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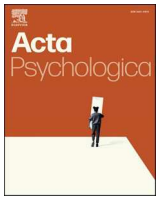

Exploring the effects of COVID-19-related traumatic events on the mental health of university students in Brazil: A cross-sectional investigation

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ABSTRACT

University students are vulnerable to mental health issues during their academic lives. During the COVID-19 pandemic, university students faced mental distress due to lockdowns and the transition to e-learning. However, it is not known whether these students were also affected specifically by COVID-19-related traumatic events. This study examined the impact of COVID-19-related traumatic events on 2277 university students from two federal institutions of higher education in Brazil. The university students completed an online questionnaire covering demographics, lifestyle habits, health characteristics, COVID-19-related traumatic events, and depression, anxiety, and stress symptoms. The results showed that an increased intensity of COVID-19-related traumatic events was positively associated with stress, anxiety, and depressive symptoms, and each specific type of event was associated with these symptoms. In addition, we found a negative association between these symptoms and male sex and age and a positive association with having or having had a history of cardiovascular, respiratory, neurological, or mental disorders or another disease diagnosed by a physician. In conclusion, this study emphasizes the heightened risk of mental health issues in university students in the face of COVID-19-related traumatic events. Women, young people and people who have or have had a history of disease were the most vulnerable to mental health issues during the COVID-19 pandemic.

1. Introduction

In March 2020, the World Health Organization (WHO) declared the coronavirus disease 2019 (COVID-19) outbreak a pandemic (WHO, 2020). COVID-19 is a highly contagious disease that has caused many deaths globally (Worldometers, 2021). This pandemic triggered new stressors and significant social, economic, and financial changes and negatively impacted the mental health of the general population. Frontline healthcare workers are at greater risk of developing mental health disorders (Gama et al., 2022; Machado et al., 2023; Pappa et al.,

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2020; Portugal et al., 2022). However, other populations are also at risk, particularly women, black individuals, single individuals, younger people, individuals with comorbidities, individuals who use medication, and individuals who do not exercise regularly (Duarte et al., 2020; Molock & Parchem, 2022; Wang et al., 2020; Xiong et al., 2020). Notably, the mental health of university students may have been uniquely affected during the pandemic due to disruptions in their academic and social lives and uncertainty about their academic future associated with the global public health concerns (Lederer et al., 2021; Zhai & Du, 2020).

Even before the pandemic, university students were already at high risk for mental health problems due to academic pressure, the transition to university life, social pressures, parental and personal expectations, uncertainties about the future, financial problems, changes in relationships and social support, and unhealthy lifestyles (Bruffaerts et al., 2018; Eisenberg et al., 2012; Ibrahim et al., 2013; Stallman, 2010). A systematic review on the prevalence of depression among university students from different countries conducted before the COVID-19 pandemic reported rates ranging from 10 % to 85 %, with a weighted mean prevalence of 30.6 % (Ibrahim et al., 2013). Furthermore, in a systematic review of 48 articles involving 40 countries and 56,816 university studies, Soares et al. (2020) reported a prevalence of 24.5 % for anxiety symptoms and 26.1 % for depressive symptoms.

As university students are particularly vulnerable to mental health issues during their academic lives, they could also be significantly affected by pandemic stressors. In a study conducted by Cao et al. (2020), which involved a sample of 7143 Chinese university students, the proportions of mild, moderate, and severe anxiety were reported to be 21.3 %, 2.7 %, and 0.9 %, respectively. The results indicated that several factors, as well as economic effects, impacts on daily life, and delays in academic activities, contributed to the increase in anxiety among students, including having family members or acquaintances infected by COVID-19. Furthermore, among 195 college students included in a study conducted in the United States, 71 % reported a significant increase in stress and anxiety due to the COVID-19 pandemic (Son et al., 2020). Several stressors were identified as contributing to this increase in students, including concerns about their health and that of their loved ones (91 % of participants), difficulties concentrating (89 %), sleep disorders (86 %), reduced social interactions due to physical distancing (86 %), and academic concerns (82 %). Therefore, factors associated with the pandemic contributed to increased stress and anxiety among university students (Cao et al., 2020; Son et al., 2020). According to Wang et al. (2020), Chinese university students were found to have higher risks of stress, anxiety, and depression compared to elderly individuals in the general population. During the lockdown (April to May 2020), French university students had a high prevalence of mental health issues, with 42.8 % of participants reporting at least one symptom of mental suffering; specifically, 24.7 % of the participants had high levels of perceived stress, 16.1 % had severe depression, and 27.5 % had severe anxiety (Wathelet et al., 2020). Additionally, a study with a sample of Brazilian university students conducted during the pandemic showed that the prevalence of anxiety was 42.5 % and that of depression was 33.2 % (de Paula et al., 2022).

As mentioned above, the COVID-19 pandemic not only posed a threat to physical health but also had significant implications for mental health. The stressful events encountered during the COVID-19 pandemic were intense, and many of these events fell under the Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5) definition of traumatic events. According to the DSM-5, a traumatic event involves exposure to actual or threatened death, serious injury, or sexual violence, either experienced directly or witnessed (APA, 2014). As the pandemic progressed, exposure to the risk of death, fear of infection, fear of infecting close contacts, loss of loved ones, and reports of fatalities due to COVID-19 were common, all of which were traumatic events related to COVID-19. Previous studies have shown the adverse effects of COVID-19-related traumatic events on the mental health of specific populations, such as healthcare workers. For example, Pappa et al. (2020), Portugal et al. (2022), Gama et al. (2022), and Machado et al. (2023) reported high rates of anxiety, depression, insomnia, and posttraumatic stress disorder (PTSD) symptoms among health care workers during the pandemic.

To our knowledge, no study has assessed the specific effect of the intensity of COVID-19-related traumatic events on the mental health of university students, a group that was not on the frontline of the pandemic but had preexisting vulnerabilities associated with academic life. This population is increasing in Brazil and will be part of the workforce soon; therefore, it is extremely relevant to study their mental health. Thus, the principal aim of this study was to explore the associations between the intensity of traumatic events specifically related to COVID-19 and depression, anxiety, and stress symptoms among Brazilian university students. In addition, we explored the impact of other associated factors that might increase vulnerability to mental health issues, such as being a woman, being a black individual, being a single person, being young, having comorbidities, using medication and not exercising regularly.

2. Materials and methods

The present study was conducted following relevant guidelines and national regulations and approved by the local ethics committees of the universities (Federal University of Minas Gerais under process number CAAE 36481920.7.3001.5149 and Federal University of Ouro Preto under process number CAAE 36481920.7.0000.5150). All participants provided informed consent before participating in the study. The data will be made available upon reasonable request.

2.1. Participants and procedure

This cross-sectional study was conducted with university students from two Brazilian Federal Institutions of Higher Education in the state of Minas Gerais in the southeast region of Brazil. The data were collected from March 24 to April 24, 2021. During this period, face-to-face academic activities were suspended, and lessons were conducted remotely. Furthermore, during this period, no vaccine against COVID-19 was available for the age group of our sample.

All university students aged between 18 and 35 years were invited to participate in the research via an institutional email, sent by the corresponding sectors of the institutions, containing a link to the questionnaire available on Google Forms (Google®). The text contained the inclusion criteria and the informed consent form, with clarifications about the research; the first page of the questionnaire requested authorization for the use of the data and could be downloaded. To access the questionnaire, participants were required to read and accept the terms and conditions by ticking a box.

The invitation was sent to 46,224 university students, with 2450 responding to the questionnaires, totalling a response rate of 5.3 %. A total of 173 students were excluded: 101 for failing to meet the inclusion criterion of being between 18 and 35 years of age and 72 for a duplicate response generated by Google system error. The final sample comprised 2277 university students. The age criterion was used because the participants were invited to a second phase evaluation composed of physiological measures with this age requirement. Volunteers did not receive any benefit for participating.

2.2. Measures

2.2.1. Sociodemographic questions

The following sociodemographic variables, lifestyle habits, and health characteristics were evaluated: sex, age, marital status, ethnicity/race, current or a history of a cardiovascular, respiratory, neurological, or mental disorder or another disease diagnosed by a physician, medication use, and regular physical exercise.

2.2.2. Traumatic experiences during the COVID-19 pandemic questionnaire

We used the "Traumatic experiences during the COVID-19 pandemic questionnaire" (Gama et al., 2022; Machado et al., 2023; Portugal et al., 2022). This questionnaire was initially developed to investigate the traumatic situations experienced by health care workers during the COVID-19 pandemic. We made small changes to this trauma questionnaire to adapt it to university students. The items included in the questionnaire were chosen based on an agreement of trauma experts (two psychiatrists and one psychologist); the items were pandemic-related events that corresponded with the DSM-5 examples of traumatic events, which include direct or indirect exposure to death, threatened death, and actual or threatened serious injury. Thus, the content validity of the questionnaire was examined qualitatively based on expert judgement. The items adapted to university students were as follows: (1) losing a relative and/or someone close to them due to COVID-19 infection; (2) learning, through others, about the death of a relative and/or someone close to them due to COVID-19 infection; (3) being related or close to someone at risk of imminent death because they contracted COVID-19; (4) being exposed to people who had COVID-19 and were at risk of death; (5) contracting COVID-19; and (6) fearing (or receiving confirmation) that they might have infected someone close to them (e.g., partner, friend, or relative). As for health workers, for each item, participants were asked if they had experienced the given situation and answered "yes or no.". Participants who answered "yes" were asked to rate the event's intensity on a scale from 1 to 5 (1 = not stressful at all to 5 = extremely stressful). The total sum of the intensities, calculated by adding the intensities of the six traumatic events, was used to create the "intensity score" variable.

2.2.3. Depression Anxiety Stress Scale-21 (DASS-21)

Depression, anxiety, and stress symptoms were evaluated using the short form of the Depression Anxiety Stress Scale-21 (DASS-21) (Lovibond & Lovibond, 1995), which was translated and validated in Portuguese by Vignola and Tucci (2014). This self-report instrument contains three subscales (depression, stress, and anxiety) with adequate reliability and validity for the Brazilian population (Vignola & Tucci, 2014). Participants are asked to choose the level of symptoms described in the statement that applied to the previous week. Responses to each item are scored on a four-point Likert scale ranging from 0 (did not apply at all) to 3 (applied considerably or most of the time). The sum of Items 3, 5, 10, 13, 16, 17 and 21 composed the depression subscale score; the sum of Items 1, 6, 8, 11, 12, 14 and 18 composed the stress subscale score; and the sum of Items 2, 4, 7, 9, 15, 19 and 20 composed the anxiety subscale score. Internal consistency for the present study was assessed by Cronbach's alpha. All subscales have had high reliability (depression subscale: 0.91, stress subscale: 0.87 and anxiety subscale: 0.86). Because the psychometric instrument used to measure our outcome (DASS-21) was applied online, i.e., in a different mode from the validated version of the scale, we ran a confirmatory factor analysis (CFA) to examine the construct validity of the DASS-21 for the present sample. The results are presented in the supplementary material.

2.3. Statistical analysis

The database was constructed using Microsoft Office Excel 2013© software, and statistical tests were performed using Statistica software version 10.0 (StatSoft, 2011) and the R programming language (R Core Team, 2020). Initially, the participants' sociodemographic characteristics, lifestyle habits, health characteristics, the intensities of traumatic events, and depression, anxiety, and stress symptoms were examined using descriptive analysis. Subsequently, to assess whether the dependent variables related to mental health (stress, anxiety, and depression symptoms) were associated with the independent variables (traumatic event intensity, sex, ethnicity, marital status, disease status, medication use, and regular physical exercise status), a multiple regression model was adopted. The model was fitted using the backwards method to eliminate predictive variables (Draper & Smith, 2014). This method was chosen with the goal of retaining only significant and nonredundant predictive variables in the final model. Backwards elimination was performed at each step considering the Akaike information criterion (AIC). This criterion is based on a trade-off between the goodness of fit of the model (measured by its log-likelihood) and its simplicity, regarding the number of parameters of a candidate model. After selection using this criterion, a given predictive variable was retained in the model only if it was significant at the 0.05 significance level.

Then, the associations of the response variables (depression, anxiety, and stress symptoms) with each type of traumatic event were investigated using logistic regression models, dichotomizing the response variables. For each type of traumatic event, an independent variable referring to the traumatic event intensity was defined, ranging from 0 (no trauma) to 5 (maximum trauma). The advantage of this approach was that it allowed for odds ratios to be calculated considering different pairs of traumatic event intensity values ($\Delta 5$, $\Delta 4$, $\Delta 3$, $\Delta 2$, and $\Delta 1$).

The dependent variables were dichotomized according to the following cut-off points: depression, ≤ 20 (low depression) and >20 (high depression); anxiety, ≤ 14 (low anxiety) and >14 (high anxiety); and stress, ≤ 25 (low stress) and >25 (high stress). Participants classified as having severe and extremely severe symptoms were included in the high-intensity group, and those classified as having normal, mild, and moderate symptoms were included in the low-intensity group, according to Lovibond and Lovibond (2004).

With the fitted logistic regression models, the odds ratios were calculated considering the different intervals of each traumatic event intensity. For example, with X being the intensity of a given traumatic event, the odds ratio could be estimated by considering $X = 5$ in relation to $X = 0$ (that is, $\Delta X = 5$). Different ΔX values (5, 4, 3, 2, and 1) were considered. A value of $\Delta X = 4$, for example, made it possible to calculate the odds ratios for $X = 5$ in relation to $X = 1$ or for $X = 4$ in relation to $X = 0$.

For the logistic regression and all statistical tests, the significance level was set at 0.05.

3. Results

3.1. Characteristics of the participants

In total, 2277 university students, with a mean age of 24.1 years (SD = 4.1), participated in the study (69.8 % women). Most participants were white, single, have or had a history of cardiovascular, respiratory, neurological, or mental diseases, did not use medication, and exercised regularly. Based on the range scores proposed by Lovibond and Lovibond (1995), 49.4 % of the participants presented with high depressive symptoms (ranging from severe to extremely severe), 43.1 % presented with high anxiety symptoms (ranging from severe to extremely severe), and 48.3 % presented with high stress symptoms (ranging from severe to extremely severe) (see Table 1 for further details).

3.2. Type and intensity of COVID-19-related traumatic events

The frequencies of the types of COVID-19-related traumatic events experienced by the participants and the intensity of each event are outlined in Table 2. Of the participants, 28.9 % experienced the loss of a relative and/or someone close to them due to COVID-19 infection, 90.7 % learned, through others, about the loss of a relative and/or someone close to them due to COVID-19 infection, 34.1 % had a relative and/or someone close to them who was at risk of imminent death due to contracting COVID-19, 19.2 % were exposed to people who had COVID-19 and were at risk of death, 9.6 % had COVID-19 and 32.0 % feared (or had received confirmation) that they might have transmitted COVID-19 to someone close to them (for example, a partner, friend or relative).

Table 1
Characteristics of the participants ($N = 2277$).

Variable		N	%
Sociodemographic characteristics			
Sex	Female	1589	69.8
	Male	688	30.2
Ethnicity/race	White	1221	53.6
	Black	936	41.1
	Indigenous, Asian, and Unknown	120	5.3
Marital status	Single	2019	88.7
	Married	246	10.8
	Divorced	12	0.5
Health			
Have or had a history of disease	No	1114	48.9
	Yes	1163	51.1
Medication use	No	1435	63.0
	Yes	842	36.9
Regular physical exercise	No	1447	63.6
	Yes	830	36.5
Emotional state			
Depression	Normal	479	21.0
	Mild	236	10.4
	Moderate	436	19.2
	Severe	342	15.0
	Extremely severe	784	34.4
Anxiety	Normal	727	(31.9)
	Mild	140	(6.2)
	Moderate	429	18.8
	Severe	249	10.9
	Extremely severe	732	32.2
Stress	Normal	517	22.7
	Mild	222	9.8
	Moderate	436	19.2
	Severe	557	24.5
	Extremely severe	545	23.9

Note. N = Number of individuals; % = percentage.

3.3. The total COVID-19-related traumatic event intensity scores associated with depression, anxiety, and stress symptoms, controlling for the influential variables

The total traumatic event intensity score and a history or current presence of disease were positively associated with depression, anxiety, and stress symptoms. Thus, the current presence of a disease and a greater traumatic event intensity were positively associated with higher scores on the depression, anxiety, and stress subscales. Age and sex were negatively associated with depression, anxiety, and stress symptoms. Therefore, males and older participants had lower scores for depression, anxiety, and stress symptoms (Table 3).

3.4. COVID-19-related traumatic event type and intensity associated with depression, anxiety, and stress symptoms

Table 4 shows a significant positive association between the intensity of each type of COVID-19-related traumatic event and depression, anxiety, and stress symptoms. Participants who reported high-intensity COVID-19-related traumatic events were more likely to experience symptoms of mental disorders than were those who reported lower-intensity COVID-19-related traumatic events. For example, for depression, consider COVID-19-related traumatic event 1 (Have you experienced the loss of a relative and/or someone close to you due to COVID-19 infection?), the risk of developing symptoms vs. not developing symptoms was 1.45 times greater for intensity X = 5 than for X = 0. For an intensity X = 4, in relation to X = 0, the odds ratio was 1.35 and decreased with a decrease in traumatic event intensity. This association was observed for all traumatic event types in relation to mental health issues (depression, anxiety, and stress). Thus, participants who reported a greater intensity of a given COVID-19-related traumatic event were more likely to develop depression, anxiety, and stress symptoms.

4. Discussion

This study evaluated whether exposure to traumatic events specifically related to COVID-19 could predict mental disorder symptoms among Brazilian university students. The main results showed that having experienced a high-intensity COVID-19-related traumatic event,

Table 3
Backwards multiple regression: COVID-19-related traumatic event intensity scores and possible influential variables as predictors of depression, anxiety, and stress symptoms.

Variable	Estimate	SE	P
Depression ($R^2 = 0.052$)			
Intensity score	0.36	0.04	<0.001
Sex	−1.91	0.54	<0.001
Age	−0.30	0.06	<0.001
Have or had a history of disease	1.93	0.49	<0.001
Anxiety ($R^2 = 0.130$)			
Intensity score	0.53	0.04	<0.001
Sex	−3.88	0.47	<0.001
Age	−0.30	0.05	<0.001
Have or had a history of disease	1.83	0.43	<0.001
Stress ($R^2 = 0.118$)			
Intensity score	0.44	0.04	<0.001
Sex	−4.39	0.46	<0.001
Age	−0.33	0.05	<0.001
Have or had a history of disease	1.44	0.42	<0.001

Note. Significant at $p < 0.05$. SE = Standard error.

Table 2
Frequency and percentage of COVID-19-related traumatic events and the intensities of the traumatic events experienced by participants.

COVID-19-related traumatic events	No N (%)	Yes N (%)	If yes (1: not stressful at all – 5: extremely stressful) N (%)				
			1	2	3	4	5
Event 1: Have you experienced the loss of a relative and/or someone close to you due to COVID-19 infection?	1617 (71.0)	660 (28.9)	15 (2.3)	51 (7.7)	147 (22.3)	205 (31.1)	242 (36.7)
Event 2: Did you learn, through others, about the loss of a relative and/or someone close to you due to COVID-19 infection?	211 (9.3)	2066 (90.7)	92 (4.5)	251 (12.2)	644 (31.2)	625 (30.3)	454 (21.9)
Event 3: Has any relative and/or someone close to you been at risk of imminent death due to contracting COVID-19?	1500 (65.9)	777 (34.1)	4 (0.4)	21 (2.7)	107 (13.8)	221 (28.4)	424 (54.6)
Event 4: Have you been exposed to people with COVID-19 who were at risk of death?	1840 (80.8)	437 (19.2)	3 (0.7)	18 (4.1)	63 (14.4)	116 (26.5)	237 (54.2)
Event 5: Have you had COVID-19?	2059 (90.4)	218 (9.6)	12 (5.5)	22 (10.1)	33 (15.1)	35 (16.)	116 (53.21)
Event 6: Do you fear (or have you received confirmation) that you might have transmitted COVID-19 to someone close to you (e.g., a partner, friend, or relative)?	1548 (67.9)	729 (32.0)	2 (0.3)	22 (3.0)	77 (10.6)	161 (22.1)	467 (64.1)

Note. N = Number of individuals; % = percentage.

Table 4
Simple logistic regression odds ratios (ORs) and 95 % confidence internals (95 % CIs) for depression, anxiety, and stress symptoms by traumatic event type and intensity. Each ΔX value corresponds to an interval between two values of traumatic event intensity.

Variable	Traumatic event type	Traumatic event intensity (1-not stressful at all—5-extremely stressful)				
	Estimate (*p* value)	OR - 95 % CI (ΔX = 5)	OR - 95 % CI (ΔX = 4)	OR - 95 % CI (ΔX = 3)	OR - 95 % CI (ΔX = 2)	OR - 95 % CI (ΔX = 1)
Depression						
Event 1	0.07	1.45	1.35	1.25	1.16	1.08
	(<0.001)	(1.16–1.81)	(1.13–1.61)	(1.09–1.43)	(1.06–1.27)	(1.03–1.13)
Event 2	0.11	1.76	1.57	1.40	1.25	1.12
	(<0.001)	(1.32–2.33)	(1.25–1.97)	(1.18–1.66)	(1.12–1.40)	(1.06–1.18)
Event 3	0.08	1.52	1.39	1.28	1.18	1.09
	(<0.001)	(1.25–1.84)	(1.19–1.63)	(1.14–1.44)	(1.09–1.28)	(1.05–1.13)
Event 4	0.11	1.69	1.52	1.37	1.23	1.11
	(<0.001)	(1.33–2.15)	(1.26–1.84)	(1.19–1.58)	(1.12–1.36)	(1.06–1.17)
Event 5	0.08	1.50	1.38	1.27	1.17	1.08
	(<0.001)	(1.07–2.09)	(1.06–1.80)	(1.04–1.56)	(1.03–1.34)	(1.01–1.16)
Event 6	0.10	1.65	1.49	1.35	1.22	1.11
	(<0.001)	(1.36–2.01)	(1.28–1.75)	(1.20–1.52)	(1.13–1.32)	(1.06–1.15)
Anxiety						
Event 1	0.15	2.14	1.84	1.58	1.35	1.16
	(<0.001)	(1.71–2.67)	(1.54–2.19)	(1.38–1.80)	(1.24–1.48)	(1.11–1.22)
Event 2	0.24	3.28	2.59	2.04	1.61	1.27
	(<0.001)	(2.43–4.43)	(2.03–3.29)	(1.70–2.44)	(1.43–1.81)	(1.19–1.35)
Event 3	0.12	1.86	1.64	1.45	1.28	1.13
	(<0.001)	(1.53–2.26)	(1.40–1.92)	(1.29–1.63)	(1.19–1.39)	(1.09–1.18)
Event 4	0.16	2.18	1.87	1.60	1.37	1.17
	(<0.001)	(1.72–2.78)	(1.54–2.26)	(1.38–1.85)	(1.24–1.50)	(1.11–1.23)
Event 5	0.10	1.67	1.51	1.36	1.23	1.11
	(<0.001)	(1.20–2.33)	(1.16–1.97)	(1.12–1.66)	(1.08–1.40)	(1.04–1.18)
Event 6	0.15	2.08	1.80	1.55	1.34	1.16
	(<0.001)	(1.71–2.53)	(1.54–2.10)	(1.38–1.74)	(1.24–1.45)	(1.11–1.20)
Stress						
Event 1	0.11	1.77	1.58	1.41	1.26	1.12
	(<0.001)	(1.42–2.21)	(1.32–1.89)	(1.23–1.61)	(1.15–1.37)	(1.07–1.17)
Event 2	0.23	3.23	2.55	2.02	1.60	1.26
	(<0.001)	(2.41–4.33)	(2.02–3.23)	(1.69–2.41)	(1.42–1.80)	(1.19–1.34)
Event 3	0.11	1.73	1.55	1.39	1.25	1.12
	(<0.001)	(1.42–2.11)	(1.33–1.82)	(1.23–1.56)	(1.15–1.35)	(1.07–1.16)
Event 4	0.15	2.13	1.83	1.57	1.35	1.16
	(<0.001)	(1.67–2.72)	(1.51–2.23)	(1.36–1.82)	(1.23–1.49)	(1.11–1.22)
Event 5	0.11	1.76	1.57	1.40	1.25	1.12
	(<0.001)	(1.26–2.47)	(1.20–2.06)	(1.15–1.72)	(1.10–1.44)	(1.05–1.20)
Event 6	0.16	2.18	1.86	1.59	1.36	1.17
	(<0.001)	(1.79–2.65)	(1.59–2.18)	(1.42–1.79)	(1.26–1.48)	(1.12–1.22)

Note. Significant at $p < 0.05$. OR = Odds Ratio. CI = Confidence Interval. Event 1: "Have you experienced the loss of a relative and/or someone close to you due to COVID-19 infection?"; Event 2: "Did you learn, through others, about the loss of a relative and/or someone close to you due to COVID-19 infection?"; Event 3: "Has any relative and/or someone close to you been at risk of imminent death due to COVID-19 infection?"; Event 4: "Have you been exposed to people with COVID-19 who were at risk of death?"; Event 5: "Have you had COVID-19?"; Event 6: "Do you fear (or have received confirmation) that you might have transmitted COVID-19 to someone close to you (for example, a partner, friend, or relative)?"

currently having or had a history of disease, being younger, and being a woman were positively associated with more severe depression, anxiety, and stress symptoms.

More than 80 % of the participants experienced traumatic events 3, 4, and 6 (being related or close to someone at risk of imminent death due to COVID-19 infection; being exposed to people with COVID-19 who were at risk of death; and fearing (or receiving confirmation) that they might have transmitted the disease to someone close to them (e.g., a partner, friend, or relative), respectively). The participants evaluated these traumatic events as being highly intense. The results highlight that these traumatic events were intensely experienced and that we should be concerned about how traumatic events affect the mental health of individuals who have experienced or may experience them.

Concomitantly, we aimed to assess whether each type and intensity of traumatic event could account for symptoms of mental disorders. We found that all six event types investigated in this study accounted for depression, anxiety, and stress symptoms, corroborating the findings of other studies. Accordingly, we suggest that regardless of the type of exposure to traumatic events, whether directly (for example, infection with the virus) or indirectly (for example, learning that someone close to you was infected), the experience increased the risk of symptoms of mental disorders (Bridgland et al., 2021; Kira et al., 2021). In addition, participants who reported experiencing high-intensity events were more likely to have symptoms of mental disorders. Our results are in line with the relationship between events experienced during the pandemic and symptoms of mental disorders found in previous studies (Bridgland et al., 2021; Gallagher et al., 2021; Kira et al., 2021). However, to our knowledge, this is the only study that has related the intensity of stress triggered by COVID-19 traumatic events to mental health in a non-frontline sample of university students. According to Kira et al. (2021), COVID-19-related stress events are related not only to having COVID-19 but also to the perceived or actual threat of being infected with the virus, the direct and indirect economic and social consequences of measures implemented to prevent virus transmission and secondary traumatic

events such as the loss of loved ones due to COVID-19 infection. Accordingly, the worsened mental health of the population due to the pandemic may be associated with the intensity of the specific COVID-19-related traumatic events experienced.

In our study, we found that many students reported having high levels of mental health symptoms including depression (49.6 %), anxiety (43.1 %), and stress (48.4 %) symptoms, ranging from severe to extremely severe. These values were greater than those reported in previous studies conducted during the COVID-19 pandemic. This was noted in a systematic review study conducted by Wang et al. (2023), which analysed 13 studies involving non-Chinese college students and 15 studies involving Chinese college students, totalling 436,799 students, that found that the prevalence of anxiety, depression, and stress was 29 %, 37 %, and 23 %, respectively. On the other hand, our findings corroborated those of a study including a sample of 356 Brazilian university students conducted by de Paula et al. (2022) during the pandemic, which showed that the prevalence of anxiety was 42.5 % and that of depression was 33.2 %. Some hypotheses include differences in sample characteristics, cultural and regional factors, and in the intensity and frequency of pandemic-related stress. According to the COVID-19 Performance Index, Brazil ranked as the poorest performer in managing the COVID-19 pandemic among 98 countries (Lowy Institute, 2021). This index was composed of the total number of cases and deaths due to COVID-19 in each nation, the availability of tests, and the percentage of the population affected by the pandemic. We believe that the extremely aversive context created by the pandemic could have been worsened by a denialist government, and consequently could have increased stress, anxiety, and depression in the Brazilian population compared to the populations of other countries. Another possibility is the timing of the data collection. Previous studies may have been conducted when the pandemic was less intense or during a different stage of the pandemic when the majority of the population was vaccinated. Our data were collected at a moment when the pandemic was intense in Brazil, the universities were closed and no vaccine was available for the university students because of their age.

The increased mental health issues of university students might have been triggered by preventive measures, such as lockdowns, including the closure of higher education institutions and the adoption of remote learning, which occurred only a few months after the pandemic was declared, generating uncertainties in academic life. Social distancing can negatively affect students' mental well-being. Being socially distant can lead to feelings of loneliness, depression, anxiety, stress, sleep problems, and difficulty concentrating (Al-Khani et al., 2019; Barros et al., 2021; Esteves et al., 2020; Pai & Vella, 2021; Teixeira et al., 2021). In a review of the impacts of social distancing and quarantine on mental health in previous outbreaks before COVID-19, Brooks et al. (2020) observed a significant increase in symptoms of anxiety and depression, among other mental disorders, in various countries. From a neurobiological perspective, social isolation can be considered a threat, as humans are naturally social and need to be close to their conspecifics (Dezecache et al., 2020). Our research group recently demonstrated that higher reports of loneliness in a sample of healthy adults were associated with less social support and social touch (Araújo et al., 2022). Having a good social support network can help create a sense of security, which can reduce stress, unlike the lack of social connections. This can make the brain more vigilant about potential threats to the environment and has long-term effects (Cacioppo & Cacioppo, 2014). Therefore, we believe that during the COVID-19 pandemic, when the social interaction that is so necessary for the survival of the human species was considered a factor that could spread the virus and cause death, the increase in loneliness may have increased the risk of mental health issues in the population.

We also found that increased depression, anxiety, and stress symptoms were associated with being younger and female and having current or previous disease. Our findings corroborate those of other studies conducted during the pandemic, as demonstrated in a systematic review of 19 studies (Xiong et al., 2020), which found that the risk factors associated with mental health issues included being female, being younger ($\leq$40 years), and having chronic/psychiatric diseases. Other studies performed during the pandemic corroborated the results of increased mental health issues in younger age groups (Beam & Kim, 2020; Duarte et al., 2020), women (Duarte et al., 2020; El-Monshed et al., 2021; Wathelet et al., 2020), and individuals with diseases (Varshney et al., 2020; Wang et al., 2020). Regarding the increase in symptoms associated with the younger age group, it is plausible that this is related to family caregiver roles, job loss, and economic unpredictability, which can be particularly stressful for this group (Xiong et al., 2020). Additionally, many young people faced challenges, such as school closures, difficulties in remote learning, exam postponements, and the cancellation of social events (Cao et al., 2020). The association between mental health symptoms and female sex may be partly attributed to the fact that women face a disproportionate caregiving burden, including responsibilities for children, elderly family members, and household chores (Craig & Churchill, 2021). Furthermore, women held a significant proportion of jobs affected by COVID-19, such as retail, services, and healthcare jobs (Alon et al., 2020). The increase in domestic violence during confinement (Bradbury-Jones & Isham, 2020) and the fact that women may present different neurobiological responses to stress may have contributed to the higher prevalence of mental disorders among women (Eid et al., 2019; Goel et al., 2014). Finally, the relationship between symptoms of mental health issues and chronic/psychiatric illnesses could be attributed to compromised immunity due to preexisting conditions, making individuals with these illnesses more susceptible to infection and at greater risk of mortality (Sawalha et al., 2020). Patients were especially concerned about the pandemic because of the increased risk of complications and uncertainty regarding medical treatment during that period (Xiong et al., 2020). Furthermore, significantly higher mortality rates have been observed among patients diagnosed with common chronic conditions (Guo et al., 2020; Emami et al., 2020), generating concern and uncertainty among individuals affected by these conditions.

The present study had certain limitations. First, the cross-sectional design may limit the ability to infer underlying causality in the relationship between COVID-19-related traumatic events and mental disorder symptoms. However, there is an important association between both measures. Second, we used a convenience sample of university students from two Brazilian institutions; therefore, we must be careful when generalizing our findings. Third, our results may only represent the mental health status of students during the specific period of data collection because the dynamics related to the COVID-19 pandemic were constantly changing. Our data was collected at a moment when the pandemic was intense in Brazil, the universities were closed and no vaccine was available for university students because of their age. Fourth, the content validity of the college student-adapted version of the Traumatic Experiences during the COVID-19 Pandemic Questionnaire (Gama et al., 2022; Machado et al., 2023; Portugal et al., 2022) was examined only qualitatively and relied on the subjective judgments of trauma experts observing the DSM 5 criteria for trauma, but no quantitative approach was used. Therefore, this must be taken into account when interpreting our findings.

A strength of the present study is that it was the first to evaluate the impact of the intensity of COVID-19-related traumatic events on the mental health of university students, a nonfrontline sample. Most participants in our study had high scores for depression, anxiety, and stress symptoms as well as high-intensity stress triggered by COVID-19-related traumatic events.

This study provides new evidence regarding mental health outcomes during the COVID-19 pandemic. Mental health assessments should include COVID-19-related traumatic events to help assess the impact of COVID-19 on the mental health status of university students and the general population. We highlight the emerging need to provide mental health services to the university student population and, more broadly,

to the entire population. Based on the Brazilian context, we recommend that interventions for university students include mental support services, such as individual or group psychotherapy and psychiatric treatment, the practice of physical exercise, and integrative and complementary health practices, such as yoga, reiki, and acupuncture. In addition, as some university students in Brazil are socially vulnerable, it is also necessary for them to be accompanied by a social worker and receive scholarships to remain at the university. Furthermore, studies that assess the effects of the pandemic on the mental health of university students can provide important information for policy and practice decisions for higher education institutions, helping ensure the mental health and well-being of students.

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CRediT authorship contribution statement

Nacha Samadi Andrade Rosário: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis. **Gabriel Soares Emiliano do Santos:** Writing – review & editing, Methodology, Investigation. **Ana Luiza Batista:** Writing – review & editing, Methodology, Investigation. **Aisllan Diego de Assis:** Writing – review & editing, Investigation. **Carlos Eduardo Nórte:** Writing – review & editing, Investigation. **Izabela Mocaiber:** Writing – review & editing, Investigation. **Eliane Volchan:** Writing – review & editing, Investigation. **Grace Schenatto Pereira:** Writing – review & editing, Investigation. **Mirtes Garcia Pereira:** Writing – review & editing, Investigation. **Letícia de Oliveira:** Writing – review & editing, Investigation. **Adriana Lúcia Meireles:** Writing – review & editing, Investigation. **Eduardo Bearzoti:** Writing – review & editing, Methodology, Investigation, Formal analysis. **Gabriela Guerra Leal Souza:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The Authors declare that there is no conflict of interest.

Data availability

Data will be made available on request.

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Not applied.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2024.104300.

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