RESEARCH ARTICLE

The Impact of COVID-19 on Social Anxiety and Rejection Sensitivity

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ABSTRACT

The following study explores the potential impact of COVID-19 on Social Anxiety and Rejection Sensitivity among college students. Over 300 college students completed a survey asking about whether they had contracted COVID-19, and, if they had, additional characteristics (i.e., when they contracted the disease, whether they were symptomatic, whether their symptoms were neurological, how many times they had contracted COVID-19). In addition, they indicated their current levels of Social Anxiety and Rejection Sensitivity, as well as general classroom anxiety. Lastly, participants indicated whether they had been formally diagnosed with related psychological disorders (autism, ADHD, anxiety disorders, mood disorders, rejection sensitivity dysphoria), as well as roughly when they had been diagnosed. Approximately half of the sample reported that they had contracted COVID-19 at least once, and approximately one third of the total sample had been previously diagnosed with anxiety. Results indicated that about one third of those who contracted COVID-19 indicated increases in anxiety or depression post-COVID-19. In addition, females in reported higher Social Anxiety and general classroom anxiety. Results did find that there were higher amounts of Social Anxiety and classroom anxiety among those who had been diagnosed with COVID-19 more recently, these results were no longer significant after controlling for previously diagnosed mental illness. There were otherwise no significant relationships between any aspects of contracting COVID-19 and Social Anxiety, rejection sensitivity, or classroom anxiety. This indicates that while students are reporting increased anxiety and depression, and while recently diagnosed COVID-19 does contribute to Social Anxiety and classroom anxiety, that these increases are likely due to the stress of being ill rather than the virus itself.

Introduction

The World Health Organization (WHO) declared a global pandemic on March 11, 2020 due to emergence of the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) or COVID-19 [1,2]. COVID-19 infection is characterized by a wide range of symptoms including cough, fever, shortness of breath, anosmia, congestion, fatigue, and headache [3]. To protect the health and safety of the population, the United States (US) government declared a nationwide emergency on March 13, 2020, and by March 15, 2020, US states began to implement shutdowns and social distancing regulations. Since the emergence of COVID-19, the virus has infected more than 760,000,000 individuals and claimed more than 6,900,000 lives worldwide [4].

According to WHO, the global prevalence of anxiety and depression increased by 25% due to the COVID-19 pandemic [5]. Data suggest that women and young people experienced these symptoms at disproportionately elevated rates [5,6]. During the pandemic, college students reported increases in anxiety and depression [7], heightened levels of stress, and poorer quality of sleep [8]. Specifically, the increase in mental health outcomes among college students has been deemed a critical public health concern [9]. Young adults are particularly vulnerable to developing mental disorders [10] due to continued brain development throughout late adolescence, with the prefrontal lobe and the limbic system among the last neural regions to fully mature [11].

It has been well established that women have a higher prevalence of anxiety disorders compared to men [12]. Similarly, previous research has identified that women experienced greater levels of stress and anxiety during the COVID-19 pandemic [13-15]. These differences are likely due to sex-specific variations in hormones and brain chemistry [16], differences in caregiving and domestic responsibilities [17], and other psychosocial factors [13].

While the public health precautionary measures, such as shutdowns and social distancing mandates, curbed the transmission of the virus and thus, prevented a higher number of infections and deaths, the accompanying economic and social implications were devastating to many. Social isolation, due to pandemic restrictions, has been associated with depression [18] and reduced psychological well-being [19]. Additionally, heightened stress levels, as observed during the pandemic, are associated with an elevated risk of anxiety and depression. Excess stress levels stemmed from fear of infection [20], grief [21], financial concerns [22] and academic disruption [23]. Additionally, overall, health and wellness decreased due to increased sedentarism, reduced physical activity, and poorer dietary habits [24] which directly impact mental health. Research surrounding the negative mental health impacts experienced by college students during the pandemic is mounting; however, it is likely that in addition to the psychological and social consequences of the pandemic, biological factors associated with COVID-19 infection may directly impact mental health as well.

After acute COVID-19 infection subsides, many individuals completely recover within several weeks; however, others may experience the persistence or new onset of symptoms. This condition has been labeled several names including long COVID, post-acute COVID-19 condition, and post-acute sequelae of SARS-CoV-2 infection (PASC). In October of 2021, WHO established a clinical case definition for post COVID-19 condition which states that the condition typically occurs within three months of confirmed COVID-19 infection [25]. Recent research estimates that globally more than 65 million individuals suffer from long COVID [26]. Several of the most common lingering symptoms include shortness of breath, fatigue, impaired concentration, difficulty sleeping, anxiety, depression, and brain fog [27]. "Brain fog" is a comprehensive term that encompasses the neurological symptoms such as fatigue, lack of concentration, difficulty focusing, confusion, and forgetfulness [28]. It has been estimated that within six months of initial acute COVID-19 infection, nearly one third of survivors had been diagnosed with a neuropsychiatric disorder [29].

Although COVID-19 is classified as a respiratory disease, COVID-19 is additionally associated with numerous neurologic sequalae such as headaches, dizziness, alterations to taste and smell, confusion, insomnia, fatigue, seizures, and stroke [3]. Several mechanisms have been hypothesized to be responsible for the association between COVID-19 infection and neuropsychiatric outcomes including neuroinflammation [30], alterations in the microbiome [31], immune response, and vascular damage [32]. It is plausible that SARS-CoV-2 directly infects the nervous system through human angiotensin-converting enzyme 2 (ACE2) receptors, the olfactory bulb, or by crossing the blood brain barrier [33]. Elevated levels of neuroinflammatory biomarkers have been linked with anxiety in patients experiencing long COVID [34]. Emerging research suggests that COVID-19 infection is

associated with atrophy in the limbic regions of the brain with observed alterations in the gray matter volume (GMV) and white matter microstructure [35] among individuals post mild COVID-19 infection [36]. The limbic system plays a critical role in anxiety disorders and depression [37].

Post-viral syndromes are not unique to COVID-19. Many infectious diseases have been associated with post-viral syndromes including severe acute respiratory syndrome (SARS) [38], Lyme disease [39], H1/N1 influenza [40], and varicella zoster virus [41]. Interestingly, the chronic sequalae associated with these different viruses share many common features including fatigue, neurocognitive impairments, sleep disturbances, mood swings, irritability, and depression.

Due to the elevated rates of depression and anxiety and the neuropsychiatric nature of many of the long COVID symptoms, in our study, we aim to explore whether COVID-19 infection correlates with social anxiety (SA), classroom anxiety, and rejection sensitivity (RS) among undergraduate student populations. We investigate how factors such as the number of times experiencing COVID-19, recency of COVID-19 diagnosis, history of symptomatic COVID-19, and pre-COVID diagnoses of mental disorders impact student experiences.

Methods
Power Analysis

An a-priori power analysis using G*Power determined that, expecting a medium effect, an ideal sample size would be conservatively 128 participants in order to achieve sufficient power of $\beta = .80$.

Recruitment

Participants were recruited from Midwestern colleges and universities, including both public and private institutions. Participants were recruited by placing posters around college campuses containing the QR code for the survey, as well as a prompt: "Seeking students to complete a 15 minute survey about psychological effects of COVID-19. Complete the survey, and enter a drawing for a $50 amazon gift card." Additional copies of the QR code and recruitment prompt were distributed on social media and via e-mail to recruit participants. In all, N = 329 participants completed the survey. Four participants were excluded due to incomplete surveys.

Procedure

Once participants followed the QR code, they completed an informed consent form. They were then asked to complete a series of demographic questions (age and gender).

Participants then completed a branching series of questions about their experiences with COVID-19 using Surveymonkey, where a "yes" answer prompted participants to respond with additional detail, and a "no" answer prompted a new question. Specifically, they were asked whether they'd been diagnosed with COVID-19; if they had, they were asked how many times, the approximate date of their last diagnosis (using a date function in Surveymonkey), and whether that diagnosis had been symptomatic. If it had been, they were asked to indicate how many of their symptoms had been neurological from a checklist of symptoms (loss of smell, loss of taste, fatigue, brain fog, and insomnia). Lastly, they were asked to indicate which of those same neurological symptoms had lingered after their illness.

Participants then completed measures of SA, RS, and classroom anxiety.

Social Anxiety
In order to measure social anxiety (SA), participants completed the Liebowitz Social Anxiety Scale[42] (LSAS) which asked them to rate a series of 24 scenarios (i.e. "Telephoning in public") based on level of fear (0 = none, 3 = severe) and likelihood of avoidance (0 = never, 3 = usually). To score the test, all ratings were summed. A score of 55-65 is considered to indicate moderate social phobia; a score of 65-80 indicates marked social phobia; 80-95 indicates severe social phobia; greater than 95 indicates severe social phobia.

Rejection Sensitivity
Participants also completed the Rejection Sensitivity Questionnaire (Young Adult Version) [43] to measure rejection sensitivity (RS). This measure has 18 scenarios ("You ask your boyfriend/girlfriend to come home to meet your parents"), and asks participants to rate both their concern about the outcome ("How concerned or anxious would you be over whether or not your boyfriend/girlfriend would want to meet your parents? 1 = very unconcerned, 6 = very concerned), and the likelihood that they would be accepted ("I would expect that he/she would want to meet my parents." 1 = very unlikely, 6 = very likely) for each scenario, leading to 36 total ratings. Overall RS was calculated by multiplying the concern ratings

by the reversed acceptance ratings, and then dividing by the total number of scenarios. High scores indicated high rejection sensitivity, concern, and expectation of rejection.

Classroom anxiety

Lastly, participants were asked a five-item questionnaire about their classroom anxiety at school in the last year; it included questions such as "I have had times when I've felt too anxious to attend class," and "I have avoided talking to my classmates due to my anxiety." (α = .887).

In the final part of the questionnaire, participant were asked a series of questions about whether they had been formally diagnosed with pre-existing conditions that could impact RS and SA; specifically, they were asked if they had ever been formally diagnosed with a Mood disorder, Autism,

Attention Deficit Hyperactivity Disorder (ADHD), Rejection Sensitive Dysphoria (RSD), or a Social Anxiety disorder. If they had, they were asked to provide the approximate date of diagnosis.

Participants then were directed to a separate questionnaire to enter a drawing for the gift certificate, and were thanked for their participation.

Results
Demographics

Gender, Age

Participants consisted of 325 college students (N = 73 male, N = 244 female, N = 8 other/did not respond). Over 90% of our sample was between the ages of 18-22. See Table 1 for a breakdown of participant age.

Table 1. Age of participants.

Age	N	%
18	93	28.3%
19	120	36.5%
20	46	14.0%
21	25	7.6%
22	18	5.5%
23	8	2.4%
24	3	0.9%
25 or higher	9	2.7%

General Social Anxiety, Rejection Sensitivity, Classroom anxiety

Participants had a mean SA score of M = 55.88 (SD = 30.87), indicating moderate social phobia. Their classroom anxiety average was slightly above the midpoint, M = 3.72, SD = 1.80. Rejection sensitivity scores were likewise slightly elevated, M = 6.24, SD = 1.42.

COVID-19 status

Among our respondents, N=202 indicated they had been diagnosed with COVID-19, and N=123 indicated they had not. Participants who reported that they had been diagnosed with COVID-19 reported that they had contracted the disease an average of M = 1.48 times (SD = 0.75), and that their last diagnosis was an average of M = 406.86 days since taking the survey (SD = 253.49). See Table 2 below for the number of times contracting COVID-19.

Table 2. Number of times contracting COVID-19.

Number of times	N	%
1	131	64.9%
2	50	24.8%
3	16	7.9%
4	5	2.5%

Of those who had been diagnosed, N = 163 reported they had contracted symptomatic COVID-19, and N = 41 reported being asymptomatic. When reporting neurological symptoms, of participants who reported experiencing symptomatic COVID-19, there was an average of

M = 2.43 neurological symptoms (SD = 1.20), and M = 1.78 (SD = 0.86) lingering neurological symptoms. The most frequently reported neurological symptom was fatigue. See Tables 3 and 4 for the breakdown of the proportion of initial

neurological symptoms and lingering neurological symptoms respectively.

Table 3. Proportion of initial neurological symptoms

Symptom	N	%
Smell	69	21.0%
Taste	62	18.8%
Fatigue	146	44.4%
Brain fog	66	20.1%
Insomnia	34	10.3%

Table 4. Proportion of lingering neurological symptoms

Lingering Symptom	N	%
Smell	37	11.2%
Taste	35	10.6%
Fatigue	53	16.1%
Brain fog	30	9.1%
Insomnia	5	1.5%

Increase in depression, anxiety
Participants who reported that they had contracted COVID-19 were asked whether they had experienced increases in depression and anxiety following their diagnosis. A significant sub-section of participants did indicate an increase in anxiety and depression, although approximately two-thirds of the sample did not. See Table 5 below for the relevant statistics.

Table 5. Proportion of sample reporting increase in anxiety, depression

	Yes N	%	No N	%
Anxiety	62	32.0%	132	68.0%
Depression	43	22.2%	151	77.8%

Psychological Disorder Diagnosis
Participants were asked whether they had been diagnosed with depression, anxiety, ADHD, autism, and RSD. See Table 6 below for a breakdown of the diagnoses reported.

Table 6. Proportion of sample diagnosed with disorders

Disorder	N	%
Anxiety	110	34.7%
Depression	44	13.9%
ADHD	45	14.3%
Autism	1	0.3%
RSD	3	1.0%

Participants were also asked to provide the approximate date of diagnosis. One of the factors we explored was whether participants had been diagnosed after the widespread lockdowns initiated during March of 2020; Table 7 below summarizes the proportion of people diagnosed before and after March 2020.

Table 7. Proportion of disorder diagnoses prior, post lockdown

Disorder	N prior lockdown	%	N post lockdown	%
Anxiety	74	67.9%	35	32.1%
Depression	33	78.6%	9	21.4%
ADHD	36	81.8%	8	18.2%
Autism	1	100%	0	0%
RSD	1	50%	1	50%

Of those who reported that they had both contracted COVID-19 and had received diagnosis of a psychological disorder, most reported being diagnosed with their disorder before contracting COVID-19; however, there were a few who

reported being diagnosed after contracting COVID-19 (See Table 8).

Table 8. Proportion of disorder diagnoses prior, post COVID-19

Disorder	N prior COVID-19	%	N post COVID-19	%
Anxiety	67	89.3%	8	10.7%
Depression	30	90.9%	3	9.1%
ADHD	30	96.8%	1	3.2%
Autism	1	100%	0	0%
RSD	1	100%	0	0%

Correlations

A series of correlations were run on continuous variables of SA, RS, average classroom anxiety, number of initial neurological symptoms, number of lingering neurological symptoms, number of times contracting COVID-19, and recency of diagnosis. Classroom anxiety, social anxiety, and rejection sensitivity were all positively correlated to each other; in addition, the number of lingering neurological symptoms, the number of initial neurological symptoms, and how many times people had contracted COVID were all positively correlated. Recency of diagnosis was positively correlated with initial neurological symptoms, and negatively correlated with the number of times COVID-19 had been contracted. There were no other significant correlations. See Table 9 below for all relevant correlations.

Table 9. Correlation table.

	1	2	3	4	5	6	7
	1	.525**	.057	.028	.450**	.030	-.035
		1	.022	.023	.653**	.018	-.125
al neurological			1	.795**	.075	.548**	.141*
gering neurological				1	.056	.380**	.102
ssroom anxiety					1	.009	-.126
mber of times tracting COVID-19						1	-.208*
ency of diagnosis							1

*p ≤ .05 **p ≤ .01

Our next set of analyses were to determine whether having COVID-19 would impact SA, RS, and classroom anxiety. We also wanted to determine whether symptomatic COVID-19, number of times contracting COVID-19, number of initial neurological symptoms, lingering neurological symptoms, and recency of latest diagnosis impacted these variables. In addition to testing these factors, we also wished to explore whether gender interacted with any of our variables of interest, based on previous research [13-15].

Lastly, we wanted to control for whether the students had been formally diagnosed with anxiety, depression, or ADHD prior to contracting COVID-19.

When setting up our analyses, we coded our variables of symptomatic COVID-19, number of times contracting COVID-19, number of initial neurological symptoms, and number of lingering neurological symptoms to include participants who had not contracted COVID-19 in the "0" group. (Note; we ran a version of the analyses with the group who hadn't contracted COVID-19 excluded, and the results followed the same basic pattern.)

COVID-19

First, a series of two-way ANOVAs were run on the data to test the effects of gender and covid diagnosis on SA, RS, and classroom anxiety.

Social anxiety
Results showed a main effect of gender, where females indicated higher levels of social anxiety (M = 60.59, SD = 30.29) compared to males (M = 36.65, SD = 24.93), $F(1,287) = 18.97$, $p < .001$. There was no significant main effect for COVID-19, $F(1,287) = 1.60$, $p = .207$, or a significant interaction between gender and COVID-19, $F(1,287) = 0.89$, $p = .412$.

Rejection sensitivity
Results showed no effect of gender, $F(1,303) = 1.42$, $p = .243$, COVID-19, $F(1,303)$ -0.02, $p = .889$, or an interaction between gender and COVID-19, $F(303) = 0.06$, $p = .944$ on rejection sensitivity.

Classroom anxiety
Results showed a main effect of gender, where females indicated higher levels of classroom anxiety (M = 4.04, SD = 1.76) compared to males (M = 2.60, SD = 1.49), $F(1,304) = 19.49$, $p < .001$. There was no significant main effect for COVID-19, $F(1,304) = 0.99$, $p = .321$, or a significant interaction between gender and COVID-19, $F(1,304) = 0.44$, $p = .643$.

Symptomatic COVID-19

Next, a series of two-way ANOVAs were run on the data to test the effects of gender and symptomatic COVID-19 on SA, RS, and classroom anxiety.

Social anxiety
Results showed a main effect of gender, where females indicated higher levels of social anxiety (M = 60.59, SD = 30.29) compared to males (M = 37.22, SD = 24.17), $F(1,287) = 17.71$, $p < .001$. There was no significant main effect for symptomatic COVID-19, $F(1,287) = 1.84$, $p = .176$, or a significant interaction between gender and symptomatic COVID-19, $F(1,287) = 0.84$, $p = .433$.

Rejection sensitivity
Results showed no effect of gender, $F(1,303) = 1.54$, $p = .215$, symptomatic COVID-19, $F(1,303)$ 0.01, $p = .928$, or an interaction between gender and symptomatic COVID-19, $F(303) = 0.53$, $p = .949$ on rejection sensitivity.

Classroom anxiety
Results showed a main effect of gender, where females indicated higher levels of classroom anxiety (M = 4.04, SD = 1.75) compared to males (M = 2.60, SD = 1.49), $F(1,304) = 19.85$, $p < .001$. There was no significant main effect for symptomatic COVID-19, $F(1,304) = 0.85$, $p = .358$, or a significant interaction between gender and symptomatic COVID-19, $F(1,192) = 0.36$, $p = .697$.

A series of hierarchical regressions were run on the data to test the impact of number of times contracting COVID-19 and gender on SA, RS, and Classroom anxiety. Number of times contracting COVID-19 was centered, and placed into Step 1 along with gender (where males = 1 and females = 0); the interaction was placed into Step 2. The same process was then done for initial neurological symptoms, lingering neurological symptoms, and recency of last diagnosis.

Social Anxiety

Number of times
Results indicated that the overall model was significant, $R = .316$, $R^2 = .100$, $F(3,285) = 10.54$, $p < .001$. This was driven by the significant main effect of gender, $B = -23.40$, $t = -5.62$, $p < .001$; there were no other significant results.

Initial neurological symptoms
Results indicated that the overall model was significant, $R = .321$, $R^2 = .103$, $F(3,285) = 10.91$, $p < .001$. This was driven by the significant main effect of gender, $B = -24.11$, $t = -5.69$, $p < .001$; there were no other significant results.

Lingering neurological symptoms
Similar patterns were found when number of lingering neurological symptoms were substituted instead of initial neurological symptoms; the overall model was significant, $R = .321$, $R^2 = .103$, $F(3,285) = 10.88$, $p < .001$, due to gender, $B = -23.744$, $t = -5.64$, $p < .001$.

Recency of last diagnosis
Likewise, the overall model was significant, $R = .322$, $R^2 = .104$, $F(3,179) = 6.82$, $p < .001$. There was a main effect of gender, $B = -23.54$, $t = -4.18$, $p < .001$. Number of days since diagnosis did emerge as a significant result as well, $B = -0.17$, $t = -1.99$, $p = .049$.

Rejection sensitivity

Number of times
Results indicated no significance of the overall model, $R = .113$, $R^2 = .013$, $F(3,301) = 1.30$, $p = .275$.

Initial neurological symptoms
Results indicated no significance of the overall model when it came to initial neurological symptoms, $R = .107$, $R^2 = .011$, $F(3,301) = 1.16$, $p = .324$.

Lingering neurological symptoms
Similar findings were obtained when substituting lingering neurological symptoms, $R = .100$, $R^2 = .010$, $F(3,301) = 1.02$, $p = .384$.

Recency of last diagnosis
Likewise, the overall model was not significant, $R = .153$, $R^2 = .024$, $F(3,187) = 1.50$, $p = .216$.

Classroom anxiety

Number of times
Results indicated that the overall model was significant, $R = .338$, $R^2 = .114$, $F(3,302) = 12.95$, $p < .001$. This was driven by the significant main effect of gender, $B = -1.44$, $t = -6.20$, $p < .001$; there were no other significant results.

Initial neurological symptoms
Results indicated that the overall model was significant, $R = .335$, $R^2 = .112$, $F(3,302) = 12.75$, $p < .001$. This was driven by the significant main effect of gender, $B = -1.43$, $t = -6.04$, $p < .001$; there were no other significant results.

Lingering neurological symptoms
A similar pattern was found when lingering neurological symptoms were substituted instead; the overall model was significant, $R = .336$, $R^2 = .113$, $F(3,302) = 12.80$, $p < .001$, due to gender, $B = -1.43$, $t = -6.08$, $p < .001$

Recency of last diagnosis
The overall model was significant, $R = .366$, $R^2 = .134$, $F(3,188) = 9.71$, $p < .001$. There was a main effect of gender, $B = -1.57$, $t = -5.02$, $p < .001$. Number of days since diagnosis did emerge as a significant result as well, $B = -0.01$, $t = -2.11$, $p = .036$.

Controlling for Anxiety, Depression, ADHD Diagnoses

Additional regression analyses were performed to determine whether controlling for the three most common pre-existing diagnoses (anxiety, depression, ADHD) would lead to differing results.

First, all participants who indicated they were previously diagnosed with anxiety, mood, ADHD, autism, or RSD disorders after contracting COVID-19 were filtered from the data. Then, number of times contracting COVID-19 was placed into Step 1, followed by gender and initial number of neurological symptoms at Step 2, and the interaction between gender and initial neurological symptoms at Step 3. A similar process was done for initial neurological symptoms and lingering neurological symptoms.

Classroom anxiety
Number of times. The overall model was significant, $R = .523$, $R^2 = .273$, $F(8,287) = 13.48$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 1.40$, $t = 6.38$, $p < .001$, as was depression, $B = 0.91$, $t = 2.88$, $p = .004$; the R square change was significant for Step 2 ($p < .001$) due to gender in Step 2, $B = -1.04$, $t = -4.47$, $p < .001$. There were no other significant effects.

Initial neurological symptoms. The overall model was significant, $R = .520$, $R^2 = .271$, $F(8,287) = 13.31$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 1.40$, $t = 6.38$, $p < .001$, as was depression, $B = 0.91$, $t = 2.88$, $p = .004$; the R square change was significant for Step 2 ($p < .001$) due to gender in Step 2, $B = -1.02$, $t = -4.34$, $p < .001$. There were no other significant effects.

Lingering neurological symptoms. Similarly, the overall model was significant, $R = .520$, $R^2 = .271$, $F(8,287) = 13.31$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 1.40$, $t = 6.38$, $p < .001$, as was depression, $B = 0.91$, $t = 2.88$, $p = .004$; the R square change was significant for Step 2 ($p < .001$) due to gender in Step 2, $B = -1.02$, $t = -4.34$, $p < .001$. There were no other significant effects.

Recency of last diagnosis. The overall model was significant, $R = .590$, $R^2 = .348$, $F(8,175) = 11.69$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 1.58$, $t = 5.87$, $p < .001$, as was depression, $B = 1.01$, $t = 2.62$, $p = .009$; the R square change was significant for Step 2 ($p = .002$) due to gender in Step 2, $B = -1.06$, $t = -3.40$, $p = .001$. While recency was significant above, when controlling for prior diagnoses, it became no longer significant, $B = -0.01$, $t = -1.34$, $p = .183$

Rejection sensitivity
Number of times. The overall model was significant, $R = .374$, $R^2 = .140$, $F(8,287) = 5.85$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 0.52$, $t = 2.82$, $p = .005$, as was depression, $B = 1.04$, $t = 3.89$, $p < .001$. There were no other significant effects.

Initial neurological symptoms. With results mirroring that of the previous analysis, the

overall model was significant, $R = .347$, $R^2 = .140$, $F(8,287) = 5.82$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 0.52$, $t = 2.82$, $p = .005$, as was depression, $B = 1.04$, $t = 3.89$, $p < .001$; there were no other significant results.

Lingering neurological symptoms. Similarly, the overall model was significant, $R = .371$, $R^2 = .138$, $F(8,287) = 5.72$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 0.52$, $t = 2.82$, $p = .005$, as was depression, $B = 1.04$, $t = 3.89$, $p < .001$; there were no other significant results.

Recency of last diagnosis. Similarly to the other models, the overall model was significant, $R = .384$, $R^2 = .148$, $F(8,175) = 3.79$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 0.62$, $t = 2.79$, $p = .006$, as was depression, $B = 0.85$, $t = 2.70$, $p = .008$. There were no other significant effects.

Social anxiety

Number of times. The overall model was significant, $R = .497$, $R^2 = .247$, $F(8,271) = 11.13$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 15.89$, $t = 4.11$, $p < .001$, as was depression, $B = 22.66$, $t = 4.03$, $p < .001$; the R square change was significant for Step 2 ($p = .002$), and gender was significant within Step 2, $B = -18.26$, $t = -4.34$, $p < .001$. There were no other significant effects.

Initial neurological symptoms. The overall model was significant, $R = .500$, $R^2 = .250$, $F(8,271) = 11.27$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 15.89$, $t = 4.11$, $p < .001$, as was depression, $B = 22.66$, $t = 4.03$, $p < .001$; the R square change was significant for Step 2 ($p < .001$), and gender was significant within Step 2, $B = -18.90$, $t = -4.43$, $p < .001$. There were no other significant effects.

Lingering neurological symptoms. Likewise, the overall model was significant, $R = .500$, $R^2 = .250$, $F(8,271) = 11.21$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 15.89$, $t = 4.11$, $p < .001$, as was depression, $B = 22.66$, $t = 4.03$, $p < .001$; the R square change was significant for Step 2 ($p < .001$), and gender was significant within Step 2, $B = -18.61$, $t = -4.39$, $p < .001$. There were no other significant effects.

Recency of last diagnosis. Similarly to the other models, the overall model was significant, $R = .567$, $R^2 = .321$, $F(8,167) = 9.89$, $p < .001$. Initial anxiety diagnosis at Step 1 was significant, $B = 21.05$, $t = 4.50$, $p < .001$, as was depression, $B = 23.78$, $t = 3.56$, $p < .001$; the R square change was significant for Step 2 ($p = .003$), and gender was significant within Step 2, $B = -17.63$, $t = -3.13$, $p < .001$. While recency was significant above, when controlling for prior diagnoses, it became no longer significant, $B = -0.01$, $t = -1.65$, $p = .101$

Discussion

Overall, the results showed a snapshot of current college students in the Midwest and their experiences with COVID-19, SA, RS, and classroom anxiety. In general, students reported currently feeling moderate social phobia, and were slightly above the midpoint in ratings of classroom anxiety and rejection sensitivity. In addition, over a third of our sample had been diagnosed with anxiety.

Of those who had been diagnosed with anxiety, approximately a third had been diagnosed within the last two years; about a fifth of those diagnosed with depression and ADHD likewise received their diagnosis within the last two years. The proportion of those respondents indicating recently diagnosed anxiety, as well as the classroom anxiety score above the midpoint and the moderate social phobia expressed by the sample on average does suggest that the experience of the global pandemic may have played a role in increasing anxiety among young people. Our study reflects what has been described about the declining mental health status among not only college students [44] but also the population as a whole [5].

Results indicated that a little over half of the students participating in our survey had contracted COVID-19. Of those who contracted COVID-19, most experienced at least one neurological symptom. In addition, a few received diagnoses of psychological disorders after their illness, and about a third of those who had contracted COVID-19 indicated increases in depression and anxiety following their illness.

Another key significant finding that emerged consistently was that gender and prior diagnoses of anxiety and depression impacted current SA and classroom anxiety scores. Female respondents tended to be higher in SA and classroom anxiety; likewise, those who had a previous diagnosis of anxiety and depression tended to be higher in SA, RS, and classroom anxiety. In our study, the observed gender differences in anxiety and depression diagnoses are supported by the current body of research [45,46]. Specifically, we highlight increases in anxiety among a unique population, female undergraduate students in the Midwest.

However, notably, there were minimal differences across our sample when it came to the role of COVID-19 in increasing SA, RS, and classroom

anxiety. This question was explored from multiple angles; contracting COVID, contracting symptomatic COVID, the number of times contracting COVID, the number of initial neurological symptoms, the lingering neurological symptoms, and the recency of last diagnosis. While most of these factors did not result in significant differences, recency of diagnosis did appear to play a modest role in increases in classroom anxiety and social anxiety; however, these results were no longer significant when accounting for previous diagnoses of anxiety or depression. The majority of the studies investigating post-COVID-19 depression have not focused specifically on undergraduate student populations [47]. Therefore, it is possible that associations between COVID-19 infection and mental health are more evident among populations of different ages.

This would suggest that our sample overall had increases in depression and anxiety that were related to the experiences of the widespread lockdowns, quarantining, and the stress associated with that experience; these increases do not appear to have been triggered by contracting COVID-19. Moreover, the increase in mental health challenges among college students has been occurring since before COVID-19 [44]. Our data corroborates the declining mental health status of college students as well as previous research highlighting the link between factors associated with COVID-19 protective measures and mental health [18,19,48].

This lack of significance in our study was surprising. It has been well-established that COVID-19 enters the central nervous system and exhibits neurological effects [3]. Previous research has found increases in neuropsychiatric outcomes among patients positive for COVID-19 [49-51]. The COVID-19 pandemic presented numerous challenges and it is difficult to disentangle the impacts of the psychosocial implications stemming from the precautionary measures, socioeconomic burdens, and direct COVID-19 infection.

The study collected data from over 300 participants; however, it is possible that several of the factors we were examining were too subtle to be detected with our sample size. In addition, while we asked follow-up information about their most recent COVID-19 diagnosis, we did not specify about prior COVID-19 experiences; while most of our sample who contracted COVID-19 did so once, it is possible that someone may have experienced neurological symptoms in an earlier case. However, as we did measure generally whether someone had contracted COVID-19 at all, in addition to taking

into account number of times contracted, that doesn't necessarily appear to be a factor at work.

Students in college clearly have faced unique and distinct challenges due to COVID-19. One of the unique additions this study contributes to the overall literature is a more direct measure of classroom-related anxiety, where student classroom behavior was assessed; in addition to general Social Anxiety and Rejection Sensitivity questionnaires, this measure asked students directly about classroom-specific challenges that substantially interfere with their ability to succeed – including ability to engage with their instructor, to engage with their peers, and to participate in classroom presentations and discussions. This classroom anxiety mapped closely onto social anxiety measures more broadly speaking, but provided an opportunity to more specifically explore how the recent pandemic has impacted the student experience in classroom settings.

Future research might further explore the specific additional components of recently contracted COVID-19 that might explain increases in anxiety, depression, social anxiety, and classroom anxiety that we were able to document. For instance, the stress of quarantining, fear of infecting others, feeling behind in academic studies, or other factors may be at work beyond the neurological symptoms of COVID-19. Identifying the importance of these underlying factors is critical to future prevention efforts. This would also suggest that institutions of higher learning should further examine the attendance and late work policies in place; this could help to reduce student stress. Additionally, future research must focus on improving access to effective mental health resources on college campuses.

Conclusion

In conclusion, our results highlight that current undergraduate students are experiencing significant mental health challenges. In our study, female college students reported higher anxiety compared to male students. Although we did not observe a significant association between the neuropsychiatric symptoms and COVID-19 infection, the mental health status of college students is concerning. It is likely that COVID-19 indirectly impacted mental health through elevated stress, social isolation, and economic challenges, among other factors. Mental health programming on college campuses needs to adequately support the rise in student mental health needs.

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