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Personality and neuropsychiatric symptoms in individuals diagnosed with long COVID

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Abstract

Objective This study investigates persistent physical and neuropsychiatric symptoms in Long COVID, focusing on their severity and assessing risk/resilience factors, including conscientiousness and neuroticism. The study utilizes a mediation model to explore the potential role of psychological distress in mediating its impact on cognitive decline.

Methods In an online survey, 114 participants diagnosed with Long COVID completed assessments, including the Patient Health Questionnaire (PHQ-9) and Generalized Anxiety Disorder (GAD-7) for psychological distress, Subjective Cognitive Decline (SCD) questionnaire for cognitive decline, Pittsburgh Sleep Quality Index (PSQI) for sleep disorders, and Multidimensional Scale of Perceived Social Support (MSPSS) with "BIG-5 inventory" subscales for risk/resilience factors.

Results Findings showed high rates of depressive disorders (45.6%), generalized anxiety disorders (21%), sleep disturbances (76.3%), and reported cognitive changes (94.7%). Conscientiousness negatively correlated with psychological distress ($p < .001$, $r = -.48$) and cognitive decline ($p < .001$, $r = -.36$), while neuroticism positively correlated ($p < .001$, $r = .62$ and $p < .001$, $r = .41$, respectively). Social support negatively correlated with psychological distress ($p < .001$, $r = -.52$) and cognitive decline ($p < .001$, $r = -.41$). Psychological distress fully mediated personality traits and cognitive decline correlations, with significant full mediation for neuroticism [95% CI = (0.22, 0.48)] and conscientiousness [95% CI = (-0.33, -0.07)], controlling for age, gender, other chronic morbidity and social support.

Conclusion The study underscores the significance of incorporating psychological interventions into treatment plans to alleviate distress symptoms associated with cognitive decline in conditions like Long COVID.

Keywords Long covid, Personality traits, Conscientiousness, Neuroticism, Psychological distress, subjective cognitive decline (SCD)

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Introduction

Long COVID, also known as post-COVID syndrome, describes the prolonged illness experienced by individuals following a SARS-CoV-2 infection, lasting for a month or more after the acute phase of the disease [26, 87, 93]. An estimated 65 million individuals globally grapple with Long COVID, marked by diverse symptoms ranging from those reminiscent of the acute phase to new manifestations [28, 76]. This syndrome's trajectory may involve chronicity or intervals of remission and relapse, adding to its complexity [28, 76].

Various studies have identified risk factors associated with Long COVID symptoms, including gender, disease severity, and the nature of symptoms during the acute phase [6, 26, 122]. However, findings regarding the impact of age on Long COVID development vary. While meta-analyses suggest age as a risk factor, particularly among hospitalized patients post-discharge, other research indicates a decrease in Long COVID risk with age, with a higher prevalence observed among young adults [107].

Long COVID can manifest in distinct categories based on prevalent residual symptoms, such as Cardio-Respiratory Syndrome, Fatigue Syndrome, and Neuropsychiatric Syndrome, the latter characterized by headaches, sleep disturbances, cognitive changes, and other mental health-related issues [93]. Notably, a meta-analysis revealed widespread cognitive changes among individuals with Long COVID, with "brain fog" reported by 32% of individuals, encompassing difficulties in concentration, memory decline, and problems with executive functions [90]. Pathophysiological examinations of Long COVID suggest potential mechanisms involving oxidative stress, viral-specific variation, immunologic abnormalities, and inflammatory damage, all of which are associated with neuropsychiatric diseases like depression [87]. Chronic inflammation, in particular, has been implicated in understanding psychological distress [18, 79, 86].

Psychological distress

Psychological distress, characterized by emotional suffering marked by depression and anxiety symptoms, is widely recognized in research literature [1, 16, 95, 119, 120]. Notably, depression and anxiety often co-occur, posing a two-way risk for individuals [54, 70].

Depressive symptoms constitute a predominant aspect of the neuropsychiatric syndrome associated with Long COVID [96], leading to the conceptualization of Long COVID Depression (LCD), resembling major depressive disorder (MDD) in symptomatology [37, 75]. Moreover, neuroimaging findings in individuals with LCD indicate structural alterations akin to those observed in MDD cases [10].

The COVID-19 pandemic has led to an approximate 25% increase in the worldwide prevalence of depression and anxiety, highlighting the global mental health impact [118].

Subjective cognitive decline and psychological distress

Subjective cognitive decline (SCD), defined as self-perceived cognitive decline over time, is often associated with objectively identified cognitive deficits [58, 59]. Psychological distress has been established as a critical risk factor for cognitive decline, with symptoms of anxiety and depression playing a central role [30, 38, 71]. Specifically, both anxiety and depression have been shown to influence SCD [56, 109, 121]. Depressive symptoms are particularly predictive of declines in episodic memory and executive functions. When combined, symptoms of anxiety and depression have been associated with decreased attention skills [3], while anxiety alone predicts declines in verbal memory [50]. In the context of COVID-19, a longitudinal study investigating its enduring consequences on cognitive function revealed that depressive symptoms were the primary factor impacting cognitive function, even when accounting for a range of clinical and socio-demographic variables [89]. These findings underscore the intricate interplay between psychological distress and cognitive decline, highlighting the need for further exploration of factors influencing these phenomena.

Personality traits: influencers of mental health and cognitive function

Personality traits, particularly those outlined in the Big Five model, are widely recognized for their predictive value in understanding various health conditions [40, 92, 106]. This study examines two traits within this framework: neuroticism, which is considered a risk factor, and conscientiousness, which is viewed as a protective factor, due to their established associations with cognitive function and mental health [7, 20]. Neuroticism, often referred to as emotional instability, reflects variations in emotional reactivity, experiences, and social interactions [47, 82]. In contrast, conscientiousness represents a stable tendency to control impulses, set goals, delay gratification, and act according to norms and rules [12, 52, 80]. Individuals with high levels of neuroticism frequently experience adverse cognitive-emotional processes, which are characterized by phenomena such as worry, rumination, ineffective coping mechanisms, and diminished emotional regulation. In contrast, individuals with low scores in conscientiousness often demonstrate deficiencies in responsibility, motivation, and self-control [91]. Each of these traits independently contributes to psychological distress, and their interaction may further

influence the overall experience of distress. Research conducted across different cultural contexts suggests that these traits interact to shape psychological distress, with conscientiousness mitigating the negative effects of high levels of neuroticism [14, 80]. Psychological explanations for these associations emphasize the role of emotional regulation and cognitive schemas. For instance, individuals high in neuroticism are more likely to adopt a "stress-as-threat" mindset, whereas those high in conscientiousness view stress as a challenge [21]. These traits are also closely linked to cognitive decline, in both typical aging and neurodegenerative conditions such as Alzheimer's disease. Specifically, high levels of neuroticism and low levels of conscientiousness are associated with increased cognitive vulnerability [33, 41, 111]. Furthermore, neuroticism has been linked to faster rates of cognitive decline, while conscientiousness appears to promote cognitive resilience, even after accounting for age-related factors [20, 73].

Despite established associations between personality traits, psychological distress, and cognitive decline [15, 21, 27, 34, 52], research on their combined impact in Long COVID remains scarce.

Social support

Social support, stemming from interpersonal relationships and social connections during challenging times [43, 48], encompasses emotional, instrumental, informational, and appraisal aid. It plays a pivotal role in nurturing mental and physical well-being and aiding in coping with chronic illness [105, 110]. Research indicates social support as a predictor of cognitive functions [13, 65], with its influence persisting even after accounting for variables like depression, gender, and age [32].

During the COVID-19 pandemic, studies have highlighted social support as a protective factor against depression, anxiety, and sleep disturbances [49, 85]. Additionally, reported levels of social support show correlations with conscientiousness and neuroticism traits. Higher conscientiousness tends to associate with greater perceived support, whereas elevated neuroticism tends to associate with lower perceived support [2].

The current study

This study aims to characterize neuropsychiatric symptoms in individuals with Long COVID, exploring risk and resilience factors such as personality traits and social support. Specifically, we investigate the role of neuroticism and conscientiousness in subjective cognitive decline, mediated by psychological distress. We hypothesize that conscientiousness acts as a protective factor, while neuroticism poses a risk for cognitive decline, with psychological distress mediating these associations.

Methods

Participants

A priori power analysis using G*Power 3.1 [62], for a multiple regression model with six predictors ($f^2 = 0.15$, $\alpha = 0.05$, power = 0.90) indicated a minimum sample size of 88 participants. This target ensures sufficient statistical power to detect medium effects in the study.

The inclusion criteria were individuals aged 18 and above, proficient in both reading and speaking Hebrew, diagnosed with Long COVID, and who attended a follow-up session more than a month after recovery. Exclusion criteria comprised individuals who did not manifest persistent symptoms, such as fatigue, insomnia, 'brain fog,' shortness of breath, cough, etc., a month or more after the acute phase of the disease. Additionally, patients requiring hospitalization or oxygen supplementation during the acute phase of SARS-CoV and those who failed to complete all questionnaires were excluded.

Procedure

Informed consent to participate was obtained in writing from all study participants in accordance with the guidelines outlined by the Ethics Committee of Sourasky Tel Aviv Medical Center (Approval No. 044322). All procedures involving human participants were performed in accordance with the relevant guidelines and regulations as approved by the Ethics Committee of Sourasky Tel Aviv Medical Center.

Participants were recruited from the pool of patients diagnosed with Long COVID undergoing follow-up at the medical center's 'post-COVID-19' outpatient clinic between the beginning of 2020 and the end of 2022. Initial contact attempts were made with all listed patients ($n = 742$), resulting in 438 answered calls. Patients were presented with a comprehensive study overview. Eight patients reported not being diagnosed with Long COVID, five indicated a lack of proficiency in reading Hebrew, and two cited challenges with technology. Sixty-five individuals chose not to complete the questionnaire for personal reasons, citing a perceived lack of personal benefit. From those who agreed to participate and met the inclusion and exclusion criteria ($n = 373$), 116 signed the electronic informed consent form and completed the full set of questionnaires. Two patients, not meeting the Long COVID criteria based on our study questionnaire, were subsequently excluded from the analysis. Responses to questionnaires were collected over approximately four months, from January 16 to May 13, 2023.

Questioners

The questionnaires utilized in the current study have been validated and are widely employed worldwide, including in Israel.

Demographic questionnaire: The participants were required to report several personal and demographic questions related to age, gender, marital status, and co-morbidity.

Personality trait (BIG-5): The BIG-5 Personality questionnaire, based on the model proposed by John et al. [60], is a self-report instrument assessing five personality factors. The abbreviated version of the questionnaire comprises 44 items that cover the dimensions of personality: neuroticism, conscientiousness, openness, extroversion, and agreeableness. Participants respond on a 5-point Likert scale, ranging from 1 ("do not agree at all") to 5 ("strongly agree"). Specific to the current study, we focused on two subscales: conscientiousness (9 items) and neuroticism (8 items). The questionnaire, translated into Hebrew, demonstrated good reliability for the conscientiousness scale ($\alpha = 0.73$) and the neuroticism scale ($\alpha = 0.81$) [36]. In the current sample, internal consistency for the two subscales remained high (Cronbach's alpha: conscientiousness, $\alpha = 0.82$; neuroticism, $\alpha = 0.86$).

Anxiety (GAD-7): A self-report questionnaire designed to assess Generalized Anxiety Disorder (GAD), based on the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [104]. It employed as part of a comprehensive diagnostic tool known as the Patient Health Questionnaire (PHQ). The GAD-7 has demonstrated good sensitivity and specificity, not only for generalized anxiety disorder but also for three anxiety disorders frequently encountered in primary care: panic disorder, social anxiety, and post-traumatic stress disorder [68, 117]. It comprises 7 items, where participants indicate the extent to which a sentence describes their experiences in the last two weeks. Responses range from 0 (not at all) to 3 (almost every day), resulting in a total score that ranges from 0 to 21. Scores of 5 or more, 10 or more, and 15 or more indicate mild, moderate, and severe levels of symptoms, respectively [104]. A meta-analysis investigating the psychometric properties of the questionnaire identified acceptable diagnostic cutoff scores for Generalized Anxiety Disorder, ranging from 7 to 10. In this study, scores ≥ 10 were used as indicators of anxiety symptoms [88]. The*GAD-7*was selected for its high sensitivity and specificity in assessing generalized anxiety and related disorders, with strong validity and reliability demonstrated across diverse populations, including Israeli samples [46, 72, 78]. In the current sample, the internal consistency was $\alpha = 0.95$.

Depression (PHQ-9): A self-report questionnaire designed to assess symptoms of depression consists of a 9-item depression module taken from the full Patient Health Questionnaire (PHQ). Responses range from 0, "not at all," to 3, "almost every day." This questionnaire was translated into Hebrew and validated, with scores of ≥ 5, ≥ 10, ≥ 15, and ≥ 20 representing mild, moderate, moderate-severe, and severe depression, respectively [44]. A total score of ≥ 10 was defined in this study as indicative of depression symptomatology [74]. The Cronbach's alpha, as reported by the developers, was 0.89 and 0.86 in the validation studies of the PHQ-9 [67]. The *PHQ-9* was chosen for its proven reliability in assessing depression severity, with well-established cut-off scores and validation across various populations, including Israeli samples [116]. In the current sample, the internal consistency was $\alpha = 0.84$.

Long COVID: A self-report questionnaire was used to assess symptoms characteristic of Long COVID in terms of duration and severity, occurring more than a month after infection. Participants rated the extent of their symptom experience on a scale of 0 (no suffering) to 10 (significant suffering). Symptoms were categorized into domains, including general, respiratory and cardiovascular, skin, gastrointestinal, and neuropsychiatric. The questionnaire, developed by the medical staff at a specialized COVID-19 clinic, aligns with Long COVID diagnosis guidelines. Scores range from 0 to 180, with higher scores indicating greater symptom severity [64].

Subjective cognitive decline (SCD): A self-report questionnaire, comprising six items, assesses the extent of cognitive difficulties experienced by participants. The scale ranges from 0 (rarely/not at all) to 3 (almost always/significant change). Each item prompts participants to evaluate how specific cognitive aspects have declined compared to their previous experiences, using a scale from 0 (no change) to 3 (Significant Change). Scores range from 0 to 36, with higher scores indicating a more pronounced and severe subjective cognitive decline. Developed by Dr. Odalia Elkana and colleagues [35], the tool shows correlations with objective cognitive abilities, overall subjective cognitive perception, and indices related to pain among individuals diagnosed with fibromyalgia and with Long covid [5]. It was specifically developed and validated for assessing subjective cognitive decline and has been previously utilized in Israeli studies, further supporting its suitability for this sample [35]. In the current sample, the internal consistency was $\alpha = 0.95$.

Sleep Quality (PSQI): The Pittsburgh Sleep Quality Index is a self-rated questionnaire that assesses sleep quality and sleep disturbances over a 1-month period. The questionnaire consists of 19 items contributing to seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The sum of scores for these components yields one global score, ranging from 0 to 21, where

higher scores represent poorer sleep quality [17]. A general score of 5 serves as a cut-off, distinguishing between individuals with good and poor sleep. The PSQI is a widely validated tool for assessing sleep quality and disturbances, with established reliability both globally and in Hebrew [102]. In the current sample, the internal consistency was $\alpha = 0.82$.

Social support (MSPSS): The Multidimensional Perceived Social Support scale is a self-report questionnaire designed to assess an individual's subjective perception of their social support. It consists of 12 items categorized into three subscales: family, friends, and significant others. Participants are required to indicate their agreement with each statement using a modified 7-point Likert scale [123]. In this study, we utilized a modified version of the Likert scale, reducing it to three degrees (1 to 3), deviating from the original 7-point scale. The Hebrew version, with the reduced scale, demonstrated high internal reliability for the three subscales: $\alpha = 0.87$ for family support, $\alpha = 0.86$ for friends, and $\alpha = 0.90$ for significant others [23]. The MSPSS was selected for measuring social support based on its strong psychometric properties and its extensive use in Hebrew-language studies [1, 85, 97, 103]. The present study confirmed high internal consistency reliability for the total score of the questionnaire ($\alpha = 0.92$).

Data analysis

Statistical analysis of the data was conducted using SPSS 26.0 for Windows. Categorical data were presented as numbers and percentages, while quantitative data were expressed as the mean ± standard deviation (SD). Quantitative variables were assessed for correlations using the Pearson correlation coefficient.

The psychological distress index was computed by averaging scores from the anxiety questionnaire (GAD-7) and the depression questionnaire (PHQ-9). This composite measure, referred to as the Patient Health Questionnaire Anxiety-Depression Scale (PHQ-ADS) in common assessment practices [69, 81, 113], adheres to the principle of parsimony. This choice is supported by the substantial correlation between the two tools in the present study ($r = .81$).

To test the hypothesis of the mediation model, the PROCESS macro for SPSS was employed [51]. The models incorporated conscientious or neurotic personality traits as alternative predictor variables, psychological distress as the mediating variable, and cognitive decline as the predicted variable. Both models included age, gender, other chronic morbidity and social support as covariates.

Results

Personal and demographic information

The sample included 114 participants, of whom 29 were men (25.4%) and 85 were women (74.6%). The age range was 20 to 78 years (mean = 44.5, SD = 14.4). Among them, 61 (53.5%) were married, 22 (19.3%) were divorced, 1 (0.9%) was a widower, and 30 (26.3%) were single. Additionally, 36 participants (31.5%) reported dealing with a chronic disease other than long COVID. Of these, 8 participants (22.2%) with asthma, 5 (13.8%) had diabetes, 9 (24.3%) had fibromyalgia, 5 (13.8%) had bowel diseases (Crohn's/colitis), 4 (11.1%) had hypothyroidism, 6 (16.6%) had high blood pressure, and 14 (38.8%) reported other chronic diseases.

Neuropsychiatric symptoms

Overall, the mean GAD-7 score was 6.16 ± 10.8 (ranging from 0 to 21), breaking down into 61 (53.5%) non-anxious, 29 (25.4%) mildly anxious, 8 (7%) moderately anxious, and 16 (14%) severely anxious responses. According to the GAD-9 scoring criteria, 78.9% of participants were classified into the non-anxiety group, and 21.05% into the anxiety group. For the PHQ-9 questionnaire, the mean score was 9.7 ± 6.5 (ranging from 0 to 25), breaking down into 29 (25.4%) non-depressed, 33 (28.9%) mildly depressed, 22 (19.3%) moderately depressed, 17 (14.9%) moderate-severe depressed, and 13 (11.9%) severely depressed. Based on the PHQ scoring criteria, 54.3% fell into the non-depressed group, and 45.6% were classified into the group exhibiting depressed symptomatology. The mean PSQI score was 9.5 ± 5.1, ranging from 0 to 20. According to PSQI scoring criteria, 23.7% of participants were defined as having good sleep, while 76.3% were classified as having poor sleep. The average score on the cognitive decline questionnaire was 18.5 ± 10.8, ranging from 0 to 36. Six subjects (5.3%) reported the minimum score of 0, indicating no cognitive changes. The majority, 94.7%, scored 1 or higher, signifying a noticeable cognitive change compared to their past experiences (baseline). Long COVID symptom severity questionnaire was 75.6 ± 34.8, ranging from 1 to 148.

Risk and resilience factors

In examining the descriptive statistics of the personality trait, the mean score for neuroticism was found to be 23.3 ± 6.8, ranging from 10 to 40 in the current sample, derived from the potential range of 8 to 40. Additionally, the mean score of conscientiousness was found to be 36.1 ± 5.8. ranging from 18 to 45, compared to the potential range of 9–45. Examining social support, MSPSS mean score was 31.3 ± 5.3, ranging from 12 to 36, in accordance with the original range potential. Table 1 presents the correlation between the variables.

Table 1 Correlations between the study variables according to Pearson's correlation coefficient (*N*=114)

	1.	2.	3.	4.	5.	6.	7.	8.
Age								
Subjective cognitive decline	0.21*							
Psychological distress	0.12	0.67***						
BIG-5 neuroticism	0.14	0.41***	0.62***					
BIG-5 Conscientiousness	-0.09	-0.36***	-0.48***	0.63***				
Social support	-0.23*	-0.41***	-0.52**	-0.45***	0.54***			
Sleep disturbances	0.22*	0.66***	0.69***	0.41***	-0.38***	-0.4***		
Long COVID symptoms	0.16	0.68***	0.65***	0.4***	-0.27***	-0.32***	0.62***	

*$p < .05$; **$p < .01$; ***$p < .001$

(1). The inset diagram highlights the correlations of the variables included in the mediation analysis

(2). The psychological distress variable was computed as an average of the scores on the depression questionnaire (PHQ9) and the anxiety questionnaire (GAD7), based on the theory presented on page 13. This was done after identifying a high correlation between them (r=0.81)

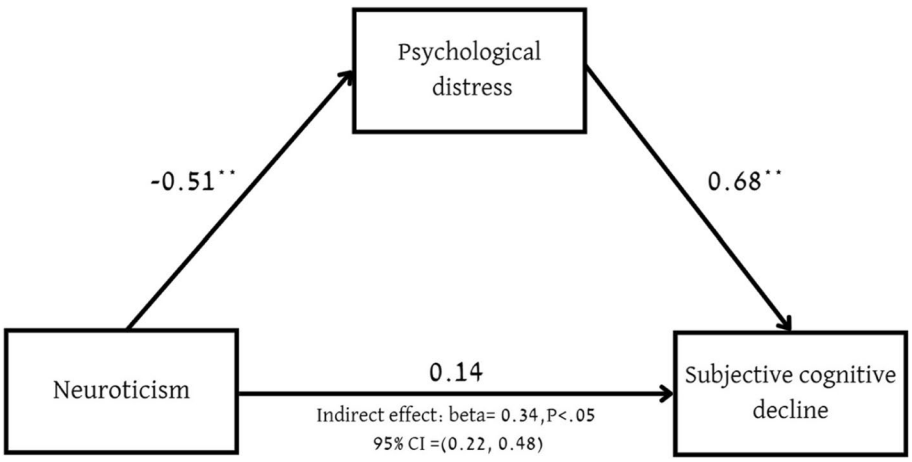

Fig. 1 Mediation analysis of contributors to subjective cognitive decline Numbers on solid lines are standardized path coefficients This analysis was carried out while controlling for age, sex and social support (not presented in the figure) CI, confidence interval. *$P < .05$; **$P < .01$

Mediations analysis

The total effect (path C) of neuroticism on SCD was statistically significant ($P=.01$, $\beta=0.25$, $b=0.41$). Furthermore, the indirect pathway (path ab) indicating the impact of neuroticism on SCD through psychological distress was also significant ($P<.001$, $b=0.56$, $\beta=0.34$, 95% CI = [0.37, 0.39]). Notably, the direct path (path C') representing the effect of neuroticism on SCD in the absence of mediation was not found to be significant ($P=.37$, $\beta=-0.09$, $b=-0.14$). See Fig. 1.

The total effect (path C) of conscientiousness on SCD was statistically significant ($P=.04$, $\beta=-0.21$, $b=-0.41$). Additionally, the indirect pathway (path ab) denoting the influence of conscientiousness on SCD through psychological distress also yielded significance ($P<.001$, $b=-0.39$, $\beta=-0.2$, 95% CI = [−0.63, −0.17]). The direct path (path C') representing the effect of conscientiousness on SCD independently of mediation was found to be non-significant ($P=.89$, $\beta=-0.01$, $b=-0.02$). See Fig. 2.

Discussion

The present study offers a comprehensive examination of the emotional and cognitive profiles of individuals diagnosed with long COVID in Israel, with a specific focus on personality traits and neuropsychiatric symptoms. The study's main objectives are threefold: first, to characterize neuropsychiatric symptoms; second, to explore risk and resilience factors; and third, to propose a mediation model that clarifies the association between personality traits and neuropsychiatric symptoms in individuals coping with Long COVID.

The sample exhibited a notable prevalence of females, aligning with findings indicating that women are three times more likely to be diagnosed with long COVID compared to males [9]. The differences in prevalence based on sex are attributed to distinct patterns of immune system activity. More specifically, females tend to exhibit a quicker and more robust immune response, which is beneficial for the initial reaction to infection. However, this heightened immune activity may simultaneously increase susceptibility to persistent autoimmune conditions [84].

Analyzing the rates of neuropsychiatric symptoms revealed a consistent pattern in anxiety percentages, aligning with findings in post-COVID literature. However, elevated prevalence rates were observed for depression symptoms and sleep disturbances [90]. Specifically, a noteworthy 45.6% of participants met the criteria for depression symptomatology, and a substantial 76.3% reported experiencing sleep difficulties. These figures markedly surpass the corresponding rates of 17% for depression and 30% for sleep difficulties reported in the existing literature [8, 90].

Disparities in findings may be ascribed to various factors. Primarily, variations could arise from the use of diverse measurement tools. Specifically, the depression questionnaire employed in this study, the PHQ-9, identified symptoms of depression in approximately half of the long COVID cases studied [37]. Another plausible explanation relates to the heterogeneity in sample populations across studies, where individuals diagnosed with the disease, those hospitalized during the acute phase, or those exhibiting symptoms without an alternative explanation were occasionally included [28, 100]. In our current sample, participants sought care at a specialized clinic, suggesting potentially heightened symptom severity compared to individuals from the general community. Additionally, considering the relatively recent nature of

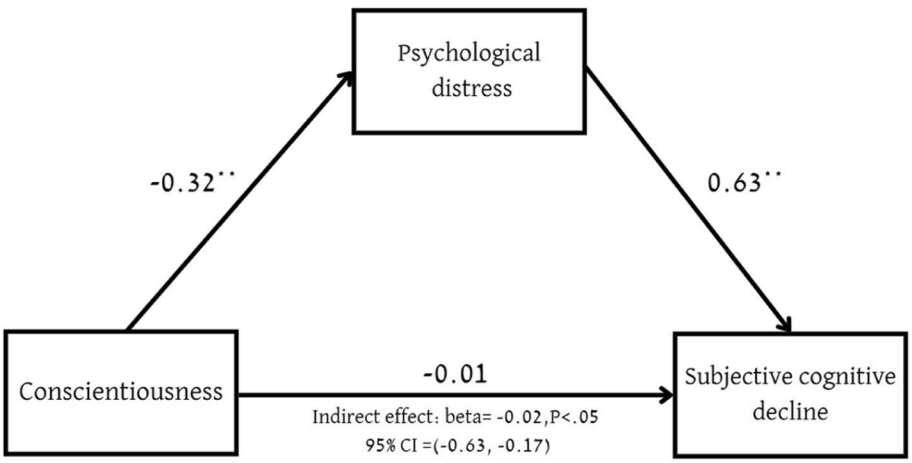

Fig. 2 Mediation analysis of contributors to subjective cognitive decline Numbers on solid lines are standardized path coefficients This analysis was carried out while controlling for age, sex and social support (not presented in the figure) CI, confidence interval. *$P<.05$; **$P<.01$

this medical diagnosis, the lack of uniformity in diagnostic guidelines persists even when diagnosed patients are included [19].

The interpretation of SCD exhibits variability across studies contingent upon the contextual framework in which it is investigated. In clinical settings, for instance, the mere referral of a patient to a cognition clinic serves as indicative evidence of cognitive decline. The assessment of SCD lacks clearly defined cut-off scores, necessitating adaptability based on the specific research hypothesis. In some cases, the research inquiry pertaining to cognitive decline comprises a single dichotomous question, requiring a binary response (yes or no), thereby delineating the presence or absence of SCD [77]. in this study, SCD was assessed using a newly introduced questionnaire previously applied to individuals with fibromyalgia—a prevalent comorbidity in the sample. The mean SCD score was 18.5, indicating cognitive decline compared to past functioning. However, this score was lower than findings in fibromyalgia studies, suggesting potential differences in cumulative damage due to the chronicity of the conditions.

Self-perception of mental and cognitive states varies across demographic groups, with notable differences observed along gender lines [94]. These differences can introduce biases in self-reported measures of cognitive decline. For example, women are more likely than men to underestimate their intelligence, reflecting the influence of gender identity on self-assessments [42]. Furthermore, subjective self-assessments have been shown to be stronger predictors of objective cognitive decline in women compared to men [83]. These findings highlight the importance of accounting for gender-specific biases when interpreting subjective psychological and cognitive evaluations. Incorporating gender-specific analyses in future research is recommended to explore potential differences in self-perceived cognition and understand how gender may shape subjective reporting patterns.

The second aim of the study was to examine risk and resilience factors influencing neuropsychiatric symptoms. The results confirmed the hypothesis that personality traits are associated with neuropsychiatric symptoms. Specifically, conscientiousness emerged as a protective factor, while neuroticism was identified as a risk factor. A high level of conscientiousness was linked to a reduced likelihood of experiencing psychological distress, cognitive decline, and sleep problems, whereas a high level of neuroticism increased the chances of encountering these symptoms.

These findings align with existing literature that explicates the impact of these personality traits on the susceptibility to mood disorders [66]. Additionally, they are consistent with research conducted within aging population, illustrating associations between neuroticism and conscientiousness and cognitive decline, dementia, and the risk of transitioning between different stages of cognitive impairment [7, 73, 111, 112].

Stressful life events, shaped by cultural factors, play a complex role in influencing cognitive functioning, with their predictive value for cognitive deficits varying across studies [45]. In the Israeli context, historical trauma and unique social dynamics contribute to heightene vulnerability to stress-related cognitive decline. At the same time, these factors also promote resilience through collective coping mechanisms, emphasizing the critical role of cultural contexts in understanding long COVID-related cognitive outcomes [24, 53, 67].

Enhancing our comprehension of the connection between personality traits, psychological distress, and cognitive decline could be achieved by taking into account the role of the immune system [40]. Research indicates associations between specific personality traits, particularly high neuroticism and low conscientiousness, and elevated blood levels of cytokine proteins, such as interleukin-6 (IL-6) and C-reactive protein (CRP), markers for inflammatory activity and chronic inflammation [108]. Interleukin-6 is implicated as a central component in the etiology of neuropsychiatric symptoms, as observed in long COVID patients [63].

One plausible explanation for the observed association between conscientiousness, neuroticism, and psychological distress in the context of long COVID is their potential influence on coping with uncertainty. Individuals grappling with long COVID face the sustained impacts of a relatively novel disease. Consequently, ongoing advancements in professional understanding and available interventions contribute to a persistent lack of clarity regarding the medical prognosis [39, 98].

Individuals with high neuroticism tend to interpret situations as threatening, undergoing a rapid development of heightened arousal. This impact is observable in the neuronal activity of the brain, as individuals with elevated neuroticism indices demonstrate a more robust neuronal response to uncertain situations compared to their response to negative feedback [29, 55]. In contrast, those characterized by high conscientiousness, focus on creating action plans to resolve problems rather than experiencing distress in uncertain scenarios [11, 115]. The variations in coping styles during stressful situations, particularly in dealing with uncertainty, provide a rationale for why neuroticism functions as a risk factor while conscientiousness operates as a protective factor in the current context.

Another protective factor for neuropsychiatric symptoms was social support. The positive influence of social support during the peak of the COVID-19 epidemic,

marked by social distancing and feelings of loneliness, underscores its importance [85, 99]. Moreover, social support is acknowledged for its potential in protecting against disorders associated with immune system activity and enhancing positive responses to vaccines [114]. It is plausible that social support is beneficial for individuals experiencing long COVID, enhancing their sense of agency and commitment to medical treatment for the amelioration of their condition [4].

The third aim of the study was to examine a model elucidating the nature of the correlation between personality traits and cognitive decline. It was found that psychological distress serves as a full, rather than partial, mediating variable. The model reveals that a high tendency towards neuroticism heightens the risk of psychological distress, subsequently increasing the risk of SCD. In addition, a high tendency towards conscientiousness reduces the risk of psychological distress, consequently mitigating the risk of SCD. Thus, the results indicate that the correlation between these personality traits and SCD depends on the presence of symptoms of psychological distress.

Individuals with high levels of neuroticism often undergo adverse cognitive-emotional processes, characterized by phenomena such as worry, rumination, inadequate coping mechanisms, and reduced emotional regulation. Conversely, individuals scoring low in conscientiousness exhibit deficiencies in responsibility, motivation, and self-control [91]. The interplay of these two traits may collectively contribute to the experience of psychological distress.

The influence of psychological distress on cognitive decline has been extensively documented. This impact is attributed to various factors, including biological aspects such as brain function or immune system activity, behavioral factors like societal engagement, and cognitive factors such as repetitive thinking and negative schemas about oneself and the future [25, 61]. The findings underscore the potential efficacy of implementing psychological interventions targeting symptoms of psychological distress as integral components of treatment plans for individuals affected by long COVID.

The intricate relationship between personality traits and cognitive and emotional changes lacks clear evidence of unidirectional causality [40]. Although the predominant theoretical assumption posits that personality traits develop early and maintain relative stability [22]. Nevertheless, it is conceivable that life experiences may contribute to fluctuations in personality indices. For instance, the cognitive decline observed in the present sample may have influenced the lower scores in conscientiousness, particularly in domains related to planning, control, order, and self-discipline [12]. Additionally, this could have elevated anxiety levels, as indicated by a higher neuroticism score. A study investigating the link between neuroticism and life events over a 16-year period revealed a reciprocal association, indicating mutual influence and providing an interpretation that distinguishes between temporary changes in neuroticism and persistent changes in the individual's baseline or set point of the trait [57]. This interpretation gains significance, especially when addressing diseases that impact brain function, as various areas of the brain are linked with personality measures [31, 101]. in consideration of this, the model presented here may represent one pathway through which personality traits influence cognitive function. There may be another pathway wherein cognitive decline influences personality traits, either directly or mediated through psychological distress.

The present study has several limitations that warrant careful consideration. Firstly, as a cross-sectional study, it lacks the capacity to establish causal relationships between the variables in the proposed model. While the findings provide initial insights, future research should employ longitudinal designs to better understand the temporal dynamics and causative influences of personality traits on psychological distress and cognitive decline. Secondly, the reliance on self-report questionnaires introduces potential biases due to their subjective nature. Although subjective measures are valuable for exploring associations with emotional variables and self-perception, future research should integrate objective cognitive assessments to validate these findings and offer a more comprehensive understanding of cognitive outcomes. Additionally, gender-specific analyses are recommended to explore potential differences in self-perceived cognition, as gender may influence subjective reporting patterns. Thirdly, the sample characteristics present notable limitations. The broad age range of the participants necessitated controlling for age as a fixed variable, which may have diluted specific age-related effects. Future research would benefit from employing a more homogeneous sample, particularly one focusing on specific age groups, to refine the understanding of age-related associations. Moreover, the limited sample size constrained the ability to fully evaluate the combined effects of neuroticism and conscientiousness on cognitive decline. Larger samples in future studies would enable a more robust examination of interactions between personality traits and their influence on psychological and cognitive outcomes. Lastly, this study did not account for psychiatric history or socioeconomic status, which could significantly influence both psychological distress and cognitive outcomes. Incorporating these factors in future research would enhance the contextualization and generalizability of the findings. Expanding the sample to include a more

diverse population would also strengthen external validity and broaden the applicability of the results across different populations and cultural contexts.

In conclusion, individuals diagnosed with long COVID exhibit diverse neuropsychiatric symptoms, with depression symptoms and sleep disturbances being particularly prominent. Personality traits and social support were found to modulate symptom severity, with conscientiousness and social support appearing to confer protective effects, while neuroticism was associated with greater risk. These findings highlight the potential for psychological interventions to alleviate distress in Long COVID patients; however, such interventions should be approached with caution. Further research is needed to substantiate the efficacy of these interventions, particularly in diverse populations and through longitudinal studies.

Abbreviations

PHQ-9	Patient Health Questionnaire
GAD-7	Generalized Anxiety Disorder
SCD	Subjective Cognitive Decline

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AA: Writing - Original Draft; Methodology; Data Collection; Data Analysis; Visualization.AK: Ethical Approval; Conceptualization; Data Collection.DA: Data Collection.GG: Conceptualization.JNA : Project Administration; Conceptualization.OE: Supervision; Conceptualization; Writing - Review & Editing.

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Data and material are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
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