



HAL
open science

Impact of COVID-19-like symptoms on occurrence of anxiety/depression during lockdown among the French general population

Murielle Mary-Krause, Joel José Herranz Bustamante, Mégane Héron, Astrid Juhl Andersen, Tarik El Aarbaoui, Maria Melchior

► To cite this version:

Murielle Mary-Krause, Joel José Herranz Bustamante, Mégane Héron, Astrid Juhl Andersen, Tarik El Aarbaoui, et al.. Impact of COVID-19-like symptoms on occurrence of anxiety/depression during lockdown among the French general population. PLoS ONE, 2021, 16 (7), pp.e0255158. 10.1371/journal.pone.0255158 . hal-03336358

HAL Id: hal-03336358

<https://hal.sorbonne-universite.fr/hal-03336358>

Submitted on 7 Sep 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

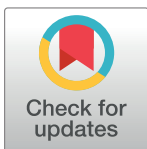
RESEARCH ARTICLE

Impact of COVID-19-like symptoms on occurrence of anxiety/depression during lockdown among the French general population

Murielle Mary-Krause *, Joel José Herranz Bustamante, Mégane Héron, Astrid Juhl Andersen, Tarik El Aarbaoui, Maria Melchior

Sorbonne Université, INSERM, Institut Pierre Louis d'Épidémiologie et de Santé Publique (IPLESP), Equipe de Recherche en Epidémiologie Sociale (ERES), Paris, France

* murielle.mary-krause@inserm.fr



OPEN ACCESS

Citation: Mary-Krause M, Herranz Bustamante JJ, Héron M, Andersen AJ, El Aarbaoui T, Melchior M (2021) Impact of COVID-19-like symptoms on occurrence of anxiety/depression during lockdown among the French general population. PLoS ONE 16(7): e0255158. <https://doi.org/10.1371/journal.pone.0255158>

Editor: Michio Murakami, Fukushima Medical University School of Medicine, JAPAN

Received: January 29, 2021

Accepted: July 10, 2021

Published: July 26, 2021

Copyright: © 2021 Mary-Krause et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: Research participants were guaranteed that the raw data they provided will remain confidential. To request access to the data, please send an email to cohort@inserm.fr. Anonymized data can only be shared after explicit approval of the French national committee for data protection for approval (Commission Nationale de l'Informatique et des Libertés, CNIL).

Abstract

Background

The outbreak of the COVID-19 epidemic led to high levels of morbidity and mortality around the globe. Consequences of this outbreak and possible associated infection are an increase in mental health disorders and an increased likelihood of internalizing problems, particularly depression. However, to date few studies have tested this hypothesis while taking into account individuals' preexisting mental health difficulties.

Methods

We used longitudinal data collected among 729 persons in the context of the French TEMPO cohort between March and June 2020 (7 waves of data collection). COVID-19-like symptoms as well as anxiety/depression (assessed by the Adult Self Report), were reported at each wave of data collection. To study the relationship between COVID-19-like symptoms and anxiety/depression, we used generalized estimation equation (GEE) models controlled for socio-demographic and health-related characteristics, including anxiety/depression prior to 2020.

Results

Overall, 27.2% of study participants reported anxiety/depression during lockdown. 17.1% of participants reported COVID-19-like symptoms during the course of follow-up, 7.3% after the beginning of lockdown, with an average number of 2.7 symptoms, and 3.6% reported respiratory distress. In multivariate analyses, nearly all the considered indicators of COVID-19-like symptoms were associated with higher odds of symptoms of anxiety/depression (symptoms Yes/No: OR = 1.66, 95% CI = 1.08–2.55; symptoms after the beginning of lockdown: OR = 1.91, 95% CI = 1.03–3.52; number of symptoms: OR for each additional symptom = 1.19, 95% CI = 1.02–1.39). This relationship exists after taking into account prior symptoms of anxiety/depression, which are associated with a 5-fold increased likelihood of psychological distress. And this impact is stronger among men than women.

Funding: This project has received funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement numbers 101016127 (RESPOND).

Competing interests: The authors have declared that no competing interests exist.

Conclusions

Our study shows higher risk of anxiety/depression among persons who experienced COVID-19-like symptoms, even after accounting for prior mental health difficulties. COVID-19 infection could have both a direct and indirect impact on the occurrence of psychological difficulties, and this association should be studied in greater detail.

Introduction

The COVID-19 outbreak, caused by the SARS-CoV-2 virus and the associated public health control measures have been shown to be associated with increased mental health disorders in the general population [1, 2]. Prevalence of mental health problems due to COVID-19 infection in the general population varies depending on the study population and the setting of the COVID-19 outbreak [3]. At the beginning of the outbreak, anxiety and depression were respectively observed among 28.8% and 16.5% in the Chinese population [4]. Systematic reviews indicate that in general population samples, the prevalence of anxiety symptoms ranges from 6.3% to 50.9% and that of depressive symptoms from 14.6% to 48.3% [5, 6]. This high heterogeneity could be due to differences in studied countries, the epidemic conditions of COVID-19 in under-developed and developing countries imposing greater psychological effects on the population and because uncertainty about health status and care increasing the vulnerability of such communities [5]. The time when prevalences were estimated may also explain the differences as the highest levels of anxiety and depression were shown to occur in the early stages of lockdown and declined fairly rapidly after [7]. This could also be due to the sampling method introducing possible bias, due to differences in sex, age or levels of education distribution in the studied population. Among young adults (18–24 years), a study conducted in the US reported a prevalence of 49.1% for anxiety disorders and 52.3% for depressive disorders [8], while another investigation conducted among adolescent athletes reported a prevalence of moderate and severe anxiety symptoms of 20.1% and 16.6% respectively [9]. In France, the prevalence of anxiety and depressive symptoms during lockdowns (March 17-May 11, 2020 and October 30- December 15, 2020, respectively) were around 20% in the general population [10].

Risk factors of mental health problems during the COVID-19 epidemic include socio-demographic characteristics such as female sex, younger age and lower educational and socio-economic status [4, 6], but also pre-existing mental illness [11–13], self-rated health status and social isolation [6]. Moreover factors linked to the COVID-19 infection such as related symptoms, contact with persons affected with COVID-19, COVID-19-related fear, as well as the level of information regarding COVID-19, have also been found to contribute to the deterioration of mental health [4, 6, 11–15]. However, most of these studies were cross-sectional [6], and some associations were found only in univariate models [4, 12].

Moreover, even though many studies have reported increased anxiety and depression as a consequence of the COVID-19 epidemic, individuals' pre-pandemic history of mental health problems was mostly not taken into account, with the exception of few studies for which this information was collected retrospectively and may therefore have been tainted by recall bias [11–13]. Some studies tried to compare prevalences before and after the COVID-19 epidemic. They showed that the prevalence of symptoms of anxiety and depression in 2020 is higher than in the same period in 2019 [16], 2018 [17], or before the pandemic [18]. So, direct evidence of COVID-19 infection as a risk factor associated with an increase in mental health risk

is limited. Moreover, mental health surveys conducted during the COVID-19 pandemic most frequently relied upon convenience samples, which are prone to substantial bias [19]. Nevertheless, a recent study in 3 Dutch cohorts comparing people with and without mental health disorders [20], showed that, compared to periods prior to COVID-19, symptoms of depression and worry increased during the pandemic, with no significant changes in symptoms of anxiety, and no overall increase in symptom severity in individuals with the largest mental health disorder burden. Thus, while it may be that preexisting mental health difficulties increase risk of poor mental health during the COVID-19 pandemic, this hypothesis has not been fully supported by existing data, and requires to be examined by taking into account risk factors specific to this period, including COVID-19 infection itself and consequences of this infection.

To limit COVID-19 transmission, France established a first lockdown from March 17th to May 12th 2020. The objective of this study is to examine the associations between different measures of the COVID-19 symptomatology and anxiety/depression during the first COVID-19 lockdown in a cohort of middle-aged adults in France, taking into account other risk factors including comorbidity, prior mental health problems and socio-economic characteristics. We hypothesize that the relationship between COVID-19-like symptoms and anxiety/depression exists even when prior mental health problems are taken into account.

Methods

Study population

The TEMPO COVID-19 project derives from the TEMPO (Trajectoires Épidémiologiques en POpulation) cohort, a study set up in 2009 to evaluate individual, familial and social determinants of mental health difficulties, addictive behaviors and their trajectories over time. TEMPO cohort participants took part in a study of children's psychological problems and access to mental healthcare in 1991 (age 4–16 years, $n = 2,582$) and were followed-up via self-completed questionnaires in 1999, 2009, 2011, 2014 and 2018 [21]. Since 1991, a total of 3,401 persons participated in at least one wave of data collection, responding to the study questionnaire either online or via postal questionnaire.

The TEMPO COVID-19 project comprises 7 waves of data collection starting March 24th 2020, one week after the beginning of the first COVID-19-related lockdown in France, until one week after the end of the lockdown, May 12th 2020. Data were collected via self-completed electronic surveys sent out to the 1224 TEMPO cohort participants with a valid email address. Data were collected weekly for the first 5 surveys and fortnightly for the 6th and 7th surveys (S1 Table). Overall, 729 individuals completed at least one study questionnaire between March 24 and June 06, 2020.

The TEMPO cohort received approval from the French national committee for data protection (Commission National Informatique et Liberté, CNIL, n° 908163). In accordance with French regulations when the study was implemented, participants were informed that they had the right to refuse participation or withdraw from the study.

Measures

Outcome variable: Symptoms of anxiety/depression. Participants' symptoms of anxiety/depression were assessed using the specific subscale of the Adult Self Report (ASR) Achenbach System [22, 23]. Eight items were included in wave 1 [23] and 13 items in waves 2 to 7 [24] of the TEMPO COVID-19 project (S2 Table). Each item is scored 0 to 2 and the level of symptoms is calculated by summing all relevant items. To be rendered comparable between waves, ASR scores were standardized from 0 to 100. Following ASR guidelines, we dichotomized the score using the 85th percentile, people with higher scores being considered anxious/depressed [25].

Exposure variables: COVID-19-like symptoms. In each wave of the TEMPO COVID-19 questionnaire, participants were asked whether they had experienced COVID-19-like symptoms and if yes, which ones (from a list including: fever, cough, muscle soreness, respiratory problems, loss of taste, loss of smell, fatigue) and the date at which these symptoms started. In the first questionnaire, we asked about the presence of COVID-19-like symptoms at any point in time. From the 2nd questionnaire onwards we only asked about the presence of COVID-19-like symptoms in the preceding 7 days. Based on this information, we derived four measures: 1) the presence of COVID-19-like symptoms (yes vs. no), 2) the timing of COVID-19-like symptoms (none, before the beginning of lockdown (< March 17, 2020), after the beginning of lockdown (\geq March 17, 2020)), 3) the number of COVID-19-like symptoms, 4) the type of COVID-19-like symptoms (none, mild, respiratory distress).

Covariates. Covariates included participants' demographic, socioeconomic and health characteristics. Level of education was divided into 3 categories: " \leq High School degree", "2 to 4 years university degree", and " \geq 5 years university degree". Household configuration during lockdown was divided into 3 categories: "Living with a partner + children", "Living with a partner (without children)" and "Other". Household income level/month during lockdown was dichotomized in two categories: ">2500 €" vs. " \leq 2500 €". Employment stability during lockdown was defined as follows: "Permanent contract or civil servant" or "Self-employed" were considered as stable, any other occupational status was considered as unstable. Working status during lockdown was considered using three categories: "Working from home / Changed working patterns", "Working as usual" and "Unemployed".

History of anxiety/depression prior to 2020 was assessed using TEMPO data collected in 2009, 2011 or 2018. For each individual, the most recent information available was taken into account. Anxiety/depression was assessed by the ASR in 2009 and 2018 and by the Mini-International Neuropsychiatric Interview (MINI) [26] in 2011. Scores from different scales were standardized from 0 to 100 and dichotomized according to the 85th percentile of the most recent information available, corresponding to a mean score of 34. Persons who participate more actively in the survey are more likely to be in the latter wave resulting in a possible bias. So, a sensitivity analysis was conducted using the first available (oldest) data to establish whether participants had a history of anxiety/depression prior to 2020, instead of the most recent information.

Statistical analysis

To study the relationship between participants' COVID-19-like symptoms and anxiety/depression, we proceeded as follows. First, we described sample characteristics according to whether participants reported COVID-19-like symptoms or not. No collinearity between all variables was observed. Second, we tested bivariate and multivariate associations between COVID-19-like symptoms and anxiety/depression using generalized estimation equation (GEE) models with a logit link, binomial distribution and unstructured correlation matrix. Four different GEE models were implemented, one for each of the four measures of COVID-19-like symptoms, retaining all covariates found to have a p-value < 0.2 in bivariate analyses. Third, interactions between COVID-19-like symptoms and a) sex, b) income level, c) diabetes and/or overweight/obesity, d) anxiety/depression prior to 2020 and all variables included in the final models were tested. All analyses were carried out using SAS[®] 9.4.

Results

Among the 729 participants to the TEMPO COVID-19 project, 27.2% (n = 195) reported symptoms of anxiety/depression during lockdown. COVID-19-like symptoms were reported

Table 1. Characteristics of TEMPO cohort participants during the first COVID-19-related lockdown (March–June 2020, France, % or mean ± Standard Deviation (SD)).

	Total (n = 729) n (%)	Absence of COVID-19-like symptoms (n = 604) n (%)	Presence of COVID-19-like symptoms (n = 125) n (%)	p-value
Socio-demographic characteristics				
Sex (n = 729)				
Male	257 (35.3%)	220 (36.4%)	37 (29.6%)	0.1461
Female	472 (64.7%)	384 (63.6%)	88 (70.4%)	
Age (n = 729)				
Mean ± SD	39.3 ± 3.6	39.3 ± 3.6	39.3 ± 3.9	0.8971
Median (Q1–Q3)	40 (37–42)	40 (37–42)	40 (37–42)	
Highest level of education (n = 728)				
≤High School	76 (10.4%)	65 (10.8%)	11 (8.8%)	0.5495
2 to 4 years university degree	310 (42.6%)	260 (43.1%)	50 (40.0%)	
≥5 years university degree	342 (47.0%)	278 (46.1%)	64 (51.2%)	
Household Configuration (n = 714)				
Living with a partner + children	461 (64.6%)	390 (65.9%)	71 (58.2%)	0.2439
Living with a partner	78 (10.9%)	61 (10.3%)	17 (13.9%)	
Other	175 (24.5%)	141 (23.8%)	34 (27.9%)	
Household Income level/month (n = 695)				
> 2500 €	566 (81.4%)	468 (81.4%)	98 (81.7%)	0.9437
≤ 2500 €	129 (18.6%)	107 (18.6%)	22 (18.3%)	
Employment stability (n = 706)				
Yes	644 (91.2%)	531 (91.1%)	113 (91.9%)	0.7787
No	62 (8.8%)	52 (8.9%)	10 (8.1%)	
Working status during lockdown (n = 717)				
Working from home/Changed working patterns	447 (62.4%)	375 (63.0%)	72 (59.0%)	0.6004
Working as usual	112 (15.6%)	93 (15.6%)	19 (15.6%)	
Unemployed	158 (22.0%)	127 (21.4%)	31 (25.4%)	
Health-related characteristics				
Diabetes and/or Overweight-Obesity (n = 729)				
No	640 (87.8%)	529 (87.6%)	111 (88.8%)	0.7052
Yes	89 (12.2%)	75 (12.4%)	14 (11.2%)	
Contacts with COVID-19 infected persons (n = 729)				
No	578 (79.3%)	495 (82.0%)	83 (66.4%)	< .0001
Yes	151 (20.7%)	109 (18.0%)	42 (33.6%)	
Anxiety/depression prior to 2020 (n = 719)				
No	533 (74.1%)	449 (75.1%)	84 (69.4%)	0.1946
Yes	186 (25.9%)	149 (24.9%)	37 (30.6%)	
Anxiety-depression during lockdown (n = 719)				
No	524 (78.8%)	448 (75.3%)	76 (61.3%)	0.0014
Yes	195 (27.2%)	147 (24.7%)	48 (38.7%)	

<https://doi.org/10.1371/journal.pone.0255158.t001>

by 17.1% of participants (n = 125) during the course of follow-up, 7.3% (n = 53) after the beginning of lockdown, with an average number of 2.7 symptoms (standard deviation SD = 1.5), and 3.6% (n = 26) had respiratory distress. **Table 1** presents participants'

Table 2. COVID-19-like symptoms and anxiety/depression in the TEMPO cohort during the first COVID-19-related lockdown (March-June 2020, France, bivariate GEE models, Odds-Ratio (OR), 95% Confidence Interval (CI)).

Measures of COVID-19-like symptoms		Model 1 (n = 719)	Model 2 (n = 717)	Model 3 (n = 681)	Model 4 (n = 681)
		OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Any COVID-19-like symptoms					
	<i>No</i>	1	-	-	-
	<i>Yes</i>	1.76 [1.19; 2.59]	-	-	-
Timing of COVID-19-like symptoms					
	<i>None</i>	-	1	-	-
	<i>Before lockdown (<March 17, 2020)</i>	-	1.55 [0.97; 2.49]	-	-
	<i>After lockdown (≥March 17, 2020)</i>	-	2.10 [1.18; 3.74]	-	-
Number of COVID-19-like symptoms					
	(Continuous Variable)	-	-	1.22 [1.07; 1.39]	-
Type of COVID-19-like symptoms					
	<i>None</i>	-	-	-	1
	<i>Mild</i>	-	-	-	1.93 [1.15; 3.23]
	<i>Respiratory distress</i>	-	-	-	2.32 [1.12; 4.81]

<https://doi.org/10.1371/journal.pone.0255158.t002>

characteristics according to whether they reported COVID-19-like symptoms or not and **Table 2** provides the results of all four bivariate GEE models for each measure of COVID-19-like symptoms. COVID-19-like symptoms were associated with anxiety/depression regardless of the indicator considered: any COVID-19-like symptoms, COVID-19-like symptoms after lockdown, number of COVID-19-like symptoms, and mild symptoms as well as respiratory distress. After adjustment (**Table 3**), any COVID-19-like symptoms remained associated with anxiety/depression during lockdown (66% increased odds), as were COVID-19-like symptoms after the beginning of lockdown (91% increased odds), the number of COVID-19-like symptoms (19% increased odds for each additional symptom). All types of COVID-19-like symptoms were not found associated with anxiety/depression but the significance is close: mild symptoms: OR = 1.71, 95% CI = 0.96–3.05, respiratory distress: OR = 1.96, 95% CI = 0.93–4.15. In the sensitivity analysis using the first rather than the latest available information on participants' history of anxiety/depression, results are very similar and the conclusions the same (**S3 Table**).

Among covariates, female, low household income, unemployed, diabetes and/or overweight/obesity and anxiety/depression prior to 2020 were also associated with an increase in the odds of anxiety/depression during lockdown.

The only statistical interaction that was statistically significant was between the presence of COVID-19-like symptoms and participants' sex. After stratifying on sex, we observed a stronger association between COVID-19-like symptoms and anxiety/depression in men than in women (respectively OR = 3.67, 95% CI = 1.39–9.71 and OR = 1.30, 95% CI = 0.80–2.12) (**Table 4**).

Discussion

Our study highlights the association between COVID-19-like symptoms and anxiety/depression during the Spring of 2020, which exists even after accounting for individuals' preexisting mental health difficulties. The higher the number of symptoms, and the more severe the manifestations of COVID-19-like, the higher the odds of anxiety/depression.

This study has some limitations which can impact the interpretation of our results. First, TEMPO participants are a sample of individuals whose parents also participate in a long-term

Table 3. COVID-19-like symptoms and anxiety/depression in the TEMPO cohort during the first COVID-19-related lockdown (March-June 2020, France, multivariate GEE models, adjusted Odds-Ratio (OR), 95% Confidence Interval (CI)).

Variables		Model 1 (n = 656)	Model 2 (n = 655)	Model 3 (n = 623)	Model 4 (n = 623)
		OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Any COVID-19-like symptoms					
	No	1	-	-	-
	Yes	1.66 [1.08; 2.55]	-	-	-
Timing of COVID-19-like symptoms					
	None	-	1	-	-
	Before lockdown (<March 17, 2020)	-	1.53 [0.90; 2.61]	-	-
	After lockdown (≥March 17, 2020)	-	1.91 [1.03; 3.52]	-	-
Number of COVID-19-like symptoms (Continuous Variable)		-	-	1.19 [1.02; 1.39]	-
Type of COVID-19-like symptoms					
	None	-	-	-	1
	Mild	-	-	-	1.71 [0.96; 3.05]
	Respiratory distress	-	-	-	1.96 [0.93; 4.15]
Sex					
	Male	1	1	1	1
	Female	1.54 [0.99; 2.38]	1.54 [0.99; 2.38]	1.65 [1.04; 2.61]	1.64 [1.03; 2.59]
Household configuration					
	Living with a partner + children	1	1	1	1
	Living with a partner	1.36 [0.76; 2.45]	1.35 [0.75; 2.44]	1.56 [0.86; 2.82]	1.57 [0.87; 2.83]
	Other	0.79 [0.47; 1.34]	0.79 [0.47; 1.34]	0.74 [0.42; 1.30]	0.75 [0.43; 1.30]
Household income level/month					
	> 2500€	1	1	1	1
	≤ 2500€	1.89 [1.10; 3.27]	1.89 [1.09; 3.25]	1.92 [1.08; 3.40]	1.90 [1.09; 3.33]

<https://doi.org/10.1371/journal.pone.0255158.t003>

epidemiological study (the GAZEL cohort) [27] and are not representative of the French population. Indeed, due to selective attrition, women are over-represented (65%), as are persons with high socio-economic level, and in good health. Nevertheless, TEMPO participants are a heterogeneous group and sufficiently diverse in terms of geography and socio-economic characteristics to produce generalizable results, but the estimates of associations between COVID-19-like symptoms and anxiety/depression we report may be underestimated. Moreover, levels of mental health difficulties such as depression and anxiety in the TEMPO cohort

Table 4. Sex stratified bivariate and multivariate GEE models of anxiety/depression problems and absence/presence of COVID-19-like symptoms.

COVID-19-like symptoms		Males	Females
		OR [95% CI]	OR [95% CI]
Bivariate model (Males n = 255 / Female n = 464)			
	No	1	1
	Yes	2.41 [1.07; 5.43]	1.47 [0.93; 2.31]
Multivariate model (Males n = 237 / Female n = 419)			
	No	1	1
	Yes	3.67 [1.39; 9.71]	1.30 [0.80; 2.12]

<https://doi.org/10.1371/journal.pone.0255158.t004>

are comparable to those observed in the general population [28, 29], making TEMPO participants an appropriate sample to study these topics. Second, all data were collected through online questionnaires during lockdown, and participants' responses were self-reported. Nevertheless, the ASR has been established to evaluate internalizing problems under such conditions [22]. Third, COVID-19-like symptoms were self-reported with no positive PCR test, and misclassification bias is possible. But in the spring of 2020, PCR tests were not widely available in France and there was no possibility to offer a test to study participants [30]. Thus our results suggest that self-reported COVID-19-like symptoms could have a negative impact on mental health.

Our study has several strengths that offset the previously cited limitations. First, the main strength is that anxiety/depression prior to 2020 was collected prospectively before the COVID-19 pandemic, eliminating memory and subjective bias. Second, longitudinal collection of anxiety/depression symptoms in 7 waves during lockdown allowed more consistent results than cross-sectional studies.

The prevalence of anxiety/depression during lockdown of 27% observed in our study is higher than the 18–20% prevalence reported in France in the same period [10]. Differences may be due to differences in scales: the Hospital Anxiety and Depression Scale (HAD) [31] by Santé Publique France and the Adult Self Report (ASR) Achenbach System [22, 23] in our study. In addition, it is important to note that another study using the Mental Health Inventory (MHI-5) indicated that 36% of the French general population presented psychological distress [32]. Our data are also different from those that were reported from other European countries. Indeed, in Germany 45% of individuals were reported to have anxiety symptoms and 14% depression [18], whereas in Italy, 19% of adults reported anxiety and 32% depression [33], these percentages being respectively 20% and 30% in Spain [34] and 22% and 22% in the UK [35]. A meta-analysis reported a prevalence of 32% of anxiety and 34% of depression [5], while literature reviews report a prevalence of anxiety and depression ranging respectively from 6% to 51% and from 15% to 48% [6, 36]. This between-country heterogeneity in prevalence of mental health problems due to COVID-19 infection in the general population may be due to differences in study populations, in the level of confidence towards the government and the setting of the COVID-19 outbreak, but also in differences in terms of scales measuring depression and anxiety used.

The prevalence of mental health difficulties we report is higher than observed outside of the COVID-19 epidemic. Indeed, a recent review suggests that approximately 10% of the French population experiences clinical depression at any one point in time [37] and almost 1% has depression severe enough to require hospitalization [38], which is higher than in most other industrialized countries. In terms of anxiety disorders, approximately 20% of the population is thought to be affected, the most frequent disorders being generalized anxiety disorder (approximately 12%), panic disorder (approximately 6%), social anxiety disorder (approximately 4%), and less than 1% post-traumatic stress disorder [39]. This higher prevalence during the pandemic suggest an impact of COVID-19 and associated preventive measures on mental health [6, 40, 41].

Past studies showed that people who experienced COVID-19 symptoms had an elevated prevalence of mental health problems with an OR ranging from 1.2 to 5.1 for anxiety and from 1.2 to 3.6 for depression [4, 11, 12, 14], which is supported by the findings of the present study even after taking into account prior mental health problems. To study impact of COVID-19, most of studies compared the prevalence of mental health disorders to periods prior to the pandemic [16–18], or with individuals suffering from other forms of pneumonia [42]. But it is essential to take into account confounding factors such as prior mental health symptoms and socio-economic position. When this is the case, in most cases the information was collected

retrospectively and may be subject to recall bias. Moreover, as the association between COVID-19 and psychiatric disorder may be directional [43], taking into account history of mental health disorders is crucial. Hence the importance of this longitudinal study.

Nevertheless, our findings suggest that the impact of anxiety/depression prior to 2020 on psychological distress during the COVID-19 lockdown is far greater than the impact of the experience of COVID-19-like symptoms (OR = 5.3 vs 1.7 in model 1 respectively). People with symptoms of anxiety/depression before lockdown are more vulnerable to anxiety/depression during lockdown, which could be explained by the stability and continuity of mental health problems throughout adulthood [44–46]. Moreover, many consequences of COVID-19 pandemic on all aspects of society, including mental health [6, 40, 41], may be increased in vulnerable people.

In our study, women were found to have a higher risk of symptoms of anxiety and depression, which is consistent with prior studies [4, 6, 47, 48]. This may be because in women other factors may contribute to psychological distress, particularly during the COVID-19 epidemic, including increased family and childcare responsibilities, and more job loss and reduced incomes [49–51]. Nevertheless, after stratification on sex, we showed that the relationship between COVID-19-like symptoms and anxiety/depression is stronger among men than women (OR = 3.7 vs 1.3 respectively); to our knowledge this has never previously been shown. Although women in the general population report a higher level of anxiety than men, men are reported to be more anxious in case of chronic pain and men's catastrophic reactions also have a more negative impact on their mood [52, 53].

The impact of COVID-19-like symptoms on anxiety/depression can be due to several mechanisms. First of all, the fear of being infected, as well as COVID-19 infection or death of close ones could explain the occurrence of stress, anxiety or depression [54]. Second, lockdown leads to disruptions in people's lives and social isolation [54–56]. Third, economic, social and personal consequences such as job loss, loss of income and financial uncertainty, could also impact mental health problems [40, 57]. A study conducted in France showed that after 10 days of lockdown, 19% of individuals already experienced financial difficulties and 21% were unemployed due to the lockdown [32]. Importantly, these psychological difficulties were observed not only during the course of an epidemic, but also in its aftermath as it was observed in previous epidemics, and could possibly be heightened by feelings of shame and guilt experienced by individuals who have lost close ones, as they could think that they have transmitted the disease, or they may end up being stigmatized because of the epidemic [58].

Another possible mechanism that may explain the onset of mental health problems is the COVID-19 infection itself and its possible biological and immunological impacts. Indeed, SARS-CoV-2 can affect brain tissue by causing a cytokine storm, which is believed to have an impact on neurological and psychiatric symptoms, and trigger an immune response that could have an impact on mental health [59, 60]. During this cytokine storm, pro-inflammatory factors are intensively released and enter the central nervous system (CNS), initiating a neuro-inflammatory process [61]. Moreover, an excessive and dysregulated immune response seen in patients affected by COVID-19 contribute to high levels of various pro-inflammatory cytokines, these cytokines are elevated in patients with depression and could be a hypothetical mechanism distinct from social isolation and psycho-socioeconomic stressors [60]. Additionally, the presence of the SARS-Cov-2 virus in the brain can also manifest in psychiatric symptoms [59]. Some biological alterations due to coronavirus infection were found, especially activation of microglia and cytokine signaling, that are common alterations in psychotic disorders without establishing a causal relationship [59].

The association between the number of COVID-19-like symptoms and the odds of anxiety/depression could be explained by fear related to symptoms severity, and also the increased biological alterations described above.

Conclusions

Our study shows elevated levels of symptoms of anxiety/depression among persons who experienced COVID-19-like symptoms, even after accounting for mental health difficulties prior to 2020. This suggests that COVID-19 infection may have both a direct, virus itself, and indirect, consequences of the epidemic, impact on psychological difficulties, which should be studied in greater detail.

Supporting information

S1 Table.
(DOCX)

S2 Table.
(DOCX)

S3 Table.
(DOCX)

Acknowledgments

We thank all TEMPO study participants who provided data for this project.

Author Contributions

Conceptualization: Maria Melchior.

Formal analysis: Joel José Herranz Bustamante.

Funding acquisition: Maria Melchior.

Investigation: Murielle Mary-Krause, Joel José Herranz Bustamante, Mégane Héron, Tarik El Aarbaoui.

Methodology: Murielle Mary-Krause, Tarik El Aarbaoui, Maria Melchior.

Project administration: Murielle Mary-Krause, Joel José Herranz Bustamante.

Supervision: Murielle Mary-Krause, Maria Melchior.

Validation: Murielle Mary-Krause, Mégane Héron, Astrid Juhl Andersen, Tarik El Aarbaoui, Maria Melchior.

Writing – original draft: Murielle Mary-Krause, Joel José Herranz Bustamante.

Writing – review & editing: Mégane Héron, Astrid Juhl Andersen, Tarik El Aarbaoui, Maria Melchior.

References

1. Torales J, O'Higgins M, Castaldelli-Maia JM, Ventriglio A. The outbreak of Covid-19 coronavirus and its impact on global mental health. *Int J Soc Psychiatry*. 2020; 66(4): 317–320. <https://doi.org/10.1177/0020764020915212> PMID: 32233719
2. Vindegaard N, Benros ME. COVID-19 pandemic and mental health consequences: systematic review of the current evidence. *Brain Behav Immun*. 2020; 89: 531–542. <https://doi.org/10.1016/j.bbi.2020.05.048> PMID: 32485289
3. Cénat JM, Blais-Rochette C, Kokou-Kpolou CK, Noorishad PG, Mukunzi JN, McIntee SE, et al. Prevalence of symptoms of depression, anxiety, insomnia, posttraumatic stress disorder, and psychological distress among populations affected by the COVID-19 pandemic: A systematic review and meta-

- analysis. *Psychiatry Res.* 2021; 295: 113599. <https://doi.org/10.1016/j.psychres.2020.113599> PMID: 33285346
4. Wang C, Pan R, Wan X, Tan Y, Xu L, Ho CS, et al. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Publ Health.* 2020; 17(5): 1729. <https://doi.org/10.3390/ijerph17051729> PMID: 32155789
 5. Salari N, Hosseini-Far A, Jalali R, Vaisi-Raygani A, Rasoulpoor S, Mohammadi M, et al. Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. *Global Health.* 2020; 16(1): 57. <https://doi.org/10.1186/s12992-020-00589-w> PMID: 32631403
 6. Xiong J, Lipsitz O, Nasri F, Liu LMW, Gill H, Phan L, et al. Impact of COVID-19 pandemic on mental health in the general population: A systematic review. *J Affect Disord.* 2020; 277: 55–64. <https://doi.org/10.1016/j.jad.2020.08.001> PMID: 32799105
 7. Fancourt D, Steptoe A, Bu F. Trajectories of anxiety and depressive symptoms during enforced isolation due to COVID-19 in England: a longitudinal observational study. *Lancet Psychiatry.* 2021; 8(2): 141–149. [https://doi.org/10.1016/S2215-0366\(20\)30482-X](https://doi.org/10.1016/S2215-0366(20)30482-X) PMID: 33308420
 8. Vahia IP, Jeste DV, Reynolds 3rd CF. Older adults and the mental health effects of COVID-19. *JAMA.* 2020; 324(22): 2253–2254. <https://doi.org/10.1001/jama.2020.21753> PMID: 33216114
 9. McGuire TA, Biese KM, Petrovska L, Hetzel S, Reardon C, Kliethermes S, et al. Mental health, physical activity, and quality of life of US adolescent athletes during Covid-19-related school closures and sport cancellations: a study of 13 000 athletes. *J Athl Train.* 2020. <https://doi.org/10.4085/1062-6050-0478.20> PMID: 33290516
 10. Santé Publique France. Prévalences et évolutions des indicateurs de santé mentale et des problèmes de sommeil (% pondérés), ENquête CoviPrev, France métropolitaine, 2020 [Prevalence and changes in mental health indicators and sleep problems (weighted percentage), CoviPrev survey, metropolitan France, 2020]. Available from <https://www.santepubliquefrance.fr/etudes-et-enquetes/covid-19-une-enquete-pour-suivre-l-evolution-des-comportements-et-de-la-sante-mentale-pendant-l-epidemie#block-249162> [accessed 25 January 2021]
 11. McCracken LM, Badinlou F, Buhrman M, Brocki KC. Psychological impact of COVID-19 in the Swedish population: Depression, anxiety, and insomnia and their associations to risk and vulnerability factors. *Eur Psychiatry.* 2020; 63(1): e81. <https://doi.org/10.1192/j.eurpsy.2020.81> PMID: 32843115
 12. Newby JM, O'Moore K, Tang S, Christensen H, Faasse K. Acute mental health responses during the COVID-19 pandemic in Australia. *PLoS One.* 2020; 15(7): e0236562. <https://doi.org/10.1371/journal.pone.0236562> PMID: 32722711
 13. Ozdin S, Bayrak Ozdin S. Levels and predictors of anxiety, depression and health anxiety during COVID-19 pandemic in Turkish society: the importance of gender. *Int J Soc Psychiatry.* 2020; 66(5): 504–11. <https://doi.org/10.1177/0020764020927051> PMID: 32380879
 14. Al Zubayer A, Rahman E, Islam B, Babu SZD, Rahman QM, Al Mazid Bhuiyan R, 2021 et al. Psychological states of Bangladeshi people four months after the COVID-19 pandemic: An online survey. *Heliyon.* 2020; 6(9): e05057. <https://doi.org/10.1016/j.heliyon.2020.e05057> PMID: 33015396
 15. Olagoke AA, Olagoke OO, Hughes AM. Exposure to coronavirus news on mainstream media: The role of risk perceptions and depression. *Br J Health Psychol.* 2020; 25(4): 865–74. <https://doi.org/10.1111/bjhp.12427> PMID: 32415914
 16. Czeisler ME, Lane RI, Petrosky E, Willey JF, Christenson A, Njai R, et al. Mental Health, substance use, and suicidal ideation during the COVID-19 pandemic—United States, June 24–30, 2020. *MMWR Morb Mortal Wkly Rep.* 2020; 69(32): 1049–57. <https://doi.org/10.15585/mmwr.mm6932a1> PMID: 32790653
 17. Twenge JM, Joiner TE. Mental distress among U.S. adults during the COVID-19 pandemic. *J. Clin. Psychol.* 2020; 76(12): 2170–82. <https://doi.org/10.1002/jclp.23064> PMID: 33037608
 18. Bäuerle A, Teufel M, Musche V, Weismüller B, Köhler H, Hetkamp M, et al. Increased generalized anxiety, depression and distress during the COVID-19 pandemic: a cross-sectional study in Germany. *J Public Health (Oxf).* 2020; 42(4): 672–8. <https://doi.org/10.1093/pubmed/fdaa106> PMID: 32657323
 19. Pierce M, McManus S, Jessop C, John A, Hotopf M, Ford T, et al. Says who? The significance of sampling mental health surveys during COVID-19. *Lancet Psychiatry.* 2020; 7(7): 567–8. [https://doi.org/10.1016/S2215-0366\(20\)30237-6](https://doi.org/10.1016/S2215-0366(20)30237-6) PMID: 32502467
 20. Pan KY, Kok AAL, Eikelenboom M, Horsfall M, Jörg F, Luteijn RA, et al. The mental health impact of the COVID-19 pandemic on people with and without depressive, anxiety, or obsessive-compulsive disorders: a longitudinal study of the three Dutch case-control cohorts. *Lancet Psychiatry.* 2021; 8(2): 121–9. [https://doi.org/10.1016/S2215-0366\(20\)30491-0](https://doi.org/10.1016/S2215-0366(20)30491-0) PMID: 33306975

21. Mary-Krause M, Herranz Bustamante JJ, Bolze C, Galéra C, Fombonne EJ, Melchior M. Cohort profile: The TEMPO cohort study. *Int J Epidemiol*. 2021; May 20: dyab026. <https://doi.org/10.1093/ije/dyab026> PMID: 34015132
22. Achenbach TM, Rescorla LA. Manual for the ASEBA adult forms & profiles. Burlington: University of Vermont, Research Center for Children, Youth & Families; 2003.
23. Rescorla LA, Achenbach TM, 2004. The Achenbach System of Empirically Based Assessment (ASEBA) for Ages 18 to 90 Years. In Maruish M.E.(Ed). The use of psychological testing for treatment planning and outcomes assessment. Volume 3: Instruments for adults, New York: Lawrence Erlbaum Associate Publishers; 2004, p. 115–52.
24. Ivanova MY, Achenbach TM, Rescorla LA, Tumer LV, Ahmeti-Pronaj A, Au A, et al. Syndromes of self-reported psychopathology for ages 18–59 in 29 societies. *J Psychopathol Behav Assess*. 2015; 37(2): 171–83. <https://doi.org/10.1007/s10862-014-9448-8> PMID: 29805197
25. Achenbach TM. Achenbach system of empirically based assessment (ASEBA). In John Wiley & Sons (Ed). The encyclopedia of clinical psychology. 2014, p. 1–8. <https://doi.org/10.1002/9781118625392.wbecp150>
26. Sheehan DV, Lecrubier Y, Sheehan KH, Amorim P, Janavs J, Weiller E, et al. The Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry*. 1998; 59 (Suppl20): 22–33, quiz 34–57. PMID: 9881538
27. Goldberg M, Leclerc A, Bonenfant S, Chastang JF, Schmaus A, Kaniewski N, et al. Cohort profile: the GAZEL Cohort Study. *Int J Epidemiol*. 2007; 36(1): 32–9. <https://doi.org/10.1093/ije/dyl247> PMID: 17101614
28. Allchin A, Melchior M, Fombonne E, Surkan PJ. Parental social networks during childhood and offspring depression in early adulthood: a lifecourse approach. *Depress Anxiety*. 2016; 33(11): 1031–8. <https://doi.org/10.1002/da.22538> PMID: 27373544
29. Melchior M, Touchette E, Prokofyeva E, Chollet A, Fombonne E, Elidemir G, et al. Negative events in childhood predict trajectories of internalizing symptoms up to young adulthood: an 18-year longitudinal study. *PLoS One*. 2014; 9(12): e114526. <https://doi.org/10.1371/journal.pone.0114526> PMID: 25485875
30. Service Public. Tests PCR: plus besoin d'une ordonnance pour en bénéficier et être remboursé [PCR tests: no more need for a prescription to benefit and be reimbursed]. République Française, 2020. Available from <https://www.service-public.fr/particuliers/actualites/A14195> [accessed 25 January 2021]
31. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand*. 1983; 67 (6): 361–70. <https://doi.org/10.1111/j.1600-0447.1983.tb09716.x> PMID: 6880820
32. Peretti-Watel P, Verger P, Launay O, COCONEL Study Group. The French general population's attitudes toward lockdown against COVID-19: a fragile consensus. *BMC Public Health*. 2020; 20(1): 1920. <https://doi.org/10.1186/s12889-020-10048-1> PMID: 33339543
33. Mazza C, Ricci E, Biondi S, Colasanti M, Ferracuti S, Napoli C, et al. A nationwide survey of psychological distress among Italian people during the COVID-19 pandemic: Immediate psychological responses and associate factors. *Int Environ Res Public Health*. 2020; 17(9): 3165. <https://doi.org/10.3390/ijerph17093165> PMID: 32370116
34. Odriozola-Gonzalez P, Planchuelo-Gomez A, Iruiria MJ, de Luis-Garcia R. Psychological symptoms of the outbreak of the COVID-19 confinement in Spain. *J Health Psychol*. 2020. <https://doi.org/10.1177/1359105320967086> PMID: 33124471
35. Shevlin M, McBride O, Murphy J, Miller JG, Hartman TK, Levita L, et al. Anxiety, depression, traumatic stress and COVID-19-related anxiety in the UK general population during the COVID-19 pandemic. *Br J Health Psychol Open*. 2020; 6(6): e125. <https://doi.org/10.1192/bjo.2020.109> PMID: 33070797
36. Rajkumar RP. COVID-19 and mental health: A review of the existing literature. *Asian J Psychiatr*. 2020; 52: 102066. <https://doi.org/10.1016/j.ajp.2020.102066> PMID: 32302935
37. Fond G, Lançon C, Auquier P, Boyer L. Prévalence de la dépression majeure en France en population générale et en populations spécifiques de 2000 à 2018: une revue systématique de la littérature [Prevalence of major depression in France in general and specific populations from 2000 to 2018: a systematic review of the literature]. *La Presse Médicale*. 2019; 48(4): 365–5. Available from <https://hal-amu.archives-ouvertes.fr/hal-02473305/document> [accessed 25 January 2021] <https://doi.org/10.1016/j.lpm.2018.12.004> PMID: 30679093
38. Filipovic-Pierucci A, Samson S, Fagot JP, Campagna AF. Estimating the prevalence of depression associated with healthcare use in France using administrative databases. *BMC Psychiatry*. 2017; 17 (1): 1. <https://doi.org/10.1186/s12888-016-1163-4> PMID: 28049496

39. Pignon B, Amad A, Pelissolo A, Fovet T, Thomas P, Vaiva G, et al. Increased prevalence of anxiety disorders in third-generation migrants in comparison to native and first-generation migrants. *J Psychiatr Res.* 2018; 102: 38–43. <https://doi.org/10.1016/j.jpsychires.2018.03.007> PMID: 29597072
40. Holmes EA, O'Connor R, Perry VH, Tracey I, Wessely S, Arseneaut L, et al. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *Lancet Psychiatry.* 2020; 7(6): 547–60. [https://doi.org/10.1016/S2215-0366\(20\)30168-1](https://doi.org/10.1016/S2215-0366(20)30168-1) PMID: 32304649
41. Pierce M, Hope H, Ford T, Hatch S, Hotopf M, John A, et al. Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. *Lancet Psychiatry.* 2020; 7: 883–892. [https://doi.org/10.1016/S2215-0366\(20\)30308-4](https://doi.org/10.1016/S2215-0366(20)30308-4) PMID: 32707037
42. Yang L, Wu D, Hou Y, Wang X, Dai N, Wang G et al. Analysis of psychological state and clinical psychological intervention model of patients with COVID-19. medRxiv. 2020 <https://doi.org/10.1101/2020.03.22.20040899> published online March 24. Available from <https://www.medrxiv.org/content/10.1101/2020.03.22.20040899v1>
43. Taquet M, Luciano S, Geddes JR, Harrison PJ. Bidirectional associations between COVID-19 and psychiatric disorder: retrospective cohort studies of 62 354 COVID-19 cases in the USA. *Lancet Psychiatry.* 2021; 8: 130–140. [https://doi.org/10.1016/S2215-0366\(20\)30462-4](https://doi.org/10.1016/S2215-0366(20)30462-4) PMID: 33181098
44. Merikangas KR, Zhang H, Avenevoli S, Acharyya S, Neuenschwander M, Angst J, Zurich Cohort Study. Longitudinal trajectories of depression and anxiety in a prospective community study: the Zurich Cohort Study. *Arch Gen Psychiatry.* 2003; 60: 993–1000. <https://doi.org/10.1001/archpsyc.60.9.993> PMID: 14557144
45. Pine DS, Cohen P, Gurley D, Brook J, Ma Y. The risk of early-adulthood anxiety and depressive disorders in adolescents with anxiety and depressive disorders. *Arch Gen Psychiatry.* 1998; 55: 56–64. <https://doi.org/10.1001/archpsyc.55.1.56> PMID: 9435761
46. Penninx BWJH, Nolen WA, Lamers F, Zitman FG, Smit JH, Spinhoven P, et al. Two-year course of depressive and anxiety disorders: results from the Netherlands Study of Depression and Anxiety (NESDA). *J Affect Disord.* 2011; 133:76–85. <https://doi.org/10.1016/j.jad.2011.03.027> PMID: 21496929
47. Findlay LC, Arim R, Kohen D. Understanding the perceived mental health of Canadians during the COVID-19 pandemic. *Health Rep.* 2020; 31(4): 22–7. <https://doi.org/10.25318/82-003-x202000400003-eng> PMID: 32644764
48. Smith L, Jacob L, Yakkundi A, McDermott D, Armstrong NC, Barnett Y, et al Correlates of symptoms of anxiety and depression and mental wellbeing associated with COVID-19: a cross-sectional study of UK-based respondents. *Psychiatry Res.* 2020; 291: 113138. <https://doi.org/10.1016/j.psychres.2020.113138> PMID: 32562931
49. ACAPS. COVID-19: Impact on gender dynamics in the livelihoods sector within crisis-affected countries. Global Gender Analysis, October 2020. Available from file:///C:/Users/murie/AppData/Local/Temp/20201023_acaps_global_gender_analysis_on_livelihood.pdf [accessed 25 January 2021]
50. Glenister KM, Ervin K, Podubinski T. Detrimental health behavior changes among females, living in rural areas during the COVID-19 pandemic. *Int J Environ Res Public Health.* 2021; 18(2): E722. <https://doi.org/10.3390/ijerph18020722> PMID: 33467693
51. Wenham C. The gendered impact of the COVID-19 crisis and post-crisis period. European Parliament, Policy department for citizens' rights and constitutional affairs. Available from [https://www.europarl.europa.eu/RegData/etudes/STUD/2020/658227/IPOL_STU\(2020\)658227_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2020/658227/IPOL_STU(2020)658227_EN.pdf) [accessed 25 January 2021]
52. Jaunin-Stalder N, Mazzocato C. Hommes et femmes: Sommes-nous tous égaux face à la douleur ? [Men and women: Are we all equal in the face of pain?] *Rev Med Suisse.* 2012; 8:1470–1473. Available from https://www.revmed.ch/view/500549/4122773/RMS_idPAS_D_ISBN_pu2012-26s_sa08_art08.pdf [accessed 11 May 2021] PMID: 22934476
53. Fillingim RB, King CD, Ribeiro-Dasilva MC, Rahin-Williams B, Riley JL III. Sex, gender, and pain: a review of recent clinical and experimental findings. *J Pain.* 2009; 10: 447–485. <https://doi.org/10.1016/j.jpain.2008.12.001> PMID: 19411059
54. Serafini G, Parmigiani B, Amerio A, Aguglia A, Sher L, Amore M. The psychological impact of COVID-19 on the mental health in the general population. *QJM.* 2020; 113(8): 531–537. <https://doi.org/10.1093/qjmed/hcaa201> PMID: 32569360
55. Ko CH, Yen CF, Yen JY, Yang MJ. Psychosocial impact among the public of the severe acute respiratory syndrome epidemic in Taiwan. *Psychiatry Clin Neurosci.* 2006; 60(4): 397–403. <https://doi.org/10.1111/j.1440-1819.2006.01522.x> PMID: 16884438
56. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet.* 2020; 395(10227): 912–20. [https://doi.org/10.1016/S0140-6736\(20\)30460-8](https://doi.org/10.1016/S0140-6736(20)30460-8) PMID: 32112714

57. Wilson JM, Lee J, Fitzgerald HN, Oosterhoff B, Sevi B, Shool NJ. Job insecurity and financial concern during the COVID-19 pandemic are associated with worse mental health. *J Occup Environ Med.* 2020; 62(9): 686–91. <https://doi.org/10.1097/JOM.0000000000001962> PMID: 32890205
58. Van Bortel T, Basnayake A, Wurie F, Jambai M, Sultan Koroma A, Muana AT, et al. Psychosocial effects of an Ebola outbreak at individual, community and international levels. *Bull World Health Organ.* 2016; 94(3): 210–214. <https://doi.org/10.2471/BLT.15.158543> PMID: 26966332
59. Szczesniak D, Gladka A, Misiak B, Cyran A, Rymaszewska J. The SARS-CoV-2 and mental health, from biological mechanisms to social consequences. *Prog Neuropsychopharmacol Biol Psychiatry.* 2021; 104: 110046. <https://doi.org/10.1016/j.pnpbp.2020.110046> PMID: 32730915
60. Alpert O, Begun L, Garren P, Solhkah R. Cytokine storm induced new onset depression in patients with COVID-19. A new look into the association between depression and cytokines- two case reports. *Brain Behav Immun Health.* 2020; 9: 100173. <https://doi.org/10.1016/j.bbih.2020.100173> PMID: 33163979
61. Ribeiro DE, Oliveira-Giacomelli A, Glaser T, Arnaud-Sampaio VF, Andrejew R, Dieckmann L, et al. Hyperactivation of P2X7 receptors as a culprit of COVID-19 neuropathology. *Mol Psychiatry.* 2020. <https://doi.org/10.1038/s41380-020-00965-3> PMID: 33328588