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Psychiatric symptoms in COVID-19-positive individuals in the general population: Trajectories of depression, anxiety, and insomnia

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ABSTRACT

The present study investigates differences in the trajectories of anxiety, depression, and sleep problems among infected versus non-infected case-controlled individuals. Patients who tested positive for COVID-19 were selected from a representative sample in Norway (N > 10,000). In total, 126 of these individuals were infected during the project period, and this group was analyzed at T5 (May 2021). Of these positive cases, those who had completed both PHQ-9 and GAD-7 at all three measurement points were selected for longitudinal analysis using multilevel modeling. There was a significant difference at T5 between those who had tested positive for COVID-19 and matched controls. Anxiety and depression were reduced among those who tested positive, but there were no differences in trajectory when compared to matched controls. Limitations include the use of self-report measures and the assessment of symptoms at a time when strict virus mitigation protocols were in place. The present findings indicate that individuals who test positive for COVID-19 exhibit higher levels of depressive symptoms after restrictions are lifted. However, comparison of anxiety and depression symptom trajectories with matched controls reveals that both groups exhibited stable or slightly decreased symptoms.

1. Introduction

COVID-19 is now known to be a multi-organ disease with a broad spectrum of potential post-acute manifestations (e.g., Nalbandian et al., 2021). A rapidly increasing body of research has confirmed the existence of post-acute COVID-19 syndrome ("long COVID"), involving long-lasting complications that continue beyond the acute phase of the initial infection (Nalbandian et al., 2021). Although there are only limited data regarding the prevalence and development of long COVID, some recent studies have identified a range of somatic and psychiatric sequelae. Beyond somatic symptoms that persist for more than a month after initial infection, such as fatigue, dyspnea, muscular weakness, joint pain, headache, and anosmia (e.g., Sudre et al., 2021), a sizable proportion of patients also experience psychiatric symptom burden, including depression, anxiety, and sleep disturbance (Himmels et al., 2021; Taquet et al., 2021).

In a six-month follow-up study of 1,733 COVID-19 patients following hospital discharge, 23% reported anxiety or depression, and 26% reported sleep difficulties (Huang et al., 2021). Additionally, patients with more severe illness were at increased risk of anxiety and depression (Huang et al., 2021). Similar studies have reported rates of depression among discharged patients as 13.8% (Naidu et al., 2021) and 14.6% (Mandal et al., 2021). Corresponding patterns of depression and anxiety were also reported in earlier long-term follow-up studies of survivors of acute respiratory syndrome (e.g., Moldofsky & Patcai, 2011; Rogers et al., 2020).

Several studies and systematic reviews have reported insomnia and sleep disturbance associated with COVID-19 infection (e.g., Deng et al., 2020; Dong et al., 2021; Taquet et al., 2021), but evidence regarding the persistence of these symptoms beyond the acute phase remains sparse. Some studies note that insomnia symptoms are frequently observed in long COVID patients (e.g., Cabrera et al., 2021; Fortini et al., 2021; Mazza et al., 2020), but little is known about the long-term development of psychiatric symptoms following COVID-19 infection.

The existing literature leaves several questions unanswered regarding long-term psychiatric health outcomes in COVID-19 patients

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beyond the acute illness phase. As symptoms range across disciplinary boundaries (Norton et al., 2021; Blomberg et al., 2021), there is a need to take account of psychiatric as well as medical complications. Moreover, many studies are unclear about the inclusion criteria for COVID-19 infected patients, making it difficult to disentangle the effects of acute COVID-infection and post-COVID infection on psychiatric symptoms. Additional limitations include the absence of non-infected control groups and repeated measures over a longer follow-up period. Many studies to date have also focused on hospitalized individuals with a more severe illness course (e.g., need for respirator), some of whom may experience long-lasting symptoms as a consequence of post-intensive care syndrome (PICS) (Himmels et al., 2021) rather than as a result of the viral infection alone. This is a significant research gap, as the assessment of long-term psychiatric symptoms should include individuals from the general population with a mild course of infection as well as those who are hospitalized.

By sampling infected individuals from a longitudinal population study, it was possible to investigate the trajectories of anxiety, depression, and sleep problems among infected and non-infected case-controlled individuals and how symptoms persist and change over time and after the initial infection period. Building on the strengths of repeated assessment, the present study contributes to the literature by investigating differences in the trajectories of psychiatric symptoms among infected and non-infected individuals. Finally, as there is a need for more reliable predictors of how these psychiatric symptoms change and develop, the present study also examined specific predictors of anxiety and depression, including age and physical activity level.

2. Methods

2.1. Participants and sampling

The study participants were drawn from the Norwegian COVID-19, Mental Health and Adherence project, a large (N = 10061) ongoing national longitudinal study of the Norwegian adult population spanning the sixteen months since the onset of the pandemic in Norway in March 2020. Ethical approval was granted by the Regional Committee for Medical and Health Research Ethics (reference: 125510).

All participants were adults (aged > 18 years) currently residing in Norway. They were recruited when the project commenced (i.e., T1, March 31, 2020) and continued to provide responses across five waves of systematic sampling from May 8, 2021 to May 25, 2021 (T5). A two-step sampling procedure was used to ensure that all members of the general adult population had an equal probability of participating in the study. In the first step, an algorithm was used to reach out to a random selection of all Norwegian adults on Facebook, accounting for 85% of the country's adult population. As a second step, the survey was disseminated through national, regional, and local TV, newspaper, and radio channels to reach the remaining 15% of the adult population. Participation was voluntary and commenced only after informed consent.

To control for any associated psychosocial outcomes, each measurement wave followed approximately two weeks after each modification of national protocols for virus mitigation. Data collection was terminated immediately following the announcement of any such modification, so controlling for expectation effects. To investigate any divergence in psychiatric symptom trajectories following SARS-CoV-2 infection, data from T3 to T5 were used a) to obtain a sample of sufficient statistical power to support modeling of long-term trajectories and b) to ensure a sufficient number of participants in each measurement wave to control for strictness of virus mitigation protocols, which has been shown to covary with psychiatric symptom severity across the general population in Norway (e.g., Ebrahimi et al., 2021; Norwegian Institute of Public Health, 2020). More precisely, the implemented protocols were similar in severity at T3 (December 2, 2020) and T4 (February 2, 2021) and were less strict at T5 (May 8, 2021). On that basis, symptom levels would be expected to decrease between T3 and T5.

2.2. Design

The case-control design ensured that all of the sampled participants had a theoretically equal probability of being infected by COVID-19. Participants who were infected by COVID-19 during the longitudinal study were defined as cases, and all other participants were defined as eligible controls. Controls were chosen by random sampling of the roster of participants (Wacholder, 1995) and were matched on relevant parameters as specified below.

The participants were divided into three groups. In total, 126 were infected during the project period, and this group was analyzed at T5. Of the 126 positive cases at T5 (May 2021), those who had completed the PHQ-9 and GAD-7 at all three time points were selected for the longitudinal analysis. These 70 COVID-positive participants were further divided into (1) a short-term impact group comprising those infected after October 19, 2020 but 30 days prior to data collection at T3 (n = 49) and (2) a long-term impact group comprising those infected before October 19, 2020 (n = 21). The third group included a case control group randomly selected from a pool of infection-free individuals who closely matched the other two groups in terms of demographic variables previously found to be associated with psychiatric symptoms during the pandemic (i.e., age, sex, education level, relationship status, prevalence of psychiatric disorder), using propensity score matching as outlined in Section 2.4.

2.3. Measures

General Anxiety Disorder-7 (GAD-7). The GAD-7 (Spitzer et al., 2006) measures anxiety on a four-point Likert scale; total scores range from 0 to 21. Following Johnson et al. (2019), a cut-off value of 8 or above was used for present purposes. Cronbach's alpha values ranged from 0.89 to 0.905 across measurement points, indicating good internal consistency.

Patient Health Questionnaire-9 (PHQ-9). Depressive symptoms were measured using the PHQ-9 (Kroenke et al., 2001), again on a four-point Likert scale, with total scores ranging from 0 to 27. A cut-off value of 10 or above were used for the PHQ-9 (Kroenke et al., 2001). Subscales of somatic (item 3,4,5) and cognitive (items 1,2,6,7,8,9) depression factors were also used in the analysis. Cronbach's alpha ranged from 0.881 to 0.894 across measurement points, indicating good internal consistency.

Bergen Insomnia Scale (BIS). Item 6 from the Bergen Insomnia Scale (Pallesen et al., 2008) was used to measure sleep issues; this spared participants the burden of a long questionnaire, and this item is most highly correlated with the overall scale (r = 0.862). Specifically, item 6 measures the number of days per week over the previous month when the participant was dissatisfied with their sleep on a scale ranging from 0 to 7.

Physical activity. For present purposes, physical activity was measured in terms of frequency during the preceding two weeks and was defined as activity that lasted at least 30 minutes and produced at least a light sweat or increased pulse.

2.4. Statistical analysis

Using the R-package MatchIt (version 4.2.0), propensity score matching (PSM) was used to randomly select a balanced comparison group, so reducing bias and possible confounding characteristics (Zhang et al., 2018; Morgan, 2018). The PSM analysis included demographic characteristics (age, biological sex, education, relationship status) and presence or absence of psychiatric diagnosis.

The COVID-infected group (n = 126) contained a subsample of 70 individuals who participated in all measurement waves. This allowed for cross-sectional comparison of 126 COVID-positive individuals at T5 and

Table 1
Participants' demographic data ($N = 126$).

Subgroup	*N* (%) in SARS-CoV-2 group	*N* (%) in matched case control group without COVID-19
Age group (years)		
18–30	59 (46.83%)	59 (46.83%)
31–44	40 (31.75%)	38 (30.16%)
45–64	24 (19.05%)	26 (20.63%)
65+	3 (2.38%)	3 (2.38%)
Sex		
Female	107 (84.92%)	108 (85.71%)
Male	18 (14.29%)	18 (14.29%)
Transgender	1 (0.79%)	0 (0.00%)
Civil Status		
Single	49 (38.89%)	47 (37.30%)
Married or in a civil union	62 (49.21%)	69 (54.76%)
In a relationship	15 (11.90%)	10 (7.94%)
Education Level		
Junior High School	3 (2.38%)	4 (3.17%)
Senior High School	17 (13.49%)	18 (14.29%)
Currently studying	29 (23.02%)	28 (22.22%)
University Degree	77 (66.11%)	76 (60.32%)
Psychiatric Diagnosis		
Yes	19 (15.08%)	17 (13.49%)
No	107 (84.92%)	109 (86.51%)

Note. As far as possible, each infected participant was matched with a non-infected individual with their exact characteristics. Across the two groups of 126 COVID-positive individuals and controls (252 in total) and 16 levels of variables, 4,032 datum points were matched, of which 4,004 (99.31%) were fully matched.

longitudinal comparison within the subgroup of 70. Using PSM, two separate randomly selected case-control groups ($n = 126$ and $n = 70$) were drawn to match these two groups. The first control group ($n = 126$) was drawn from a sample of individuals who had not contracted COVID-19 and for whom there were no missing data points on key variables of interest ($N = 2{,}876$); this group matched 99.31% of the key demographic characteristics of the COVID-positive group. The second control group ($n = 70$) matched 98.67% of the key characteristics of its COVID-positive comparison group. Key characteristics of main and case-control groups for the full sample of 126 individuals who had contracted COVID-19 can be found in Table 1.

Independent sample t-tests were used to compare mean values of anxiety, depression, and sleep issues at T5. Cohen's d was used to measure effect size. Multilevel models were used to analyze the longitudinal data (Fitzmaurice et al., 2004). On investigating which combination of random effects and covariance structure of residuals best fit the "empty" model (without fixed predictors other than the intercept), the preferred model included a random intercept and heteroscedastic residual variance over time (covariance structure, diagonal). Using Akaike's information criterion (AIC) to compare model fit, those yielding an AIC reduction greater than 2 were considered better (Burnham and Anderson, 2004).

To begin, we used time as a predictor to estimate anxiety and depression trajectories. November 2020 was designated as the first assessment point because it was the natural point at which to separate those who were infected one month before the first assessment from those who received a later diagnosis. Secondly, we added the positive COVID-19 test date as a covariate, coding this variable 1 for pre-October 19 and 0 for the period after the first assessment point. This covariate was used as a predictor with time interaction.

Third, we investigated whether age and physical activity predicted anxiety and depression trajectories by adding a predictor x time interaction to the models. Finally, we investigated whether the trajectories of psychiatric symptoms in COVID-positive individuals differed from those of the matched controls from the general population. The analyses and visualizations used a significance level of $p < 0.05$, R software version 4.1.0 (R Core Team, 2020), and SPSS 27.0 (IBM, 2020).

3. Results

3.1. Symptom levels at T5

In May 2021, 27.8% of those who tested positive for COVID-19 ($N = 126$) were above the established cut-off for anxiety, and 38.1% were above the cut-off for depression; among the matched controls, the corresponding figures were 15.1% for anxiety and 20.6% for depression. An independent sample t-test revealed a trend in the difference in anxiety between those who tested positive for COVID-19 ($M = 5.18$, $SD = 4.42$) and matched controls ($M = 4.17$, $SD = 3.77$), t(243.8) = -1.96, $p = 0.051$, $d = 0.25$. There was a significant difference in depression symptoms between COVID-19-positive individuals ($M = 7.84$, $SD = 5.37$) and matched controls ($M = 5.77$, $SD = 4.36$), t(239.9) = -3.35, $p = < 0.001$, $d = 0.42$. However, there were no significant differences in sleep problems between those who tested positive for COVID-19 ($M = 3.67$, $SD = 2.39$) and matched controls ($M = 3.21$, $SD = 2.47$), t(249.7) =-1.50, $p = 0.134$, $d = 0.19$.

3.2. Trajectories of anxiety and depression

From November 2020 through May 2021, anxiety (*estimate* = -0.40, $SE = 0.20$, $t(68.7) = -2.02$, $p = 0.047$) and depression (*estimate* = -0.59, SE =0.25, $t(86.5) = -2.40$, $p = 0.018$) decreased among the 70 participants who had tested positive for COVID-19 and had provided measures at every time point.

3.3. Predictors of trajectory

Age and level of physical activity were included as predictors in interaction with time in two models. Age was not a significant predictor of anxiety (*estimate* = 0.001, $SE = 0.01$, $t(68.1) = 0.09$, p=0.928) or depression (*estimate* = 0.01, $SE = 0.020$, $t(85.5) = -0.729$, $p = 0.468$). Level of physical activity in November 2020 did not predict the trajectory for anxiety (*estimate* = -0.13, $SE = 0.16$, t (68.3)= -0.839, p=0.405) or for depression (*estimate* = -0.04, SE =0.19, $t(86.7) = -0.210$, $p = 0.834$).

3.4. Long COVID

There were no significant differences in trajectory between the long-term COVID group ($N = 21$, coded 1) and the short-term COVID group (N=49, coded 0) for anxiety (*estimate* = 0.33, SE =0.44, $t(67.9) = 0.76$, p=0.453) or depression (*estimate* = 0.70, $SE = 0.53$, $t(84.9) = 1.32$, $p = 0.190$).

3.5. Somatic and cognitive depression factors

There were no significant changes on the somatic subscale across the whole sample (*estimate* = -0.15, $SE = 0.10$, t (79.9) = -1.42, $p = 0.160$), but there was a significant reduction on the cognitive subscale (*estimate* = -0.45, SE =0.17, t (88.4) = -2.65, $p = 0.009$).

3.6. Sleep

There were no changes in sleep over three time periods (*estimate* = 0.05, $SE = 0.15$, t (89.4) = 0.33, $p = 0.739$), and there were no significant differences in the trajectories of those with long-term (coded 1) and short-term COVID (coded 0) (*estimate* = -0.13, $SE = 0.33$, t (88.5) = -0.39, $p = 0.696$).

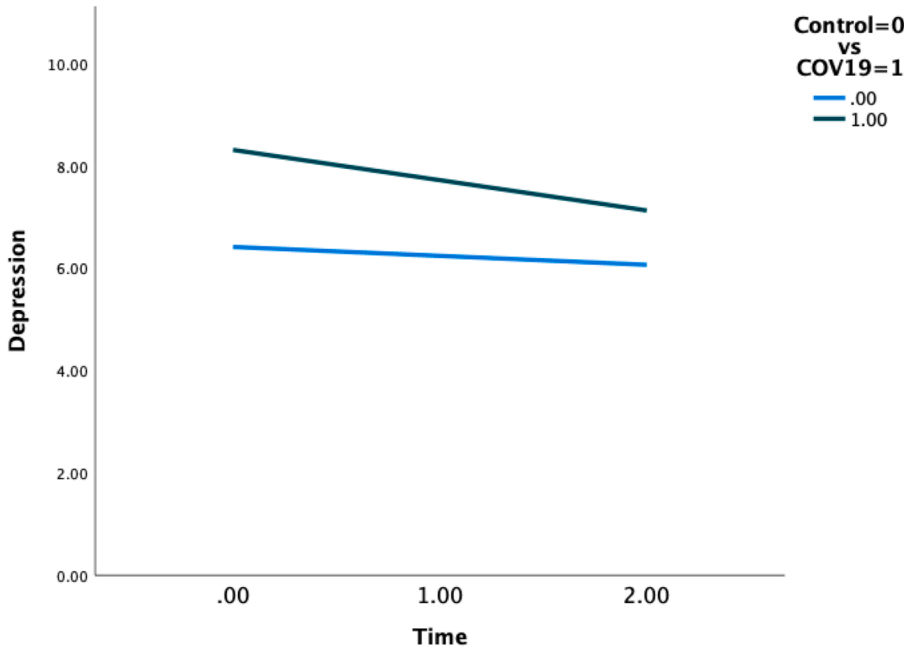

Fig. 1. Trajectories over time: Depression.
Note: 0 = November 2020, 1 =February 2021, 2 =May 2021, Controls = Matched controls, COV19 = Covid-19 positive.

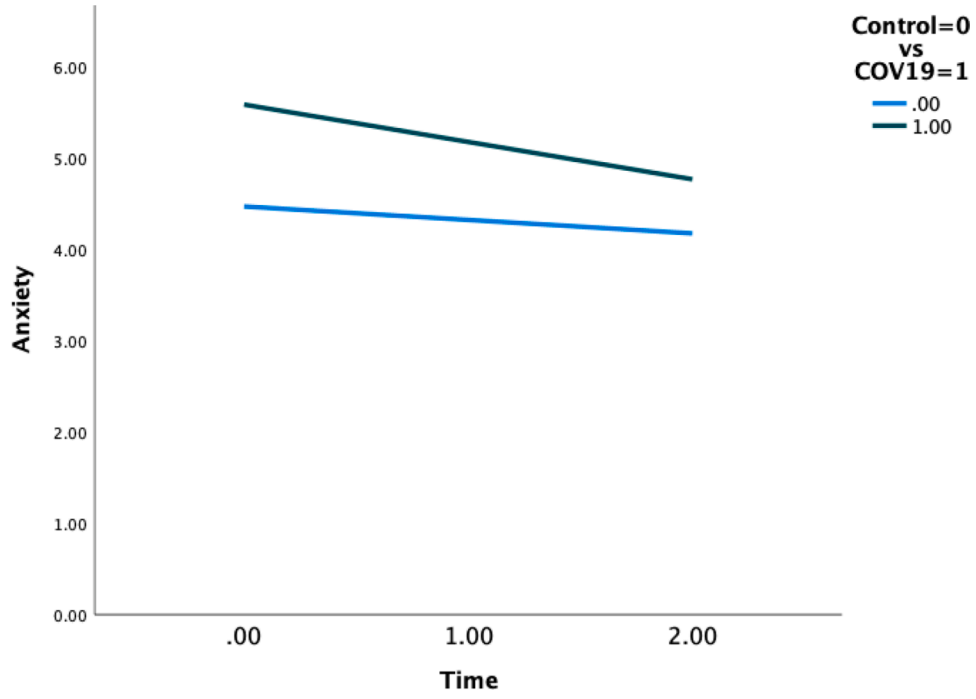

Fig. 2. Trajectories over time: Anxiety.
Note: 0 = November 2020, 1 = February 2021, 2 = May 2021, Controls = Matched controls, COV19 = Covid-19 positive.

3.7. COVID-19 vs matched controls

There was no main effect of group (matched control and COVID-19 positive) for depression (*estimate* = 1.34, *SE* = 0.74, *t* (135.9) = 1.80, $p = 0.074$) or anxiety (*estimate* = 0.83, *SE* = 0.64, *t*(137.67) = 0.195, $p = 0.195$), which indicates that the intercept was not significantly higher for those who had tested positive for COVID-19 compared to matched controls. There was no significant difference in trajectories (interaction of time and group) between those who tested positive for COVID-19 and the matched control for sleep (*estimate* = -0.22, *SE* = 0.19, *t* (176.0) = -1.12, $p = 0.261$), anxiety (*estimate* = -0.26, *SE* = 0.31, *t* (163.3) = -0.84, $p = 0.401$), or depression (*estimate* = -0.42, *SE* = 0.33, *t* (181.6) = -1.27, $p = 0.207$. (See Figs. 1 and 2.)

4. Discussion

The purpose of this longitudinal population study was to investigate the trajectories of anxiety, depression, and sleep problems and predictors of those trajectories among those infected by COVID-19. Comparisons were also drawn with the trajectories of individuals who had

not been infected during the observation period.

In the overall group of individuals who tested positive for COVID-19, anxiety and depression decreased slightly across the three time points in the follow-up period. This was unsurprising in light of the ease and discontinuation of a substantial proportion of viral mitigation protocols in May 2021 that were known to be associated with these symptoms in the Norwegian population (e.g., Ebrahimi et al., 2021, 2022b, 2022a; Norwegian Institute of Public Health, 2020). There were no significant differences in trajectory between those who were infected earlier and those infected more recently.

Multilevel model analyses further revealed no differences in the course of anxiety, depression, and sleep problems between those who tested positive for COVID-19 and matched controls. However, those who were COVID-positive exhibited greater symptoms of depression at the last measurement point. To that extent, our results align with those of Taquet et al. (2021), who concluded that there is substantial neurological and psychiatric morbidity in the 6 months following infection. However, despite their greater prevalence, symptoms of anxiety and depression were found to decrease over time at rates equivalent to the control group. Although there were significant differences between the groups in May 2021, the crucial question is whether the trajectories of infected and non-infected groups differ in the long term. The present study does not support any such conclusion. Age and level of physical activity did not alter the slopes of anxiety and depression; in other words, these variables did not predict the trajectories of anxiety and depression.

The main conclusion to be drawn from the current study is that COVID-19 infection does not increase psychiatric symptomatology over time. There are some indications that those who test positive for COVID-19 report higher levels of depressive symptoms, but further research will be needed to validate this finding.

4.1. Limitations and strengths

The present study has several limitations. As we had no access to physiological indicators or somatic health data, there was no objective measure of severity of infection or length of illness, and we could only assess the presence or absence of infection. Existing studies have focused on different degrees of severity in COVID-19 patients (Magnúsdóttir et al., 2022). While most experience mild symptoms, a smaller number are hospitalized and suffer acute illness or illness resulting in death. In the present case, it was not possible to distinguish between mild and severe infection, which may influence the severity of associated psychiatric symptoms. One 6-month follow-up study of patients discharged from a Chinese hospital (Huang et al., 2021) found that 23% reported symptoms of anxiety or depression, and those who were more severely affected by the illness reported greater anxiety and depression. The use of self-reporting rather than clinical interviews is another limitation, as is the assessment of symptoms during periods of strict virus mitigation. It follows that the increase in observed levels of symptoms may also be related to lockdown, and the subsequent decrease in symptoms at the last measurement point may be linked to the discontinuation of these protocols as previously observed in the study population. Other covariates of intensive mitigation include economic insecurity and other pandemic-related stressors.

The strengths of this study include the longitudinal design, which enabled us to examine psychological variables at three different time points following infection by COVID-19. Assessments were timed to match changes in virus mitigation strategies (e.g., stay-at-home orders). Psychiatric symptoms were assessed using standardized and well-established measures. Finally, the large number of participants in the present study enabled us to precisely and randomly select control participants who matched the characteristics of the infected group, controlling accurately for key characteristics.

5. Conclusion

These findings suggest that individuals who have tested positive for COVID-19 experience higher levels of depression after restrictions are lifted. However, as compared to matched controls, the psychiatric symptoms of SARS-CoV-2-positive individuals changed over time at roughly the same rate as in the non-infected general population. While those infected by the virus reported some elevation in symptoms, their trajectories did not differ significantly from matched controls.

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CRediT authorship contribution statement

Sverre Urnes Johnson: Conceptualization, Writing – original draft, Methodology, Formal analysis. **Ole Myklebust Amundsen:** Writing – review & editing, Conceptualization, Formal analysis. **Miriam Sinkerud Johnson:** Writing – review & editing, Conceptualization. **Asle Hoffart:** Writing – review & editing, Conceptualization. **Øyvind Halsøy:** Writing – review & editing, Conceptualization. **Nora Skjerdingstad:** Writing – review & editing, Conceptualization. **Sara Ebling:** Writing – review & editing, Conceptualization. **Omid V. Ebrahimi:** Writing – review & editing, Conceptualization, Formal analysis.

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References

Blomberg, B., Mohn, K.G., Brokstad, K.A., Zhou, F., Linchausen, D.W., Hansen, B.A., Lartey, S., Onyango, T.B., Kuwelker, K., Sævik, M., Bartsch, H., Tøndel, C., Kittang, B.R., , Bergen COVID-19 Research Group, Cox, R.J., Langeland, N., 2021. Long COVID in a prospective cohort of home-isolated patients. Nat. Med. https://doi.org/10.1038/s41591-021-01433-3, 10.1038/s41591-021-01433-3Advance online publication.

Cabrera Martimbianco, A.L., Pacheco, R.L., Bagattini, Â.M., Riera, R., 2021. Frequency, signs and symptoms, and criteria adopted for long COVID: a systematic review. Int. J. Clin. Pract. e14357. https://doi.org/10.1111/ijcp.14357. May 11.

R Core Team, 2020. R: A Language and Environment for Statistical Computing (Version 4.0.2) [Computer software]. R Foundation for Statistical Computing.

Deng, J., Zhou, F., Hou, W., Silver, Z., Wong, C.Y., Chang, O., Huang, E., Zuo, Q.K., 2020. The prevalence of depression, anxiety, and sleep disturbances in COVID-19 patients: a meta-analysis. Ann. N.Y. Acad. Sci. 1486 (1), 90–111. https://doi.org/10.1111/nyas.14506.

Dong, F., Liu, H.L., Dai, N., Yang, M., Liu, J.P., 2021. A living systematic review of the psychological problems in people suffering from COVID-19. J. Affect. Disord. 292, 172–188. https://doi.org/10.1016/j.jad.2021.05.060.

Ebrahimi, O.V, Hoffart, A, Johnson, S.U, 2021. Physical distancing and mental health during the COVID-19 pandemic: factors associated with psychological symptoms and adherence to pandemic mitigation strategies. Clin. Psychol. Sci., 2167702621994545 https://doi.org/10.1177/2167702621994545.

Ebrahimi, O.V., Hoffart, A., & Johnson, S.U. (2022a). Mechanisms associated with the trajectory of depressive and anxiety symptoms: a linear mixed-effects model during the COVID-19 Pandemic. *Curr. Psychol. (New Brunswick, N.J.)*, 1–18. Advance online publication. https://doi.org/10.1007/s12144-022-02732-9.

Ebrahimi, O.V., Bauer, D., Hoffart, A., Johnson, S.U., 2022b. The evolution of depressive symptomatology across three waves of the COVID-19 pandemic: a 17-month representative longitudinal study of the adult population. J. Psychopathol. Clin. Sci. (in press).

Fitzmaurice, G., Laird, N., Ware, J., 2004. Applied longitudinal analysis. John Wiley and Sons.

Fortini, A., Torrigiani, A., Sbaragli, S., Lo Forte, A., Crociani, A., Cecchini, P., Innocenti Bruni, G., Faraone, A., 2021. COVID-19: persistence of symptoms and lung alterations after 3–6 months from hospital discharge. Infection 1–9. https://doi.org/10.1007/s15010-021-01638-1. Advance online publication.

Himmels, J.P.W., Qureshi, S.A., Brurberg, K.G., Gravningen, K.M., 2021. COVID-19: Long term effects of COVID-19. Norwegian Institute of Public Health. https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2021/covid-19-long-term-effects-of-covid-19-report-2021.pdf.

Huang, C., Huang, L., Wang, Y., Li, X., Ren, L., Gu, X., Kang, L., Guo, L., Liu, M., Zhou, X., Luo, J., Huang, Z., Tu, S., Zhao, Y., Chen, L., Xu, D., Li, Y., Li, C., Peng, L., Cao, B., 2021. 6-month consequences of COVID-19 in patients discharged from hospital: a

cohort study. Lancet N. Am. Ed. 397 (10270), 220–232. https://doi.org/10.1016/S0140-6736(20)32656-8.

IBM Corp, 2020. IBM SPSS Statistics for Windows, Version 27.0. IBM Corp.

Johnson, S.U., Ulvenes, P.G., Øktedalen, T., Hoffart, A., 2019. Psychometric properties of the General Anxiety Disorder 7-item (GAD-7) scale in a heterogeneous psychiatric sample. Front. Psychol. 10, 1713. https://doi.org/10.3389/fpsyg.2019.01713. –1713.

Magnúsdóttir, I., Lovik, A., Unnarsdóttir, A.B., McCartney, D., Ask, H., Kõiv, K., Valdimarsdóttir, U.A., 2022. Acute COVID-19 severity and mental health morbidity trajectories in patient populations of six nations: an observational study. The Lancet Public Health 7 (5), e406–e416. https://doi.org/10.1016/S2468-2667(22)00042-1.

Mandal, S., Barnett, J., Brill, S.E., Brown, J.S., Denneny, E.K., Hare, S.S., Heightman, M., Hillman, T.E., Jacob, J., Jarvis, H.C., Lipman, M., Naidu, S.B., Nair, A., Porter, J.C., Tomlinson, G.S., Hurst, J.R., ARC Study Group, 2021. Long-COVID': a cross-sectional study of persisting symptoms, biomarker and imaging abnormalities following hospitalisation for COVID-19. Thorax 76 (4), 396–398. https://doi.org/10.1136/thoraxjnl-2020-215818.

Mazza, M.G., De Lorenzo, R., Conte, C., Poletti, S., Vai, B., Bollettini, I., Melloni, E., Furlan, R., Ciceri, F., Rovere-Querini, P., , COVID-19 BioB Outpatient Clinic Study group, Benedetti, F., 2020. Anxiety and depression in COVID-19 survivors: role of inflammatory and clinical predictors. Brain Behav. Immun. 89, 594–600. https://doi.org/10.1016/j.bbi.2020.07.037.

Moldofsky, H., Patcai, J., 2011. Chronic widespread musculoskeletal pain, fatigue, depression and disordered sleep in chronic post-SARS syndrome: a case-controlled study. BMC Neurol. 11 (1), 37.

Morgan, C.J., 2018. Reducing bias using propensity score matching. J. Nucl. Cardiol. 25 (2), 404–406. https://doi.org/10.1007/s12350-017-1012.

Naidu, S.B., Shah, A.J., Saigal, A., Smith, C., Brill, S.E., Goldring, J., Hurst, J.R., Jarvis, Limpman, M., Mandal, S., 2021. The high mental health burden of "Long COVID" and its association with on-going physical and respiratory symptoms in all adults discharged from hospital. Eur. Respir. J., 2004364 https://doi.org/10.1183/13993003.04364-2020.

Nalbandian, A., Sehgal, K., Gupta, A., Madhavan, M.V., McGroder, C., Stevens, J.S., Cook, J.R., Nordvig, A.S., Shalev, D., Sehrawat, T.S., Ahluwalia, N., Bikdeli, B., Dietz, D., Der-Nigoghossian, C., Liyanage-Don, N., Rosner, G.F., Bernstein, E.J., Mohan, S., Beckley, A.A., Seres, D.S., Wan, E.Y., 2021. Post-acute COVID-19 syndrome. Nat. Med. 27 (4), 601–615. https://doi.org/10.1038/s41591-021-01283-z.

Norton, A., Olliaro, P., Sigfrid, L., Carson, G., Paparella, G., Hastie, C., Kaushic, C., Boily-Larouche, G., Suett, J.C., O'Hara, M., ISARIC and GloPID-R Long COVID Forum Working Group, 2021. Long COVID: tackling a multifaceted condition requires a multidisciplinary approach. Lancet. Infect. Dis. 21 (5), 601–602. https://doi.org/10.1016/S1473-3099(21)00043-8.

Norwegian Institute of Public Health, 2020. Life Quality and Mental Health During the Corona Pandemic November–December 2020. Norwegian Institute of Public Health. https://www.fhi.no/div/helseundersokelser/fylkeshelseundersokelser/livskvalitet-ogpsykisk-helse-under-koronaepidemien–nov-des-2020/.

Rogers, J.P., Chesney, E., Oliver, D., Pollak, T.A., McGuire, P., Fusar-Poli, P., Zandi, M.S., Lewis, G., David, A.S., 2020. Psychiatric and neuropsychiatric presentations associated with severe coronavirus infections: a systematic review and meta-analysis with comparison to the COVID-19 pandemic. Lancet Psychiatry 7 (7), 611–627. https://doi.org/10.1016/S2215-0366(20)30203-0.

Sudre, C.H., Murray, B., Varsavsky, T., Graham, M.S., Penfold, R.S., Bowyer, R.C., Pujol, J.C., Klaser, K., Antonelli, M., Canas, L.S., Molteni, E., Modat, M., Jorge Cardoso, M., May, A., Ganesh, S., Davies, R., Nguyen, L.H., Drew, D.A., Astley, C.M., Joshi, A.D., Steves, C.J., 2021. Attributes and predictors of long COVID. Nat. Med. 27 (4), 626–631. https://doi.org/10.1038/s41591-021-01292-y.

Taquet, M., Luciano, S., Geddes, J.R., Harrison, P.J., 2021. Bidirectional associations between COVID-19 and psychiatric disorder: retrospective cohort studies of 62,354 COVID-19 cases in the USA. Lancet Psychiatry 8 (2), 130–140. https://doi.org/10.1016/S2215-0366(20)30462-4.

Wacholder, S., 1995. Design issues in case-control studies. Stat. Methods Med. Res. 4 (4), 293–309. https://doi.org/10.1177/096228029500400403.

Zhang, Z., Kim, H.J., Lonjon, G., Zhu, Y., 2018. Balance diagnostics after propensity score matching. Ann. Transl. Med. 7 (1), 16. https://atm.amegroups.com/article/view/22865.