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Psychological features and emotional well-being in COVID-19 patients with gastrointestinal symptoms

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Abstract

The prevalence of gastrointestinal (GI) symptoms in COVID-19 patients is more than 20%. Research has revealed that the incidence of GI symptoms, including anorexia, nausea, vomiting, and abdominal pain, can be as high as 79.1%, and that diarrhea, as the main symptom, can be present in 49.5% of the cases. Among these patients, the psychological impact of various GI symptoms poses an essential consideration in the quality of life after hospital discharge and recovery. In this study, 102 patients hospitalized for COVID-19, with GI symptoms, were divided into two groups: The GI group ($n = 54$), with the predominant GI symptoms of anorexia, nausea, vomiting, and abdominal pain, and the D group ($n = 48$), with the predominant symptom of diarrhea. Questionnaires assessing positive and negative moods, anxiety, and depression were administered to all patients, and psychological evaluation took place 3 months after the first positive polymerase chain reaction test for COVID-19. The results demonstrate that patients in the GI group exhibited lower scores in the negative mood, anxiety, and depression tests, and higher scores in the positive mood test, compared to the patients in the D group. In conclusion, emotions play an important role in the outcome of COVID-19 patients with different GI symptoms. Notably, diarrhea is an important symptom associated with negative mood, anxiety, and depression. Understanding the emotional impact of specific GI symptoms on COVID-19 patients is essential for developing a comprehensive approach to the care and well-being of COVID-19 patients.

Keywords: Psychological features; COVID-19 patients; Digestive system; Gastrointestinal effects; Diarrhea; Anxiety

1. Introduction

Since its emergence in 2019, severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2) has rapidly spread from China across the globe, resulting in millions of hospitalizations and thousands of disabilities and deaths.[1-3] Over 450 million cases of the COVID-19 pandemic were reported worldwide in the first 2 years, including approximately 100 million cases in the European Union alone. Aerosolized respiratory particles released when infected individuals cough, sneeze, or speak in close proximity to others are the primary mode of SARS-CoV-2 transmission. These infectious particles can be inhaled or come in contact with the eyes, nose, or mouth, leading to new infections.[4]

During the COVID-19 pandemic, several studies have focused on the impact of the virus on the respiratory system, largely due to the high prevalence and severity of symptoms such as cough, dyspnea, oxygen desaturation, and respiratory failure. These symptoms are responsible for the majority of the disease's devastating and life-threatening complications. However, clinicians and researchers rapidly recognized that the novel strains of SARS-CoV-2 do not exclusively target the respiratory system. On the contrary, in most cases, multiple organ systems were involved. Apart from the lungs, organs such as the brain, heart, intestine, gallbladder, and liver have also been shown to be susceptible to SARS-CoV-2 infection.[5]

One of the frequently affected organs by SARS-CoV-2 is the gastrointestinal (GI) tract. GI diseases affect 5 – 20% of the general population.[6] Their potential causes are often multifactorial, including genetic predisposition, dietary habits, gut–brain axis dysregulation, and stress.[7] Irritable bowel syndrome and functional dyspepsia are classified among the most common GI diseases. Factors that can trigger these conditions include stress, negative life events, and anxiety.[8]

GI symptoms, such as abdominal pain, nausea, vomiting, anorexia, and diarrhea, have been reported in more than 20% of hospitalized COVID-19 patients.[9] SARS-CoV-2 primarily binds to angiotensin-converting enzyme 2 (ACE2) receptors to enter human cells, initially affecting the lungs and subsequently the GI tract. According to research, a significant number of ACE2 receptors are expressed in the GI system, particularly in the colon and small bowel. This receptor distribution is potentially why diarrhea is the main GI symptom in COVID-19 patients.[10]

Damage to the intestinal mucosal barrier and alterations in the host immune response, particularly inflammatory factor production, can contribute to developing GI symptoms.[11] Notably, infection of lung cells by SARS-CoV-2 activates effector cluster of differentiation-positive ($CD4^+$) T cells, which can affect the small intestine through the gut-lung axis, resulting in intestinal immune damage and diarrhea. Reports indicate that COVID-19 patients with GI symptoms tend to have longer viral detoxification time and a higher potential for SARS-CoV-2 detection in fecal samples.[12] In addition, the majority of COVID-19 patients are treated with a combination of antiviral and antibacterial medications, which frequently induce diarrhea as a side effect.[11] GI symptoms such as diarrhea in COVID-19 are linked to several mechanisms, such as gut microbiota changes and pro-inflammatory cytokines release, either due to the virus interaction with ACE2 receptors or as adverse effects of pharmacological treatment.[13] Recently, two critical questions have emerged: First, whether the presence of GI symptoms worsens the overall prognosis in COVID-19 patients; and second, whether the increased prevalence of these symptoms is linked to emerging variants of the virus.[1]

Nutritional status plays a significant role in immunity at various levels, including susceptibility to infection, severity of illness, and the duration of recovery and hospitalization. In addition, COVID-19 may affect the digestive system, further compromising nutritional status.[12] Therefore, it is advised that physicians managing COVID-19 patients closely monitor GI symptoms, body weight, and overall nutritional status.[14] Moreover, the efforts to restrain the spread of the virus, such as social and physical distancing, in addition to the fear of infection, have significantly disrupted daily life. These disruptions have contributed to widespread psychological disturbances, such as anxiety and frustration, and may have led to more severe and catastrophic psychological and psychiatric disorders in the general population.[15]

Psychopathology can be triggered by immune system dysregulation resulting from viral infections, potentially leading to numerous psychiatric consequences. Respiratory viral illnesses have been associated with both short-term and long-term psychopathological impacts in survivors.[6] Coronaviruses, negatively stranded RNA viruses, are known to cause illnesses ranging from the common cold to more severe conditions such as SARS. Evidence from previous coronavirus outbreaks, including Middle East respiratory syndrome and SARS, has shown a clear association between coronavirus and the development of neuropsychiatric illnesses. Follow-up studies of SARS survivors have reported increased incidence of mental health diagnoses, such as panic disorder, obsessive–compulsive disorder, post-traumatic stress disorder (PTSD), and depression.[6]

The recent COVID-19 pandemic seems to have significant psychiatric consequences. Preliminary data

suggest that COVID-19 patients may experience delirium, depression, anxiety, and insomnia. Coronaviruses can contribute to psychopathological outcomes either directly, through viral infection of the central nervous system (CNS), or indirectly, through immune responses. There is evidence that coronaviruses may exhibit neurotropic properties and can induce neuronal injuries, as demonstrated in clinical cases, post-mortem examinations, animal models, *in vitro* experiments, and cell culture studies. In addition to potential CNS infiltration, the host immune response to coronaviruses, or "cytokine storm," may also contribute to psychiatric symptoms by triggering neuroinflammation.[7]

It is well-recognized that the digestive tract is one of the systems affected by SARS-CoV-2. Recent research has demonstrated GI symptoms, such as nausea, diarrhea, and abdominal discomfort, as common manifestations in COVID-19 patients. This association is supported by the presence of ACE2 receptors in the GI epithelium, which facilitate viral entry. While it was not the main focus of the current investigation, acknowledging the GI tract's role could provide a more comprehensive understanding of the disease.[6] Recent research also highlights the significance of the gut-brain axis in the development of mental and cognitive disorders. Changes in gut microbiota have been increasingly linked to conditions such as depression, anxiety, schizophrenia, autism spectrum disorders, and cognitive impairment involving memory and attention.

Patients with COVID-19 have reported significant levels of anxiety and depression symptoms. Those experiencing social isolation exhibited higher anxiety levels. While these findings are noteworthy, many of the existing studies have been limited to single-point assessments and have not investigated the long-term mental health outcomes of COVID-19 patients following hospital discharge. Evidence from previous pandemics revealed that hospitalized individuals often reported higher rates of PTSD and increased psychological distress.[8]

Recent research demonstrates that COVID-19 patients, regardless of disease severity, from asymptomatic to critically ill, may present with both short- and long-term neurological symptoms. The frequency and intensity of neurological symptoms linked to COVID-19 may differ to some extent depending on several factors, such as the extent of neuroinflammation. Furthermore, the cognitive system, including executive functions and long-term memory, is most influenced by COVID-19.[7]

Stress, anxiety, and depression are prevalent in COVID-19 patients. According to reports, one in five survivors continues to experience anxiety, depression, or insomnia as late as 3 months after their initial positive polymerase chain reaction (PCR) test for COVID-19.[13,14] In addition to morbidity and mortality, the psychological impact of COVID-19 significantly affects patients' quality of life. These findings underscore the need for prompt recognition and intervention to address the wide-ranging psychological consequences of the pandemic.

There is mounting evidence that GI symptoms are not only prevalent in COVID-19 patients but also linked to higher stress and anxiety levels, as well as a lower quality of life.[13] These psychological impacts are partly mediated through the gut–brain axis, a bi-directional communication pathway between the CNS and the GI tract. In light of this connection, investigating the mental health outcomes in this particular cohort was both pertinent and significant.

The goal of this study was to investigate the relationship between psychological factors and GI symptoms in COVID-19 patients. Specifically, the study sought to assess the psychological impact of these symptoms in two distinct patient groups, based on medical records: One group presenting with predominant GI symptoms, such as anorexia, nausea, vomiting, and abdominal pain, and another group in which diarrhea was the predominant symptom.

2. Materials and methods

2.1. Materials

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects/patients were approved by the Bioethics and Ethics Committee of AHEPA University Hospital, School of Medicine, Aristotle University of Thessaloniki, Greece, under the number 34191.

This study enrolled 102 COVID-19 patients and was performed in the COVID-19 internal medicine clinics of three hospitals in central Macedonia, Greece, from September 2022 to December 2022. Written informed consent was obtained from all patients who agreed to participate in the study. Inclusion criteria included hospitalization due to COVID-19, age over 18 years, a positive COVID-19 PCR test, and the presence of GI symptoms, including anorexia, nausea, vomiting, abdominal pain, or diarrhea. Eligible patients experienced GI symptoms for 3 – 10 days. Exclusion criteria included a history of psychiatric illness, transfer to the intensive care unit, and inability to read or comprehend the consent form or testing instructions due to language barriers or limited educational background. A total of 102 COVID-19 patients who presented with GI symptoms were enrolled in

the study and divided into two groups based on their predominant GI symptom: (i) GI group (n = 54): Patients with predominant GI symptoms of anorexia, nausea, vomiting, and abdominal pain, and (ii) D group (n = 48): Patients with diarrhea as the predominant symptom.

2.2. Psychological assessments

Psychological assessments were conducted by an experienced clinical psychologist holding a doctoral degree in psychology, 3 months after each patient's positive PCR test for COVID-19. Interviews were initiated only after patients demonstrated an understanding of the instructions. The following validated instruments were administered to assess mood and emotional states:

(i) Positive and negative affect schedule (PANAS)[16]: This scale, also known as a scale composed of various feelings and emotions, is the most popular and frequently used scale to measure two independent dimensions: positive affect and negative affect. Positive affect reflects the extent to which an individual feels enthusiastic, active, and alert even when facing challenges, while negative affect relates to distress and unpleasant emotions, such as anger, contempt, guilt, and fear. The PANAS has demonstrated excellent psychometric properties across general and clinical populations and has been validated in multiple languages.

(ii) State-trait anxiety inventory (STAI)[17]: Developed by psychologists Gorsuch, Lushene, and Spielberger, the STAI is a commonly used measure for the assessment of both trait anxiety (a general tendency to perceive situations as threatening) and state anxiety (a temporary emotional state). It can be used to identify anxiety and distinguish it from depressive illnesses in medical settings. It is also frequently used in research as a measure of caregivers' distress for a variety of illnesses. This assessment consists of 40 self-report items rated on a 4-point Likert scale, with higher scores indicating greater anxiety levels. The most recent iteration, Form Y, is accessible in over 40 languages.

(iii) Zung self-rating depression scale (SDS)[18]: The SDS is a 20-item self-report questionnaire used to measure the level of depression. It evaluates four common characteristics of depression: pervasive effect, biological equivalents, psychomotor actions, and other disturbances. Each item is scored on a 4-point Likert scale, with total raw scores ranging from 20 to 80. Certain items are reverse-scored, that is, from 4 to 1. While less studied than the Beck depression inventory-II, the SDS has been widely used in medical studies, particularly in antidepressant medications.

All these questionnaires used in this study have been translated into Greek and standardized for use within the Greek population, ensuring cultural and linguistic relevance.

2.3. Statistical analysis

All data were analyzed descriptively in great detail. The distributions of key baseline sample characteristics between groups were compared to identify imbalances and potential confounding factors. Patient matching was conducted based on demographic data. Separate statistical analyses were carried out for every questionnaire. Pearson's correlation coefficients were calculated to explore relationships between variables, and independent samples t-tests were used to assess differences between the two patient groups. An alpha level of 0.001 was set to determine statistical significance.

3. Results

3.1. Demographics

Initially, 107 patients agreed to participate in the study. However, three patients were excluded for refusing to complete the psychological tests, and two were excluded after relocating and continuing treatment in other hospitals. The remaining 102 COVID-19 patients (50 male, 52 female) with GI symptoms participated in the study (Figure 1). None of the participants withdrew after enrolment. The age of the patients ranged from 42 years old to 64 years old (mean ± SD: 49.96 ± 7.77). Educational attainment ranged from 6 years to 16 years (mean ± SD: 13.60 ± 3.15). Table 1 displays the patients' demographic information by groups.

The two groups did not differ significantly in terms of age (p=0.155), educational level (p=0.623), and gender (p=0.432) (Table 2). The level of significance was established at 0.001 (two-tailed).

3.2. Psychological differences between GI symptom subgroups

Independent-samples t-tests were conducted for each questionnaire. Patients in the GI group scored significantly lower on negative mood (p<0.001), anxiety (p<0.001), and depression (p=0.001), and scored significantly higher on positive mood (p<0.001, compared to patients in the D group (Table 2).

3.3. Correlation between GI symptoms and psychological outcomes

To investigate the relationship between GI symptoms and emotional responses, Pearson's correlation coefficient was used. The analysis evaluated the linear relationship

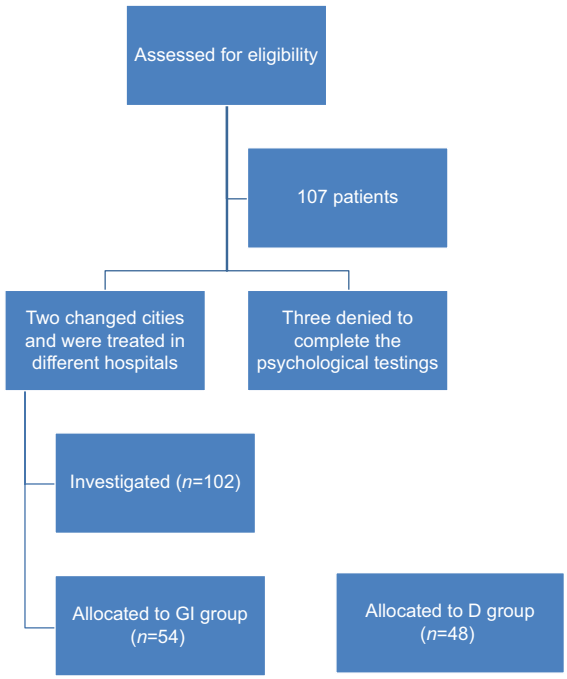

Figure 1. Flowchart of participant recruitment and selection
Abbreviations: D: Diarrhea; GI: Gastrointestinal.

Table 1. Patients' demographics by group

Demographics	GI (*n*=54)	D (*n*=48)
Age	48.1 (±8.41)	48.9 (±9.12)
Educational level	14.45 (±4.54)	15 (±5.74)
Gender	Female/male (31/23)	Female/male (24/24)

Note: Data on age and educational level presented as mean (±standard deviation).
Abbreviations: D: Diarrhea; GI: Gastrointestinal.

Table 2. Mean scores in psychological questionnaires

Psychological emotions	GI (*n*=54)	D (*n*=48)
Positive mood	46.4 (±8.8)	30.2 (±7.5)
Negative mood	26.7 (±5.4)	48.3 (±8.5)
Anxiety	38.4 (±7.5)	67.8 (±9.4)
Depression	35.4 (±6.9)	62.7 (±8.4)

Note: Data presented as mean (±standard deviation).
Abbreviations: D: Diarrhea; GI: Gastrointestinal.

between particular GI symptoms and scores on psychological tests. A statistically significant positive correlation was found between diarrhea and negative mood ($r[90] = 0.79$, $p<0.001$), anxiety ($r[90] = 0.68$, $p<0.001$), and depression ($r[90] = 0.41$, $p<0.001$). Similarly, vomiting was positively correlated with negative mood ($r[90] = 0.71$, $p=0.001$), anxiety ($r[90] = 0.60$, $p<0.001$), and depression ($r[90] = 0.32$, $p<0.001$). In contrast, symptoms such as anorexia, nausea, and abdominal pain did not show statistically significant correlations with any of the psychological measures.

4. Discussion

The present study investigated emotional states among COVID-19 patients presenting with different GI symptoms, focusing on the relationship between these GI symptoms and psychological outcomes. The results show that patients with GI symptoms such as anorexia, nausea, vomiting, and abdominal pain reported significantly lower levels of negative emotions, including negative mood, anxiety, and depression, compared to those in the D group. In addition, these patients demonstrated higher levels of positive mood than those in the D group. One possible explanation lies in the gut–brain axis, a bidirectional communication system linking the emotional and cognitive centers of the brain with GI function. Through inflammatory pathways and neurochemical mechanisms, SARS-CoV-2 infection induces alterations in gut microbiota to affect mood and stress responses. Furthermore, diarrhea GI symptoms may intensify patients' perceptions of illness conditions, leading to elevated emotional discomfort and health-related anxiety. Social stigma and a lack of clarity regarding symptom interpretation may further exacerbate the emotional burden in the GI group.[19,20]

The COVID-19 pandemic has led to a marked increase in the number of people experiencing frustrating psychological problems. The most prevalent mental disorders affecting quality of life are depression and anxiety. Numerous studies suggest that a majority of populations experienced a high prevalence of psychological disturbances during the pandemic.[19,20] Stressful life experiences have a significant impact on the occurrence of anxiety, particularly in people with GI symptoms.[20,21] Furthermore, stress and depression remain prevalent in COVID-19 patients even 3 months after a positive diagnosis.[13,14] In addition, diarrhea has been identified as the most frequently reported GI symptom in COVID-19 patients,[22] affecting 50% or more of cases in certain studies.[1]

Patients with GI symptoms are more likely to exhibit signs of anxiety and depression. Depressive symptoms and emotional stress are recognized as independent risk factors for the development of GI diseases. It was discovered that patients with various GI symptoms were more prone to depressive and anxious symptoms.[23] Among these symptoms, diarrhea stands out as especially distressing and often stigmatized, significantly affecting patients' quality of life and psychological health, especially when occurring during an already stressful COVID-19 diagnosis. In addition, diarrhea may be a sign of dysregulation of the

gut-brain axis and broader involvement of the GI tract, which could lead to increased emotional symptoms, such as despair and anxiety. These findings underscore the need to explore the specific relationship between GI symptoms, such as diarrhea, and mental health consequences.[23]

The prevalence of emerging psychiatric sequelae among COVID-19 survivors is high, with many individuals exhibiting clinically significant symptoms of at least one mental health disorder. It is expected that survivors will experience greater-than-average rates of PTSD, major depressive disorder, and anxiety–all highly burdensome non-communicable conditions linked to years of living with a disability. In addition, depression is associated with a notably high risk of both mortality by cause and overall mortality.[23]

The risk factor profile for the various psychiatric manifestations associated with COVID-19 shows minor variations across disorders. Factors linked to an increased risk of anxiety and depression include female gender, greater illness severity, presence of medical comorbidities, having relatives or close contacts infected with COVID-19, social stigma, decreased quality of life, and a history of psychiatric illness.[24] The rates of moderate-to-severe depression occurring 2 – 3 months after hospital discharge range from 10% to 42% according to studies.[25,26] These patients had higher perceived stigma related to COVID-19, were quarantined after hospitalization, and had a history of psychiatric manifestations.[23]

The long-lasting psychological effects of COVID-19 are poorly understood in terms of their causes, prevalence, and risk factors. Although a growing body of research has explored psychological symptoms following COVID-19 infection, the results are typically from studies based on surveys or self-reported data, which should be interpreted with caution.[27] Nonetheless, the existing data point to a serious issue and shed light on potential causes for the psychological effects of COVID-19. While the precise pathophysiological mechanisms of SARS-CoV-2 across various physiological systems remain unclear, insights from other coronavirus subtypes offer a speculative understanding of possible outcomes.[28] Coronavirus may induce psychopathological complications through immune responses or a direct viral invasion of the CNS. The neuropathological consequences of COVID-19 are thought to arise from multiple mechanisms, including direct viral infection, neuroinflammation, systemic inflammatory responses, neurodegeneration, and microvascular thrombosis.[29] Numerous studies have proposed that viral infections may result in long-lasting neuropsychiatric symptoms, including affective, behavioral, and cognitive symptoms, that can endure for varying periods post-infection.[27,30] These symptoms may be caused by chronic infection or abnormal immune responses.

It is crucial to remember that delirium and stress-related symptoms (e.g., depression, anxiety, and PTSD) have been associated with an approximately fourfold increased risk of developing neurocognitive impairments. This raises concerns about the potential direct effects of psychiatric manifestations on cognitive health.[31] Long-term COVID-19 symptoms seem to have an impact on social engagement, physical and cognitive functioning, and health-related quality of life.[32] For example, post-COVID-19 depression has been associated with a higher risk of experiencing chronic physical symptoms, such as pain and dyspnea.[27]

Prevention efforts, particularly in terms of rehabilitation programs, are essential to halt the progression of COVID-19-related psychiatric manifestations. These programs can enhance the functioning and quality of life of affected individuals and reduce the risk of developing neurocognitive impairments in addition to the already severe psychiatric manifestations.[32] To identify people who suffer from depression, anxiety, or PTSD, common screening tools should be used. Moreover, patients recovering from COVID-19 should undergo neuropsychological testing.[27] In COVID-19 patients, a comprehensive assessment of psychological, cognitive, and behavioral variables is required.[30] This aligns with the conclusions of previous studies that discovered a strong correlation between cognitive complaints and psychological distress,[33] and that demonstrated that the optimal indicator of cognitive function and its improvement is depression.[34] Thus, additional research is essential to describe a more detailed picture of the long-term psychiatric functioning following COVID-19. To better manage post-COVID-19 syndromes, close interdisciplinary collaboration between medical professionals and specialized post-COVID-19 rehabilitation centers should be enhanced.[35] Patients' health-related quality of life may be enhanced through interventions that reduce COVID-19-related self-stigma and enhance mental health.[36] Finally, probiotics may be a safe adjunctive therapy for psychiatric sequelae in COVID-19 survivors, offering an alternative or complement to conventional psychotropic medications.[27] Probiotics have been shown to reduce inflammation and modulate the immune system.[37] These may reduce the severity of infections in the GI tract and upper respiratory tract by acting on the innate and adaptive immune systems.

There are a number of limitations to take into account in this study. First, due to the cross-sectional design, causal relationships between GI symptoms and psychological results cannot be established. Second, although the

sample size is sufficient for preliminary research, it may not fully represent the variation among various clinical or demographic subgroups within Central Macedonia, Greece, thereby limiting the generalizability of the findings. Third, there is a potential for reporting bias, as both GI and emotional symptoms were based on self-reported data. Finally, while not taken into account in this study, external variables, such as media exposure during the pandemic, social isolation, or past mental health history, may have affected participants' psychological states.

To our knowledge, no prior studies have specifically examined the association between emotional states and different GI symptoms in COVID-19 patients, nor the relationship between GI symptoms and responses to psychological tests. Our findings provide novel insights that may have significant implications for understanding the quality of life and daily functioning of COVID-19 patients experiencing GI symptoms. Future research should further explore these associations in larger and more diverse populations, paving the way for targeted interventions that improve patient outcomes.

5. Conclusion

Emotional disturbances, such as stress, anxiety, depression, and insomnia, are prevalent among COVID-19 patients[13,14] and play an important role in shaping patient outcomes. Diarrhea, in particular, has emerged as an important GI symptom associated with negative mood, heightened anxiety, and depressive symptoms. Early recognition and management of emotional distress in COVID-19 patients with GI symptoms are essential for improving clinical outcomes and overall well-being.

Among COVID-19 survivors, psychiatric sequelae are commonly observed, with at least one disorder frequently reaching pathological levels. The prevalence of PTSD, major depressive disorder, and anxiety in survivors is anticipated to be higher than average. These three extremely burdensome, non-communicable conditions are all associated with disability. Additionally, depression has been linked to a significantly increased risk of both cause-specific and overall mortality.[23]

COVID-19 infection has profound and concerning effects on mental health.[23] In efforts to mitigate the long-term impact of the disease, particularly among those with pre-existing mental health conditions, systemic assessments of psychopathological symptoms in COVID-19 survivors are recommended. Continuous monitoring of psychological adjustment and quality of life over time is crucial. Given its central role in recovery, quality of life should be a key consideration in both clinical management and future research efforts.[38-40]

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Conflict of interest

Kalliopi Megari is the Youth Editorial Board Member of this journal, but was not in any way involved in the editorial and peer-review process conducted for this paper, directly or indirectly. Separately, other authors declared that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Writing – review & editing: Kalliopi Megari, Evanthia Thomaidou

Ethics approval and consent to participate

All procedures involving human subjects/patients were approved by the Bioethics and Ethics Committee of AHEPA University Hospital, School of Medicine, Aristotle University of Thessaloniki, Greece, under the approval number 34191. Human subjects were involved, and written permission was obtained from each of the subjects to participate in the study.

Consent for publication

Human subjects were involved, and written permission was obtained from each of the subjects to publish their data and/or images.

Availability of data

Data cannot be shared publicly due to the sensitive nature of the research.

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