

RESEARCH ARTICLE

COVID-19 and mental health in the UK: Depression, anxiety and insomnia and their associations with persistent physical symptoms and risk and vulnerability factors

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Abstract

Objectives: Mental health problems and persistent COVID-19 symptoms were prevalent in the context of COVID-19. However, despite the long-observed association between physical symptoms and mental health problems, such association has not been adequately examined in the context of COVID-19. Our understanding of wider patterns of risk and vulnerability factors for mental health also remains limited. This study investigated the associations between general mental health, and persistent physical symptoms, and additional risk and vulnerability factors in the context of COVID-19.

Methods: Two hundred fourteen adults, living in the UK, recruited via social media, completed the online survey and were included in the analyses. Correlation and regression analyses were conducted to examine the associations of persistent physical symptoms and risk and vulnerability factors with measures of general mental health including depressive symptoms, anxiety and insomnia.

Results: 78.5% of the participants reported between 1 and 26 persistent symptoms, and about 28%–92% of them associated these symptoms with COVID-19 infection. Persistent physical symptoms were uniquely associated with all measures of mental health, $\beta = .19$ –.32. Mental health history and worries were the most prominent risk factors, $|\beta| = .12$ –.43.

Conclusions: People who experience more persistent physical symptoms post-COVID-19 have poorer mental health. It may be important to consider and discuss the recovery from COVID-19 beyond a negative COVID-19 test.

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Multidisciplinary interventions that address the complex impact of COVID-19 for people with long COVID are needed.

KEYWORDS

'long COVID', mental health, persistent symptoms, risk factors

Practitioner points

- Individuals with persistent COVID-19 symptoms are particularly vulnerable to mental health problems.
- Individuals with mental health histories and more worries are more vulnerable to the psychological implication of long COVID.
- Recovery from COVID-19 should consider the longer term, beyond recovery from the acute infection, for some individuals.
- Multidisciplinary interventions can potentially help to address the complex and lasting impact of COVID-19.

INTRODUCTION

Evidence for the lasting detrimental effect of COVID-19 has been accumulating (Lopez-Leon et al., 2021). It is estimated that 80% of the infected patients with SARS-CoV-2 developed one or more long-term symptoms (Lopez-Leon et al., 2021). In the United Kingdom, about 1.9 million people living in private households (2.9% of the population) were experiencing self-reported long COVID symptoms and for 1.5 million people these symptoms adversely impacted on their day-to-day activities (Office for National Statistics, 2023). However, our understanding regarding the lasting effect of COVID-19, such as the burden of long-term symptoms, remains limited.

Several studies identified the adverse effects of persistent COVID-19 symptoms on overall health status, quality of life, psychological distress and physical functioning (Han et al., 2022; Shanbehzadeh et al., 2023). A Lancet study (Magnúsdóttir et al., 2022) examined acute COVID-19 severity and mental health morbidity trajectories in patients across six nations. It was found that people who had more severe acute COVID-19 were at higher risk of symptoms of depression and anxiety, and the authors speculated that persistent symptoms associated with more severe acute COVID-19 might explain the association with depression and anxiety. Nevertheless, this association was not explored in this study.

The reporting of physical symptoms has long been found to predict mental health problems (Kroenke et al., 1994, 1997; Larson et al., 2001). However, the associations between persistent physical symptoms and mental health have rarely been explored in the context of COVID-19. One Swedish study (McCracken et al., 2020) examined the associations between persistent COVID-19 symptoms and mental health and found that people with more persistent symptoms reported poorer mental health, including low mood, anxiety and insomnia. Nevertheless, the association between persistent COVID-19 symptoms and mental health has not been examined in the UK population.

Our understanding of the factors that contribute to the impact of COVID-19 on mental health remains limited. Several studies identified risk factors such as female gender, younger age, socially disadvantaged backgrounds, more substance use and use of media, less sleep, less time outside, worse quality of social contacts and poorer psychological and physical health prior to the pandemic, and

COVID-19-related worry (Knolle et al., 2021; McCracken et al., 2020; O'Connor et al., 2021; Plomecka et al., 2020). Nevertheless, the wider pattern of risk and vulnerability factors for mental health in the context of COVID-19 are yet to be explored.

The aim of this study was to explore associations between general mental health and persistent symptoms, and other risk and vulnerability factors, in the context of COVID-19, in a UK community sample. This includes two objectives: (1) to investigate the correlations between persistent physical symptoms, demographics, physical and psychological risk and vulnerability factors and COVID-19 status, and general mental health including depressive symptoms, anxiety and insomnia; (2) to examine the independent role of persistent symptoms and selected potential risk and vulnerability factors in relation to each measure of general mental health.

METHODS

Study design and procedure

This study was a cross-sectional online survey of adults living in the United Kingdom, using online survey tool Qualtrics. Ethical approval was obtained for this study from the Psychology Research Ethics Committee of the first author's affiliated institution. Informed consent was obtained from all participants.

Advertisement with the link for the online survey was distributed in widely accessible online social media including Twitter and Facebook. Potential participants clicked on the link for the online survey to access information about the study, and provided informed consent and participated if they wished to.

Participants

Adults who lived in the United Kingdom were recruited for this survey. Initially, 305 potential participants responded to the advertisements between August and October 2021, among which 265 provided consent. Among those who provided consent, five did not meet the inclusion criteria (aged 18 or above and living in the United Kingdom). Therefore, 260 participants took part in the survey. Among these participants, 214 provided data on all measures of mental health and were included in the analyses. [Table 1](#) shows the demographic characteristics and physical and psychological status of participants.

Measures

Persistent symptoms, COVID-19 status and COVID-19-related worries

Current (having persisted for at least 6 weeks) persistent symptoms were assessed with 26 items developed in a previous study (McCracken et al., 2020), including fatigue, shortness of breath, cough, heart palpitation, weight loss, gut problems, memory problems, attention difficulties, chest pain/pressure, sleep difficulties, skin change, changed sense of taste, changed sense of smell, joint pain, pins and needles in the limbs, nausea, decreased lung function, headache, decreased appetite, fever, sore throat, depression, anxiety, decreased quality of life, decreased everyday functioning and one item asking participants to indicate whether they have any other symptoms that have persisted for at least 6 weeks or not. These were based on the Swedish National Agency for Medical and Social Evaluation compiled based on available literature at the time and reported on 21 December 2020 (Swedish National Agency for Medical and Social Evaluation (SBU), 2020). For each symptom, participants were also asked to indicate if they associated the symptom with COVID-19. The total number of persistent symptoms was calculated. The total number of persistent physical symptoms (excluding depression, anxiety, sleep

TABLE 1 Demographic characteristics and physical and psychological status of participants.

Variable	Subcategory	N (%) or mean (SD)
Gender	Women	109 (50.9%)
	Men	103 (48.1%)
	Other	2 (0.9%)
Age		38.49 (13.75)
Ethnicity	White	181 (84.6%)
	Black	19 (8.9%)
	Mixed	7 (3.3%)
	Other	4 (1.9%)
	Asian	3 (1.4%)
Years of education		15.15 (3.10)
Living area	Suburbs	114 (53.3%)
	City	72 (33.6%)
	Countryside	23 (13.1%)
Working status	Working full-time	106 (49.5%)
	Working part-time	52 (24.3%)
	Student	15 (7%)
	Unemployed	13 (6.1%)
	Retired	13 (6.1%)
	Sick leave	8 (3.7%)
	Unpaid work (e.g., volunteer, carer, homemaker)	5 (2.3%)
	Parental leave	2 (9%)
Work change due to COVID-19	Reduced working hours or work days	81 (37.9%)
	No change	65 (30.4%)
	Lost job	18 (8.4%)
	Changed roles or responsibilities	18 (8.4%)
	Reduced salary	16 (7.5%)
	Taking sick leave	16 (7.5%)
Health care worker for COVID-19 patients	No	190 (88.8%)
	Yes	23 (10.7%)
Economic status	Average	111 (51.9%)
	Below average	46 (21.5%)
	Above average	37 (17.3%)
	Much below average	13 (6.1%)
	Much above average	6 (2.8%)
Relationship status	Married	80 (37.4%)
	Single	75 (35%)
	In a relationship-living apart	23 (10.7%)
	In a relationship-cohabitation	20 (9.3%)
	Separated/Divorced/Widowed	16 (7.5%)
Children under 18 years old	None	143 (66.8%)
	One	41 (19.2%)
	More than one	27 (12.7%)

TABLE 1 (Continued)

Variable	Subcategory	N (%) or mean (SD)
Number of people in household	1	56 (26.2%)
	2	47 (22%)
	3	50 (23.4%)
	4	31 (14.5%)
	More than 4	22 (10.3%)
Number of physical risk factors	0	105 (49.1%)
	1	53 (24.8%)
	2	27 (12.6%)
	3	15 (7%)
	More than 3	14 (6.6%)
Psychological risk factors	Having a previous history of mental health problems	59 (27.6%)
COVID-19 infection	Not infected	132 (61.7%)
	Had been infected	82 (38.3%)
Hospitalized for COVID-19	No	188 (87.9%)
	Yes	26 (12.1%)
Vaccination status	Complete vaccination	130 (60.7%)
	Incomplete vaccination	22 (10.3%)
	Not vaccinated	62 (29%)
Health state	Above average	78 (36.4%)
	Average	68 (31.8%)
	Below average	68 (31.7%)

Note: Physical risk factors include age over 70 years, high blood pressure, angina, stroke, heart disease, diabetes, cancer, smoking, respiratory diseases, impaired immune system and living with someone at risk. Regarding vaccination status, participants were asked to indicate if they have received the first dose (or incomplete vaccination), the second dose (or complete vaccination) or none.

difficulties, decreased daily functioning and decreased life quality) was also calculated for the analyses of the associations between persistent physical symptoms and mental health.

Participants were also asked if they had been infected with COVID-19, hospitalized for COVID-19 and vaccinated against COVID-19. In addition, participants were asked to rate their worries about their health, the health of their family and friends, their own finance/economy, the financial situation in the United Kingdom and the world, and the worry that the pandemic will have a negative impact on their future, on a scale from 'not at all worried' to 'extremely worried'.

Demographic variables

Information about gender, age, ethnicity, years of education, living area, working status, work change due to COVID-19, being a health care worker for COVID-19 patients, economic status, relationship status, having children under 18 years old and household size, were collected.

Physical and psychological risk and vulnerability factors

The 10 items developed in a previous study (McCracken et al., 2020) were used in this study to assess the presence of physical health risk for adverse outcomes from COVID-19. These risk factors included age

over 70 years, high blood pressure, angina, stroke, heart disease, diabetes, cancer, smoking, respiratory diseases and impaired immune system. Participants were also asked if anyone else in the household had a chronic condition that places them at risk. Psychological risk factors were assessed by asking participants if they have any previous history of mental health problems. Additionally, participants were asked about their current general health state.

Patient Health Questionnaire-9 (PHQ-9)

The PHQ-9 is a 10-item self-report assessment for depression severity. The first nine items assess symptoms of depression and are rated on a scale from 0 indicating 'not at all' to 4 indicating 'nearly every day'. The last item assesses the impact of depression and is rated from is rated on a scale from 'not difficult at all' to 'extremely difficult'. The total score of the first nine items reflects the severity of depression, with higher score reflecting higher level of severity of depression. The PHQ-9 is regarded as a reliable and valid index of depression severity (Kroenke et al., 2001). A summary score of 0–4 for the first 9 items indicates none to minimal depression, 5–9 mild depression, 10–14 moderate depression, 15–19 moderately severe depression and 20–27 severe depression. In the current sample, the PHQ-9 demonstrated excellent internal consistency, Cronbach's $\alpha = .91$.

The general anxiety disorder-7 (GAD-7)

The GAD-7 is a 7-item self-reported measure for screening for GAD and assessing its severity (Spitzer et al., 2006). Participants asked to rate the frequency of symptoms in the past 2 weeks. Each item is rated a scale from 0 indicating 'not at all' to 3 indicating 'nearly every day'. A summary score of 0–4 for the seven items indicates none to minimal level of anxiety, 5–9 mild level of anxiety, 10–14 moderate level of anxiety and 15–21 severe level of anxiety. In the current sample, the GAD-7 demonstrated excellent internal consistency, Cronbach's $\alpha = .93$.

The insomnia severity index (ISI)

The ISI is a 7-item self-report questionnaire assessing the nature, severity and impact of insomnia (Bastien et al., 2001; Morin et al., 2011). Participants are asked to rate the severity of sleep onset, sleep maintenance and early morning awakening problems, sleep dissatisfaction, interference of sleep difficulties with daytime functioning, noticeability of sleep problems by others and distress caused by the sleep difficulties, on a scale from 0 indicating no problem to 4 indicating severe problem. A summary score of 0–7 indicates absence of insomnia, 8–14 sub-threshold insomnia, 15–21 moderate insomnia and 22–18 severe insomnia. In the current sample, the ISI demonstrated excellent internal consistency, Cronbach's $\alpha = .93$.

Statistical analyses

IBM SPSS Statistics 28.0.0 was used to analyse data. Several categorical variables, including ethnicity, housing, employment status, work change, economic status, relationship status and number of children, vaccination status and health state, were recoded into binary variables for correlational analyses.

Pearson's correlations were calculated to investigate the associations of persistent physical symptoms, and demographic variables, physical and psychological risk and vulnerability factors and

COVID-19 status, with measures of general mental health, including depressive symptoms, anxiety and insomnia. A series of regression analyses were conducted to investigate the independent role of persistent physical symptoms, demographic variables, physical and psychological risk and vulnerability factors and COVID-19 status in relation to each measure of mental health. Only variables that were significantly correlated with the measures of mental health were included in the regression models, respectively. For each regression model, demographic variables were entered in the first block, physical and psychological risk and vulnerability factors the second block, persistent physical symptoms and COVID-19 status variables the third block, COVID-19 related worry the last block. Missing data were excluded pairwise.

RESULTS

The rates of persistent symptoms mental health problems in the sample

Overall, 78.5% of the participants reported between 1 and 26 persisting symptoms, and 28%–92% of them associated these symptoms with COVID-19 infection. [Figure 1](#) shows the percentage of participants reporting persisting symptoms and attributing them to COVID-19 infection. About a third or more of the participants had symptoms including anxiety, fatigue, decreased life quality, sleep difficulties, depression, memory problem, decreased everyday functioning, attention difficulties and joint pain.

[Table 2](#) shows the rates of mental health variables including depressive symptoms, anxiety and insomnia. 54.21% of the participants reported moderate-to-severe depression, 40.2% moderate-to-severe anxiety, 28.1% moderate-to-severe insomnia.

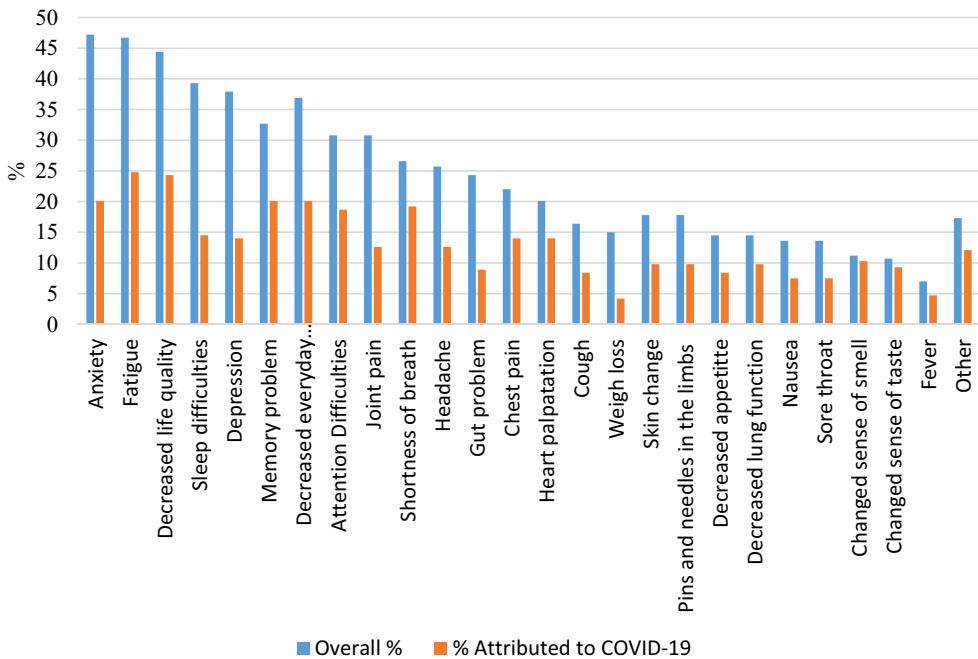


FIGURE 1 Percentage reporting persistent physical symptoms and attributing them to COVID-19 infection.

TABLE 2 Rates of mental health.

Mental health	Mean (SD)	Score	n (%)
<i>Patient Health Questionnaire-9 (0–27)</i>			
Minimal or no depression	10.49 (7.08)	0–4	52 (24.3)
Mild depression		5–9	46 (21.5)
Moderate depression		10–14	57 (26.64)
Moderately severe depression		15–19	32 (14.95)
Severe depression		20–27	27 (12.62)
<i>Generalized anxiety disorder-7 (0–21)</i>			
No anxiety	8.06 (6.03)	0–4	78 (36.4)
Mild anxiety		5–9	50 (23.4)
Moderate anxiety		10–14	49 (22.9)
Severe anxiety		15–21	37 (17.3)
<i>Insomnia severity index (0–28)</i>			
Absence of insomnia	10.82 (7.1)	0–7	75 (35)
Sub-threshold insomnia		8–14	42 (19.6)
Moderate insomnia		15–21	41 (19.2)
Severe insomnia		22–28	19 (8.9)

Descriptive statistics for physical risk and vulnerability factors

9.8% of the participants were over 70 years old 9.8% ($n = 21$). 13.1% ($n = 28$) of the participants had high blood pressure, 6.1% ($n = 13$) angina, 3.7% ($n = 8$) stroke, 6.1% ($n = 13$) heart disease, 5.6% ($n = 12$) diabetes, 3.3% ($n = 7$) cancer and 11.2% ($n = 24$) compromised lung function. 8.4% ($n = 18$) of the participants were taking immune system suppressing medications and 27.1% ($n = 58$) smoked. For 12.1% ($n = 26$) of the participants, other people in the household were at risk.

Correlations between persistent physical symptoms, other risk and vulnerability factors and mental health

Table 3 shows Pearson's Correlations between total persistent physical symptoms (excluding depression, anxiety, sleep difficulties, decreased daily functioning and decreased life quality), demographic variables, psychological and physical risk factors, COVID-19 status and mental health variables. The total number of persistent physical symptoms showed significant correlations with all measures of mental health. Work changed due to COVID-19 and economic status below average were significantly correlated with worse mental health. History of mental health problems and general health state were significantly correlated with all measures of mental health.

Regression analyses

Table 4 shows results from regression analyses. The total number of persistent physical symptoms (excluding depression, anxiety, sleep difficulties, decreased daily functioning and decreased life quality) was significantly and independently associated with all measures of mental health. Among demographic variables, only work change due to COVID-19 and being employed were significantly associated with depressive symptoms. Mental health history was significantly and independently associated with depressive symptoms and anxiety and general health state with depression.

TABLE 3 Pearson's Correlations between persistent physical symptoms, demographic variables, physical and psychological risk factors, COVID-19 status and worries and mental health variables.

	PHQ-9	GAD-7	ISI
Persistent symptoms (number of)	.57***	.47***	.53***
<i>Demographic variables</i>			
Gender	.12	.07	.09
Age	-.08	-.05	-.10
White	.04	-.01	.07
Years of education	-.14*	-.09	-.21**
Living in the city	-.26***	-.25***	-.27***
Employed	-.16*	-.05	-.10
Work changed due to COVID-19	.16*	.17*	.19**
Health care worker	.09	.11	.08
Economic status below average	.26***	.23**	.26***
Alone (relationship status)	.05	<.001	.05
Having any children under 18 years old	<.001	<.001	0.01
Household size	-.01	-.04	-.01
<i>Physical and psychological risk factors</i>			
Physical risk factors (number of)	.08	.09	.07
Mental health history	.37***	.30***	.34***
<i>COVID-19 status and general health status</i>			
Infected with COVID-19	.35***	.33***	.29***
Hospitalized for COVID-19	.13	.21**	.13*
Vaccinated against COVID-19	.24***	.30***	.14*
Health state below average	.51***	.40***	.39***
<i>COVID-19-related worries</i>			
Worry about own health	.51***	.48***	.48***
Worry about health of family and friends	.48***	.49***	.46***
Worry about own economy	.44***	.42***	.43***
Worry about UK and global economy	.33***	.33***	.38***
Worry about impact on own future	.49***	.48***	.52***

Abbreviations: GAD-7, generalized anxiety disorder-7; ISI, insomnia severity index; PHQ, Patient Health Questionnaire-9.

Note: * $p < .05$, ** $p < .01$, *** $p < .001$. The values are in bold to emphasize the correlations between persistent symptoms and mental health, which is the primary research question.

COVID-19 infection and being vaccinated against COVID-19 were not uniquely associated with any measures of mental health and being hospitalized for COVID-19 was only uniquely associated with insomnia. Finally, COVID-19-related worries were significantly and uniquely associated with all measures of mental health.

DISCUSSION

We found that nearly 80% of the participants were experiencing persistent symptoms that are common in 'long COVID', and they perceived an association between these symptoms and COVID-19 to varying degrees. Total number of persistent physical symptoms, along with mental health history, and COVID-19-related worries appear to be the most prominent factors associated with mental health. To

TABLE 4 Results from regression analysis for each measure of mental health.

Block	Predictor	F change	df	Adjusted R ²	Δ R ²	β
<i>Depressive symptoms</i>						
1	Years of education	11.10***	(5, 203)	.20	.22	-.07
	Living in the city					-.05
	Employed					-.17**
	Work changed due to COVID-19					.13*
	Economic status below average					.10
2	Mental health history	32.67***	(2, 201)	.39	.19	.15**
	Health state below average					.17**
3	Infected with COVID-19	10.24***	(3, 198)	.46	.08	-.07
	Total persistent physical symptoms					.24**
	Vaccinated against COVID-19					.04
4	Total worry	23.83***	(1, 197)	.52	.06	.31***
<i>Anxiety</i>						
1	Living in the city	12.81***	(3, 209)	.14	.16	-.09
	Work changed due to COVID-19					.10
	Economic status below average					.08
2	Mental health history	20.62***	(2, 207)	.28	.14	.23***
	Health state below average					.04
3	Infected with COVID-19	4.78**	(4, 203)	.33	.06	-.11
	Hospitalized for COVID-19					.10
	Total persistent physical symptoms					.19*
	Vaccinated against COVID-19					-.11
4	Total worry	41.9***	(1, 202)	.44	.11	.43***
<i>Insomnia</i>						
1	Years of education	7.56***	(4, 204)	.11	.13	-.02
	Living in the city					-.03
	Work changed due to COVID-19					.02
	Economic status below average					.10
2	Mental health history	18.76***	(2, 202)	.24	.14	.12
	Health state below average					.02
3	Infected with COVID-19	11.06***	(4, 198)	.37	.13	-.10
	Hospitalized for COVID-19					.16**
	Total persistent physical symptoms					.32***
	Vaccinated against COVID-19					.08
4	Total worry	25.49***	(1, 197)	.44	.07	.35***

Note: * $p < .05$; ** $p < .01$; *** $p < .001$. Only demographic variables, physical and psychological risk factors, COVID-19 status variables that were significantly correlated with each measure of mental health were included in these regression models, respectively.

our knowledge, this is the first study that investigated persistent physical symptoms in relation to mental health in the context of COVID-19 in the United Kingdom.

In our study, more than half of the participants experienced clinically significant depression, about 40% clinically significant anxiety and less than 30% clinically significant insomnia. The rate of mental health problems identified in this study appear comparable or higher compared with other studies conducted in the United Kingdom (O'Connor et al., 2021; Pieh et al., 2021).

In line with previous studies (Lopez-Leon et al., 2021), fatigue was the most common persistent physical symptom, alongside other common symptoms including cognitive problems such as attention difficulties and memory problem, and headache. Despite the diagnoses, the burden of these persistent symptoms, including their long-term detrimental impact on emotional and physical functioning, have been well-researched in various conditions, such as chronic fatigue syndrome (Price et al., 2008).

Notably, the number of persistent physical symptoms was among the strongest predictors of mental health. Given the high prevalence of persistent COVID-19 symptoms (Lopez-Leon et al., 2021; Office for National Statistics, 2023), it is possible that the strong associations between persistent physical symptoms and mental health that we identified here can partly explain the elevated mental health problems. While managing physical symptoms would appear to be a direct route to improve mental health for people who live with these persistent symptoms, it is also important to identify the mechanisms through which physical symptoms exert their influence on mental health. For instance, psychological flexibility has been identified as a resilience factor mitigating the COVID-19 impacts on mental health (McCracken et al., 2021). Exploring the role of psychological flexibility (Hayes et al., 2011) in the relationship between persistent symptoms and mental health may shed some light particularly in developing intervention to reduce the impact of persistent physical symptoms on mental health.

Intriguingly, in our exploratory analysis, when the attribution of persistent symptoms to COVID-19 infection was considered, the results remained similar. Furthermore, COVID-19 infection was not independently associated with mental health. It seems that the association between these persistent symptoms and mental health may be independent of the context of COVID-19. In fact, 'long COVID' symptoms involve almost every system and part of the body, which so far makes it difficult to distinguish between 'long COVID' and other unexplained symptoms in clinical practice, due to limited understanding of the condition (Salisbury, 2023). Perhaps the challenges that come with these symptoms are not specific to COVID-19 infection and existing interventions for other respiratory diseases or psychological interventions that include a trans-diagnostic approach to symptoms would be suitable to address the impact of these on mental health.

In line with previous studies in the United Kingdom and Europe (McCracken et al., 2020; O'Connor et al., 2021), people with a history of a mental health problem history appeared particularly vulnerable to the psychological impact of the pandemic. The reduction of mental health services reported in the United Kingdom during the pandemic may have further contributed to deteriorated mental health for people who are already suffering from mental health problems (Chen et al., 2020).

In line with findings in Norway (Blix et al., 2021), COVID-19-related worries emerged as the strongest predictor of mental health. In fact, worry has long been observed to be associated with poorer mental health (Vislå et al., 2022). Qualitative studies to identify possible source of anxiety and worry, such as the role of the media and the public communication about COVID-19-related measures, and policies can potentially help informing the development of measures to reduce the psychological impact of the pandemic and similar events.

There are limitations to acknowledge. First, we cannot infer causal relations between persistent physical symptoms and mental health due to the cross-sectional design of the study. Longitudinal studies that explore factors that moderate the effect of persistent symptoms and mental health are needed, to inform the development of interventions. Second, we cannot definitively attribute the elevated mental health problems to the pandemic due to the cross-sectional design of the study. However, findings regarding the prevalence of mental health problems were compared with data outside of the pandemic, which clearly suggested an elevated level of mental health problems during the pandemic. Third, the participants were recruited via online social media, which limited the representativeness of the sample. Nevertheless, about 80% of the participants were white, and half of the participants were women, which is broadly in line with the demographic of the UK population (GOV.UK, 2022). Next, the sample size of this study is relatively small, which may limit the reliability and generalizability of the findings. Finally, we only examined the total number of persistent symptoms. More comprehensive investigation that includes the duration and interference of each symptom could provide more refined understanding of the

implication of long COVID. Investigations that include other factors, such as medication usage, could also help further delineating the role of each risk and vulnerability factor.

With limitations in mind, results here suggest tentative practical recommendations. For one, it seems relevant, and may be important for some individuals for clinicians to consider, and in some situations discuss, that recovery from COVID-19 may extend beyond a negative COVID-19 test (Alwan, 2020). It appears to remain the case that we need to develop multidisciplinary interventions that address the complex impact of COVID-19 for people with long COVID.

CONCLUSION

People who experience greater numbers of persistent physical symptoms post COVID-19 have had poorer mental health. People having previous mental health problems, and COVID-19-related worries, appear particularly vulnerable to mental health problems in the context of COVID-19. Additional longitudinal studies are warranted to identify the factors that moderate the influence of these risk and vulnerability factors on mental health, and eventually inform the development of intervention that target these.

AUTHOR CONTRIBUTIONS

Lin Yu: Conceptualization; methodology; data curation; investigation; formal analysis; writing – original draft; project administration. **Lance M. McCracken:** Conceptualization; methodology; resources; validation; writing – review and editing.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study will be openly available in UK Data Service.

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