Research paper

Mental health trajectories among the general population and higher-risk groups following the COVID-19 pandemic in Switzerland, 2021–2023

Stephanie Schrempft [a,*], Nick Pullen [a], Hélène Baysson [a,b], María-Eugenia Zaballa [a], Julien Lamour [a], Elsa Lorthe [a,c], Mayssam Nehme [a,d], Idris Guessous [b,d,1], Silvia Stringhini [a,e,f,1], the Specchio-COVID19 study group[2]

[a] Unit of Population Epidemiology, Division of Primary Care Medicine, Geneva University Hospitals, Geneva, Switzerland
[b] Department of Health and Community Medicine, Faculty of Medicine, University of Geneva, Geneva, Switzerland
[c] Université Paris Cité, Inserm, INRAE, Centre for Research in Epidemiology and Statistics Paris (CRESS), Paris, France
[d] Division of Primary Care Medicine, Geneva University Hospitals, Geneva, Switzerland
[e] School of Population and Public Health, Faculty of Medicine, University of British Columbia, Vancouver, Canada
[f] University Centre for General Medicine and Public Health, University of Lausanne, Lausanne, Switzerland

A B S T R A C T

Background: Mental health deteriorated in the early stages of the COVID-19 pandemic, but improved relatively quickly as restrictions were eased, suggesting overall resilience. However, longer-term follow-up of mental health in the general population is scarce.
Methods: We examined mental health trajectories in 5624 adults (58 % women; aged 18–97 years) from the Specchio-COVID19 cohort, using the Generalized Anxiety Disorder scale-2 and the Patient Health Questionnaire-2, administered each month from February to June 2021, and in Spring 2022 and 2023.
Results: Depressive and anxiety symptoms declined during a pandemic wave from February to May 2021 ($\beta = -0.06$ [$-0.07, -0.06$]; -0.06 [$-0.07, -0.05$]), and remained lower at longer-term follow-up than at the start of the wave. Loneliness also declined over time, with the greatest decline during the pandemic wave ($\beta = -0.25$ [$-0.26, -0.24$]). Many higher-risk groups, including socioeconomically disadvantaged individuals, those with a chronic condition, and those living alone had poorer mental health levels throughout the study period. Women and younger individuals had a faster improvement in mental health during the pandemic wave. Loneliness trajectories were associated with mental health trajectories throughout the study period.
Limitations: We cannot definitively conclude that the observed changes in mental health were due to experiences of the pandemic.
Conclusions: While there was a need for additional mental health support during stricter policy responses to COVID-19, overall, mental health improved relatively soon after measures were eased. Nevertheless, the persistence of mental health disparities highlights the need for further efforts from the government and healthcare practitioners to support vulnerable groups beyond the pandemic.

1. Introduction

Population-based studies found that mental health deteriorated in the early stages of the pandemic, during times of stricter government policies relating to COVID-19 (Robinson et al., 2022). The uncertainty and sudden change to everyday life, reduced social contact, health concerns, and perceived financial risks contributed to the early increase

in distress (Robinson and Daly, 2021). However, mental health improved as early restrictions were eased, suggesting overall resilience in mental health (Robinson et al., 2022). In this context, resilience is defined as the ability to quickly recover from an adverse situation (Carver, 1998; Daly and Robinson, 2021; Filippou and Giannouli, 2023).

Beyond the early stages of the pandemic, some studies found that mental health deteriorated again during a pandemic wave at the end of

---

2020, which coincided with a retightening of restrictions (Piumatti et al., 2022; Rosa et al., 2022; Zaninotto et al., 2022). By the summer of 2021, there were fewer COVID-19 cases, and government measures were less stringent than earlier in the year (Hale et al., 2021). Consistent with findings from elsewhere in Europe (Rossi et al., 2023), we found that the overall prevalence of psychological distress in June 2021, after a pandemic wave in Switzerland, was comparable to pre-pandemic levels (Schrempft et al., 2023). Anxiety and depression were highest at the start of the pandemic wave in February 2021 and declined from February to June with the relaxation of measures (Schrempft et al., 2023).

Although research suggests that mental health was overall close to pre-pandemic levels by June 2021 (Rossi et al., 2023; Schrempft et al., 2023), it is not yet known whether mental health has stabilized and remains at pre-pandemic levels (Penninx et al., 2022). To our knowledge, there has been no reported longer-term follow up of mental health trajectories in the general population beyond 2021. It is also unknown whether longer-term mental health trajectories differ for higher-risk groups, such as those who have a pre-existing mental health condition, and those who live alone. People who contracted COVID-19 in the early stages of the pandemic, or those who report post COVID symptoms, may also be vulnerable to longer-term adverse mental health effects, due to psychosocial factors and/or direct effects of the virus (Iob et al., 2022; Thompson et al., 2022).

Research to date showed that many pre-pandemic risk factors for poor mental health, such as economic hardship, having a mental health condition, and living alone, remained important risk factors for poor mental health during the COVID-19 pandemic (Fancourt et al., 2021; Kwong et al., 2021; Pierce et al., 2020; Schrempft et al., 2023). However, pre-existing inequalities in mental health increased at the start of the pandemic for some demographic groups, including women and younger individuals (Kwong et al., 2021; Pierce et al., 2020). These inequalities decreased, but were still present, by the end of lockdown in August 2020 (Fancourt et al., 2021). Subsequent research found that increases in anxiety and depression during the pandemic wave at the end of 2020 were accompanied by increases in loneliness (Rosa et al., 2022; Zaninotto et al., 2022).

The aim of this study was to examine medium-term mental health trajectories in the general population and among higher-risk groups from the start of a pandemic wave in Switzerland (February 2021), until the most recent follow-up in Spring (April/May) 2023. Following a decline in anxiety and depression symptoms between the start and the final phases of a pandemic wave (February to May 2021; (Schrempft et al., 2023)), we hypothesized that symptoms would remain lower at longer-term follow-up in 2022 and 2023. We expected that many pre-pandemic risk factors for poor mental health would remain important risk factors for mental health throughout the study period. In line with previous research (Fancourt et al., 2021), we also hypothesized that women and younger individuals would have a faster rate of improvement in mental health initially, during the pandemic wave, but that these effects would diminish by longer-term follow-up. Lastly, we expected that loneliness trajectories would be associated with trajectories of anxiety and depressive symptoms.

2. Methods

2.1. Participants and design

Data were from Specchio-COVID19, a population-based digital study launched in December 2020 to follow up serosurvey participants in Geneva, Switzerland (Baysson et al., 2022). Serosurvey participants were randomly selected from the Bus Santé population-based study (de Mestral et al., 2020), from Geneva registries (SEROCoV-POP, (Stringhini et al., 2020, 2021a)), and from a list of private and public companies and institutions (SEROCoV-WORK, (Stringhini et al., 2021b)). Adult serosurvey participants were invited to take part in the Specchio-COVID19

study after a baseline serologic test. All participants with a valid email address received an invitation to create a personal account on the Specchio-COVID19 digital platform. In order to be included in the cohort, participants had to complete an initial questionnaire. After this inclusion step, other questionnaires related to the COVID-19 pandemic and its impact on physical and mental health were proposed to participants. Informed consent was obtained during the baseline serology testing visit. The study was approved by the Cantonal Research Ethics Commission of Geneva, Switzerland (project number 2020–00881).

Anxiety and depression were assessed through questionnaires administered each month from February to June 2021, and followed up again in April/May of 2022 and 2023 (a total of 7 time points). A monthly questionnaire was administered in 2021 (February to June 2021) to closely monitor mental health in the earlier stages of the pandemic. In 2022 and 2023, an annual questionnaire was used to continue to monitor mental health over time. Of the 8552 participants enrolled in Specchio-COVID19 by February 2021, 6067 individuals (71 %; mean age = 51 years (range = 18–97 years)) completed the monthly questionnaire administered in February 2021; all these participants provided complete data on the measures of anxiety and depression. We included individuals with mental health data from at least three time points during the study period (baseline data in February 2021 plus at least two more time points of data up until April/May 2023; N = 5624; see Supplementary Fig. S1).

2.2. Measures

2.2.1. Mental health

Anxiety and depression were assessed at each time point using the Generalized Anxiety Disorder-2 scale (GAD-2) and the Patient Health Questionnaire-2 (PHQ-2), respectively. The GAD-2 and PHQ-2 are validated measures of core symptoms of anxiety and depression (Kroenke et al., 2003; Kroenke et al., 2007), and have the advantage of reduced response burden when there are frequent surveys due to their brevity (OECD, 2023). Respondents indicate how often they experienced each symptom over the past 2 weeks. The respective scores are summed (range 0–6), with higher values reflecting poorer mental health. Internal consistency of each of the scales was high in the present sample (Cronbach's α range = 0.78–0.84).

2.2.2. Sociodemographic factors and living circumstances

Sociodemographic factors included age (years), biological sex (male, female), and living arrangement (living alone, as a single parent with children, or with other adults). Education level was primary (none or compulsory education), secondary (high school diploma or vocational training), or tertiary (university level qualification). Employment status was employed or self-employed, retired, unemployed, or other economically inactive (not working and not looking for work, such as students, and people unable to work for health reasons or disability). Financial difficulties were assessed by asking participants whether there are times during the month when they have real financial difficulties meeting their needs (food, rent, service charges, insurance, loans, etc.). Responses were coded as 'no, this has never happened', 'not now, but this has happened in the past', and 'this has happened in the recent past'.

2.2.3. Health and psychosocial factors

At registration, participants were asked if they had any long-standing chronic illness, and to select their illness(es) from a list, which included physical and mental health conditions. These responses were used to create a variable indicating presence or absence of a physical health condition, and a variable indicating presence or absence of a mental health condition.

Loneliness was assessed at each time point using the 3-item Revised UCLA Loneliness Scale (Hughes et al., 2004). Higher scores indicate greater loneliness. Internal consistency of the scale was high in the present sample (Cronbach's α range = 0.82–0.87).

2.2.4. COVID-19-specific factors

Previous SARS-CoV-2 infection was measured as: 1) a positive serology test result during the period March to December 2020 (before roll-out of COVID-19 vaccination (Stringhini et al., 2020, 2021a)), and 2) a positive anti-nucleocapsid serology test result during the period May to June 2021 (when mRNA-based vaccines were available in Switzerland (Perez-Saez et al., 2023; Stringhini et al., 2021c)). Self-reported post COVID ('are you currently or have you suffered from long-term COVID, that is, long-term manifestations of COVID-19 [such as symptoms that persist beyond three weeks]?') was assessed in June 2021 and categorized as 'Yes, with ongoing symptoms', 'Yes, but symptoms no longer present', or 'No'.

2.3. Statistical analysis

Linear, quadratic, and piecewise trajectory types were considered for best fit to the data. We determined best fit by visual inspection of the overall trajectory and Akaike's information criterion (AIC), with lower values indicating better fit. For the piecewise models, we defined two phases: (i) the third pandemic wave from February 2021 until May 2021 (slope includes the baseline assessment of February 2021, and those of March 2021, April 2021, May 2021), and (ii) following the third pandemic wave (slope includes June 2021, April/May 2022, and April/May 2023). The trajectory type with the best fit was carried forward.

Mixed-effects models, with a random intercept and a random linear slope, were used to calculate the fixed slope for the sample, as well as participants' personal slopes (change in PHQ-2 / GAD-2 score per month) across the months of follow-up. The models took the form: $B_{ij} = (\gamma_0 + \gamma_1 ij) + (\mu_{0i} + \mu_{1i} ij) + \epsilon_{ij}$, where B_{ij} is the PHQ-2 / GAD-2 score measured for individual 'i' at time 'j', γ_0 and γ_1 are the fixed intercept and slope estimated for the sample, and μ_{0i} and μ_{1i} are the random intercepts and slopes estimated for each individual. Each model included months of follow-up as the time indicator. Mixed models do not require an equal number of observations from all participants therefore those with baseline mental health data and at least two subsequent time points during the study period (February 2021 to April/May 2023) were included in the analysis.

To examine growth trajectories by sociodemographic, health-related, psychosocial, and COVID-19-specific characteristics, each model included the risk factor of interest as well as an interaction term between the risk factor and time (months of follow-up). A significant interaction effect indicates that the risk factor is associated with the rate of change in mental health. All risk factors of interest were included as time invariant factors, except for loneliness, which was assessed at each time point. For loneliness, the random slopes for each participant were extracted and treated as an independent variable. Each model included age at baseline, sex, education, and pre-existing mental health condition as covariates, alongside the risk factor of interest. Bonferroni corrections were applied to take account of multiple comparisons.

Statistical analyses were conducted using Stata® version 16 (Stata Corporation, College Station, TX, USA), and R version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Descriptive results

Table 1 shows characteristics of the study sample at baseline. In total, there were 5624 participants (39,368 observations) with mental health data for at least 3 time points during the study period (Feb 2021 to April/May 2023). The study sample was slightly older than the total sample with baseline data (52 vs. 51 years, p < 0.05), but there were no significant differences with respect to the other study variables.

Fig. 1 shows the mental health trajectories for the total sample (N = 5624). Piecewise mixed effects models provided the best fit to the data and showed that the slopes for the first phase (February 2021 to May

Table 1
Characteristics of the total baseline sample and analysis sample.

	Total baseline sample	Analysis sample	P
	N = 6067	N = 5624	
	% (N)	% (N)	
Age in years, mean (SD)	50.9 (13.4)	51.5 (13.2)	0.011
Sex			0.77
Male	42.8 (2585)	42.5 (2381)	
Female	57.2 (3456)	57.5 (3218)	
Living circumstances			0.79
With other adults	78.4 (4754)	78.0 (4386)	
Single parent	6.4 (391)	6.4 (358)	
Alone	15.2 (922)	15.6 (880)	
Education			0.78
Tertiary	64.7 (3924)	64.7 (3637)	
Secondary	31.7 (1920)	31.9 (1793)	
Primary	3.6 (218)	3.4 (189)	
Employment situation			0.59
Working	74.6 (4527)	74.1 (4168)	
Retired	16.8 (1021)	17.7 (996)	
Other economically inactive	6.5 (396)	6.2 (349)	
Unemployed	2.0 (123)	2.0 (111)	
Financial difficulties			0.78
No, never happened	61.0 (3468)	61.3 (3235)	
No, but happened in the past	32.8 (1862)	32.8 (1731)	
Yes, this has happened recently	6.2 (353)	5.9 (311)	
Physical health condition			0.65
No	78.2 (4742)	77.8 (4376)	
Yes	21.8 (1325)	22.2 (1248)	
Mental health condition			0.99
No	97.9 (5941)	97.9 (5507)	
Yes	2.1 (126)	2.1 (117)	
Loneliness at baseline[a], mean (SD)	4.9 (1.7)	4.9 (1.7)	0.84
Positive serology result, Mar–Dec 2020			0.94
No	86.7 (5224)	86.6 (4841)	
Yes	13.3 (803)	13.4 (747)	
Self-reported post COVID			0.99
No	93.1 (4617)	93.1 (4505)	
Yes, but symptoms no longer present	2.9 (146)	2.9 (140)	
Yes, symptoms still present	4.0 (196)	4.0 (193)	
Depressive symptoms at baseline[b], mean (SD)	0.9 (1.3)	0.9 (1.3)	0.93
Anxiety symptoms at baseline[c], mean (SD)	1.2 (1.4)	1.2 (1.4)	0.91

SD = standard deviation.
[a] From the 3-item Revised UCLA Loneliness Scale.
[b] From the Patient Health Questionnaire-2 (PHQ-2).
[c] From the Generalized Anxiety Disorder-2 scale (GAD-2).

2021) and second phase (June 2021 to April/May 2023) significantly differed for each mental health measure (for PHQ-2, β = 0.06, p < 0.001; for GAD-2, β = 0.07, p < 0.001) and loneliness (β = 0.23, p < 0.001). There was a decline in depressive symptoms during the pandemic wave from February to May 2021 (β = −0.06 [−0.07, −0.06], p < 0.001), and no significant change from June 2021 to April/May 2023 (β = 0.00, p = 0.399). Anxiety symptoms also declined during the pandemic wave (β = −0.06 [−0.07, −0.05], p < 0.001), but increased during the second phase (notably June 2021 to April/May 2022; β = 0.01 [0.01, 0.01], p < 0.001), reaching a mean level (1.18 [1.14, 1.23]) comparable to that in April 2021 (1.20 [1.16, 1.24]). There was a steep decline in loneliness over time, with the greatest decline from February to June 2021 (β = −0.25 [−0.26, −0.24], p < 0.001), and a smaller decline from June 2021 to April/May 2023 (β = −0.02 [−0.02, −0.02], p < 0.001).

3.2. Mental health levels and trajectories among higher-risk groups

Table 2 shows risk factors associated with the mean levels of anxiety and depression at baseline (intercept). Pre-existing sociodemographic risk factors for poor mental health, namely being younger, female,
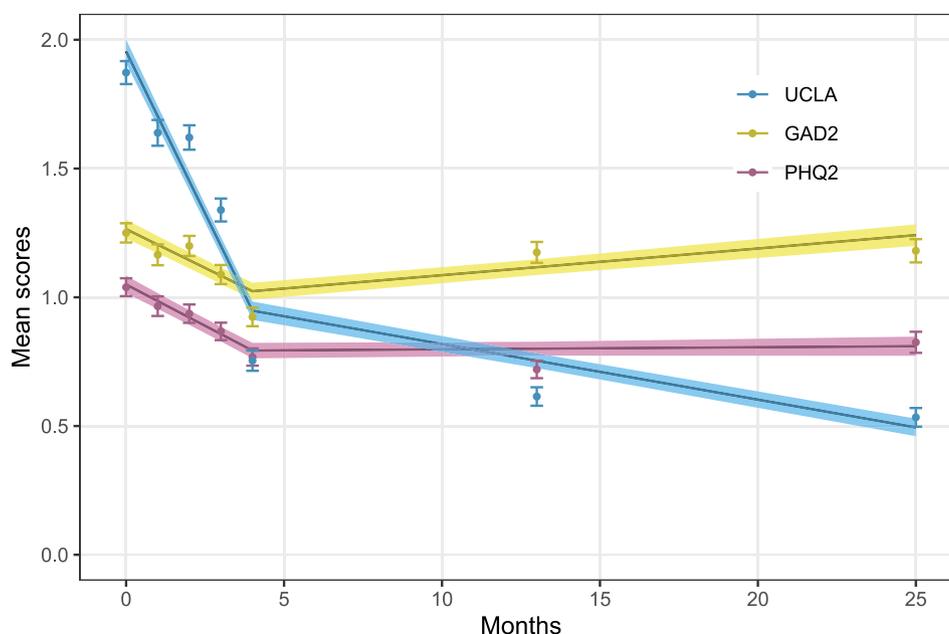
Fig. 1. Predicted growth trajectories (and 95 % confidence intervals) of mean anxiety (GAD2), depression (PHQ2), and loneliness (UCLA) scores for the total sample (N = 5624) across the months of follow-up from baseline in February 2021 until April/May 2023. Raw mean scores and 95 % confidence intervals for the measures are also presented. Depression and anxiety scores range from 0 to 6; loneliness scores range from 3 to 9, which were rescaled to 0 to 6.

unemployed (or other economically inactive), and experiencing recent financial difficulties were associated with higher mean levels of depression and anxiety at baseline. Living alone (or as a single parent) and having a lower education level were associated with higher depression but not anxiety symptom scores. Having a pre-existing physical or mental health condition, and greater loneliness at baseline were also associated with higher depression and anxiety symptom scores. Self-reported post COVID was also associated with higher depression and anxiety symptom scores, but there was no association between having a positive serology test result and depression or anxiety symptom levels.

Risk factors associated with the rate of change in anxiety and depression during the pandemic wave (February–May 2021) were age, sex, and loneliness slopes. Effects were small, but there was a faster rate of improvement in depressive and anxiety symptoms for women compared to men, a faster rate of improvement in depressive symptoms for younger compared to older adults, and a faster rate of improvement in anxiety symptoms for older compared to younger adults (see Fig. 2 and Table 3). Individuals who had a faster rate of improvement in loneliness during the pandemic wave also showed a faster rate of improvement in depressive and anxiety symptoms. Individuals with a pre-existing physical health condition had a marginally faster rate of improvement in anxiety symptoms than individuals without a physical health condition, but the effect did not persist after adjustment for multiple comparisons (Table 3).

Individuals with better loneliness trajectories during follow-up (June 2021–April/May 2023) also had better depressive and anxiety symptom trajectories during this time: individuals with a decline in loneliness had a decline in depressive symptoms during follow-up, while those with an increase in loneliness had an increase in depressive symptoms; individuals with a decline in loneliness had no change in anxiety symptoms during follow-up, while those with an increase in loneliness had an increase in anxiety symptoms. Individuals with a positive serology test result had a marginally greater increase in anxiety during follow-up than individuals with a negative serology test result (but the effect did not persist after adjustment for multiple comparisons). There was a marginal effect for employment situation (individuals who were unemployed did not show an increase in anxiety during follow-up, while individuals who

were working or retired showed a small increase), but this did not persist after adjustment for multiple comparisons. No other factors were associated with the rate of change in anxiety and depression at follow-up. All results are shown in Table 3.

4. Discussion

Mental health was overall better at longer-term follow-up in April/ May 2023 compared with mental health at the start of a pandemic wave in February 2021. Depressive symptoms remained at levels comparable to those at the end of the pandemic wave, and loneliness continued to decline. There was a small but significant increase in anxiety symptoms at longer-term follow-up (notably June 2021 to April/May 2022), but the mean level remained lower than that at the start of the pandemic wave. Also consistent with our hypotheses, we found that many pre-pandemic risk factors for poor mental health including economic hardship, having a mental health condition, and living alone, remained important risk factors for poor mental health during this time period. For some higher-risk groups, including women and younger individuals, pre-existing inequalities in mental health slightly decreased during the pandemic wave, but were still present at longer-term follow-up. Individuals who had faster improvements in loneliness during the pandemic wave showed greater improvements in anxiety and depressive symptoms, which continued over longer-term follow-up.

Research during the earlier stages of the pandemic found that anxiety and depression declined following lockdown (Fancourt et al., 2021), but there were reports of further increases during the second pandemic wave at the end of 2020 (Rosa et al., 2022; Zaninotto et al., 2022). Our finding that anxiety, depression, and feelings of loneliness remained lower at longer-term follow-up than at the start of a pandemic wave in 2021 is reassuring and suggests overall resilience in mental health (in the sense that the overall trend was recovery). It is not clear why there was a slight increase in anxiety during longer-term follow-up, but it could be in part due to the complete lifting of COVID-19 measures in Switzerland in Spring 2022. While the lifting of lockdown has been shown to improve mental health (Serrano-Alarcón et al., 2022), the complete lifting of measures could be associated with anxiety due to uncertainty about the future, stress in returning to normal daily life, and economic concerns

Table 2

Risk factors associated with the mean levels of anxiety and depressive symptoms at baseline (N = 5624).

	Depressive symptoms		Anxiety symptoms	
	Coefficient (95 % CI)	P	Coefficient (95 % CI)	P
Age in years, per one unit increase	−0.02 (−0.02, −0.01)	<0.001	−0.02 (−0.02, −0.01)	<0.001
Sex (ref: male)				
Female	0.13 (0.08, 0.18)	<0.001	0.28 (0.22, 0.34)	<0.001
Living circumstances (ref: with other adults)				
Single parent	0.13 (0.02, 0.23)	0.020	0.06 (0.06, 0.18)	0.313
Alone	0.17 (0.10, 0.24)	<0.001	0.02 (0.06, 0.10)	0.626
Education (ref: tertiary)				
Secondary	0.10 (0.04, 0.15)	0.001	0.02 (−0.05, 0.08)	0.628
Primary	0.15 (0.01, 0.30)	0.037	0.13 (−0.04, 0.29)	0.127
Employment status (ref: employed)				
Retired	0.02 (−0.07, 0.11)	0.648	−0.05 (−0.15, 0.05)	0.362
Other economically inactive	0.25 (0.15, 0.36)	<0.001	0.24 (0.11, 0.36)	<0.001
Unemployed	0.25 (0.07, 0.43)	0.008	0.31 (0.11, 0.52)	0.003
Financial difficulties (ref: no)				
No, but happened in the past	0.20 (0.15, 0.26)	<0.001	0.25 (0.18, 0.31)	<0.001
Yes, this has happened recently	0.47 (0.36, 0.58)	<0.001	0.50 (0.37, 0.63)	<0.001
Physical health condition (ref: no)				
Yes	0.15 (0.09, 0.21)	<0.001	0.18 (0.11, 0.25)	<0.001
Mental health condition (ref: no)				
Yes	0.99 (0.81, 1.17)	<0.001	0.93 (0.73, 1.13)	<0.001
Loneliness intercept, per one unit increase	0.41 (0.40, 0.42)	<0.001	0.38 (0.37, 0.40)	<0.001
Positive serology result, Mar–Dec 2020	−0.04 (−0.12, 0.03)	0.286	−0.02 (−0.10, 0.07)	0.676
Self-reported post COVID				
Yes, but symptoms no longer present	0.16 (0.00, 0.32)	0.049	0.22 (0.04, 0.41)	0.016
Yes, symptoms still present	0.44 (0.30, 0.57)	<0.001	0.52 (0.37, 0.68)	<0.001

All models included participant's age at baseline, sex, education level, and pre-existing mental health condition as covariates.
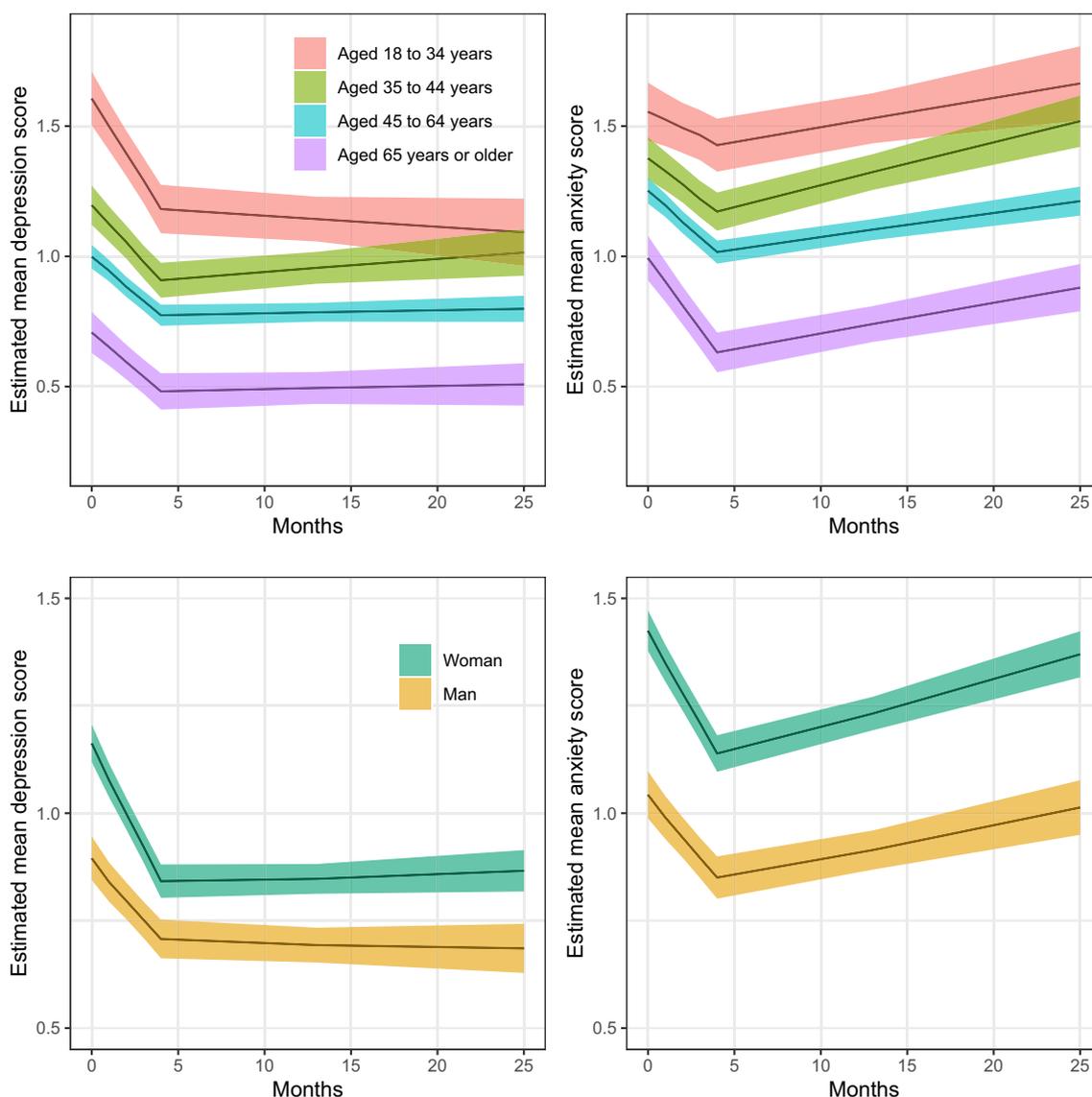
CI = confidence interval; Ref = reference group.

Fig. 2. Predicted growth trajectories (and 95 % confidence intervals) of mean anxiety and depression scores by age group and sex.

during a time of increased inflation (Codagnone et al., 2021). Other significant global events, such as the war in Ukraine and global warming, may also have contributed to the slight increase in anxiety. Our finding that many pre-existing risk factors for poor mental health, such as economic hardship, having a pre-existing mental health condition, and living alone, persisted during the COVID-19 pandemic corroborates earlier research (Fancourt et al., 2021; Kwong et al., 2021; Pierce et al., 2020; Schrempft et al., 2023), and highlights the continued need for efforts to support vulnerable groups beyond the pandemic.

Some higher-risk groups, including women and younger individuals, had a faster rate of improvement in mental health during the pandemic wave, and these effects subsided at longer-term follow-up, which is in line with previous research. Inequalities in mental health increased for women and younger individuals at the start of the pandemic (Kwong et al., 2021; Pierce et al., 2020), but decreased following UK lockdown in August 2020 (Fancourt et al., 2021). These findings suggest that some individuals may have greater initial sensitivity or reactivity to COVID-19 events. Interestingly, while younger individuals showed a faster rate of improvement in depressive symptoms during the pandemic wave, they had a slower rate of improvement in anxiety symptoms compared to older adults. Older adults are more vulnerable to serious effects of COVID-19 (Onder et al., 2020), and may have greater initial anxiety

reactivity during pandemic waves than younger individuals (and a faster subsequent decline), even in the absence of a pre-existing physical health condition. Previous research has also shown that older adults have not been immune to mental health effects during the COVID-19 pandemic (Zaninotto et al., 2022), even though older adults typically have lower levels of anxiety and depression than younger individuals. On the contrary, the slower improvement of anxiety symptoms in younger adults, could indicate sustained mental health effects in this age group.

The finding that loneliness trajectories were associated with trajectories of anxiety and depression is consistent with research during the second pandemic wave (Rosa et al., 2022; Zaninotto et al., 2022). Loneliness – the subjective experience or perception of being isolated – is an established predictor of poor health and well-being (Cacioppo et al., 2010; Hawkley and Cacioppo, 2010; Holt-Lunstad et al., 2015). The decline in loneliness alongside anxiety and depression in the present study could be attributed to the relaxation of social restrictions during the pandemic wave, prompting changes in the frequency of social contact, although we did not directly measure this. Social isolation – the absence of regular contact with family and friends and lack of involvement in social organizations – and loneliness tend to co-occur, but they can also be experienced independently of one another, and are often

Table 3

Risk factors associated with the rate of change in anxiety and depression during time 1 (February to May 2021) and time 2 (June 2021–April/May 2023); N = 5624.

	Depressive symptoms		Anxiety symptoms	
	Coefficient (95 % CI)	P	Coefficient (95 % CI)	P
Interaction effects for time 1				
Age in years, per one unit increase	0.00 (0.00, 0.00)	0.001	−0.00 (−0.00, −0.00)	<0.001
Sex (ref: male)				
Female	−0.03 (−0.05, −0.02)	<0.001	−0.03 (−0.04, −0.01)	<0.001
Living circumstances (ref: with other adults)				
Single parent	−0.00 (−0.03, 0.03)	0.956	−0.02 (−0.05, 0.01)	0.182
Alone	0.01 (−0.01, 0.03)	0.375	0.02 (−0.00, 0.04)	0.107
Education (ref: tertiary)				
Secondary	−0.01 (−0.03, 0.00)	0.167	−0.01 (−0.02, 0.01)	0.269
Primary	−0.01 (−0.05, 0.03)	0.712	−0.01 (−0.05, 0.03)	0.658
Employment status (ref: employed)				
Retired	−0.01 (−0.04, 0.01)	0.293	−0.00 (−0.03, 0.02)	0.878
Other economically inactive	−0.01 (−0.04, 0.02)	0.375	−0.01 (−0.04, 0.03)	0.690
Unemployed	0.00 (−0.05, 0.05)	0.972	−0.00 (−0.05, 0.05)	0.968
Financial difficulties (ref: no)				
No, but happened in the past	−0.01 (−0.02, 0.01)	0.412	−0.01 (−0.03, 0.00)	0.159
Yes, this has happened recently	−0.01 (−0.04, 0.02)	0.574	−0.01 (−0.04, 0.03)	0.674
Physical health condition (ref: no)				
Yes	−0.00 (−0.02, 0.02)	0.845	−0.02 (−0.04, −0.00)	0.029
Mental health condition (ref: no)				
Yes	0.01 (−0.04, 0.06)	0.562	−0.03 (−0.08, 0.03)	0.332
Loneliness slope during pandemic wave	0.45 (0.41, 0.49)	<0.001	0.31 (0.27, 0.35)	<0.001
Positive serology result, Mar–Dec 2020	−0.01 (−0.03, 0.01)	0.476	−0.01 (−0.03, 0.01)	0.327
Self-reported post COVID				
Yes, but symptoms no longer present	−0.03 (−0.08, 0.01)	0.144	−0.02 (−0.07, 0.03)	0.369
Yes, symptoms still present	−0.03 (−0.07, 0.01)	0.164	−0.02 (−0.06, 0.02)	0.332
Interaction effects for time 2				
Age in years, per one unit increase	−0.00 (−0.00, 0.00)	0.596	−0.00 (−0.00, 0.00)	0.871
Sex (ref: male)				
Female	0.00 (−0.00, 0.01)	0.272	0.00 (−0.00, 0.01)	0.152
Living circumstances (ref: with other adults)				
Single parent	0.01 (−0.00, 0.01)	0.215	0.01 (−0.00, 0.01)	0.160
Alone	−0.00 (−0.01, 0.00)	0.075	−0.01 (−0.01, −0.00)	0.049
Education (ref: tertiary)				
Secondary	0.00 (−0.00, 0.00)	0.800	−0.00 (−0.01, −0.00)	0.038
Primary	−0.00 (−0.02, 0.01)	0.465	−0.01 (−0.02, 0.00)	0.084
Employment status (ref: employed)				
Retired	−0.00 (−0.01, 0.01)	0.814	0.00 (−0.00, 0.01)	0.418
Other economically inactive	−0.00 (−0.01, 0.00)	0.362	−0.01 (−0.01, 0.00)	0.199
Unemployed	0.00 (−0.01, 0.01)	0.980	−0.02 (−0.03, −0.00)	0.022
Financial difficulties (ref: no)				
No, but happened in the past	−0.00 (−0.01, 0.00)	0.269	0.00 (−0.00, 0.00)	0.839
Yes, this has happened recently	0.00 (−0.00, 0.01)	0.403	0.00 (−0.00, 0.01)	0.367
Physical health condition (ref: no)				
Yes	0.00 (−0.00, 0.01)	0.177	−0.00 (−0.01, 0.00)	0.939
Mental health condition (ref: no)				
Yes	−0.00 (−0.02, 0.01)	0.597	0.01 (−0.01, 0.02)	0.291
Loneliness slope during follow-up	0.62 (0.56, 0.68)	<0.001	0.44 (0.37, 0.50)	<0.001
Positive serology result, Mar–Dec 2020	0.00 (−0.00, 0.01)	0.153	0.01 (0.00, 0.01)	0.013
Positive serology result, May–Jun 2021	0.00 (−0.00, 0.01)	0.431	0.01 (0.00, 0.01)	0.041
Self-reported post COVID				
Yes, but symptoms no longer present	−0.00 (−0.02, 0.01)	0.524	−0.00 (−0.02, 0.01)	0.611
Yes, symptoms still present	0.00 (−0.01, 0.01)	0.669	0.00 (−0.01, 0.01)	0.482

All models included participant's age at baseline, sex, education level, and pre-existing mental health condition as well as interaction terms between time (time 1 and time 2) and age/sex as well as the risk factor of interest. All models included a random intercept and random linear slopes for time. CI = confidence interval; Ref = reference group.

moderately correlated (Coyle and Dugan, 2012; Perissinotto and Covinsky, 2014). Associations between loneliness and mental health are complex, and likely reflect both genetic and non-shared environmental influences (Matthews et al., 2016).

Evidence from case reports and studies of severe coronavirus infections has shown that there can be adverse mental health effects following COVID-19 infection, especially during the acute stage of the illness (Mazza et al., 2020; Taquet et al., 2021; Wu et al., 2020). Population-based studies can add to existing research by capturing broader and subclinical mental health impacts of COVID-19 infection over time. Our study extends previous population-based research by including serology-assessed COVID-19 infection alongside self-report measures, and by examining associations with both mental health levels and trajectories. While previous population-based studies found that individuals with suspected COVID-19 (based on self-reports of perceived symptoms or positive test results) in the early stages of the pandemic report poorer mental health levels than those without COVID-19 (Daly and Robinson, 2023; Iob et al., 2022; Wilding et al., 2022), just one known study included serology-assessed COVID-19 infection alongside self-report measures (Thompson et al., 2022). This study also found that suspected COVID-19 was associated with poorer mental health, but there were no differences in mental health outcomes for those with positive and negative serology, suggesting that contextual and psychosocial aspects of COVID-19 could be stronger predictors of poor mental health outcomes in the general population than any specific neurological consequences of infection. We found that self-reported post COVID symptoms, but not serology-assessed infection, predicted higher levels of anxiety and depression throughout the study period. The null association between serology-assessed COVID-19 is not completely surprising given that it includes asymptomatic infections and does not capture infection severity. An association for self-reported post COVID may have been detected because it identifies individuals with ongoing symptoms with no known end date. While self-reported post COVID was associated with mental health levels, it was not associated with the rate of change in mental health over time. Associations between post COVID symptoms and mental health trajectories may be evident over the longer term, and for certain symptoms. For example, the experience of cognitive decline can negatively affect mental health (Parikh et al., 2016). Research also indicates that individuals with poorer mental health are more susceptible to post COVID (Wang et al., 2022). Poor mental health is associated with chronic inflammation and immune system dysregulation (Bauer and Teixeira, 2019; Maes, 1995), potentially making people more vulnerable to post COVID.

4.1. Practical implications

Ensuring safe access to essential services (such as childcare, as well as day services for older adults), financial security (for example through government investment in debt respite and eviction protection measures), free or heavily subsidized mental health services (face-to-face or online, where appropriate), loneliness and social isolation alleviation initiatives (such as the Let's Talk Loneliness campaign, and digital inclusion strategies), and mental health promotion within the community (such as in schools and universities) are ways in which vulnerable groups can be supported during and following the pandemic (Aknin et al., 2022; McDaid, 2021). Healthcare providers also play a key role in responding to their patients concerns related to COVID-19 (Adhanom Ghebreyesus, 2020), and ensuring they receive the necessary care if suffering from ongoing symptoms.

4.2. Strengths and limitations

The strength of this study is the population-based assessment of longer-term mental health trajectories, alongside a range of pre-pandemic and COVID-19-specific risk factors for poor mental health. The GAD and PHQ are widely used, validated self-report measures

(OECD, 2023; Shevlin et al., 2022), and correlate strongly with clinically diagnosed psychiatric disorder (Kroenke et al., 2003, 2007); although they do not capture all forms of mental distress. The use of additional mental health measures would provide further insight into longer-term health trajectories, though it is notable that the pattern of mental health change during the early stages of the pandemic (deterioration followed by a rapid return to pre-pandemic levels) was observed for most symptom types (Robinson et al., 2022). Although we examined various factors associated with mental health trajectories, psychological factors, such as personality and coping style, likely contribute to resilience and thriving (Carver, 1998), and could be associated with longer-term mental health trajectories following the pandemic. Unfortunately, these measures were not available in our cohort. Research during the earlier stages of the pandemic found that anxiety and depressive symptoms decreased over time for all coping strategies, but socially supportive coping was associated with a faster decrease in symptoms (Fluharty et al., 2021), suggesting that this is an adaptive coping strategy following adversity. Moreover, although we measured mental health during and following a pandemic wave, we cannot definitively conclude that the observed changes in mental health were due to adverse experiences of the pandemic. The decline in anxiety, depression, and loneliness during the pandemic wave was observed from winter to summer, therefore the observed changes could be partly attributed to natural fluctuations in mental health with the seasons. However, the effects seem greater than usual seasonal variations (Winthorst et al., 2011). Compared to the general Swiss population, Specchio-COVID19 has an under-representation of younger adults and individuals with a low education level, therefore some degree of self-selection bias may have been present. Very vulnerable individuals with poor mental health are less likely to participate in surveys. Although we tried to identify high-risk groups in the general population, the findings may not generalize to more vulnerable groups who may experience ongoing adverse effects of the pandemic due to prior trauma, grief, serious health problems due to SARS-CoV-2 infection, long-term unemployment, and financial difficulties. Our study extends existing research by examining mental health trajectories in the general population beyond 2021, but continued monitoring of mental health is needed to determine any longer-term impact of the pandemic.

5. Conclusions

There have been concerns that acute distress during the COVID-19 pandemic may lead to long-term mental health problems, therefore it is important to continue to monitor mental health trajectories beyond the earlier stages of the pandemic. Our findings indicate that, overall, in the general population, mental health had improved by the end of the pandemic wave in June 2021, and remained better than at the start of the wave at longer-term follow-up in 2022 and 2023. These findings suggest that, while there was a need for additional mental health support during times of stricter government policies relating to COVID-19, there has been overall resilience in mental health. Nevertheless, many pre-existing risk factors for poor mental health persisted over longer-term follow-up, highlighting the persistence of inequalities in mental health. These findings provide important information for future pandemic preparedness and highlight the need for ongoing efforts from the government and healthcare practitioners to support vulnerable groups beyond the pandemic.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2024.05.065.

Public Health (Corona Immunitas Research Program), and the Fondation des Grangettes. The funders had no role in the study design; in the collection, analysis and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

CRediT authorship contribution statement

Declaration of competing interest

None.

Data availability

The data are available on request from the corresponding author. The ethics protocols under which the data were collected do not permit public data deposition.

Acknowledgements

References

Adhanom Ghebreyesus, T., 2020. Addressing mental health needs: an integral part of COVID-19 response. World Psychiatry 19, 129–130. https://doi.org/10.1002/wps.20768.

Aknin, L.B., De Neve, J.-E., Dunn, E.W., Fancourt, D.E., Goldberg, E., Helliwell, J.F., Jones, S.P., Karam, E., Layard, R., Lyubomirsky, S., Rzepa, A., Saxena, S., Thornton, E.M., VanderWeele, T.J., Whillans, A.V., Zaki, J., Karadag, O., Ben Amor, Y., 2022. Mental health during the first year of the COVID-19 pandemic: a review and recommendations for moving forward. Perspect. Psychol. Sci. 17, 915–936. https://doi.org/10.1177/17456916211029964.

Bauer, M.E., Teixeira, A.L., 2019. Inflammation in psychiatric disorders: what comes first? Ann. N. Y. Acad. Sci. 1437, 57–67. https://doi.org/10.1111/nyas.13712.

Baysson, H., Pennacchio, F., Wisniak, A., Zaballa, M.-E., Pullen, N., Collombet, P., Lorthe, E., Joost, S., Balavoine, J.-F., Bachmann, D., Azman, A.S., Pittet, D., Chappuis, F., Kherad, O., Kaiser, L., Guessous, I., Stringhini, S., 2022. The Specchio-COVID19 cohort study: a longitudinal follow-up of SARS-CoV-2 serosurvey participants in the canton of Geneva, Switzerland (Study protocol). BMJ Open 12, e055515. https://doi.org/10.1136/bmjopen-2021-055515.

Cacioppo, J.T., Hawkley, L.C., Thisted, R.A., 2010. Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study. Psychol. Aging 25, 453–463. https://doi.org/10.1037/a0017216.

Carver, C.S., 1998. Resilience and thriving: issues, models, and linkages. J. Soc. Issues 54, 245–266. https://doi.org/10.1111/j.1540-4560.1998.tb01217.x.

Codagnone, C., Bogliacino, F., Gómez, C., Folkvord, F., Liva, G., Charris, R., Montealegre, F., Lupiañez Villanueva, F., Veltri, G.A., 2021. Restarting "Normal" life after Covid-19 and the lockdown: evidence from Spain, the United Kingdom, and Italy. Soc. Indic. Res. https://doi.org/10.1007/s11205-021-02697-5.

Coyle, C.E., Dugan, E., 2012. Social isolation, loneliness and health among older adults. J. Aging Health 24, 1346–1363. https://doi.org/10.1177/0898264312460275.

Daly, M., Robinson, E., 2021. Psychological distress and adaptation to the COVID-19 crisis in the United States. J. Psychiatr. Res. 136, 603–609. https://doi.org/10.1016/j.jpsychires.2020.10.035.

Daly, M., Robinson, E., 2023. Acute and longer-term psychological distress associated with testing positive for COVID-19: longitudinal evidence from a population-based study of US adults. Psychol. Med. 53, 1603–1610. https://doi.org/10.1017/S003329172100324X.

de Mestral, C., Stringhini, S., Guessous, I., Jornayvaz, F.R., 2020. Thirteen-year trends in the prevalence of diabetes in an urban region of Switzerland: a population-based study. Diabet. Med. 37, 1374–1378. https://doi.org/10.1111/dme.14206.

Fancourt, D., Steptoe, A., Bu, F., 2021. Trajectories of anxiety and depressive symptoms during enforced isolation due to COVID-19 in England: a longitudinal observational study. Lancet Psychiatry 8, 141–149. https://doi.org/10.1016/S2215-0366(20)30482-X.

Filippou, A., Giannouli, V., 2023. Exploring the experiences of integrative psychotherapists regarding resilience during the COVID-19 pandemic in Greece: an interpretative phenomenological analysis. Psych 5, 1270–1287. https://doi.org/10.3390/psych5040084.

Fluharty, M., Bu, F., Steptoe, A., Fancourt, D., 2021. Coping strategies and mental health trajectories during the first 21 weeks of COVID-19 lockdown in the United Kingdom. Soc. Sci. Med. 279, 113958 https://doi.org/10.1016/j.socscimed.2021.113958.

Hale, T., Angrist, N., Goldszmidt, R., Kira, B., Petherick, A., Phillips, T., Webster, S., Cameron-Blake, E., Hallas, L., Majumdar, S., Tatlow, H., 2021. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). Nat. Hum. Behav. 5, 529–538. https://doi.org/10.1038/s41562-021-01079-8.

Hawkley, L.C., Cacioppo, J.T., 2010. Loneliness matters: a theoretical and empirical review of consequences and mechanisms. Ann. Behav. Med. 40 https://doi.org/10.1007/s12160-010-9210-8.

Holt-Lunstad, J., Smith, T.B., Baker, M., Harris, T., Stephenson, D., 2015. Loneliness and social isolation as risk factors for mortality: a meta-analytic review. Perspect. Psychol. Sci. 10, 227–237. https://doi.org/10.1177/1745691614568352.

Hughes, M.E., Waite, L.J., Hawkley, L.C., Cacioppo, J.T., 2004. A short scale for measuring loneliness in large surveys: results from two population-based studies. Res. Aging 26, 655–672. https://doi.org/10.1177/0164027504268574.

Iob, E., Steptoe, A., Zaninotto, P., 2022. Mental health, financial, and social outcomes among older adults with probable COVID-19 infection: a longitudinal cohort study. Proc. Natl. Acad. Sci. 119, e2200816119 https://doi.org/10.1073/pnas.2200816119.

Kroenke, K., Spitzer, R.L., Williams, J.B.W., 2003. The Patient Health Questionnaire-2: validity of a two-item depression screener. Med. Care 41, 1284–1292. https://doi.org/10.1097/01.MLR.0000093487.78664.3C.

Kroenke, K., Spitzer, R.L., Williams, J.B.W., Monahan, P.O., Löwe, B., 2007. Anxiety disorders in primary care: prevalence, impairment, comorbidity, and detection. Ann. Intern. Med. 146, 317–325. https://doi.org/10.7326/0003-4819-146-5-200703060-00004.

Kwong, A.S.F., Pearson, R.M., Adams, M.J., Northstone, K., Tilling, K., Smith, D., Fawns-Ritchie, C., Bould, H., Warne, N., Zammit, S., Gunnell, D.J., Moran, P.A., Micali, N., Reichenberg, A., Hickman, M., Rai, D., Haworth, S., Campbell, A., Altschul, D., Flaig, R., McIntosh, A.M., Lawlor, D.A., Porteous, D., Timpson, N.J., 2021. Mental health before and during the COVID-19 pandemic in two longitudinal UK population cohorts. Br. J. Psychiatry 218, 334–343. https://doi.org/10.1192/bjp.2020.242.

Maes, M., 1995. Evidence for an immune response in major depression: a review and hypothesis. Prog. Neuro-Psychopharmacol. Biol. Psychiatry 19, 11–38. https://doi.org/10.1016/0278-5846(94)00101-m.

Matthews, T., Danese, A., Wertz, J., Odgers, C.L., Ambler, A., Moffitt, T.E., Arseneault, L., 2016. Social isolation, loneliness and depression in young adulthood: a behavioural genetic analysis. Soc. Psychiatry Psychiatr. Epidemiol. 51, 339–348. https://doi.org/10.1007/s00127-016-1178-7.

Mazza, M.G., De Lorenzo, R., Conte, C., Poletti, S., Vai, B., Bollettini, I., Melloni, E.M.T., Furlan, R., Ciceri, F., Rovere-Querini, P., 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.

McDaid, D., 2021. Viewpoint: investing in strategies to support mental health recovery from the COVID-19 pandemic. Eur. Psychiatry 64, e32. https://doi.org/10.1192/j.eurpsy.2021.28.

OECD, 2023. Good practices for measuring population mental health in household surveys. In: Measuring Population Mental Health.

Onder, G., Rezza, G., Brusaferro, S., 2020. Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. JAMA 323, 1775–1776. https://doi.org/10.1001/jama.2020.4683.

Parikh, P.K., Troyer, A.K., Maione, A.M., Murphy, K.J., 2016. The impact of memory change on daily life in normal aging and mild cognitive impairment. Gerontologist 56, 877–885. https://doi.org/10.1093/geront/gnv030.

Penninx, B.W.J.H., Benros, M.E., Klein, R.S., Vinkers, C.H., 2022. How COVID-19 shaped mental health: from infection to pandemic effects. Nat. Med. 28, 2027–2037. https://doi.org/10.1038/s41591-022-02028-2.

Perez-Saez, J., Zaballa, M.-E., Lamour, J., Yerly, S., Dubos, R., Courvoisier, D.S., Villers, J., Balavoine, J.-F., Pittet, D., Kherad, O., Vuilleumier, N., Kaiser, L., Guessous, I., Stringhini, S., Azman, A.S., 2023. Long term anti-SARS-CoV-2 antibody kinetics and correlate of protection against Omicron BA.1/BA.2 infection. Nat. Commun. 14, 3032. https://doi.org/10.1038/s41467-023-38744-7.

Perissinotto, C.M., Covinsky, K.E., 2014. Living alone, socially isolated or lonely—what are we measuring? J. Gen. Intern. Med. 29, 1429–1431. https://doi.org/10.1007/s11606-014-2977-8.

Pierce, M., Hope, H., Ford, T., Hatch, S., Hotopf, M., John, A., Kontopantelis, E., Webb, R., Wessely, S., McManus, S., Abel, K.M., 2020. Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. Lancet Psychiatry 7, 883–892. https://doi.org/10.1016/S2215-0366(20)30308-4.

Piumatti, G., Levati, S., Amati, R., Crivelli, L., Albanese, E., 2022. Trajectories of depression, anxiety and stress among adults during the COVID-19 pandemic in Southern Switzerland: the Corona Immunitas Ticino cohort study. Public Health 206, 63–69. https://doi.org/10.1016/j.puhe.2022.02.005.

Robinson, E., Daly, M., 2021. Explaining the rise and fall of psychological distress during the COVID-19 crisis in the United States: longitudinal evidence from the Understanding America Study. Br. J. Health Psychol. 26, 570–587. https://doi.org/10.1111/bjhp.12493.

Robinson, E., Sutin, A.R., Daly, M., Jones, A., 2022. A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic in 2020. J. Affect. Disord. 296, 567–576. https://doi.org/10.1016/j.jad.2021.09.098.

Rosa, L., Godwin, H.J., Cortese, S., Brandt, V., 2022. Predictors of longer-term depression trajectories during the COVID-19 pandemic: a longitudinal study in four UK cohorts. Evid. Based Ment. Health 25, e3. https://doi.org/10.1136/ebmental-2022-300461.

Rossi, R., Socci, V., Jannini, T.B., D'Aurizio, G., Mensi, S., Pacitti, F., Rossi, A., Di Lorenzo, G., 2023. Changes in mental health outcomes in the general population 14 months into the COVID-19 pandemic in Italy. J. Affect. Disord. 325, 35–40. https://doi.org/10.1016/j.jad.2022.12.148.

Schrempft, S., Pullen, N., Bayson, H., Wisniak, A., Zaballa, M.-E., Pennacchio, F., Vollenweider, P., Marques-Vidal, P., Preisig, M., Guessous, I., Stringhini, S., 2023. Prevalence and predictors of psychological distress before, during, and after a COVID-19 pandemic wave in Switzerland, 2021. J. Psychiatr. Res. 158, 192–201. https://doi.org/10.1016/j.jpsychires.2022.12.042.

Serrano-Alarcón, M., Kentikelenis, A., Mckee, M., Stuckler, D., 2022. Impact of COVID-19 lockdowns on mental health: evidence from a quasi-natural experiment in England and Scotland. Health Econ. 31, 284–296. https://doi.org/10.1002/hec.4453.

Shevlin, M., Butter, S., McBride, O., Murphy, J., Gibson-Miller, J., Hartman, T.K., Levita, L., Mason, L., Martinez, A.P., McKay, R., Stocks, T.V., Bennett, K.M., Hyland, P., Vallieres, F., Valiente, C., Vazquez, C., Contreras, A., Peinado, V., Trucharte, A., Bertamini, M., Panzeri, A., Bruno, G., Granziol, U., Mignemi, G., Spoto, A., Vidotto, G., Bentall, R.P., 2022. Measurement invariance of the Patient Health Questionnaire (PHQ-9) and Generalized Anxiety Disorder scale (GAD-7) across four European countries during the COVID-19 pandemic. BMC Psychiatry 22, 154. https://doi.org/10.1186/s12888-022-03787-5.

Stringhini, S., Wisniak, A., Piumatti, G., Azman, A.S., Lauer, S.A., Baysson, H., De Ridder, D., Petrovic, D., Schrempft, S., Marcus, K., Yerly, S., Arm Vernez, I., Keiser, O., Hurst, S., Posfay-Barbe, K.M., Trono, D., Pittet, D., Gétaz, L., Chappuis, F., Eckerle, I., Vuilleumier, N., Meyer, B., Flahault, A., Kaiser, L., Guessous, I., 2020. Seroprevalence of anti-SARS-CoV-2 IgG antibodies in Geneva, Switzerland (SEROCoV-POP): a population-based study. Lancet 396, 313–319. https://doi.org/10.1016/S0140-6736(20)31304-0.

Stringhini, S., Zaballa, M.-E., Perez-Saez, J., Pullen, N., de Mestral, C., Picazio, A., Pennacchio, F., Wisniak, A., Richard, A., Baysson, H., Loizeau, A., Balavoine, J.-F., Trono, D., Pittet, D., Posfay-Barbe, K., Flahault, A., Chappuis, F., Kherad, O., Vuilleumier, N., Kaiser, L., Azman, A.S., Guessous, I., Specchio-COVID19 Study Group, 2021a. Seroprevalence of anti-SARS-CoV-2 antibodies after the second pandemic peak. Lancet Infect. Dis. 21, 600–601. https://doi.org/10.1016/S1473-3099(21)00054-2.

Stringhini, S., Zaballa, M.-E., Pullen, N., de Mestral, C., Perez-Saez, J., Dumont, R., Picazio, A., Pennacchio, F., Dibner, Y., Yerly, S., Baysson, H., Vuilleumier, N., Balavoine, J.-F., Bachmann, D., Trono, D., Pittet, D., Chappuis, F., Kherad, O., Kaiser, L., Azman, A.S., Guessous, I., 2021b. Large variation in anti-SARS-CoV-2 antibody prevalence among essential workers in Geneva, Switzerland. Nat. Commun. 12, 3455. https://doi.org/10.1038/s41467-021-23796-4.

Stringhini, S., Zaballa, M.-E., Pullen, N., Perez-Saez, J., de Mestral, C., Loizeau, A.J., Lamour, J., Pennacchio, F., Wisniak, A., Dumont, R., Baysson, H., Richard, V., Lorthe, E., Semaani, C., Balavoine, J.-F., Pittet, D., Vuilleumier, N., Chappuis, F., Kherad, O., Azman, A.S., Posfay-Barbe, K., Kaiser, L., Guessous, I., on behalf of the S.-C. study, 2021c. Seroprevalence of anti-SARS-CoV-2 antibodies 6 months into the vaccination campaign in Geneva, Switzerland, 1 June to 7 July 2021. Eurosurveillance 26, 2100830. https://doi.org/10.2807/1560-7917.ES.2021.26.43.2100830.

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, 130–140. https://doi.org/10.1016/S2215-0366(20)30462-4.

Thompson, E.J., Stafford, J., Moltrecht, B., Huggins, C.F., Kwong, A.S.F., Shaw, R.J., Zaninotto, P., Patel, K., Silverwood, R.J., McElroy, E., Pierce, M., Green, M.J., Bowyer, R.C.E., Maddock, J., Tilling, K., Katikireddi, S.V., Ploubidis, G.B., Porteous, D.J., Timpson, N., Chaturvedi, N., Steves, C.J., Patalay, P., 2022. Psychological distress, depression, anxiety, and life satisfaction following COVID-19 infection: evidence from 11 UK longitudinal population studies. Lancet Psychiatry 9, 894–906. https://doi.org/10.1016/S2215-0366(22)00307-8.

Wang, S., Quan, L., Chavarro, J.E., Slopen, N., Kubzansky, L.D., Koenen, K.C., Kang, J.H., Weisskopf, M.G., Branch-Elliman, W., Roberts, A.L., 2022. Associations of depression, anxiety, worry, perceived stress, and loneliness prior to infection with risk of post–COVID-19 conditions. JAMA Psychiatry 79, 1081–1091. https://doi.org/10.1001/jamapsychiatry.2022.2640.

Wilding, S., O'Connor, D.B., Ferguson, E., Cleare, S., Wetherall, K., O'Carroll, R.E., Robb, K.A., O'Connor, R.C., 2022. Probable COVID-19 infection is associated with subsequent poorer mental health and greater loneliness in the UK COVID-19 Mental Health and Wellbeing study. Sci. Rep. 12, 20795 https://doi.org/10.1038/s41598-022-24240-3.

Winthorst, W.H., Post, W.J., Meesters, Y., Penninx, B.W., Nolen, W.A., 2011. Seasonality in depressive and anxiety symptoms among primary care patients and in patients with depressive and anxiety disorders; results from the Netherlands Study of Depression and Anxiety. BMC Psychiatry 11, 198. https://doi.org/10.1186/1471-244X-11-198.

Wu, Y., Xu, X., Chen, Z., Duan, J., Hashimoto, K., Yang, L., Liu, C., Yang, C., 2020. Nervous system involvement after infection with COVID-19 and other coronaviruses. Brain Behav. Immun. 87, 18–22. https://doi.org/10.1016/j.bbi.2020.03.031.

Zaninotto, P., Iob, E., Demakakos, P., Steptoe, A., 2022. Immediate and longer-term changes in the mental health and well-being of older adults in England during the COVID-19 pandemic. JAMA Psychiatry 79, 151–159. https://doi.org/10.1001/jamapsychiatry.2021.3749.