

















Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Mood and Behaviors of Adolescents With Depression in a Longitudinal Study Before and During the COVID-19 Pandemic

Neda Sadeghi, PhD , Payton Q. Fors, BA , Lillian Eisner, BA , Jeremy Taigman, BS , Karen Qi, BA , Lisa S. Gorham, BA , Christopher C. Camp, BS , Georgia O'Callaghan, PhD , Diana Rodriguez, BSN, MPA , Jerry McGuire, RN, Erin M. Garth, MSN, PPCNP-BC , Chana Engel, MSN, PMHNP-BC, Mollie Davis, MSW, LCSW-C2 , Kenneth E. Towbin, MD , Argyris Stringaris, MD, PhD, FRCPsych , Dylan M. Nielson, PhD 

Dr. Sadeghi and Mss. Fors and Eisner contributed equally to this work.

Objective: To investigate whether, compared to pre-pandemic levels, depressive and anxiety symptoms in adolescents with depression increased during the pandemic.

Method: We used data from National Institute of Mental Health Characterization and Treatment of Depression (NIMH CAT-D) cohort, a longitudinal case-control study that started pre-pandemic. Most of the participants are from the states of Maryland and Virginia in the United States. We compared depressive symptoms (1,820 measurements; 519 measurements pre-pandemic and 1,302 during the pandemic) and anxiety symptoms (1,800 measurements; 508 measurements pre-pandemic and 1,292 ratings during the pandemic) of 166 adolescents (109 girls, 96 adolescents with depression) before and during the pandemic. Data were collected during yearly clinical visits, interim 4-month follow-up visits, inpatient stays, and weekly outpatient sessions, with additional data collection during the pandemic. Pre-pandemic, healthy volunteers (HVs) had a median of 1 depressive and anxiety rating (range, 1-3), and adolescents with depression had a median of 2 ratings (anxiety rating range, 1-25; depressive rating range, 1-26). During the pandemic, HVs had a median of 8 anxiety ratings and 9 depressive ratings (range, 1-13), and adolescents with depression had a median of 7 anxiety and depressive ratings (range, 1-29). We also analyzed adolescent- and parent-reported behaviors in the CoRonavIruS Health Impact Survey (CRISIS), totaling 920 self-reported measures for 164 adolescents (112 girls, 92 adolescents with depression). HVs had a median of 7 surveys (range, 1-8), and adolescents with depression had a median of 5 surveys (range, 1-8).

Results: Pre-pandemic, adolescents with depression had a mean depressive score of 11.16 (95% CI = 10.10, 12.22) and HVs had a mean depressive score of 1.76 (95% CI = 0.40, 3.13), a difference of 9.40 points (95% CI = 7.78, 11.01). During the pandemic, this difference decreased by 22.6% (2.05 points, 95% CI = 0.71, 3.40, $p = .003$) due to 0.89 points decrease in severity of scores in adolescents with depression (95% CI = 0.08, 1.70, $p = .032$) and 1.16 points increase in HVs' depressive symptoms (95% CI = 0.10, 2.23, $p = .032$). Compared to their pre-pandemic levels, adolescents with depression reported overall lower anxiety symptoms during the pandemic. Parent-on-child reports also were consistent with these results.

Conclusion: Contrary to our hypothesis, we found that both depressive and anxiety symptoms were lower for adolescents with depression during the pandemic compared to before. In contrast, the depression scores for the HVs were higher during the pandemic relative to their pre-pandemic ratings; these scores remained much lower than those of adolescents with depression.

Clinical trial registration information: Characterization and Treatment of Adolescent Depression; <https://clinicaltrials.gov/>; NCT03388606.

Key words: depression; adolescence; COVID-19; longitudinal studies

J Am Acad Child Adolesc Psychiatry 2022;61(11):1341-1350. 

Depression is a leading cause of disability in adolescence,¹ predicts worse psychiatric outcomes,² and is strongly associated with suicide.³ The effects of the coronavirus disease 2019 (COVID-19) pandemic on adolescents with psychopathology, and depression in particular, have been a major public health concern⁴⁻⁹; yet, results so far remain unclear. Here, we address this gap

using a longitudinal cohort of adolescents with and without depression from whom we had pre-pandemic and intra-pandemic follow-up data from the National Institute of Mental Health Characterization and Treatment of Adolescent Depression (NIMH CAT-D) study.

The COVID-19 pandemic is a major environmental stressor with potentially devastating effects on mental

health,¹⁰⁻¹⁴ particularly for those with pre-existing mental health problems.^{5,15-17} School closures and reductions in social interactions and activities such as sports, accompanied by an increase in media use and decreased sleep, can adversely affect mental health.

Environmental stress is associated with worsening of symptoms and high rates of relapse in adults and adolescents with major depression,¹⁸⁻²¹ as underscored by previous post-disaster studies.²²⁻²⁴ These findings are consistent with theories on the interplay of stress and vulnerability.²⁵

Yet, there is still a lack of clarity about the pandemic's effect on vulnerable adolescents with depression. Individual studies have shown a wide range of effects on mental health in general, with some reporting medium to large effects on the mental health of children and adolescents^{10,26-29} and others reporting modest or nonsignificant effects.³⁰⁻³⁴ Meta-analyses of adult studies show that the effects of the pandemic on mental health are overall small.^{7,8} In the meta-analysis of longitudinal studies that also looked at changes in mental health symptoms in youths, the difference between pre-pandemic and pandemic levels was small and not statistically significant.⁸ However, in a study of adolescent depression and anxiety symptoms, using data from 12 longitudinal studies,⁴ depressive symptoms increased significantly (median, 28%), but anxiety symptoms did not. However, only 1 sample ($n = 50$ of 1,339 adolescents) consisted of patients with depression and controls, and the patients seemed not to show an increase in depressive symptoms. Moreover, to the best of our knowledge, there are no densely sampled longitudinal studies on the effects of the pandemic on adolescents with clinical depression specifically. Assessments before and after the pandemic are essential to investigate the relationships between the pandemic and subsequent mental health symptoms. Densely sampled data allow both for more precise estimation of symptom changes and for evaluation of changes in the trajectories of symptoms over time. Most of the studies so far have relied on convenience sampling with no pre-pandemic data, and none of the studies that are based on the longitudinal data specifically have looked at adolescents with depression or were densely sampled enough to examine changes in symptom trajectories before and during the pandemic. In addition, most of these studies have relied on 1 informant, mainly youths themselves. However, having the complementary information of both parent and child reports is considered best practice. For example, difficulties with behavior are more apparent to parents, whereas emotional distress is more apparent to children themselves.^{35,36}

To overcome this gap in research, we use the NIMH CAT-D cohort, a longitudinal case control study that started pre-pandemic. As part of the CAT-D study, state-of-

the-art diagnostic interviews were conducted with each participant, and standardized questionnaires were administered to youths and their parents/caretakers on a regular basis. Also, from the onset of the pandemic, participants reported on COVID-19–related metrics using a specially developed and validated measure.³⁷

We ask 2 main questions. First, is the COVID-19 pandemic associated with changes in depression and anxiety symptoms? We consider average depression and anxiety symptoms, their trajectories, and compare healthy adolescents to adolescents with depression. Based on prior theory, we hypothesized that depression and anxiety symptoms would increase during the pandemic particularly for those with depression.

Second, we ask whether the COVID-19 pandemic is associated with changes in participants' key habits (eg, amount of sleep), behaviors (eg, exercise), relationships with family and peers, and their worries about their own physical and mental health.

METHOD

The research was performed with permission from and approved by NIMH's Institutional Review Board. All youth gave verbal and written assent, and parents gave verbal and written consent.

Participants

The data presented here are part of CAT-D, an ongoing longitudinal study at NIMH examining the development and course of depression among adolescents. CAT-D is ongoing and recruiting adolescents via community practitioner referrals, self-referrals, and responses to advertisements in the community (mainly Maryland, Virginia, and District of Columbia). To be included in the CAT-D study, one must be between ages of 11 and 17 years at the time of enrollment and have a past or current diagnosis of major depressive disorder (MDD) or subthreshold depression (s-MDD), or be included as a healthy volunteer (HV). Additional information about the study and inclusion and exclusion criteria can be found in Supplement 1, available online.

As part of the CAT-D study, adolescents with current diagnosis of MDD were also offered treatment at NIMH. Prior to the pandemic, inpatient and outpatient treatment were available; after the pandemic, outpatient treatment was offered by remote telehealth. Cognitive–behavioral therapy (CBT) was provided to all who received treatment.

There were 279 participants enrolled in the CAT-D study as of March 11, 2021 (Table S1, available online). Additional inclusion criteria were used to create subsamples

for the analyses (Figures S1 and S2, available online). For this study, we included adolescents who had a clinical determination as an HV or as a volunteer with past or current MDD (referred to here as “adolescent with depression”) based on clinician ratings on the Kiddie Schedule for Affective Disorders and Schizophrenia—Present and Lifetime Version (KSADS-PL).³⁸ In addition, for the analyses comparing measures pre- and during the COVID-19 pandemic, we included only those participants who had available data both before and during the pandemic. The World Health Organization declared COVID-19 a pandemic on March 11, 2020, which we use as a reference date for our analyses. We defined pre-pandemic scores as those completed between March 11, 2019 and March 10, 2020, and pandemic scores as those completed between March 11, 2020 and March 11, 2021. In total, 166 participants were included to answer our first question about the association of the pandemic with depression and anxiety symptoms, having at least 1 (and up to 26) measurement of depression and/or anxiety before the pandemic and at least 1 (and up to 29) measurement during the pandemic. In all, there were 1,820 measurements of depressive symptoms (519 measurements pre-pandemic and 1,302 measurements during the pandemic), and 1,800 measurements of anxiety symptoms (508 measurements pre-pandemic and 1,292 measurements during the pandemic). To answer our second question about changes in the participants’ habits and behavior, 164 participants were included who had at least 1 pandemic depressive or anxiety rating, and 2 completed CoRonavIruS Health Impact Surveys (CRISIS), for a total of 920 surveys. Demographic information of cohorts used in the analyses are shown in Table 1. There were no significant differences between the demographics of participants included in these analyses vs those excluded (Tables S2, S3, and S5, available online) and their baseline measures prior to the pandemic (Table S4, available online).

A total of 32 subjects included in the current analyses participated in either inpatient or outpatient treatment; 24 of these participants (75%) finished treatment prior to the start of the pandemic.

Measures

Demographics. Adolescents’ birthdate, sex, and race are included in screening procedures during study enrollment. Age is determined based on reported birthdate.

Depression. Adolescent depressive symptoms were measured using either the parent- or youth-reported Mood and Feelings Questionnaire (MFQ), 2-week short version.³⁹ The MFQ short version contains 13 items using a 3-point

scale with established validity and reliability.^{39,40} Scores range from 0 to 26, with a higher score reflecting greater depressive symptoms.

Anxiety. Adolescent anxiety symptoms were measured using either the parent- or youth-reported Screen for Child Anxiety Related Disorders (SCARED) and the SCARED-short.⁴¹ Five common items using a 3-point scale from the SCARED and SCARED-short were used for scoring. The 5 common items are as follows: 1 = I get really frightened for no reason at all; 2 = I am afraid to be alone in the house; 3 = People tell me that I worry too much; 4 = I am scared to go to school; and 5 = I am shy. The SCARED was used pre-pandemic and is included in the ongoing CAT-D study protocol, whereas the SCARED-short was first used during the pandemic to minimize burden on participants and was bundled with each wave of CRISIS forms. Scores range from 0 to 10, with a higher score reflecting higher anxiety symptoms.

COVID-19–Related Measures. We used the CoRonavIruS Health Impact Survey (CRISIS)³⁷ youth version (crisissurvey.org), developed at the onset of the pandemic, as a tool to measure changes in mental health, daily behaviors, and relationships as a result of the pandemic.

The following items from CRISIS were used to assess behaviors in the pandemic: time spent outdoors, exercise, time spent playing video games, time spent watching television, time spent on social media, amount of sleep per night, changes in family relationships, and changes in friendships. Responses were given on a Likert scale from 0 to 4.

Time spent outdoors and exercising ranged from none to everyday (0 = none; 1 = 1-2 days; 2 = 3-4 days; 3 = 5-6 days; 4 = every day). Time spent playing video games, watching television, and on social media ranged from no time to more than 6 hours (0 = no time spent on these media; 1 = less than 1 hour; 2 = 1-3 hours; 3 = 4-6 hours; 4 = more than 6 hours).

Responses for amount of sleep per night ranged from less than 6 hours to more than 10 hours (a = less than 6 hours; b = 6-8 hours; c = 8-10 hours; d = more than 10 hours). We created 2 binary variables for sleep by combing the above choices. One sleep variable indicating too little sleep (0 = more than 6 hours; 1 = less than 6 hours) and another for too much sleep (0 = less than 10 hours; 1 = more than 10 hours).

Higher scores for changes in family relationships and friendships indicate worsening of relationships. Items were asked within the context of the 2 weeks prior to completing the CRISIS. In addition, a total worry composite score was

TABLE 1 Cohort Demographic Information

Depressive symptoms pre- and during pandemic	Anxiety symptoms pre- and during pandemic		COVID-19–related measures during pandemic					
	HV	MDD	HV	MDD				
n = 166	70	96	n = 166	69	97	n = 164	72	92
Age, y, at first pre- pandemic measure Median (IQR)	15.92 (14.62, 17.07)	16.68 (15.27, 17.41)	15.92 (14.62, 17.07)	16.68 (15.27, 17.41)	16.80 (15.35, 17.76)	17.45 (16.04, 18.25)		
Female participants	41	68	41	68	43	69		
Ethnicity Hispanic	5	6	5	6	4	5		
Race								
White	46	64	46	65	45	61		
Black	9	8	9	8	10	7		
Biracial	6	12	5	12	7	12		
Asian	8	10	8	10	8	11		
Native Hawaiian/ Pacific Islander	0	1	0	1	1	1		
NA/decline to answer	1	1	1	1	1	0		
State	MD: 65, VA: 3, Other: 2	MD: 69, VA: 10, Other: 17	MD: 64, VA: 3, Other: 2	MD: 69, VA: 10, Other: 18	MD: 66, VA: 4, Other: 2	MD: 68, VA: 10, Other: 14		

Note: HV = healthy volunteer; IQR = interquartile range; MD = Maryland; MDD = major depressive disorder; NA = not available; VA = Virginia.

created using 5 items that inquire about COVID-related concerns, including: worries about infection, physical and mental health, and amount of time reading or talking about the pandemic. Responses were given on a Likert scale of 0 to 4, and composite scores ranged from 0 to 20. A higher score indicated more worry.

Data Collection

We included MFQ and SCARED scores from March 11, 2019 through March 11, 2021, that were collected at normally scheduled CAT-D visits (every 4 months for adolescents with depression, and every year for HVs; since October 15, 2020, the data for HVs were also collected every 4 months) and during inpatient stays and outpatient visits (weekly). Individuals were seen in person prior to the pandemic and remote telehealth afterward for the annual and outpatient visits. Measures were filled out online. In addition, we included MFQ and SCARED scores collected in March 2020 immediately following the COVID-19 pandemic (up to 3 ratings) and 8 distinct waves of data collection from April 2020 to March 2021 which included MFQ, SCARED, and CRISIS measures. Supplement 2, available online, provides details on the dates of the CRISIS data collection, and Figures S3 and S4, available online, summarizes distribution of data. Source code and data of individuals who consented to data sharing are available on GitHub <https://github.com/nimh-compmpsy/COVID19-project>.

Statistical Analysis

Analyses and visualizations were completed in R using the lme4, lmerTest, sjPlot, gtsummary, and ggplot2 packages. Linear mixed effects models were generated for continuous outcomes (depressive and anxiety symptoms, worries, and behavioral measures), and a logistic mixed effects model was generated for the binarized sleep variable. Mixed effects models were fitted to the data to answer each question for both youth-reported and parent-reported data. Effect size was calculated using the Cohen d_z .

Two different models were used to answer whether the COVID-19 pandemic has affected adolescent depression and anxiety. In the first model, we compared the mean of healthy adolescents' and adolescents with depression's depressive and anxiety symptoms before and during the pandemic. This was done by including sex (male or female), group (HV or MDD), period (pre-pandemic, pandemic), and interaction of period and group as fixed effects and participant and period as random effects. Second, we examined depressive and anxiety symptoms trajectories before and during the pandemic among adolescents with depression. Participants with at least 2 time points pre-

pandemic and 2 time points during the pandemic were included for this analysis ($n = 59$, 73% female participants). Sex, time (in months), period (pre-pandemic, pandemic), and interaction of time and period were included as fixed effects. Intercept, time, period, and interaction of time and period were included as random effects.

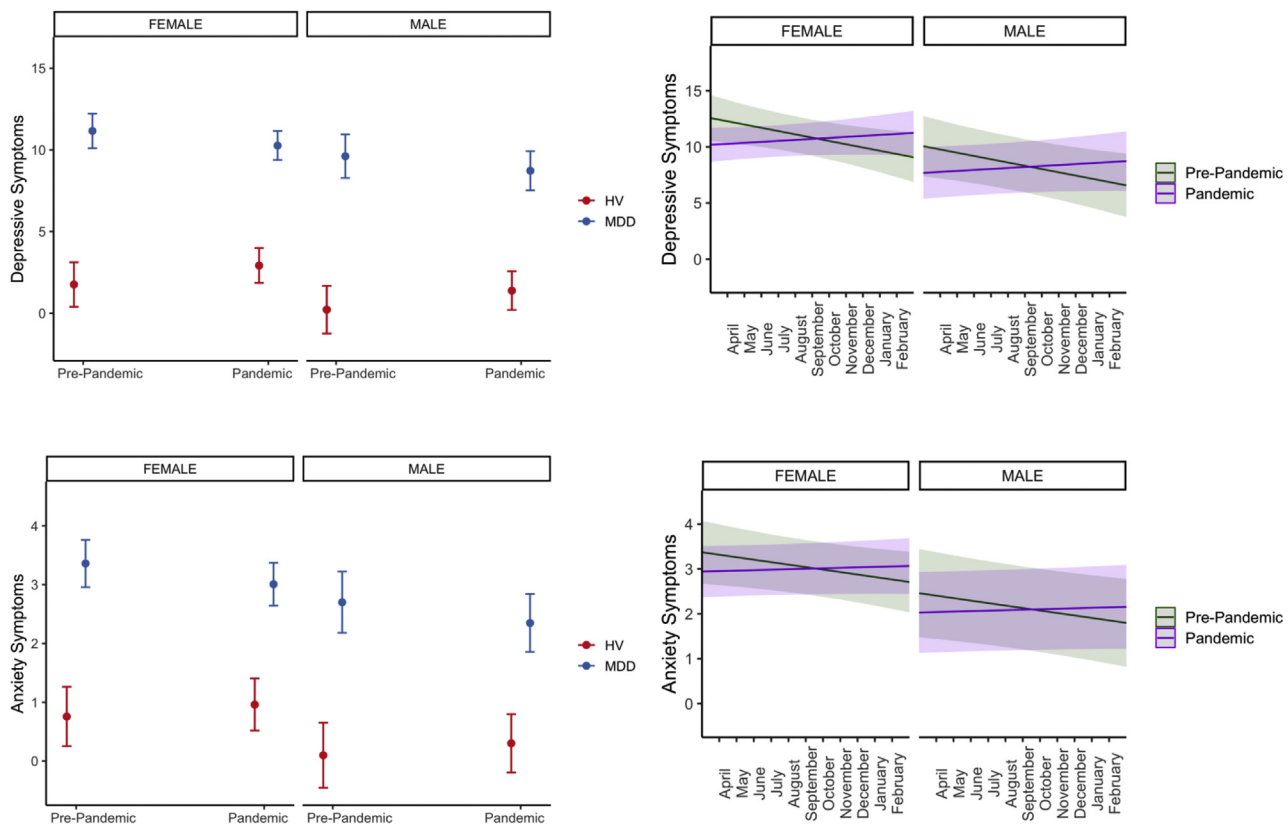
To answer the second question, we examined how behaviors and worries changed during the pandemic. Participants with at least 2 pandemic time points were included in this analysis. The main effects and interactions of diagnostic group and time were included as fixed effects, and intercept and slope (time) were also included as random effects. Bonferroni correction for multiple comparison was applied for results of COVID-19-related measures, considering $p < .005$ (.05/10) as significant.

RESULTS

Question 1: Is the COVID-19 Pandemic Associated With Adolescent Depression and Anxiety Symptoms?

Depression. Healthy volunteers reported mean depression scores of 1.76 (95% CI = 0.40, 3.13) pre-pandemic, and adolescents with depression reported mean depression scores of 11.16 (95% CI = 10.10, 12.22), a 9.40-point difference between the 2 groups (95% CI = 7.78, 11.01, $p < .001$), controlling for sex (Figure 1; Table S6, available online). During the pandemic, the difference decreased by 22.6% (2.05 points, 95% CI = 0.71, 3.40, $p = .003$) due to 1.16 points mean increase in HVs' depressive symptoms (95% CI = 0.10, 2.23, $p = 0.032$) and a slight decrease in scores of adolescents with depression (0.89 points, 95% CI = 0.08, 1.70, $p = 0.032$). Using parent-reported data, similar results were reached (Figure S5; Tables S7 and S8, available online).

We found that the trajectory of depression severity did not increase significantly during the pandemic for adolescents with depression. In the year prior to the pandemic, adolescents with depression started with mean depression scores of 12.57 (95% CI = 10.53, 14.61), and scores then trended downward 2% per month (0.29 points, 95% CI = 0.06, 0.52, $p = .015$) (Figure 1, Table S9, available online). At the beginning of the pandemic, scores were 18.9% lower than in the prior year (2.38 points, 95% CI = 0.37, 4.39, $p = .020$). During the pandemic, scores trended slightly, albeit not significantly, upward (0.09 points per month, 95% CI = -0.08, 0.25, $p = .31$) at a rate of 0.38 points per month (95% CI = 0.08, 0.67, $p = .012$) greater than the downward trend prior to the pandemic. The downward trend prior to the pandemic was not observed in the 33 individuals who were not participants in inpatient or

FIGURE 1 Depression and Anxiety Symptoms of Healthy Volunteers and Adolescents With Depression for Female and Male Participants

Note: The left side shows the mean depressive and anxiety symptoms of adolescents, and the right side shows the comparison of longitudinal changes of depression and anxiety symptoms of participants with depression before and during the pandemic. "Pre-pandemic" refers to March 11, 2019 to March 11, 2020, whereas "pandemic" refers to March 11, 2020 to March 11, 2021. HV = healthy volunteer; MDD = major depressive disorder. Please note color figures are available online.

outpatient treatment at NIMH during the study period and had at least 2 available data points during the pandemic (Figure S6 and Table S10, available online).

Anxiety. We did not find that anxiety increased more in adolescents with depression than in HVs. HVs reported anxiety scores of 0.76 (95% CI = 0.25, 1.26) (Table S6, available online) pre-pandemic, whereas adolescents with depression reported scores of 3.36 (95% CI = 2.95, 3.76), a between-group difference of 2.60 points (95% CI = 2.01, 3.19, $p < .001$), controlling for sex. During the pandemic, the difference decreased 21.5% (0.56 points, 95% CI = 0.14, 0.97, $p = .008$) owing to a nonsignificant increase in HVs' anxiety symptoms (0.20 points, 95% CI = -0.12, 0.53, $p = .221$) and a slight decrease in severity among adolescents with depression (0.35, 95% CI = 0.10, 0.61, $p = .007$) (Figure 1). Using parent-reported data, similar results were reached (Table S11, available online).

The trajectory of anxiety symptoms in adolescents with depression did not show a significant change during the

pandemic. Adolescents with depression began the year prior to the pandemic with average SCARED scores of 3.37 (95% CI = 2.67, 4.07) (Figure 1, Table S6, available online), and scores then trended downward 1.78% per month (0.06 points, 95% CI = 0, 0.11, $p = .048$) (Figure 1). During the pandemic, scores trended slightly, albeit not significantly, upward (0.01 points, 95% CI = -0.02, 0.04, $p = .501$) at a rate 0.07 points per month (95% CI = 0, 0.13, $p = .054$) greater than the downward trend prior to the pandemic. Parent-report results for anxiety were similarly nonsignificant (Table S11, available online).

Question 2: How Have Behaviors and Worries Changed Over Time During the Pandemic?

We evaluated self-reported worries, relationships, and behaviors for differences between adolescents with depression and HVs and differences in trends over time. HVs had an average baseline score of 6.55 on the worries section of the CRISIS questionnaire (95% CI = 5.75, 7.36), which assesses worries about COVID-19 and its impact on

TABLE 2 Comparison of Worry and Family Relationship Between Healthy Volunteers and Adolescents With Depression During the Pandemic via Mixed Effects Model Based on Self-Reports

	Worry			Family relationship		
	Estimate	95% CI	p	Estimate	95% CI	p
Intercept	6.55	5.75-7.36	<.001	1.89	1.73-2.05	<.001
Sex (male)	-0.81	-1.72 to 0.09	.078	-0.06	-0.22 to 0.11	.491
Group (MDD)	1.48	0.51-2.44	.003	0.29	0.10-0.48	.003
Time	-0.04	-0.11 to 0.04	.312	0.00	-0.02 to 0.02	.918
Group (MDD) × time	0.01	-0.09 to 0.11	.894	-0.01	-0.04 to 0.01	.262
ICC	0.62			0.47		
n		164			164	
Observations		920			920	
Marginal/conditional R ²		0.071/0.650			0.033/0.489	

Note: Boldface type indicates Bonferroni correction for multiple comparison was applied for results of COVID-19–related measures, considering $p < .005$ as significant. ICC = intraclass correlation coefficient; MDD = major depressive disorder.

themselves and their friends and family. Adolescents with depression scored 22.6% higher than HVs (1.48 points, 95% CI = 0.51, 2.44, $p = .003$) and reported worsening of family relationships (0.29 points, 95% CI = 0.10, 0.48, $p = .003$) (Table 2). They also spent more time playing video games than HVs (0.66 points, 95% CI = 0.32, 1, $p < .001$) (Table 3) and reported getting less than 6 hours of sleep more often, although this did not survive multiple comparison correction (odds ratio = 6.02, 95% CI = 1.47, 24.60, $p = .012$) (Table S12, available online). Other measures of activity such as time spent outdoors, engaging in exercise, and changes in friendships were not significantly different between adolescents with depression and HVs. We did not find differences in changes over time between adolescents with depression and HVs (Tables 2 and 3; Table S12, available online). Healthy adolescents had a trend of decreasing time watching television (-0.04 points

per month, 95% CI = -0.06, -0.02, $p = .001$) over the pandemic. We also examined sex differences in the same models; compared to female participants, male participants reported spending more time playing video games (1.29 points, 95% CI = 0.96, 1.61, $p < .001$) and less time on social media (-0.50 points, 95% CI = -0.79, -0.22, $p = .001$).

In parent-reported data, adolescents with depression had less exercise (-0.81 points, 95% CI = -1.26, -0.35, $p = .001$) and less time spent outdoors (-0.78 points, 95% CI = -1.19, -0.36, $p < .001$) than HVs (Table S13, available online). For trends over time during the pandemic, parents of HVs reported a slight decrease in time spent outdoors (-0.05 point per month, 95% CI = -0.08, -0.02, $p = .002$); however, as with the self-report data, there were no significant differences between the 2 groups.

TABLE 3 Comparison of Time Spent on Digital Media Between Healthy Volunteers and Adolescents With Depression During the Pandemic via Mixed Effects Model Based on Self-Reports

	Time spent playing video games			Time spent watching television			Time spent on social media		
	Estimate	95% CI	p	Estimate	95% CI	p	Estimate	95% CI	p
Intercept	0.68	0.40-0.97	<.001	2.33	2.13-2.53	<.001	2.20	1.94-2.47	<.001
Sex (male)	1.29	0.96-1.61	<.001	0.08	-0.13 to 0.29	.473	-0.50	-0.79 to -0.22	.001
Group (MDD)	0.66	0.32-1.00	<.001	0.23	-0.01 to 0.48	.061	-0.03	-0.35 to 0.30	.878
Time	-0.01	-0.04 to 0.01	.302	-0.04	-0.06 to -0.02	.001	-0.01	-0.03 to 0.01	.462
Group (MDD) × time	-0.02	-0.05 to 0.01	.251	0.03	0.00-0.06	.047	0.00	-0.03 to 0.04	.834
ICC		0.70			0.50			0.73	
n		164			164			164	
Observations		920			920			920	
Marginal/conditional R ²		0.237/0.775			0.052/0.530			0.052/0.741	

Note: Boldface type indicates Bonferroni correction for multiple comparison was applied for results of COVID-19–related measures, considering $p < .005$ as significant. ICC = intraclass correlation coefficient; MDD = major depressive disorder.

Sensitivity Analyses

It is worth noting that our adolescents with depression included participants with both ongoing and past diagnoses of MDD. To evaluate whether the results are influenced based on the clinical status, we performed a sensitivity analysis. We reran the analyses, including the clinical status in the model (Table S14, available online). Both groups had higher depression scores compared to HVs. Pre-pandemic, depression scores of adolescents with depression were 12.21 points higher (95% CI = 10.35, 14.07), and the depression scores of the remaining adolescents with depression were 7.35 points higher (95% CI = 5.63, 9.06) than those of HVs (1.74; 95% CI = 0.46, 3.03). During the pandemic, the difference between depression scores of HVs and participants with ongoing MDD decreased by 21.4% (2.61 points, 95% CI = 0.97, 4.26, $p = .002$), and the difference between HVs and the rest of the adolescents with depression decreased by 22.8% (1.68 points, 95% CI = 0.16, 3.19, $p = 0.03$). However, there was no significant difference between changes in MFQ scores from pre-pandemic to during pandemic between those with ongoing MDD vs the rest of the participants with MDD (0.94 points, 95% CI = 0.73, 2.60, $p = .27$).

A total of 32 participants (about a third of our adolescents with depression) received CBT treatment from NIMH clinicians during the study. The majority completed treatment prior to the start of the pandemic (75%, $n = 24$). However, to confirm that inclusion of NIMH-treated participants did not have an impact on our results, we conducted sensitivity analyses. Running the analyses about the effect of COVID-19 on depression and anxiety symptoms restricted to participants who did not enroll in the CBT treatment at NIMH did not alter our main results. The depressive and anxiety ratings for adolescents with depression remained higher in the pre-pandemic period compared to the pandemic period (Table S15).

In addition, we have included the demographics of those included vs excluded in the above analyses in Tables S2 to S5 (available online). There is no significant difference in sex, race, ethnicity, participation region, and first available MFQ and SCARED scores between those who are included in these analyses and those who are not. We have also performed additional analyses to assess whether there is any effect of the pandemic on subgroups (eg, dividing by age, sex), and we observed a pattern similar to that of the overall group in which depressive and anxiety symptoms were lower during the pandemic compared to pre-pandemic for adolescents with depression and higher for HVs. Compared to pre-pandemic, the female HV subgroup and the younger HVs (younger than the median age of 16.4

years) had significantly higher depressive and anxiety symptoms during the pandemic. For those with depression, the male subgroup had significantly lower depressive and anxiety symptoms during the pandemic compared to pre-pandemic. In addition, the older male subgroup with depression (older than the median age of 16.4 years) had lower depressive symptoms during the pandemic compared to pre-pandemic (Tables S16 and S17, available online).

DISCUSSION

The COVID-19 pandemic has raised substantial concerns about child mental health, particularly for those already burdened with psychiatric disorders, such as depression. This study analyzed densely collected longitudinal data from healthy adolescents and adolescents with depression over the period of the year before the pandemic through its first year. Compared to pre-pandemic, adolescents with depression reported lower depressive and anxiety symptoms during the pandemic. HVs reported higher depressive symptoms during the pandemic. Although the increase of 1.16 points is well below the 6-point reliable change index for the MFQ,⁴² it represents a medium effect size of $d = 0.46$. Such an increase in the general population could have a substantial public health impact.

Our findings are in line with studies on clinically depressed adult populations for whom having a pre-pandemic diagnosis did not predict significantly worsened depressive or anxiety symptoms.⁴³⁻⁴⁸ In some studies, clinically depressed adult populations even fared better; Tundo *et al.* reported that the psychological impact of pandemic stress on adult patients with pre-existing mood, anxiety, and obsessive-compulsive disorders relative to their family and friends was similar in 52.1% of the sample, better in 37.1%, and worse in 10.8%.⁴⁹ Another study reported increased symptoms of anxiety and depression for healthy adolescents after the onset of the COVID-19 pandemic, but no significant changes in these symptoms for adolescents with exposure to early life stress.⁵⁰ A meta-analysis of longitudinal cohort studies indicated an overall small increase in mental health symptoms during the pandemic, but no evidence of any change in symptoms among samples with pre-existing mental health conditions.⁸

For anxiety symptoms, comparing pre-pandemic to during the pandemic, we found that adolescents with depression reported less anxiety during the pandemic. In contrast, healthy adolescents reported higher anxiety, although for HVs this change was not significant in our study. There were also no significant changes in parent-reported anxiety symptoms of HVs, similar to previous findings.²⁶

Our study suggests overall lower depression and anxiety symptoms for adolescents with depression during the pandemic compared to pre-pandemic. Possible explanations for this are that adolescents with depression might have felt relief with reduced exposure to stressful social situations (eg, large social gatherings and school). Also, the general increase in worry in the population might have led adolescents with depression to feel less isolated. It is also important to note that although the change in depressive symptoms, measured by the short MFQ, during pandemic compared to pre-pandemic period is statistically significant, a 0.89-point change is well below the 6-point reliable change index for this measure.

This study's strengths include its dense sampling of the cohort before and during the pandemic, its use of clinical diagnoses of depression pre-pandemic, and its inclusion of both self-report and parent-report of mood. Limitations of this study are that most of our participants are from the District of Columbia, Maryland, and Virginia. Such a geographically limited sample may not be representative of other areas. The racial composition of our cohort has less Latino and greater Asian distribution compared to the United States population. Furthermore, participants in our study were under psychiatric care; the effects of the pandemic could be worse for adolescents with depression who did not have access to mental health care, whose access to care was even more restricted by the pandemic, or those who, for geographic, ethnic, and socioeconomic reasons, are severely underserved.

Although we observed changes in the measurements between pre-pandemic and pandemic periods, this does not establish a causal relationship between the pandemic and the patterns that we have observed.

Contrary to our initial hypothesis, we did not find a differential increase in depressive symptoms in our adolescents with depression compared to HVs. Depressive and anxiety symptoms did not increase for adolescents with depression during the pandemic, but did increase for HVs. Future work is needed to track the effects of the COVID-19 pandemic long term across a range of diagnoses, regions, co-occurring stressors, and living conditions.

REFERENCES

- Gore FM, Bloem PJ, Patton GC, *et al.* Global burden of disease in young people aged 10–24 years: a systematic analysis. *Lancet*. 2011;377(9783):2093-2102. [https://doi.org/10.1016/S0140-6736\(11\)60512-6](https://doi.org/10.1016/S0140-6736(11)60512-6)
- Weissman M, Wolk S, Goldstein RB, *et al.* Depressed adolescents grown up. *JAMA*. 1999;281(18):1707-1713. <https://doi.org/10.1001/jama.281.18.1707>
- Melhem NM, Porta G, Oquendo MA, *et al.* Severity and variability of depression symptoms predicting suicide attempt in high-risk individuals. *JAMA Psychiatry*. 2019;76(6):603. <https://doi.org/10.1001/jamapsychiatry.2018.4513>
- Barendse M, Flannery J, Cavanagh C, *et al.* Longitudinal change in adolescent depression and anxiety symptoms from before to during the COVID-19 pandemic: an international collaborative of 12 samples. Published online 2021. Preprint <https://doi.org/10.31234/osf/hn7us>
- Jones EAK, Mitra AK, Bhuiyan AR. Impact of COVID-19 on mental health in adolescents: a systematic review. *Int J Environ Res Public Health*. 2021;18(5). <https://doi.org/10.3390/ijerph18052470>
- Pfefferbaum B, North CS. Mental health and the COVID-19 pandemic. *N Engl J Med*. 2020;383(6):510-512. <https://doi.org/10.1056/NEJMp2008017>
- Prati G, Mancini AD. The psychological impact of COVID-19 pandemic lockdowns: a review and meta-analysis of longitudinal studies and natural experiments. *Psychol Med*. Published online January 13, 2021:1-11. <https://doi.org/10.1017/S0033291721000015>
- Robinson E, Sutin AR, Daly M, Jones A. A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic. *J Affect Disord*. 2022;296:567-576. <https://doi.org/10.1016/j.jad.2021.09.098>
- Yao H, Chen JH, Xu YF. Patients with mental health disorders in the COVID-19 epidemic. *Lancet Psychiatry*. 2020;7(4):E21. [https://doi.org/10.1016/S2215-0366\(20\)30090-0](https://doi.org/10.1016/S2215-0366(20)30090-0)
- Adegoye D, Williams F, Collishaw S, *et al.* Understanding why the COVID-19 pandemic-related lockdown increases mental health difficulties in vulnerable young children. *JCPP Adv*. 2021;1(1):e12005. <https://doi.org/10.1111/jcv2.12005>

Accepted April 1, 2022.

At the time of the study, Dr. Towbin and Prof. Stringaris, Mss. Eisner, Qi, Gorham, Rodriguez, Garth, Engel, and Davis, Messrs. Taigman, Camp, McGuire, were affiliated with the Section of Clinical and Computational Psychiatry, National Institute of Mental Health, Bethesda, Maryland. Mss. Eisner, Qi, Rodriguez, Engel, Davis, Mr. Taigman, and Dr. Towbin are currently with the Emotion and Development Branch, National Institute of Mental Health, Bethesda, Maryland. Ms. Gorham is currently with the Medical Scientist Training Program, Washington University in St. Louis School of Medicine, St. Louis, Missouri. Mr. Camp is currently with the Interdepartmental Neuroscience Program, Yale University, New Haven, Connecticut. Mr. McGuire is currently with the Experimental Therapeutics and Pathophysiology Branch, National Institute of Mental Health, Bethesda, Maryland. Ms. Garth is currently with the Autoimmune Brain Disorders Program, National Institute of Mental Health, Bethesda, Maryland. Prof. Stringaris is currently with the National and Kapodistrian University of Athens, Greece, and University College London, United Kingdom.

This research was supported by the Intramural Research Program of NIMH/ National Institutes of Health (NIH; ZIA-MH002957-01 to A.S.)

Author Contributions

Conceptualization: Sadeghi, Stringaris, Nielson

Data curation: Fors, Eisner, Taigman, Qi, Gorham, Camp, O'Callaghan, Rodriguez, McGuire

Formal analysis: Sadeghi, Fors, Eisner

Funding acquisition: Stringaris

Investigation: Sadeghi, Fors, Eisner

Methodology: Sadeghi, Fors, Eisner, Stringaris, Nielson

Project administration: Garth, Engel, Davis, Towbin, Stringaris

Resources: Stringaris

Software: Sadeghi, Fors, Eisner

Supervision: Towbin, Stringaris

Validation: Sadeghi, Fors, Eisner

Visualization: Sadeghi, Fors, Eisner

Writing – original draft: Sadeghi, Fors, Stringaris, Nielson

Writing – review and editing: Sadeghi, Fors, Eisner, Taigman, Qi, Engel, Towbin, Stringaris, Nielson

The authors would like to thank participants of this study and their families.

Disclosure: Prof. Stringaris is a coauthor of the Affective Reactivity Index (ARI), a cost-free psychometric instrument. He has received royalties from Cambridge University Press for *The Maudsley Reader in Phenomenological Psychiatry* and Oxford University Press for *Disruptive Mood: Irritability in Children and Adolescents*. Drs. Sadeghi, O'Callaghan, Towbin, and Nielson, Mss. Fors and Eisner, Mr. Taigman, Mss. Qi and Gorham, Mr. Camp, Ms. Rodriguez, Mr. McGuire, and Mss. Garth, Engel, and Davis have reported no biomedical financial interests or potential conflicts of interest.

Correspondence to Professor Argyris Stringaris, MD, PhD, Department of Psychiatry and Department of Clinical, Educational & Health Psychology, University College London, 1-19 Torrington Place, London, WC1E 6HB, United Kingdom; e-mail: a.stringaris@ucl.ac.uk

0890-8567/\$36.00/©2021 American Academy of Child and Adolescent Psychiatry. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

<https://doi.org/10.1016/j.jaac.2022.04.004>

11. Luo M, Guo L, Yu M, Jiang W, Wang H. The psychological and mental impact of coronavirus disease 2019 (COVID-19) on medical staff and general public—a systematic review and meta-analysis. *Psychiatry Res.* 2020;291:113190. <https://doi.org/10.1016/j.psychres.2020.113190>
12. Salehi M, Amanat M, Mohammadi M, *et al.* The prevalence of post-traumatic stress disorder related symptoms in Coronavirus outbreaks: a systematic-review and meta-analysis. *J Affect Disord.* 2021;282:527-538. <https://doi.org/10.1016/j.jad.2020.12.188>
13. Panda PK, Gupta J, Chowdhury SR, *et al.* Psychological and behavioral impact of lockdown and quarantine measures for COVID-19 pandemic on children, adolescents and caregivers: a systematic review and meta-analysis. *J Trop Pediatr.* Published online December 27, 2020. <https://doi.org/10.1093/tropej/fmaa122>
14. Wu T, Jia X, Shi H, *et al.* Prevalence of mental health problems during the COVID-19 pandemic: a systematic review and meta-analysis. *J Affect Disord.* 2021;281:91-98. <https://doi.org/10.1016/j.jad.2020.11.117>
15. Guessoum SB, Lachal J, Radjack R, *et al.* Adolescent psychiatric disorders during the COVID-19 pandemic and lockdown. *Psychiatry Res.* 2020;291:113264. <https://doi.org/10.1016/j.psychres.2020.113264>
16. Kunzler AM, Röthke N, Günthner L, *et al.* Mental burden and its risk and protective factors during the early phase of the SARS-CoV-2 pandemic: systematic review and meta-analyses. *Glob Health.* 2021;17(1):34. <https://doi.org/10.1186/s12992-021-00670-y>
17. Solomou I, Constantinidou F. Prevalence and predictors of anxiety and depression symptoms during the COVID-19 pandemic and compliance with precautionary measures: age and sex matter. *Int J Environ Res Public Health.* 2020;17(14):4924. <https://doi.org/10.3390/ijerph17144924>
18. Auerbach RP, Ho MHR, Kim JC. Identifying cognitive and interpersonal predictors of adolescent depression. *J Abnorm Child Psychol.* 2014;42(6):913-924. <https://doi.org/10.1007/s10802-013-9845-6>
19. Burcusa SL, Iacono WG. Risk for recurrence in depression. *Clin Psychol Rev.* 2007;27(8):959-985. <https://doi.org/10.1016/j.cpr.2007.02.005>
20. Paykel ES, Tanner J. Life events, depressive relapse and maintenance treatment. *Psychol Med.* 1976;6(3):481-485. <https://doi.org/10.1017/S0033291700015920>
21. Vibhakar V, Allen LR, Gee B, Meiser-Stedman R. A systematic review and meta-analysis on the prevalence of depression in children and adolescents after exposure to trauma. *J Affect Disord.* 2019;255:77-89. <https://doi.org/10.1016/j.jad.2019.05.005>
22. Bromet EJ, Atwoli L, Kawakami N, *et al.* Post-traumatic stress disorder associated with natural and human-made disasters in the World Mental Health Surveys. *Psychol Med.* 2017;47(2):227-241. <https://doi.org/10.1017/S0033291716002026>
23. Goldmann E, Galea S. Mental health consequences of disasters. *Annu Rev Public Health.* 2014;35(1):169-183. <https://doi.org/10.1146/annurev-publhealth-032013-182435>
24. North CS, Pfefferbaum B. Mental health response to community disasters: a systematic review. *JAMA.* 2013;310(5):507. <https://doi.org/10.1001/jama.2013.107799>
25. Nielsen JD, Mennies RJ, Olino TM. Application of a diathesis-stress model to the interplay of cortical structural development and emerging depression in youth. *Clin Psychol Rev.* 2020;82:101922. <https://doi.org/10.1016/j.cpr.2020.101922>
26. Bignardi G, Dalmaijer ES, Anwyll-Irvine AL, *et al.* Longitudinal increases in childhood depression symptoms during the COVID-19 lockdown. Published online November 27, 2020. <https://doi.org/10.17863/CAM.60688>
27. Giuntella O, Hyde K, Saccardo S, Sadoff S. Lifestyle and mental health disruptions during COVID-19. *Proc Natl Acad Sci.* 2021;118(9):e2016632118. <https://doi.org/10.1073/pnas.2016632118>
28. Pierce M, Hope H, Ford T, *et al.* Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. *Lancet Psychiatry.* 2020;7(10):883-892. [https://doi.org/10.1016/S2215-0366\(20\)30308-4](https://doi.org/10.1016/S2215-0366(20)30308-4)
29. Thorisdottir IE, Asgeirsdottir BB, Kristjansson AL, *et al.* Depressive symptoms, mental wellbeing, and substance use among adolescents before and during the COVID-19 pandemic in Iceland: a longitudinal, population-based study. *Lancet Psychiatry.* 2021;8(8):663-672. [https://doi.org/10.1016/S2215-0366\(21\)00156-5](https://doi.org/10.1016/S2215-0366(21)00156-5)
30. Achterberg M, Dobbelaar S, Boer OD, Crone EA. Perceived stress as mediator for longitudinal effects of the COVID-19 lockdown on wellbeing of parents and children. *Sci Rep.* 2021;11. <https://doi.org/10.1038/s41598-021-81720-8>
31. Hawes MT, Szczytko AK, Klein DN, Hajcak G, Nelson BD. Increases in depression and anxiety symptoms in adolescents and young adults during the COVID-19 pandemic. *Psychol Med.* 2021;1-9. <https://doi.org/10.1017/S0033291720005358>
32. Koenig J, Kohls E, Moessner M, *et al.* The impact of COVID-19 related lockdown measures on self-reported psychopathology and health-related quality of life in German adolescents. *Eur Child Adolesc Psychiatry.* Published online July 10, 2021. <https://doi.org/10.1007/s00787-021-01843-1>
33. Kwong ASF, Pearson RM, Adams MJ, *et al.* Mental health before and during the COVID-19 pandemic in two longitudinal UK population cohorts. *Br J Psychiatry.* 2021;218(6):334-343. <https://doi.org/10.1192/bjp.2020.242>
34. Magson NR, Freeman JYA, Rapee RM, Richardson CE, Oar EL, Fardouly J. Risk and protective factors for prospective changes in adolescent mental health during the COVID-19 pandemic. *J Youth Adolesc.* 2021;50(1):44-57. <https://doi.org/10.1007/s10964-020-01332-9>
35. Angold A, Weissman MM, John K, *et al.* Parent and child reports of depressive symptoms in children at low and high risk of depression. *J Child Psychol Psychiatry.* 1987;28(6):901-915. <https://doi.org/10.1111/j.1469-7610.1987.tb00678.x>
36. Thapar A, Pine DS, Leckman JF, Scott S, Snowling MJ, Taylor EA. *Rutter's Child and Adolescent Psychiatry.* John Wiley & Sons; 2017.
37. Nikolaidis A, Paksarian D, Alexander L, *et al.* The Coronavirus Health and Impact Survey (CRISIS) reveals reproducible correlates of pandemic-related mood states across the Atlantic. *Sci Rep.* 2021;11. <https://doi.org/10.1038/s41598-021-87270-3>
38. Kaufman J, Birmaher B, Brent D, *et al.* Schedule for Affective Disorders and Schizophrenia for School-Age Children—Present and Lifetime Version (K-SADS-PL): initial reliability and validity data. *J Am Acad Child Adolesc Psychiatry.* 1997;36(7):980-988. <https://doi.org/10.1097/00004583-199707000-00021>
39. Angold A, Costello EJ, Messer SC, Pickles A. Development of a short questionnaire for use in epidemiological studies of depression in children and adolescents. *Int J Methods Psychiatr Res.* 1995;5(4):237-249.
40. Turner N, Joinson C, Peters TJ, Wiles N, Lewis G. Validity of the Short Mood and Feelings Questionnaire in late adolescence. *Psychol Assess.* 2014;26(3):752-762. <https://doi.org/10.1037/a0036572>
41. Birmaher B, Khetarpal S, Brent D, *et al.* The Screen for Child Anxiety Related Emotional Disorders (SCARED): scale construction and psychometric characteristics. *J Am Acad Child Adolesc Psychiatry.* 1997;36(4):545-553. <https://doi.org/10.1097/00004583-199704000-00018>
42. Liu FF, Adrian MC. Is treatment working? Detecting real change in the treatment of child and adolescent depression. *J Am Acad Child Adolesc Psychiatry.* 2019;58(12):1157-1164. <https://doi.org/10.1016/j.jaac.2019.02.011>
43. Creese B, Khan Z, Henley W, *et al.* Loneliness, physical activity, and mental health during COVID-19: a longitudinal analysis of depression and anxiety in adults over the age of 50 between 2015 and 2020. *Int Psychogeriatr.* 2021;33(5):505-514. <https://doi.org/10.1017/S1041610220004135>
44. Daly M, Sutín AR, Robinson E. Depression reported by US adults in 2017–2018 and March and April 2020. *J Affect Disord.* 2021;278:131-135. <https://doi.org/10.1016/j.jad.2020.09.065>
45. Hamm ME, Brown PJ, Karp JF, *et al.* Experiences of American older adults with pre-existing depression during the beginnings of the COVID-19 pandemic: a multicity, mixed-methods study. *Am J Geriatr Psychiatry.* 2020;28(9):924-932. <https://doi.org/10.1016/j.jagp.2020.06.013>
46. Meda N, Pardini S, Slongo I, *et al.* Students' mental health problems before, during, and after COVID-19 lockdown in Italy. *J Psychiatr Res.* 2021;134:69-77. <https://doi.org/10.1016/j.jpsychires.2020.12.045>
47. Pan KY, Kok AAL, Eikelenboom M, *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 three Dutch case-control cohorts. *Lancet Psychiatry.* 2021;8(2):121-129. [https://doi.org/10.1016/S2215-0366\(20\)30491-0](https://doi.org/10.1016/S2215-0366(20)30491-0)
48. Schützwohl M, Mergel E. Social participation, inclusion and mental well-being following SARS-CoV-2 related lockdown restrictions in adults with and without mental disorders. Results from a follow-up study in Germany. Published online May 28, 2020. <https://doi.org/10.31234/osf.io/6svxw>
49. Tundo A, Betro S, Necci R. What is the impact of COVID-19 pandemic on patients with pre-existing mood or anxiety disorder? An observational prospective study. *Med Kaunas Lith.* 2021;57(4). <https://doi.org/10.3390/medicina57040304>
50. Cohen ZP, Cosgrove KT, DeVille DC, *et al.* The impact of COVID-19 on adolescent mental health: preliminary findings from a longitudinal sample of healthy and at-risk adolescents. *Front Pediatr.* 2021;9:622608. <https://doi.org/10.3389/fped.2021.622608>