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Comparing personality traits of healthcare workers with and without long COVID: Cross-sectional study

Keiko Sakai MD, PhD[1] | Seiichiro Tarutani MD, PhD[2] | Takehiko Okamura MD, PhD[2] | Hiroshi Yoneda MD, PhD[2] | Tatsuhito Kawasaki MD, PhD[3] | Masatoshi Takeda MD, PhD[1]

[1]Department of Rehabilitation, Osaka Kawasaki Rehabilitation University, Kaizuka, Osaka, Japan

[2]Osaka Institute of Clinical Psychiatry, Shin-Abuyama Hospital, Takatsuki, Osaka, Japan

[3]Mizuma Hospital, Kaizuka, Osaka, Japan

Correspondence
Keiko Sakai, MD, PhD, Department of Rehabilitation, Osaka Kawasaki Rehabilitation University, 158 Mizuma, Kaizuka, Osaka 597-0104, Japan
Email: sakaike@kawasakigakuen.ac.jp

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Abstract

Aim: Pathological mechanisms of "long COVID" after recovery from the main symptoms of COVID-19 are unclear. We compared psychological differences between individuals with and without long COVID symptoms after initial COVID-19 infections.

Methods: This study includes medical workers with and without history of COVID-19. We assessed the degree of depression, health-related quality of life (HRQOL), the degree of anxiety and fear of COVID-19, and we used an original questionnaire. In the COVID-19 group, we also assessed personality traits and anxiety. The COVID-19 group was subclassified into those with and without long COVID to examine differences in circumstantial and psychological examinations.

Results: Of 310 participants (141 men, 169 women, median age: 40 years), 167 had history of COVID-19 (83/84, 37 years) and 143 did not (58 men/85 women, 46 years). In the COVID-19 group, 26 had long COVID (12/14, 32 years) and 141 did not (58/85, 46 years). Fewer participants in the COVID-19 group had had COVID-19 vaccinations. The long COVID group had higher number of symptoms at the time of illness and higher NEO Five Factor Inventory Neuroticism scores than the non-long COVID group. They also had poorer mental health according to HRQOL than those without.

Conclusion: Risk factors for long COVID may include the number of symptoms at the time of illness and neurotic tendency on NEO Five Factor Inventory. Participants with long COVID had poorer mental health according to HRQOL. People with long COVID might be especially sensitive to and pessimistic about the symptoms that interfere with their daily lives, resulting in certain cognitive and behavioral patterns. They may benefit from early psychiatric intervention.

KEYWORDS
COVID-19, healthcare workers, long COVID, mental health, personality traits

INTRODUCTION

People are now gradually fully regaining their prepandemic lifestyle after a series of social restrictions during and after the COVID-19 pandemic.[1,2] However, various physical and psychological changes brought about by COVID-19 may continue long after the pandemic itself. For example, the exacerbation of behavioral addictions, particularly internet-related behavioral addictions, may have been caused by using the internet to cope with stress and the desire for social interaction during the lockdown periods.[3] Postpandemic mental health and behavioral addictions issues require support. Interestingly, the most trusted social institutions/agents during the pandemic were said to be professionals and administrative institutions, and their leadership is said to help people to more effectively manage crises.[4] Meanwhile, we suggest that in the event of a pandemic, as well as promoting good health behavior in the wider population as part of their job, health care professionals must be mindful of their own physical and mental health.

In this context, COVID-19 can reportedly cause various persistent or new symptoms throughout the body after initial recovery.[5] The World Health Organization has designated this as "post COVID-19 condition" with the definition of the continuation or development of new symptoms 3 months after the initial severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, with these symptoms lasting for at least 2 months with no other explanation.[6] Alternative terms include "post-COVID conditions," "long COVID," "postacute COVID-19 syndrome," and "postacute sequelae of SARS-CoV-2 infection." Symptoms include general fatigue, breathlessness, and cognitive dysfunction. It is unclear exactly which people develop long COVID, and the pathogenesis remains unknown, but it can affect everyday functioning. Considering the long-term social disability caused by long COVID, we believe it is urgent to elucidate its causes and to establish a preventive system.

Ways of coping with psychological and behavioral aspects during pandemics in relation to personality traits have been reported.[7] However, there have not been adequate reports of the relationship between personality traits of people with long COVID and the pathogenesis of long COVID.

We conducted a cross-sectional study of healthcare workers with the hypothesis that psychological differences exist between those who present with long COVID symptoms after COVID-19 infection and those who do not. We compared the groups of persons with and without long COVID, seeking to identify the characteristics of the two groups from a psychological perspective. Based on these characteristics, we also examined the pathogenesis and etiological factors of long COVID from a psychiatric perspective.

METHODS

Participants and methods

This study included 527 healthcare workers enrolled at two private psychiatric hospitals in the Kinki area of central Japan on April 1, 2023. Participants included a variety of healthcare workers, including doctors, nurses, pharmacists, medical technicians, medical office workers and others. We explained the intention of our study to the heads of each department of these hospitals, and asked them to explain it to their staff members. Questionnaires were then distributed by the department heads to those who indicated their willingness to participate in the study.

COVID-19 infection was determined as that confirmed by polymerase chain reaction test or antigen testing. "Long COVID" was defined as symptoms (e.g., cough, tired feeling, taste disorder, feeling of depression, memory impairment) observed after COVID-19 infection that persisted for at least 12 weeks and that were still present at the time of the survey. Questionnaires were distributed by hand, and collection boxes were placed in each department.

We investigated the degree of depression, quality of life (QOL), the degree of anxiety and fear of COVID-19 in all participants, and personality traits and anxiety in those who had been infected with COVID-19. We therefore conducted the following: Center for Epidemiologic Studies Depression Scale (CES-D), Medical Outcome Study 12-Item Short Form Health Survey Japanese version (SF-12), Fear of COVID-19 Scale (FCV-19S), NEO Five Factor Inventory (NEO-FFI), State–Trait Anxiety Inventory Form (STAI), and an original self-administered questionnaire. The details of each of these items follow below. Each of the items, with the exception of the original questionnaire, were translated Japanese versions verified for reliability and validity.

CES-D was developed by the National Institute of Mental Health for the purpose of detecting depression in the general population.[8] It consists of 20 questions related to depression, which are answered on a four-point scale from *None* to *Five or more days*, depending on the number of days in the past week that the symptom had appeared. We used a Japanese version, which has been reported to be effective for screening for depression in Japan.[9,10] Depression is suggested by higher scores.

SF-12 is an abbreviated version of the Health-Related Quality of Life (HRQOL) Scale consisting of 12 items selected from the SF-36.[11] The Japanese version has been validated as a measure of physical and mental health in Japan.[12,13] It consists of 12 questions, which are answered on a 3–5-point scale. QOL is defined according to eight subscales: Physical Functioning (PF), Role Physical (RP), Bodily Pain (BP), General Health Perceptions (GH), Vitality (VT), Social Functioning (SF), Role Emotional (RE) and Mental Health (MH). In addition, each subscale can be summarized in two parts: the Physical Component Summary (PCS) and the Mental Component Summary (MCS). The three subscales PF, RP, and BP mainly contribute to the PCS, while SF, RE, and MH mainly contribute to the MCS, and GH and VT contribute to both the PCS and the MCS. For both subscales and summary scores, standardized scores were used with the mean and standard deviation of the 2017 Japanese National Standard. We focused on low summary scores in this study because they suggest low level of HRQOL.

FCV-19S is a scale to measure the degree of anxiety and fear of COVID-19.[14] It has been confirmed as reliable and valid, and has

been translated and used in many different countries.[15] We used a Japanese version, which has been used to report on the characteristics of groups with fear of infection with COVID-19 in Japan.[16,17] Seven questions were answered using a 5-point Likert scale from 1 (*Not at all agree*) to 5 (*Strongly agree*). The higher the total score of the responses, the higher the fear of COVID-19 is suggested to be.

Two more psychological examinations were administered to those who had been infected with COVID-19. The NEO-FFI is an abbreviated version of the Revised NEO Personality Inventory (NEO-PI-R).[18] This personality test is based on the five-factor theory and includes Neuroticism (N), Extraversion (E), Openness (O), Agreeableness (A), and Conscientiousness (C). To evaluate personality traits, 60 questions are answered within a 5-point scale system. The Japanese version we used has previously shown relationships between burnout and personality.[19,20] Higher total scores indicate stronger representation of each personality trait.

The STAI can measure state anxiety and trait anxiety.[21] State anxiety is a transient situational response to an anxiety-provoking event, while trait anxiety describes the tendency to perceive and react to a variety of threatening situations in the same way. The STAI-JYZ, the Japanese version we used, has been used to examine the anxiety scores of Japanese workers.[22,23] It consists of 20 items each on state anxiety and trait anxiety, with the addition of some items appropriate to Japanese culture. Responses are chosen from four options and the higher the total scores of the responses, the higher the anxiety is suggested to be.

Finally, an original self-administered questionnaire featured questions about the participant's profile (sex, age, occupation, past medical history, and the number of COVID-19 vaccinations received), as well as the time of COVID-19 infection, symptoms at the time of illness, place of care, post-illness symptoms (long COVID), the impact of post-illness symptoms on work and housework, and the duration of post-illness symptoms.

Statistical analysis

To examine the characteristics of each group, we classified the participants into two groups: those who had at some point had a COVID-19 infection (COVID-19 group) and those who had not (non-COVID-19 group). The COVID-19 group was further classified into two groups: those thought to have long COVID (long COVID group) and those not thought to have long COVID (non-long COVID group). We examined the effects on these three groups (non-COVID-19 group, long COVID group and non-long COVID group) regarding age, number of COVID-19 vaccinations, CES-D total score, SF-12 summary score, and FCV-19S total score. Shapiro–Wilk tests were performed on all quantitative variables for these three groups, and normality was not found, so we adopted nonparametric tests. The results of the self-administered questionnaire were also subjected to a chi-square test and Bonferroni correction to examine differences between the three groups. Multinomial logistic regression analysis was then conducted with the non-COVID-19, long COVID and non-long COVID groups as dependent variables. As independent variables, we used the items of the questionnaire that were significantly different by nonparametric tests in this study.

We subsequently examined the effects on the long COVID and non-long COVID groups of age, the number of COVID-19 vaccinations, the number of symptoms at time of illness, CES-D total score, the SF-12 summary score, FCV-19S total score, the five factors of the NEO-FFI, and the STAI state and trait anxiety scores. Shapiro–Wilk tests were performed on all quantitative variables for both groups. Normality was not found, so we adopted nonparametric tests. The results of the self-administered questionnaire were also subjected to a chi-square test to examine differences between the two groups. To examine the factors that contribute to the development of long COVID, logistic regression analysis was then conducted with the long COVID and non-long COVID groups as dependent variables. As independent variables, we used the items considered to be risk factors for developing long COVID that were significantly different by nonparametric tests in this study. Furthermore, to examine the psychological state at the time of survey, we analyzed other items of the questionnaire that were significantly different by nonparametric tests in this study as independent variables. All statistical analyses were two-tailed, using SPSS Ver. 28 (IBM Corp.), with a statistical significance level of $p = 0.05$.

Ethical considerations

This study was performed in accordance with the Declaration of Helsinki and with the approval of Osaka Kawasaki Rehabilitation University Research Ethics Review Committee (OKRU–RA0040). The purpose of the study, methods, participants' freedom to cooperate or withdraw from the study, the need for written consent, and the protection of personal information were explained orally and in writing, and those who gave their written consent were included as research participants.

RESULTS

Questionnaires were distributed to the 392 people who indicated their willingness to participate in the study, and they could be collected from 383 people. We excluded from this total the questionnaires of 73 people because of incomplete answers. Of the remaining 310 respondents, 143 (58 men and 85 women) had not been infected with COVID-19 and 167 (83 men and 84 women) had been infected with COVID-19. Regarding the first infection, two were infected in August 2020, five were infected between May and August 2021, 139 were infected between January and December 2022, and 21 were infected in January 2023. Second infections occurred in 23 people between July 2022 and March 2023. In this cohort, all those who had been infected with COVID-19 recuperated either at home or in hotels, and none were hospitalized.

Of the COVID-19-infected participants, 26 (15.7%) had long COVID at the time of the survey. This comprised one participant with long COVID who became infected with COVID-19 in September 2021, 18 participants between January and November 2022, and seven participants in January 2023. Of those who had been infected with COVID-19 twice, long COVID appeared after the first infection in two participants who continued to have the same symptoms after the second infection. Two participants did not have long COVID after the first infection, but it appeared after the second infection. One participant had long COVID after the first infection and symptoms persisted for more than 12 weeks, but they became infected again 6 months later, and the symptoms of long COVID disappeared thereafter. Among those who had been infected twice and had long COVID, participants whose long COVID appeared during both infections adopted symptoms at the time of illness and post-illness symptoms at the first infection, while participants whose long COVID appeared after the second infection had symptoms at the time of illness and post-illness symptoms at the second infection. Finally, one participant whose long COVID had disappeared at the time of the survey was included in the non-long COVID group.

Details of the participants are presented in Table 1. Nurses accounted for 63.9% of all participants in terms of occupation. Approximately 70% of all participants had no medical history of illness. Notably, none of the people with long COVID had a history of psychiatric disorders. The most common symptoms of illness from COVID-19 across all participants (multiple responses) were fever, coughs, general fatigue, and headache (Table 2). Symptoms of long COVID included coughs, tired feeling, feeling of depression, general fatigue, memory impairment, decreased concentration, and taste disorder (Table 3). When asked if long COVID interfered with their work or housework, six participants (23.1%) said it interfered with their work and 11 participants (42.3%) said it interfered with their housework.

Comparisons of non-COVID-19 group, long COVID group and non-long COVID group

There were slight differences in the results of three-group comparisons of age, number of COVID-19 vaccinations, CES-D total score, SF-12 summary score, and FCV-19S total score across the three groups by Kruskal–Wallis test, age ($p = 0.003$), number of COVID-19 vaccinations ($p < 0.001$), CES-D total score ($p = 0.035$), and the SF-12 MCS ($p = 0.001$) (Table 4). A chi-square test and Bonferroni correction of the results of the original self-administered questionnaire comparing the three groups showed no significant differences in sex, occupation, or presence of a medical history of illness. To examine the differences of each group, we conducted multinomial logistic regression analysis with the non-COVID-19, long COVID and non-long COVID groups as dependent variables and age, sex, number of COVID-19 vaccinations, CES-D total score and SF-12 MCS as independent variables. The non-COVID-19 group was selected as the reference category. The long COVID and non-long COVID groups were revealed to have had fewer COVID-19 vaccinations than the non-COVID-19 group (odds ratio [OR]: 0.613, 95% confidence interval [CI] 0.435–0.863, $p = 0.005$, OR: 0.675, 95% CI 0.539–0.846, $p < 0.001$). The long COVID group had lower SF-12 MCS than the non-COVID-19 group (OR: 0.924, 95% CI 0.865–0.986, $p = 0.018$) (Table 5).

Psychological characteristics of participants with long COVID

There were slight differences in the results of two-group comparisons of age, number of COVID-19 vaccinations, number of symptoms at time of illness, CES-D total score, SF-12 summary scores, FCV-19S total score, the five factors of the NEO-FFI, the STAI State Anxiety and Trait Anxiety for long COVID and non-long COVID groups by Mann–Whitney's *U*-test, number of symptoms at the time of illness ($p = 0.005$), CES-D total score ($p = 0.023$), SF-12 MCS ($p < 0.001$), NEO-FFI Neuroticism (N) ($p = 0.002$), STAI State Anxiety ($p = 0.006$) and STAI Trait Anxiety ($p = 0.010$) (Table 6). A chi-square test of the results of the original self-administered questionnaire comparing the two groups showed no significant differences in sex, occupation, or the presence of a medical history of illness.

To examine the risk factors for developing long COVID, logistic regression analysis was conducted with the groups with and without long COVID as dependent variables and age, sex, number of symptoms at the time of illness, NEO-FFI N, and STAI Trait Anxiety as independent variables. In the analysis, the NEO-FFI N and the STAI Trait Anxiety are both characteristics that participants inherently possess, so we examined whether they were correlated with each other. A strong correlation was found between the two (Spearman's $\rho = 0.728$, $p < 0.001$), so only personality traits (NEO-FFI N), which we wanted to investigate in this study, were adopted as an independent variable, and we excluded the STAI Trait Anxiety. The number of symptoms at the time of illness and the NEO-FFI N were higher in the long COVID group than in the non-long COVID group (OR: 1.300, 95% CI 1.076–1.572, $p = 0.007$, OR: 1.079, 95% CI 1.022–1.139, $p = 0.006$) (Table 7).

To examine the psychological state at the time of survey, logistic regression analysis was conducted with the two groups with and without long COVID as dependent variables and age, sex, CES-D total score, SF-12 MCS and STAI State Anxiety as independent variables. Prior to the analysis, we used variance inflation factor to confirm that there was no multicollinearity in CES-D total score, the SF-12 MCS, and the STAI State Anxiety. The SF-12 MCS was lower in the long COVID group than in the non-long COVID group (OR: 0.923, 95% CI 0.861–0.989, $p = 0.024$) (Table 8). In these two analyses, the non-long COVID group was selected as the reference category.

DISCUSSION

Although some time has now passed since the outbreak of COVID-19 and social life has largely returned to prepandemic conditions, many people are still infected in elderly care facilities and in the clinical

TABLE 1 Participant profiles.

	All participants *n* = 310	**non-COVID-19 group *n* = 143**	**COVID-19 infected group *n* = 167**	**long COVID group *n* = 26**	**non-long COVID group *n* = 141**
men	*n* = 141	*n* = 58	*n* = 83	*n* = 12	*n* = 71
women	*n* = 169	*n* = 85	*n* = 84	*n* = 14	*n* = 70
Age of all participants (year)	40 (19–78)	46 (20–78)	37 (19–74)	32 (19–70)	37 (19–74)
men	39 (19–78)	40 (20–78)	37 (19–65)	30.5 (19–65)	37 (19–64)
women	42 (19–76)	47 (23–76)	36.5 (19–74)	34 (21–70)	37.5 (19–74)
Occupation					
Nurse	198	87	111	18	93
Medical office worker	31	15	16	3	13
Nurse aide	19	7	12	1	11
Certified care worker	14	10	4	0	4
Therapist	12	5	7	1	6
Caretaker	8	2	6	2	4
Social worker	6	4	2	0	2
Pharmacist	6	2	4	1	3
Doctor	5	1	4	0	4
Medical technician	4	3	1	0	1
Clinical psychologist	3	3	0	0	0
Nutritionist	3	3	0	0	0
Radiology technician	1	1	0	0	0
Past medical history (with multiple responses)					
Hypertension	27	13	14	1	13
Cardiovascular diseases	12	11	1	1	0
Respiratory diseases	7	1	6	1	5
Allergic diseases	7	3	4	1	3
Diabetes	5	4	1	0	1
Dyslipidemia	5	4	1	0	1
Gout	5	1	4	1	3
Thyroid diseases	4	1	3	1	2
Gynecological diseases	4	1	3	0	3
Mental illness	2	0	2	0	2
Orthopedic diseases	3	0	3	1	2
Ophthalmopathy	3	1	2	0	2
Malignant tumor	1	0	1	0	1
Hepatic disease	1	1	0	0	0
Renal disease	1	1	0	0	0
Migraine	1	0	1	0	1
Ulcerative colitis	1	0	1	0	1
Constipation	1	0	1	1	0

(Continues)

TABLE 1 (Continued)

	All participants *n* = 310	non-COVID-19 group *n* = 143	COVID-19 infected group *n* = 167	long COVID group *n* = 26	non-long COVID group *n* = 141
No past medical history	224	101	123	19	104
Number of COVID-19 vaccinations					
all participants	4 (0–6)	4 (0–6)	3 (0–6)	3 (0–5)	3 (0–6)
men	3 (0–6)	4 (2–6)	3 (0–5)	3 (1 –5)	3 (0–5)
women	4 (0 – 6)	4 (0–6)	3 (0–6)	3 (0–5)	3 (0–6)

TABLE 2 Symptoms of illness in the COVID-19 groups (with multiple responses).

	COVID–19 infected *n* = 167	Long COVID group *n* = 26	Non-long COVID group *n* = 141
Fever	129	23	106
Cough	111	17	94
General fatigue	105	22	83
Headache	75	21	54
Sputum	58	8	50
Loss of appetite	40	8	32
Myalgia	39	11	28
Taste disorder	22	7	15
Olfactory disorder	21	8	13
Dyspnea	11	4	7
Diarrhea	11	3	8
Nausea	11	5	6
Sore throat	11	1	10
Nasal congestion	1	0	1
Pituita	1	0	1
Hearing impairment	1	0	1
Lumbago	1	0	1
Without symptoms	17	0	17

TABLE 3 Symptoms of long COVID (with multiple responses).

Cough	8
Tired feeling	8
Feeling of depression	6
General fatigue	5
Memory impairment	4
Decreased concentration	4
Taste disorder	4
Feeling of anxiety	3
Olfactory disorder	3
Breathlessness	2
Sleep disorder	2
Irritability	2
Sputum	1
Hair loss	1
Headache	1

environment. Healthcare workers therefore need to continue to implement infection-prevention measures while constantly updating their knowledge of COVID-19. This situation is estimated to be a source of tremendous physical and mental stress. In this study, we examined the long-term effects of the pandemic on the mental and physical condition of healthcare workers, as well as the psychiatric pathogenesis of long COVID, which is said to be a sequela of COVID-19.

The highest number of infections in this survey occurred after 2022, coinciding with an explosive increase in the number of infections in Japan as the Delta variant was replaced by the Omicron variant.[24,25] Healthcare workers with expertise in infection prevention measures were assumed to be not an exception from this rise in infections. In addition, 13.8% of those infected with COVID-19 were infected twice, and all cases occurred during the Omicron outbreak period after 2022. Elsewhere, there was a reported increase in reinfection rates after the Omicron outbreak compared with before the Omicron variant, indicating the strong infectivity of the Omicron variant.[26]

Comparison of the three groups revealed that fewer COVID-19 vaccinations were associated with higher susceptibility to COVID-19, and this result was as previously reported.[27] Another study showed that not having a COVID-19 vaccination is associated with poor QOL.[28] Regular vaccination is thought to be an efficient means of maintaining good health. Compared with the non-COVID-19 group, the long COVID group showed poorer mental health in HRQOL, but there was no psychological difference from non-long COVID group. The presence of long COVID symptoms was thus suggested to have some effect on the psychological state of the participants.

TABLE 4 Comparison of age, number of COVID-19 vaccinations, CES-D, SF-12 and FCV-19S among the three groups in the non-COVID-19, long COVID and non-long COVID groups.

	Non-COVID-19 group *n* = 143	Long COVID group *n* = 26	Non-long COVID group *n* = 141	*p*-value
Age (years)	46 (20–78)	32 (19–70)	37 (19–74)	0.003**
Number of COVID-19 vaccinations	4 (0–6)	3 (0–5)	3 (0–6)	<0.001***
CES-D total score	11 (0–51)	13.5 (0–52)	10 (0–48)	0.035*
SF-12 summary scores				
PCS	50.1 (15.2–63.6)	47.1 (23.3–63.1)	49.8 (21.3–65.6)	0.488
MCS	53.5 (29.6–72.7)	45.9 (28.9–61.6)	54.8 (22.2–69.9)	0.001**
FCV-19S total score	12 (7–35)	11 (7–23)	11 (1–27)	0.880

Note: Age, number of COVID-19 vaccinations, CES-D, SF-12, and FCV-19S indicate median (min–max). Kruskal–Wallis test was used for statistical analysis.

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; FCV-19S, Fear of COVID-19 Scale; MCS, Mental Component Summary; PCS, Physical Component Summary; SF-12, Medical Outcome Study 12-Item Short-Form Health Survey.

*$p < 0.05$; **$p < 0.005$; ***$p < 0.001$.

TABLE 5 Results of multinomial logistic regression analysis with the non-COVID-19, long COVID and non-long COVID groups as dependent variables and age, sex, number of COVID-19 vaccinations, CES-D total score, and SF-12 MCS as independent variables.

		95% CI		
Independent variables	OR	Lower limit	Upper limit	*p*-value
Long COVID group				
Age	0.977	0.943	1.011	0.186
Sex	1.423	0.578	3.504	0.443
Number of COVID-19 vaccinations	0.613	0.435	0.863	0.005**
CES-D total score	0.990	0.938	1.044	0.703
SF-12 MCS	0.924	0.865	0.986	0.018*
Non-long COVID group				
Age	0.984	0.966	1.002	0.074
Sex	1.399	0.849	2.306	0.188
Number of COVID-19 vaccinations	0.675	0.539	0.846	<0.001***
CES-D total score	0.966	0.930	1.003	0.073
SF-12 MCS	0.993	0.957	1.031	0.726

Note: The non-COVID-19 group was selected as the reference category in this analysis.

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; CI, confidence interval; MCS, Mental Component Summary; OR, odds ratio; SF-12: Medical Outcome Study 12-Item Short Form Health Survey.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Participants with COVID-19 had a wide range of symptoms, including fever, coughs and sputum, as well as general fatigue, headache, loss of appetite, myalgia, taste disorder, and olfactory disorder. Hypertension and respiratory diseases were relatively commonly reported in past medical history, but more than 70% had no history, and none of them became severely ill enough to require hospitalization.

On the other hand, long COVID has been reported to occur in 10%–30% of nonhospitalized cases and 50%–70% of hospitalized cases after infection with SARS-CoV-2.[29] General fatigue, headache, decreased concentration, and hair loss are often reported as symptoms of long COVID,[5] but psychiatric symptoms, such as anxiety and depression, have also been reported in 10–30% of people with long COVID.[30,31]

Risk factors for the development of long COVID reportedly include older age, obesity, female sex, a number of symptoms at the time of illness, severity of COVID-19, and being unvaccinated.[32–34] In this study, logistic regression analysis showed that the number of symptoms at the time of illness and neurotic tendency were suggested as risk factors for developing long COVID. However, the results do not suggest a relationship between age, sex, or number of vaccinations and the onset of long COVID. Potential explanations could be that the participants in this study are all healthcare workers and are likely to be physically and mentally healthy even if at an advanced age. The number of participants who presented with long COVID was small, and as healthcare workers the participants were very likely to have been actively vaccinated. Another explanation could be that none of the participants in the study required hospitalization at the time of COVID-19 infection, and that the study included participants with relatively mild infections.

TABLE 6 Comparison of age, CES-D, SF-12, FCV-19S, NEO-FFI, STAI and number of symptoms at time of illness between the two groups in the long COVID and non-long COVID groups.

	Long COVID group $n = 26$	Non-long COVID group $n = 141$	p-value
Age	32 (19–70)	37 (19–74)	0.714
Number of COVID-19 vaccinations	3 (0–5)	3 (0–6)	0.185
Number of symptoms at time of illness (number of people)			0.005**
0	0	17	
1	1	14	
2	3	14	
3	1	17	
4	5	29	
5	8	22	
6	1	16	
7	2	6	
8	2	4	
9	0	0	
10	2	1	
11	0	1	
12	1	0	
CES-D total score	13.5 (0–52)	10 (0–48)	0.023*
SF-12 summary scores			
PCS	47.1 (23.3–63.1)	49.8 (21.3–65.6)	0.233
MCS	45.9 (28.9–61.6)	54.8 (22.2–69.9)	<0.001****
FCV-19S total score	11 (7–23)	11 (1–27)	0.880
NEO-FFI			
Neuroticism	32 (18–47)	25 (4–48)	0.002***
Extraversion	23.5 (7–39)	25 (9–44)	0.102
Openness	26.5 (12–36)	26 (12–40)	0.907
Agreeableness	28 (12–42)	31 (16–42)	0.114
Conscientiousness	27 (10–37)	25 (10–43)	0.842
STAI			
State Anxiety	28.5 (15–65)	21 (10–75)	0.006**
Trait Anxiety	49 (27–80)	44 (22–75)	0.010*

Note: Age, number of COVID-19 vaccinations, number of symptoms at time of illness, CES-D, SF-12, FCV-19S, NEO-FFI, and STAI indicate median (min–max). Mann–Whitney U-test was used for statistical analysis.

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; FCV-19S, Fear of COVID-19 Scale; MCS, Mental Component Summary; NEO-FFI, NEO Five Factor Inventory; PCS, Physical Component Summary; SF-12, Medical Outcome Study 12-Item Short Form Health Survey; STAI, State–Trait Anxiety Inventory Form.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.005$; ****$p < 0.001$.

TABLE 7 Results of logistic regression analysis with the two groups (with and without long COVID) as dependent variables and age, sex, number of symptoms at time of illness, and NEO-FFI N as independent variables.

		95% CI		
Independent variables	OR	Lower limit	Upper limit	p-value
Age	1.009	0.976	1.044	0.603
Sex	1.033	0.420	2.543	0.943
Number of symptoms at time of illness	1.300	1.076	1.572	0.007*
NEO-FFI N	1.079	1.022	1.139	0.006*

Note: The non-long COVID group was selected as the reference category in this analysis.

Abbreviations: CI, confidence interval; NEO-FFI N, NEO Five Factor Inventory Neuroticism; OR, odds ratio.

*$p < 0.01$.

TABLE 8 Results of logistic regression analysis with the two groups (with and without long COVID) as dependent variables and age, sex, CES-D total score, SF-12 MCS, and STAI State Anxiety as independent variables.

		95% CI		
Independent variables	OR	Lower limit	Upper limit	p-value
Age	0.986	0.953	1.020	0.408
Sex	1.010	0.401	2.543	0.984
CES-D total score	1.008	0.950	1.070	0.787
SF-12 MCS	0.923	0.861	0.989	0.024*
STAI State Anxiety	1.011	0.975	1.049	0.548

Note: The non-long COVID group was selected as the reference category in this analysis.

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; CI, confidence interval; MCS, Mental Component Summary; OR, odds ratio; SF-12, Medical Outcome Study 12-Item Short Form Health Survey; STAI, State–Trait Anxiety Inventory Form.

*$p < 0.05$.

The most common symptoms of long COVID in this study were coughs, tired feeling, feeling of depression, and general fatigue. Symptoms suggestive of cognitive dysfunction were also observed, such as memory impairment and decreased concentration. The participants in the long COVID group considered themselves to be in poorer mental health in HRQOL than those in the non-long COVID group. Specifically, they were less confident in their health and considered themselves to be tired and depressed. From the results of the original self-administered questionnaire, it was inferred that these conditions may be factors that interfere with activities of daily life, such as housework.

In terms of personality traits from the "Big Five" theory of the NEO-FFI, the long COVID group had higher neurotic tendency than the non-long COVID group. High neuroticism is said to be

associated with sensitivity to stressful stimuli, risk aversion, and cautious behavior.[19] For this reason, there may be an overreaction to the comparatively minor symptoms of long COVID. In addition, neuroticism is said to be closely related to depression,[35] and personality traits found in the long COVID group may have caused depression during the pandemic. Depression is thus suggested to exist at the base of the long COVID group's mood, and that affected individuals are perhaps sensitive to and pessimistic about the symptoms of long COVID that interfere with their daily lives for a long period of time. This may lead to a vicious cycle of cognitive and behavioral patterns. Prolonged depression requires attention because it can have a significant impact on an individual's social life as well as on socioeconomic activities,[36] and it may eventually lead to increased rates of job turnover/unemployment and suicide.[37,38]

The healthcare workers targeted in this study were required to go to work in a clinical environment even during a pandemic, and they had to work while taking adequate infection-control measures to avoid patients and themselves becoming infected. In such an environment, healthcare workers are reportedly at high risk of developing mental health problems.[39] Therefore, in addition to direct treatment for the physical and mental symptoms of long COVID, we recommend early psychiatric intervention for the self-image and cognitive styles of people with long COVID.

LIMITATIONS AND FUTURE DIRECTIONS

Limitations of this study include that it was a survey of healthcare workers in only one region, and the number of participants in the long COVID and non-long COVID groups was relatively few and unbalanced. Caution is required regarding generalization of the results. Furthermore, this was a cross-sectional study, so the impact of the pandemic on the personality traits of the participants has not been determined, and the causal relationship between personality traits and the development of long COVID is currently unknown. It is also noted that approximately 30% of healthcare workers may have had symptoms of posttraumatic stress disorder (PTSD) during the pandemic,[40] and the impact of PTSD on long COVID remains unclear. However, taking into account personality traits and cognitive styles of people who have been infected with COVID-19 may be effective in predicting prognosis and coping with psychiatric symptoms that occur in persons with COVID-19, such as depression and PTSD, as well as long COVID symptoms. Psychological and psychiatric investigations should ideally continue over the long term.

CONCLUSION

Participants in this cohort with long COVID had poorer mental health, and they had a tendency to demonstrate neuroticism. Along with the deterioration of mental health caused by the pandemic, their poorer mental health may be rooted in their original personality traits. Such people may be especially sensitive to and pessimistic about the symptoms of long COVID that interfere with their daily lives, resulting in certain cognitive and behavioral patterns. People with long COVID may therefore benefit from early psychiatric intervention.

AUTHOR CONTRIBUTIONS

Keiko Sakai performed statistical analyses and wrote the manuscript. Seiichiro Tarutani supported statistical analysis and manuscript writing. Takehiko Okamura, Hiroshi Yoneda, and Tatsuhito Kawasaki supported data collection and manuscript writing. Masatoshi Takeda supervised manuscript writing. All authors approved the final draft and agreed with the submission to this journal.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS APPROVAL STATEMENT

This study was approved by the Osaka Kawasaki Rehabilitation University Research Ethics Review Committee (OKRU-RA0074).

PATIENT CONSENT STATEMENT

Informed verbal and written consent were obtained from all participants.

CLINICAL TRIAL REGISTRATION

N/A.

ORCID

Keiko Sakai http://orcid.org/0009-0005-8594-678X

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