

## BRIEF REPORT

## Examining the psychopathology of COVID-19 patients

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## Abstract

Examining the psychopathology of patients who have contracted coronavirus disease 2019 remains important. The current study aims to investigate the relationship between depression, cognitive and executive functions, and their impact on quality of life. First, a comprehensive bibliographic review of relevant scientific articles and studies was carried out. Data were then collected using weighted and appropriate questionnaires. Analysis of variance and multiple regression analyses were conducted to examine the relationship between the independent variables (depression, cognitive and executive functions, and demographic factors) and the dependent variable (quality of life), to interpret and analyze the resulting associations. In contrast to depression, cognitive and executive functions did not appear to significantly influence patients' quality of life and well-being. Further scientific research is necessary to explore these factors and their potential effects more thoroughly.

**Keywords:** Depression; Cognitive-executive functions; Psychopathology; Life-quality

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## 1. Introduction

The coronavirus disease 2019 (COVID-19) is a highly infectious disease caused by the novel strain of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The COVID-19 pandemic has triggered one of the most severe public health crises in recent years globally. Both patients who remained at home and those hospitalized or admitted to intensive care units (ICUs) have experienced significant psychological effects, which continue to be a critical area of concern. Cognitive and psychopathological problems in patients with COVID-19 not only affect their physical, emotional, and spiritual health but also diminish their overall quality of life. Research suggests that complex psychopathological effects appear to persist in former COVID-19 patients even after discharge from the hospital. The coronavirus can induce psychopathological sequelae either indirectly through an immune response or directly by infecting the central nervous system (CNS). This can result in persistent neuropsychiatric symptoms, including

behavioral, emotional, and cognitive symptoms, which can occur at regular intervals after the initial infection.<sup>1</sup>

COVID-19 is transmitted through droplets from pre-symptomatic, asymptomatic, or symptomatic individuals carrying the virus. COVID-19, primarily a respiratory and vascular disease, is caused by SARS-CoV-2, which mainly targets the respiratory and vascular systems. Post-COVID-19 syndrome can manifest a wide range of complications, including respiratory, renal, cardiovascular, rheumatologic, dermatologic, neuropsychiatric, endocrinologic, urologic, and gastrointestinal issues. Depression, insecurity, stress, brain fog, declines in cognitive and executive functions, difficulty communicating with family and healthcare professionals, eating disorders, confinement, fear of death, uncertainty about recovery, stigmatization by others, and social isolation are significant factors contributing to the worsening psychopathology in these patients.<sup>2,3</sup>

Depression and anxiety are major contributors to the mental health burden, with long-term economic and social consequences being inevitable. Comorbid psychiatric illnesses have been shown to increase the vulnerability of individuals with depressive symptoms during the pandemic. Current literature suggests that the interaction between neurocircuitry and neuroinflammation plays a key role in the development of depression. Therefore, the neuroimmune response likely played a critical role in the development of depression during the pandemic. In addition to direct viral infection, an indirect immune response to the virus, such as cytokine production, may have contributed to the development of psychiatric symptoms. The association between gut microbiota and mood disorders remains under scrutiny. Numerous studies have linked depression and anxiety to an imbalance in gut flora, which leads to dysfunction in the gut-brain axis.<sup>4,5</sup>

Patients with severe COVID-19 have exhibited persistent deficits in executive function. Several initial symptoms were found to be predictors of long-term outcomes, indicating that systemic inflammation and neuroinflammation contribute to acute-phase COVID-19 symptoms. ICU stays have also been associated with reduced executive function, which highlights the importance of oxygen therapy. Hospitalized individuals are more likely to experience impairments in attention, executive function, category fluency, verbal memory, and information processing speed compared to non-hospitalized individuals. COVID-19 patients reporting cognitive symptoms showed deficits in attention, executive function, episodic memory, and visuospatial processing. Furthermore, COVID-19 survivors who required intubation displayed significantly slower mental processing speeds and less accurate verbal reasoning, with

cognitive losses estimated to be equivalent to a reduction of approximately 10 IQ points.<sup>6,7</sup>

The impacts of COVID-19 on quality of life have not been evenly distributed among populations of Organization for Economic Cooperation and Development countries. Although older individuals and men were more likely to die from COVID-19, women, and younger individuals were more likely to experience severe declines in mental health and overall quality of life. Those with lower incomes, the unemployed, and racial and ethnic minorities experienced worse mental and physical health outcomes compared to the general population. Moreover, children from disadvantaged households were at greater risk.<sup>8</sup>

Wong *et al.*<sup>9</sup> highlighted a dramatic decrease of at least 33% in the quality of life of hospitalized COVID-19 patients, compared to the healthy population, 3 months after hospital discharge. Survivors of COVID-19 have an increased prevalence of comorbid conditions, which often lead to severe, progressively worsening clinical outcomes.<sup>9,10</sup>

Biopsychosocial factors may contribute to the high rate of psychiatric symptoms in COVID-19 survivors. Direct viral infection of the CNS, or indirect effects through the immune response, may lead to the development of psychopathology in these patients. Social factors such as quarantine, isolation, social distancing, and economic hardship further exacerbate the psychopathology of COVID-19 survivors. Additionally, the widespread use of the internet and smartphones has led to an overload of information, contributing to confusion, excessive worry, and unnecessary fear. ICU admission, in particular, has been noted to contribute to patients' psychopathology. During the outbreak, many individuals were also stigmatized due to their illness, further impacting their psychological well-being.<sup>11,12</sup>

Hall *et al.*<sup>6</sup> demonstrated that symptomatic SARS-CoV-2 infections were associated with psychiatric symptoms and cognitive dysfunction. The coronavirus can cause psychopathological sequelae either indirectly through immune responses or directly through CNS infection. Mechanisms contributing to COVID-19-related neuropathology include a combination of direct viral infection, neuroinflammation, severe systemic inflammation, neurodegeneration, and microvascular thrombosis.<sup>13</sup>

The purpose of the present research is to investigate the psychopathology of patients who have contracted COVID-19. The main objectives are to examine, measure, study, and analyze the impact of depression, cognitive and executive functions, and demographic factors on patients' quality of life. The research hypotheses are formulated as follows:

- H1: Depression has a significant impact on the quality of life of patients who contracted COVID-19.
- H2: Executive and cognitive functions of patients who contracted COVID-19 affect their quality of life
- H3: Demographic characteristics of research participants influence the quality of life of patients whose physical health has been affected by the COVID-19 pandemic.

## 2. Methods

### 2.1. Participants

Data for the current research were collected from a post-COVID-19 clinic at the Regular Outpatient Clinics of Sotiria Thoracic Diseases Hospital in Athens, Greece, where follow-up was provided to patients who had either been mildly ill or hospitalized with COVID-19. All participants ( $n = 49$ ) in the present study were fully informed about the voluntary nature of the research. They were provided with a consent form, which emphasized their right to withdraw from the study at any time without consequence. The survey took place from July 1 to July 30, 2023. Participants were adult males and females, fluent in Greek (except for one Georgian woman), and all were at least 20 years old. The sample consisted of 20 male participants (40.82%) and 29 female participants (59.18%). Participants were divided into three age categories: 20 – 40 years (men:  $n = 4$ ; women:  $n = 7$ ), 41 – 60 years (men:  $n = 13$ ; women:  $n = 19$ ), and 61 years and older (men:  $n = 3$ ; women:  $n = 3$ ). Regarding employment status, 22 participants (37.9%) worked in the private sector, 8 (13.8%) in the public sector, 7 (12.1%) were self-employed, 7 (12.1%) were unemployed, 2 (3.4%) were retired, and 3 (5.2%) were students (Table 1).

### 2.2. Study design and settings

This quantitative research examined categorical, nominal, and numerical variables in the study of participants. We used one-way analysis of variance (ANOVA) to critically examine the relationship between independent variables and the dependent variable, to interpret and analyze correlations in detail. The independent variables included demographics, depression, and cognitive and executive functions, while the dependent variable was quality of life. Thus, cognitive and executive functions, demographics, and depression were the predictor variables, while quality of life served as the criterion variable.

### 2.3. Questionnaires

Psychometric tests and closed-ended questions were used to test the hypotheses, allowing us to obtain both quantitative and qualitative information, leading to more

**Table 1. Employment distribution of participants**

| Employment type | Measurement | %    |
|-----------------|-------------|------|
| Private sector  | 22          | 37.9 |
| Public Sector   | 8           | 13.8 |
| Self-employed   | 7           | 12.1 |
| Unemployed      | 7           | 12.1 |
| Pensioner       | 2           | 3.4  |
| Student         | 3           | 5.2  |

comprehensive results. Demographic characteristics collected included gender, age, marital status, educational level, employment status, and region of residence. The questionnaires used in this study were: (i) Patient Health Questionnaire (PHQ-9), (ii) Health Survey Questionnaire Short Form (HSQ SF-36), (iii) Montreal Cognitive Assessment (MoCA), and one demographic questionnaire.

### 2.4. Statistical analysis

The research objectives were examined through one-way ANOVA and two multiple regression analyses to determine and interpret correlations accurately. Statistical reliability was established with a robust internal consistency, demonstrated by a Cronbach's alpha coefficient of 0.803. Statistical significance was set at  $P < 0.05$ . All statistical analyses were performed using SPSS Statistical Package for Windows (version 28.0).<sup>14</sup>

## 3. Results

### 3.1. First multiple regression analysis

The first multiple regression analysis examined the relationship between quality of life (HSQ SF-36) as the dependent variable and depression (PHQ-9) and cognitive and executive functions (MoCA) as the independent variables. Before interpreting the results, the assumptions underlying the regression model were assessed.

In the Pearson correlation coefficient analysis, multicollinearity was assessed to ensure that the correlation coefficients between the independent variables were not  $>0.8$ . The correlation between MoCA and PHQ-9 was  $-0.077$ , which falls within acceptable limits. In addition, the correlation between MoCA and SF-36 was marginally significant, with a  $P = 0.057$ , close to the 0.05 threshold. In contrast, the correlation between PHQ-9 and HSQ SF-36 was stronger, with a significant  $P = 0.001$  (Table 2).

### 3.2. Second multiple regression analysis

The second multiple regression analysis explored the relationship between quality of life (HSQ SF-36) (dependent variable) and demographics (independent variable). As

with the first analysis, the underlying assumptions were examined before proceeding with interpretation.

None of the independent variables showed multicollinearity (correlation >0.8). The results suggest that both gender and employment status had a statistically significant impact on quality of life, with gender showing a  $P = 0.046$  and employment status marginally significant at 0.052 (Table 3).

### 3.3. One-way ANOVA

A one-way ANOVA was applied between the HSQ SF-36 and demographic variables, as the data could be grouped into at least three categories, with each group containing at least three measurements. One-way ANOVA was used to investigate differences in quality of life (HSQ SF-36) across age groups, assuming equal variances. The results showed no statistically significant difference in quality

of life between age groups, with a  $P > 0.05$ , meaning we cannot reject the null hypothesis. However, it is worth noting that individuals aged 20 – 40 reported better quality of life compared to those aged 41 – 60 (Table 4).

Similarly, when analyzing the relationship between SF-36 and employment status, the ANOVA indicated no statistically significant difference in quality of life between employment categories. However, retirees reported higher quality of life, while individuals employed in the private sector reported lower quality of life (Table 5).

## 4. Discussion

The primary objective of the present study was to evaluate the psychopathology of patients who had contracted COVID-19 and were monitored by a post-COVID-19 clinic in the Regular Outpatient Clinics of Sotiria Thoracic Diseases Hospital in Athens, Greece. Specifically, this study aimed to determine whether depression, cognitive and executive functions, and demographic characteristics influenced the quality of life of these patients, as assessed through the PHQ-9, HSQ SF-36, and MoCA questionnaires. The participants included Greek adults, both men and women, with the exception of one Georgian woman, all aged >20 years. Notably, there were fewer male participants ( $n = 20$ ) compared to females ( $n = 29$ ) in the samples.<sup>15</sup>

The first multiple regression analysis sought to predict the quality of life (HSQ SF-36) in patients who had recovered from COVID-19, based on their cognitive and executive functions (MoCA) and depression levels (PHQ-9). The findings demonstrated that depression significantly negatively affected the quality of life in COVID-19 patients. This finding aligns with existing research showing that quality of life is significantly influenced by

**Table 2. Pearson correlation coefficients of the first multiple regression analysis**

|                                 | SF_36  | Moca   | PHQ    |
|---------------------------------|--------|--------|--------|
| Pearson correlation coefficient |        |        |        |
| HSQ SF-36                       | 1.000  | 0.228  | -0.435 |
| MoCA                            | 0.228  | 1.000  | -0.077 |
| PHQ                             | -0.435 | -0.077 | 1.000  |
| Statistical significance        |        |        |        |
| HSQ SF-36                       | 0.000  | 0.057  | 0.001  |
| MoCA                            | 0.057  | 0.000  | 0.299  |
| PHQ                             | 0.001  | 0.299  | 0.000  |

Abbreviations: MoCA: Montreal Cognitive Assessment; PHQ-9: Patient Health Questionnaire; HSQ SF-36: Health Survey Questionnaire Short Form.

**Table 3. Pearson correlation coefficients of the second multiple regression analysis**

|                                 | SF_36  | Gender | Age    | Education | Employment |
|---------------------------------|--------|--------|--------|-----------|------------|
| Pearson correlation coefficient |        |        |        |           |            |
| HSQ SF-36                       | 1.000  | -0.244 | -0.105 | -0.118    | 0.235      |
| Gender                          | -0.244 | 1.000  | -0.074 | 0.024     | -0.324     |
| Age                             | -0.105 | -0.074 | 1.000  | 0.115     | -0.120     |
| Education                       | -0.118 | 0.024  | 0.115  | 1.000     | -0.167     |
| Employment                      | 0.235  | -0.324 | -0.120 | -0.167    | 1.000      |
| Statistical significance        |        |        |        |           |            |
| HSQ SF-36                       | 0.000  | 0.046  | 0.237  | 0.210     | 0.052      |
| Gender                          | 0.046  | 0.000  | 0.305  | 0.436     | 0.012      |
| Age                             | 0.237  | 0.305  | 0.000  | 0.216     | 0.206      |
| Education                       | 0.210  | 0.436  | 0.216  | 0.000     | 0.126      |
| Employment                      | 0.052  | 0.012  | 0.206  | 0.126     | 0.000      |

Abbreviation: HSQ SF-36: Health Survey Questionnaire Short Form.



**Table 4. One-way ANOVA: HSQ SF-36 and age**

|               | Sum squares | df | Means of squares | F     | Statistical significance |
|---------------|-------------|----|------------------|-------|--------------------------|
| Among groups  | 510.522     | 2  | 255.261          | 0.789 | 0.460                    |
| Inside groups | 14,884.365  | 46 | 323.573          |       |                          |
| Total         | 15,394.888  | 48 |                  |       |                          |

Abbreviation: HSQ SF-36: Health Survey Questionnaire Short Form.

**Table 5. One-way ANOVA: HSQ SF-36 and employment**

|               | Sum squares | df | Means of squares | F     | Statistical significance |
|---------------|-------------|----|------------------|-------|--------------------------|
| Among groups  | 1,335.592   | 5  | 267.118          | 0.817 | 0.544                    |
| Inside groups | 14,059.296  | 43 | 326.960          |       |                          |
| Total         | 15,394.888  | 48 |                  |       |                          |

Abbreviation: HSQ SF-36: Health Survey Questionnaire Short Form.

physical and mental health, personal beliefs, and social relationships in individuals affected by the COVID-19 pandemic.<sup>16</sup> The deterioration of mental health, specifically the exacerbation of depression in people suffering from COVID-19, was closely associated with a decline in quality of life, as demonstrated by the statistical analysis. In contrast, the use of the MoCA questionnaire did not reveal that cognitive and executive functions exerted a significant negative influence on the quality of life of individuals recovering from COVID-19. Although previous studies have confirmed that cognitive impairments can affect the quality of life in patients affected by COVID-19, this specific study found no such association. The cognitive and executive function evaluations in this sample did not have a measurable negative impact on quality of life.<sup>7,17</sup>

The second multiple regression analysis explored whether demographic characteristics – such as age, gender, employment status, and education – were related to the quality of life in patients who had been infected with SARS-CoV-2. The results indicated that none of these demographic factors had a significant impact on quality of life, as the *P*-values for gender (0.191), education (0.594), employment status (0.352), and age (0.526) were all  $>0.05$ . Consequently, demographics did not negatively influence the quality of life in this study, despite similar research showing a significant effect.<sup>18</sup> However, the data did suggest that quality of life was better for individuals aged 20 – 40 years and worse for those aged 41 – 60 years. The decline in quality of life in the 41 – 60 age group was likely due to the impact of work-related issues, unemployment, limitations in daily activities, compliance with preventive and social distancing measures, isolation, and loneliness.<sup>19</sup>

Furthermore, retirees reported a better quality of life compared to individuals employed in the private sector.<sup>20</sup> This may be attributed to the unique living conditions

created during the COVID-19 pandemic. The private sector, in particular, faced significant challenges in many countries, despite government interventions aimed at mitigating economic challenges.<sup>21,22</sup> In the ANOVA results related to the multiple regression analysis, the significance (*P*-value) was  $<0.05$ , indicating that some correlations were statistically significant. Depression had a significant impact on the daily lives of the participants in this study. However, cognitive and executive functions did not affect the quality of life in this specific cohort. One possible explanation for this finding could be the relatively small sample size ( $n = 49$ ). It is likely that with a larger sample, the results might have been different. Similarly, the lack of significant impact from demographic factors on quality of life could also be due to the limited sample size.<sup>23</sup>

## 5. Conclusion

The current study aims to examine the psychopathology of patients who contracted COVID-19, with a particular focus on the role and effects of depression and cognitive and executive functions, as assessed by the PHQ-9 and MoCA questionnaires, in relation to their quality of life. The findings support the need for further exploration into the impact of depression on patients' quality of life and well-being, and the development of cost-effective approaches for managing these effects. Future research should prioritize the early diagnosis of depression, as it is often difficult to detect without close observation by family members or healthcare providers. Ongoing clinical research is necessary to identify the underlying mechanisms of depression and to develop strategies to mitigate its effects, thereby preserving and enhancing quality of life.

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## Conflict of interest

The authors declare no conflicts of interest.

## Author contributions

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## Ethics approval and consent to participate

The study was approved by Sotiria Chest Diseases General Hospital of Athens, Athens, Greece (approval no.: 15324/08-06-2023). All participants gave consent to participate in this study.

## Consent for publication

The participants gave consent to publish their data in this study.

## Availability of data

Data used in this work are available from the corresponding author on reasonable request.

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