (r = -0.004, p = 0.977).

In the regression analyses conducted in the patient group, factors such as being male, having multiple comorbidities, and experiencing depression were found to have a significant impact on physical health, while depression played a key role in affecting the psychological, environmental, and social dimensions of quality of life. These parameters were evaluated using the WHOQOLBREF-TR scale, where the physical well-being domain encompasses energy levels, fatigue, pain, sleep quality, and mobility, while the psychological well-being domain includes emotional states, self-esteem, cognitive function, and body image. Furthermore, more comorbidities were linked to a decline in the social aspects of quality of life. (Table 3).

Table 3. β-coefficients and *p* values of regression between WHOQL-BREF-TR domains and MoCA total score, beck depression, number of comorbidity and sex

WHOQOL-BREF-TR MoCA total score	**Physical Health**		**Psychological Health**		**Social Relationship**		**Environmental Health**	
	β	**p**	β	**p**	β	**p**	β	**p**
	-0.03	0.7	-0.04	0.54	-0.2	0.06	-0.015	0.83
Beck Depression	-0.13	**0.01**	-0.18	**0.000**	-0.2	**0.000**	-0.08	**0.02**
Number of comorbidity	-0.96	**0.006**	-0.002	0.99	-1.13	**0.006**	-0.17	0.5
Sex-male	1.5	**0.03**	0.49	0.37	-0.6	0.45	0.14	0.78

DISCUSSION

In this study, we found that individuals hospitalized with mild-to-moderate cases of COVID-19 showed lower cognition, as measured by the MoCA test, 1 year after being discharged from the hospital compared to age and education-matched controls who did not contract COVID-19. According to the cut-off score based on the educational levels of the Turkish population, it was found that around one-fifth of COVID-19 patients exhibited cognitive impairment, a significantly higher percentage than the control group. Despite the varying rates, severity, and trajectories of cognitive dysfunction found in longitudinal studies, most of the studies suggest that the cognitive effects of COVID-19, at least in some susceptible individuals, may have a persistent nature. The results of a meta-analysis of 43 studies, including both hospitalized and non-hospitalized samples, show that over a fifth of individuals exhibited cognitive impairment 12 or more weeks following confirmed COVID-19 diagnosis[5]. Cognitive impairments were shown to endure at different rates in several longitudinal studies, at 6 months[11] and 12 months follow-up[12,13,35-37] after COVID-19 hospitalization. Similarly to our findings, Rass et al. observed that cognitive difficulties persisted in around one-fifth of a mixed cohort of COVID-19 patients, hospitalized and non-hospitalized, at the 1-year follow-up[37]. Moreover, they also reported that cognitive dysfunction had not improved after the 3-month follow-up.

Similarly, one-year post-infection, Cavaco et al. identified cognitive dysfunction in 18.2% of COVID-19 patients through a brief neuropsychological assessment[36]. With a more comprehensive test battery, Ferrucci et al. found that cognitive impairment persisted in almost 50% of COVID-19 patients who had been hospitalized one year after recovering from respiratory symptoms. However, they also observed improvements in several cognitive areas [13]. Miskowiak et al. also found that 1 year after hospitalization, around half of the patients continued to suffer from cognitive impairment, but they did not observe any improvement compared to the 3-month follow-up[12]. The heterogeneity of findings may be related to the age of participants, sample size, hospitalization status, severity of acute illness, and screening tool used for cognitive dysfunctions. Prior studies have indicated that enduring cognitive deficiencies are more strongly correlated with a severe presentation of the illness, including the need for ICU admission or mechanical ventilation[20,21,38]. In our study, the classification revealed that the severity

of COVID-19 in the patient group was mild to moderate. Consequently, the fact that objective cognitive impairment could be assessed one year later, while subjective cognitive complaints were not detected, aligns with the existing literature. Cognitive impairment was noted in 30% of COVID-19 survivors in the ICU in a previous study, a year after they were discharged [38]. Long-term observation of patients who have previously suffered from respiratory illnesses such as SARS and Middle East respiratory syndrome indicates that cognitive and functional impairments may endure for as long as 5 years after being discharged from the hospital, particularly in those who were severely ill with acute respiratory distress syndrome[39]. The neurobiological mechanisms behind these persistent cognitive deficits are not yet clear and are likely to be complex and multifaceted [40,41]. Prolonged respiratory distress associated with brain injury[39] and hyperinflammation may contribute to the lingering cognitive impairments seen in COVID-19 patients[41].

Some studies have established a correlation between the degree of cognitive impairment after 3 months and the intensity of acute inflammation[6,41]. In our study, we found no significant correlation between global cognition and the maximum levels of acute inflammation severity markers. This lack of correlation could be due to our study population's lower severity of illness. Moreover, in patients with less severe illness, the adverse impact of hyperinflammation may diminish more rapidly. We found a significant correlation between cognition and depressive symptoms, consistent with prior research indicating that depressive symptoms have the greatest impact on cognitive functions[11,42].

A significant number of patients in our sample continued to report symptoms, with the most common ones being dyspnea on exertion (41.7%), fatigue (31.7%), myalgia (15%), and cough (30%). These findings align with prior research suggesting that specific physical symptoms persist for a long time[1,19,43,44]. Several longitudinal prospective cohort studies have examined the physical symptoms and quality of life of hospitalized COVID-19 survivors one year after infection. These studies have consistently found significant ongoing physical health issues, including fatigue, shortness of breath, and decreased physical functioning [19,43]. Additionally, these survivors have reported low health-related quality of life scores[19,43,45] and negative impacts on their ability to work[12,19]. Conversely, Huang et al. observed that after one year of being discharged from the hospital, most survivors showed significant improvement in physical and functional abilities and could resume work. However, their health status was still not as high as that of the control population[1]. In the two-year follow-up, while there were ongoing enhancements in physical and mental health, the prevalence of symptomatic sequelae remained considerable, resulting in notably lower health status compared to the general population[46]. According to a recent study by Zhang et al., the majority of long COVID symptoms at the 3-year mark were mild to moderate, while lung function had returned to levels similar to those of matched controls[47].

In the present study, the quality-of-life scores for COVID-19 subjects were generally similar to those of the control group. Cognitive dysfunction did not seem to impact the quality of life. Predictors of poorer physical health included being male, having a higher number of comorbidities, and experiencing elevated levels of depression. Additionally, decreased social functionality was linked to a higher number of comorbidities. Our results align with previous studies that have shown pre-existing comorbidities to be associated with lower quality of life[45,4850]. While a larger number of studies have shown that female sex is associated with declines in quality of life domains [13,49,51], our findings align with one study, which found that male sex also predicted decreased QOL [52]. Moreover, depressive symptoms mainly affect the psychological, environmental, and social dimensions of quality of life. The median depression scores were found to be within the range of minimal depression for both COVID-19 and non-COVID-19 individuals. Among the patients, 23% reported mild depressive symptoms, while 16.4% reported moderate symptoms, which did not show a statistically significant difference compared to non-COVID-19 subjects. There are also studies reporting significant cognitive impairment in individuals recovering from COVID-19, accompanied by a decline in quality of life. One study found a strong association between cognitive dysfunction and diminished quality of life in COVID-19 survivors, often mediated by fatigue[53].

In our study, cognitive dysfunction did not seem to impact the quality of life, possibly because our cohort consisted of individuals with mild-to-moderate disease severity, leading to fewer long-term functional impairments compared to cohorts with more severe cases.

The control group experienced a higher number of patients with severe depression, as determined by the Beck Depression Scale score of 30-63, which could have raised the average depressive scores among the control subjects.

During a pandemic, healthcare workers are exposed to various stressors, including concerns for their own and their families' safety, exposure to suffering, separation from loved ones, and prolonged exhaustion[54]. Given this heightened stress burden on healthcare workers, their relatives—who formed our control group—may have also experienced increased psychological distress during this period, potentially contributing to higher levels of depressive symptoms.

Additionally, our study revealed that the scores obtained from the CFQ, which assesses individuals' subjective experiences of cognitive difficulties, were significantly higher in the control group compared to the patient group. This indicates that the individuals in the control group reported more frequent cognitive failures or complaints regarding their cognitive functioning. However, when we analyzed the results of the MoCA, which serves as an objective screening tool for cognitive impairment, we did not find a similar pattern or relationship. Furthermore, it is noteworthy that the control group exhibited higher depression scores as well. We found a significant positive correlation between CFQ scores and Beck Depression Inventory scores, indicating that as subjective cognitive complaints increased, so did the levels of reported depression. This finding suggests that the cognitive complaints reported by participants may be more reflective of underlying depressive symptoms rather than an accurate representation of their objective cognitive abilities. Therefore, it appears that subjective cognitive assessments may be influenced by emotional factors like depression rather than accurately indicating one's cognitive performance as measured by objective tools like the MoCA.

Depressive symptoms may persist for months after being discharged from the hospital, and they have been associated with lower cognitive functioning and a decreased quality of life in individuals with post-covid syndrome [55]. Much like cognitive dysfunction, the depressive symptoms likely have a multifaceted origin. Both sociodemographic and physiological features were identified as potential contributors to depressive psychopathology in COVID-19 survivors[56].

Depressive symptoms have been linked to the hyperinflammatory response induced by SARSCoV-2, as well as the psychological stress brought on by the pandemic[57]. Given the impact of depression on the quality of life after 1 year of infection, screening and implementing effective treatments is crucial to combat the disease burden and provide functional recovery.

Despite the strengths of our study, some limitations should be acknowledged. One major limitation is the lack of pre-pandemic assessments of cognition, depression, and quality of life, which prevented baseline comparisons. Additionally, only 60 out of 424 eligible patients (15%) participated in the post-discharge follow-up, which limits the generalizability of the results. Factors such as concerns about revisiting a tertiary COVID-19 hospital, pandemic-related anxiety, or burnout from prior research studies may have contributed to the low participation rate. In addition to the low participation rate, it should be noted that the characteristics of the participants may differ from those who did not participate, which could also impact the generalizability of the results. The use of antidepressants for depression and anxiety is prevalent in the Turkish population, with a reported rate of 6%[58]. Therefore, to avoid limiting the number of participants, individuals using antidepressants were not excluded from either the patient or control groups. While this approach allowed for a broader sample, it also introduced a potential confounding factor, as depression and anxiety themselves may affect cognitive outcomes.

No specific exclusion criteria for physical illnesses (except severe neurological conditions) were applied, which may have introduced heterogeneity in quality of life and sleep-related outcomes. In addition, the control group consisted of relatives of hospital staff and was not gender-matched with the patient group. These differences in demographic and psychosocial features may have influenced cognitive, affective, or quality-of-life measures. Although the patient group was matched with the control group by decade for age and four-year education intervals, cognitive functions were not analyzed by narrower age subgroups due to the small sample size. Grouping participants by age in future studies would allow for a more detailed and reliable evaluation of age-related effects on cognitive functions.

An important confounding factor in our study is the greater burden of comorbidities among patients compared to controls. Patients with pre-existing comorbidities were more likely to experience severe

COVID-19 and require hospitalization, which likely contributed to the high prevalence of cognitive impairment observed. However, this makes it difficult to attribute the findings solely to COVID-19, as other underlying health conditions may have also played a role. Considering the impact of comorbid conditions on cognition, their presence can be considered confounding. In future studies, matching the number of comorbidities between patient and control groups on a one-to-one basis may help address this limitation.

Also, studies have shown that asymptomatic SARS-CoV-2 infections can occur in a significant proportion of the population, with some estimates ranging from 20% to 40% of total infections[59]. While national registry and self-report data were used to confirm that controls had no history of COVID-19, asymptomatic infections cannot be entirely ruled out.

Lastly, we did not apply a full neuropsychological battery, which may have limited the detection of domain-specific cognitive impairments. Future studies with more representative samples, matched controls, and refined methodology may help better isolate the long-term impact of COVID-19.

In brief, our study of 60 COVID-19 patients with mild to moderate symptoms found that more individuals experienced cognitive issues 12 months post-discharge compared to age and education-matched controls. Both groups had low levels of depression symptoms. Cognitive problems were linked to depression but did not affect the quality of life in COVID-19 patients. Quality of life in this group was mainly influenced by depressive symptoms, indicating that treating depression could improve long-term outcomes.

These findings underscore the importance of incorporating routine cognitive and psychological assessments into post-COVID care, even for individuals with less severe illness. Given the global reach and complexity of the COVID-19 pandemic, evidence from such studies may provide critical guidance for managing the long-term consequences of future pandemics caused by respiratory viruses. Just as research on the SARS outbreak helped shape early investigations into COVID-19, insights from the current pandemic may serve as a foundation for preparedness, response, and long-term follow-up strategies in similar global health crises.

To build on these findings, future longitudinal studies with larger and more diverse samples are needed to investigate the trajectory and interplay of cognitive and emotional outcomes over time and determine whether targeted interventions for depression may help mitigate subjective cognitive complaints and enhance long-term quality of life.

Author Contributions: Concept/Design : CUP, BUB, EBEC, IHA, BÇP; Data acquisition: BUB, EBEÇ, İHA, MMK, RK; Data analysis and interpretation: CAP, BUB, EBEÇ, İHA, MMK; Drafting manuscript: CAP, MMK, BÇP, ÖFD, RK; Critical revision of manuscript: CAP, BUB, EBEÇ, İHA, MMK, BÇP, ÖFD, RK; Final approval and accountability: CAP, BUB, EBEÇ, İHA, MMK, BÇP, ÖFD, RK; Technical or material support: -; Supervision: CAP, BÇP, ÖFD; Securing funding (if available): n/a.
Ethical Approval: Istanbul University-Cerrahpasa Rectorate Clinical Research Ethics Committee 12.05.2022 date and E-83045809-604.01.01-380358 ethical approval was obtained with the numbered decision.
Peer-review: Externally peer-reviewed.
Conflict of Interest: Authors declared no conflict of interest.
Financial Disclosure: Authors declared no financial support

REFERENCES

1. Huang L, Yao Q, Gu X, Chen H, Wang W, Xu Y et al. 1-year outcomes in hospital survivors with COVID-19: a longitudinal cohort study. Lancet. 2021;398:747-58.
2. Venkatesan P. NICE guideline on long COVID. Lancet Respir Med. 2021;9:129.
3. Nakamura ZM, Nash RP, Laughon SL, Rosenstein DL. Neuropsychiatric complications of COVID-19. Curr Psychiatry Rep. 2021;23:1-9.
4. Schou TM, Joca S, Wegener G, Bay-Richter C. Psychiatric and neuropsychiatric sequelae of COVID-19: a systematic review. Brain Behav Immun. 2021;97:328-48.
5. Ceban F, Ling S, Lui LM, Lee Y, Gill H, Teopiz KM et al. Fatigue and cognitive impairment in post-COVID-19 syndrome: a systematic review and meta-analysis. Brain Behav Immun. 2022;101:93-135.
6. Miskowiak KW, Johnsen S, Sattler SM, Nielsen S, Kunalan K, Rungby J et al. Cognitive impairments four months after COVID-19 hospital discharge: pattern, severity and association with illness variables. Eur Neuropsychopharmacol. 2021;46:39-48.
7. Mendez R, Balanzá-Martínez V, Luperdi SC, Estrada I, Llamas-Velasco S, Martinez-Villalba S et al. Short-term neuropsychiatric outcomes and quality of life in COVID-19 survivors. J Intern Med. 2021;290:621-31.
8. Mattioli F, Stampatori C, Righetti F, Sala E, Tomasi C, De Palma G. Neurological and cognitive sequelae of COVID-19: a four month follow-up. J Neurol. 2021;268:4422-8.
9. Almeria M, Cejudo JC, Sotoca J, Deus J, Krupinski J. Cognitive profile following COVID-19 infection: clinical predictors leading to neuropsychological impairment. Brain Behav Immun Health. 2020;9:100163.
10. Daroische R, Hemminghyth MS, Eilertsen TH, Breitve MH, Chwiszczuk LJ. Cognitive impairment

after COVID-19: a review on objective test data. Front Neurol. 2021;12:699582.
11. Poletti S, Palladini M, Mazza MG, Rovere-Querini P, Benedetti F, Ciceri F et al. Long-term consequences of COVID-19 on cognitive functioning up to 6 months after discharge: role of depression and impact on quality of life. Eur Arch Psychiatry Clin Neurosci. 2022;272:773-82.
12. Miskowiak K, Fugledalen L, Jespersen A, Rungby J, Hansen J, Johnsen S et al. Trajectory of cognitive impairments over 1 year after COVID-19 hospitalisation: pattern, severity and functional implications. Eur Neuropsychopharmacol. 2022;59:82-92.
13. Ferrucci R, Dini M, Rosci C, Groppo E, Damiano M, Poletti S et al. One-year cognitive follow-up of COVID-19 hospitalized patients. Eur J Neurol. 2022;29:2006-14.
14. Khraisat B, Toubasi A, AlZoubi L, Al-Sayegh T, Mansour A. Meta-analysis of prevalence: the psychological sequelae among COVID-19 survivors. Int J Psychiatry Clin Pract. 2022;26:234-43.
15. Deng J, Zhou F, Hou W, Silver Z, Wong A, Li W et al. The prevalence of depression, anxiety and sleep disturbances in COVID-19 patients: a meta-analysis. Ann N Y Acad Sci. 2021;1486:90-101.
16. Troyer EA, Kohn JN, Hong S. Are we facing a crashing wave of neuropsychiatric sequelae of COVID-19? Neuropsychiatric symptoms and potential immunologic mechanisms. Brain Behav Immun. 2020;87:34-9.
17. Passavanti M, Argentieri A, Barbieri DM, Loureiro A, Fadda P, Pallottino L et al. The psychological impact of COVID-19 and restrictive measures in the world. J Affect Disord. 2021;283:36-51.
18. Hawlader MDH, Rashid MU, Khan MAS, Ma P, Feng D, Li J et al. Quality of life of COVID-19 recovered patients: a 1-year follow-up study from Bangladesh. Infect Dis Poverty. 2023;12:79.
19. O'Brien K, Townsend L, Dowds J, O'Kelly B, Conlon N, Smyth E et al. One-year quality of life and health outcomes in patients hospitalised with COVID-19: a longitudinal cohort study. Respir Res. 2022;23:115.
20. Gesser AF, Campos ML, Artismo RS, Karloh M, Matte DL, Souza HCD et al. Impact of COVID-19 critical illness on functional status, fatigue symptoms and health-related quality of life one year after hospital discharge: a systematic review and meta-analysis. Disabil Rehabil. 2023;45:1-12.
21. Rosa RG, Cavalcanti AB, Azevedo LCP, Lisboa TC, Damiani LP, Machado FR et al. Association between acute disease severity and one-year quality of life among post-hospitalisation COVID-19 patients: coalition VII prospective cohort study. Intensive Care Med. 2023;49:166-77.
22. World Health Organization. WHO guidelines on the use of chest imaging in COVID-19. Geneva, World Health Organization, 2022. https://www.who.int/publications/i/item/9789240055704 (accessed May 2021).
23. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc. 2005;53:695-9.
24. Ozdilek B, Kenangil G. Validation of the Turkish version of the Montreal Cognitive Assessment Scale (MoCA-TR) in patients with Parkinson's disease. Clin Neuropsychol. 2014;28:333-43.
25. Skevington SM, Lotfy M, O'Connell KA. The World Health Organization's WHOQOL-BREF quality of life assessment: psychometric properties and results of the international field trial. A report from the WHOQOL group. Qual Life Res. 2004;13:299-310.
26. Eser E, Fidaner H, Fidaner C, Psychometric properties of the WHOQOL-100 and WHOQOL-BREF. J Psychiatry Psychol Psychopharmacol. 1999;7:23-40.
27. Buysse DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28:193-213.
28. Ağargün MY, Validity and reliability of Turkish version of Pittsburgh Sleep Quality Index. Turk Psikiyatri Derg. 1996;7:107.
29. Beck AT, Steer RA. Internal consistencies of the original and revised Beck Depression Inventory. J Clin Psychol. 1984;40:1365-7.
30. Hisli N, A study on the validity of the Beck Depression Inventory. Turk Psychol J. 1998;6:118-23.
31. Beck AT, Steer RA, Carbin MG, Psychometric properties of the Beck Depression Inventory: twenty-five years of evaluation. Clin Psychol Rev. 1988;8:77-100.
32. Broadbent DE, Cooper PF, FitzGerald P, Parkes KR. The Cognitive Failures Questionnaire (CFQ) and its correlates. Br J Clin Psychol. 1982;21:1-16.
33. Eser HY, Inan MY, Kucuker MU, Development, validity and reliability of the 4-point Likert Turkish version of the Cognitive Failures Questionnaire. Ann Med Res. 2020;27:837.
34. World Health Organization. COVID-19 therapeutic trial synopsis. https://www.who.int/blueprint/priority-diseases/key-action/COVID-19_Treatment_Trial_Design_Master_Protocol_synopsis_Final_18022020.pdf (accessed May 2021).
35. Méndez R, Balanzá-Martínez V, Luperdi SC, Estrada I, Llamas-Velasco S, Martinez-Villalba S et al. Long-term neuropsychiatric outcomes in COVID-19 survivors: a one-year longitudinal study. J Intern Med. 2022;291:247.
36. Cavaco S, Sousa G, Gonçalves A, Almeida J, Monteiro E, Reis D et al. Predictors of cognitive dysfunction one year post COVID-19. Neuropsychology. 2023;37:849-58.

37. Rass V, Beer R, Schiefecker AJ, Kofler M, Lindner A, Asenbaum P et al. Neurological outcomes one year after COVID-19 diagnosis: a prospective longitudinal cohort study. Eur J Neurol. 2022;29:1685-96.
38. Godoy-González M, Navarra-Ventura G, Gomà G, Subirà C, Bertran MJ, Masclans JR et al. Objective and subjective cognition in survivors of COVID-19 one year after ICU discharge: the role of demographic, clinical and emotional factors. Crit Care. 2023;27:188.
39. Sasannejad C, Ely EW, Lahiri S. Long-term cognitive impairment after acute respiratory distress syndrome: a review of clinical impact and pathophysiological mechanisms. Crit Care. 2019;23:352.
40. Baldini T, Asioli GM, Romoli M, Mazziotti D, Agosta F, Mauro A et al. Cerebral venous thrombosis and severe acute respiratory syndrome coronavirus-2 infection: a systematic review and meta-analysis. Eur J Neurol. 2021;28:3478-90.
41. Mazza MG, Palladini M, De Lorenzo R, Bravi B, Poletti S, Furlan R et al. Persistent psychopathology and neurocognitive impairment in COVID-19 survivors: effect of inflammatory biomarkers at three-month follow-up. Brain Behav Immun. 2021;94:138-47.
42. Cristillo V, Pilotto A, Piccinelli SC, Gipponi S, Bonzi G, Padovani A et al. Predictors of "brain fog" one year after COVID-19 disease. Neurol Sci. 2022;43:5795-7.
43. Seeßle J, Waterboer T, Hippchen T, Schnitzler P, Götzinger F, Kräusslich HG et al. Persistent symptoms in adult patients one year after coronavirus disease 2019 (COVID-19): a prospective cohort study. Clin Infect Dis. 2022;74:1191-8.
44. Yang T, Yan MZ, Li X, Lau EH. Sequelae of COVID-19 among previously hospitalized patients up to one year after discharge: a systematic review and meta-analysis. Infection. 2022;50:1067-79.
45. Evans RA, Leavy OC, Richardson M, Tunnicliffe EM, Elneima O, Brightling CE et al. Clinical characteristics with inflammation profiling of long COVID and association with one-year recovery following hospitalisation in the UK: a prospective observational study. Lancet Respir Med. 2022;10:761-75.
46. Huang L, Li X, Gu X, Zhang H, Ren L, Gong T et al. Health outcomes in people two years after surviving hospitalisation with COVID-19: a longitudinal cohort study. Lancet Respir Med. 2022;10:863-76.
47. Zhang H, Huang C, Gu X, Li X, Hu Y, Ren L et al. Three-year outcomes of discharged survivors of COVID-19 following the SARS-CoV-2 Omicron (B.1.1.529) wave in 2022 in China: a longitudinal cohort study. Lancet Respir Med. 2024;12:55-66.
48. Todt BC, Szlejf C, Duim E, Linhares AO, Kogiso D, Fonseca RP et al. Clinical outcomes and quality of life of COVID-19 survivors: a follow-up of three months post hospital discharge. Respir Med. 2021;184:106453.
49. Menges D, Ballouz T, Anagnostopoulos A, Aschmann HE, Domenghino A, Frei A et al. Burden of post-COVID-19 syndrome and implications for healthcare service planning: a population-based cohort study. PLoS One. 2021;16:e0254523.
50. Sonnweber T, Sahanic S, Pizzini A, Luger A, Schwabl C, Tymoszuk P et al. Cardiopulmonary recovery after COVID-19: an observational prospective multicentre trial. Eur Respir J. 2021;57:2003481.
51. Evans RA, McAuley H, Harrison EM, Shikotra A, Singapuri A, Sereno M et al. Physical, cognitive and mental health impacts of COVID-19 after hospitalisation (PHOSP-COVID): a UK multicentre, prospective cohort study. Lancet Respir Med. 2021;9:1275-87.
52. Taboada M, Moreno E, Cariñena A, Rey T, Pita-Romero R, Leal S et al. Quality of life, functional status and persistent symptoms after intensive care of COVID-19 patients. Br J Anaesth. 2021;126:e110-3.
53. Calabria M, García-Sánchez C, Grunden N, Pueyo R, López-Cano M, Lleó A et al. Post-COVID-19 fatigue: the contribution of cognitive and neuropsychiatric symptoms. J Neurol. 2022;269:3990-9.
54. Hendrickson RC, Slevin RA, Hoerster KD, Pelley TJ, Gilchrist KH, Lipscomb J et al. The impact of the COVID-19 pandemic on mental health, occupational functioning and professional retention among health care workers and first responders. J Gen Intern Med. 2022;37:397-408.
55. Mazza MG, Palladini M, Poletti S, Benedetti F. Post-COVID-19 depressive symptoms: epidemiology, pathophysiology and pharmacological treatment. CNS Drugs. 2022;36:681-702.
56. Dong F, Liu HL, Dai N, Yang M, Liu JP. A living systematic review of the psychological problems in people suffering from COVID-19. J Affect Disord. 2021;292:172-88.
57. Premraj L, Kannapadi NV, Briggs J, Seal SM, Battaglini D, Fanning JP et al. Mid and long-term neurological and neuropsychiatric manifestations of post-COVID-19 syndrome: a meta-analysis. J Neurol Sci. 2022;434:120162.
58. General Directorate of Health Information Systems. Turkish Health Statistics Yearbook 2021. Ministry of Health, Ankara. https://dosyamerkez.saglik.gov.tr/Eklenti/44131/0/saglik-istatistikleri-yilligi-2021-haber-bultenipdf.pdf (accessed May 2021).
59. Oran DP, Topol EJ. Prevalence of asymptomatic SARS-CoV-2 infection. Ann Intern Med. 2021;174:286-7.