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Short communication

Trends and prevalence of suicide 2017–2021 and its association with COVID-19: Interrupted time series analysis of a national sample of college students in the United States

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ABSTRACT

Background: Suicide is among the leading causes of death for college students. We aimed to assess the impact of the pandemic on trends in suicidal thoughts and behaviors among college students, and whether suicidal thoughts and behaviors were associated with COVID-19 infection and psychosocial factors.

Methods: We analyzed 2017–2021 data from 4 waves of Healthy Minds Study including a random sample of college students ($N = 354,473$) from 286 U.S. institutions. We performed interrupted time series analysis to model the effect of the pandemic on trends in suicidal ideation (SI), plan (SP), and attempt (SA). At the per-pandemic assessment, we utilized multivariable logistic regression to examine the association of SI, SP, and SA with COVID-19 infection and psychosocial factors.

Results: We observed significant decreases in SI, SP, and SA among college students from 2017 to 2021. The pandemic was significantly associated with a 1.33 percentage points reduction in SI and a 0.85 percentage points reduction in SP but was not associated with a significant reduction in SA. Adjusted associations of SI, SP, and SA with risk factors showed the significant odds ratio (OR) for suspected COVID-19 infection (SI: 1.33, SP: 1.22, SA: 1.32), severe depression (SI: 6.39, SP: 6.63, SA: 5.63), severe anxiety (SI: 3.66, SP: 3.62, SA: 3.60), COVID-19-related financial stress (SI: 1.35, SP: 1.34, SA: 1.48), food insecurity (SI: 2.12, SP: 2.13, SA: 2.79), and academic impairment (SI: 2.07, SP: 2.05, SA: 2.14) but not for test-confirmed COVID-19.

Conclusion: Certain COVID-19 mitigation strategies might have protected college students from suicidal thoughts/behaviors.

1. Introduction

Suicide is among the leading causes of death for young adults and college students (CDC, 2020). Students with depression or anxiety are at increased risk for suicidal thoughts and behaviors (Casey et al., 2022). Prior to the coronavirus disease 2019 (COVID-19) outbreak, over one in four U.S. college students experienced at least one diagnosable mental health disorder, and 23.7% of college students were at higher risk of suicide (American College Health Association, 2020). A recent national study (Oh et al., 2022) found that around 12% of students disclosed suicidal ideation (SI), suggesting that college students might be at greater suicide risk compared with the general population (SI: 10.8% [Dubé et al., 2021]). The COVID-19 pandemic has caused public health, social, and economic turmoil that exacerbated challenges for millions of

college students (DeVylder et al., 2021; Oh et al., 2021, 2021; Zickgraf et al., 2022). Uncertainty and concerns over one's health and safety, education, and employment during the pandemic might have posed a threat to collegiate mental health, placing students at higher risk for mental health problems and suicide (Cao et al., 2020; King et al., 2022).

Many students experienced adverse psychosocial influences due to the psychological and societal consequences of the prevailing pandemic and associated mitigation measures, which might make students more susceptible to suicidal thoughts and behaviors (Oh et al., 2022). In responding to the COVID-19 emergency declaration in March 2020, colleges and universities suspended in-person classes and inhibited campus life (Sahu, 2020). Some students had concerns and fear of being infected or infecting others, and some worried about or experienced the loss of social ties due to lockdown/shelter-in-place and school closures

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for in-person learning, which exacerbated social isolation and loneliness (Tei and Fujino, 2022). During the early pandemic, some college students struggled with food insecurity and financial hardship due to the loss of employment or financial assistance (Peltz et al., 2020; Zickgraf et al., 2022). Students might also have difficulties sustaining their academic performance to complete their degrees because of psychological disturbance associated with social and economic turmoil (Duffy et al., 2020). Research showed that around 20% of college students suffered from severe depression, and 33% experienced severe anxiety in fall 2020 (Oh et al., 2021). Taken together, these COVID-19-related psychosocial factors may play an important role in suicidal thoughts and behaviors, which should not be overlooked (Choi et al., 2021).

A growing body of literature has provided important insights into suicide among U.S. college students during the COVID-19 pandemic (DeVylder et al., 2021; Gratz et al., 2021; Lipson et al., 2022; Oh et al., 2022; Oh et al., 2021); however, it remains unclear about recent trends in both suicidal thoughts and behaviors over time and whether the pandemic may have affected these trends. For example, recent research has only examined the change in SI but not suicidal plan (SP) and attempt (SA) from prepandemic to peripandemic (Gratz et al., 2021; Lipson et al., 2022). Given that suicidal behaviors (i.e., made a suicide plan, attempted suicide) present a major challenge to public health and are of particular concern for young adults and college students (Ivey-Stephenson et al., 2020), it is important to examine trends in SP and SA among this population in order to develop targeted suicide prevention strategies to reduce suicide-related morbidity and mortality (CDC, 2022). Additionally, research has not yet determined the effect of the pandemic on trends in SI, SP, and SA among U.S. college students to date. To fill the research gap, the first aim of this multi-campus national study is to examine trends in both collegiate suicidal thoughts and behaviors as well as the impact of the pandemic on these trends.

The pandemic might have exacerbated suicide risk among college students through COVID-19 infections. Research has shown that people with severe COVID-19 symptoms might be at elevated suicide risk (Choi et al., 2021; DeVylder et al., 2021). Researchers have made considerable efforts to understand the mechanisms behind the association between long-term psychiatric sequelae and COVID-19 infection (Boldrini et al., 2021; Choi et al., 2021). It is plausible that COVID-19 infection produces inflammatory cytokines that affect the kynurenine pathway, monoamine metabolism, and HPA-axis, which can impact brain functions and lead to suicidal thoughts and behaviors (Choi et al., 2021). One study has found that college students with COVID-19 infections/symptoms appear at higher risk for suicide, suggesting the effect of COVID-19 infection/symptoms on collegiate suicidal thoughts and behaviors (DeVylder et al., 2021). In this referenced study (DeVylder et al., 2021), students with suspected COVID-19 (i.e., not confirmed by testing but with COVID-19 like symptoms) were categorized into the COVID-19 infection/symptoms group along with students with test-confirmed COVID-19. It might be possible that some students acquired other respiratory illnesses that had symptoms like COVID-19, which struck fear and induced suicidal thoughts and behaviors (Quadros et al., 2021; Tei and Fujino, 2022). We wondered if suspected COVID-19 infection could also contribute to collegiate suicidal thoughts and behaviors. Thus, building upon the important existing research, we included the second aim of this present study, examining whether test-confirmed and suspected COVID-19 infection may play distinct roles in SI, SP, and SA among college students.

While an emerging body of research has been carried out on suicidality among college students during the pandemic (Fuse-Nagase et al., 2021; Gratz et al., 2021), few studies have investigated the association between psychosocial factors and suicide among U.S. college students. Recent research has found that some important psychosocial factors, such as general concerns over COVID-19 and racial/ethnic discrimination, contribute to suicide risk among U.S. college students (Oh et al., 2022). Additionally, college students' wellness encompasses other essential psychosocial components, such as mental health, academics,

and food security (Eiroa-Orosa, 2020). We wondered if these psychosocial factors might also predict suicidal thoughts and behaviors among U.S. college students during the pandemic. Thus, drawing upon previous research and leveraging a large national sample, we included the third aim of this study, examining the association of SI, SP, and SA with these psychosocial factors.

2. Methods

This retrospective cohort study was approved by the institutional review board of the University of Alabama at Birmingham. Written informed consent was obtained from all participants. We analyzed 2017–2021 data from 4 waves of the Healthy Minds Study which surveyed a random sample of college students 18 years and older from 286 US universities/colleges. Though institutions that participated varied each academic year, these study sites are diverse across institution characteristics, including institutional type, enrollment size, and geographic location. The response rate was 23% in 2017–2018, 16% in 2018–2019, 16% in fall 2019, 13% in winter/spring 2020, 14% in fall 2020, and 15% in winter/spring 2021. Given the importance of rigorous adjustment for non-response, sample weights were calculated by the Healthy Minds Study team and used to adjust non-response based on institutional data from the student populations, including sex, race/ethnicity, academic level, and grade point average. To ensure that estimates represent the full U.S. student population, weights are larger for participants from underrepresented groups/communities.

2.1. Measurements

Primary outcomes included three binary outcome variables: suicidal ideation (“In the past year, did you ever seriously think about attempting suicide?”), plan (“In the past year, did you make a plan for attempting suicide?”), and attempt (“In the past year, did you attempt suicide?”). Histories of COVID-19 infection/testing (i.e., test-confirmed COVID-19, physician-diagnosed COVID-19, suspected COVID-19, no symptoms) were measured by a single item: “Have you had COVID-19 (the novel coronavirus disease)?”. Predictors (independent variables) included severe depressive symptoms (≥ 15 on the Patient Health Questionnaire-9 [PHQ-9]; [Kroenke et al., 2001]), severe anxiety symptoms (≥ 15 on the Generalized Anxiety Disorder-7 [GAD-7]; [Spitzer et al., 2006]), COVID-19-related financial stress (“How has your financial situation been affected by the COVID-19 pandemic?”), food insecurity (“Within the past 12 months the food I bought just didn’t last and I didn’t have money to get more.”), and academic impairment (“In the past 4 weeks, how many days have you felt that emotional or mental difficulties have hurt your academic performance?”).

2.2. Data analysis

We conducted χ^2 tests to examine associations of SI, SP, and SA with academic years (2017–2018 to 2020–2021). To assess the effect of the COVID-19 pandemic on trends in SI, SP, and SA, we performed a single-arm interrupted-time series analysis, using the autoregressive integrated moving average (ARIMA) modeling approach. We analyzed data on monthly aggregations from September 2018 to May 2021 through ARIMA procedures. Data from 2017 to 2018 were not analyzed because of lacking information on participants' response dates. Given that participants' responses were collected during academic years, monthly data were missing for school breaks (i.e., June, July, and August 2019, and July and August 2020). We used an empirical imputation method recommended for ARIMA (Hyndman and Athanasopoulos, 2018; Jones, 1980; Wyatt et al., 2013; Yaffee and McGee, 2000) to estimate missing values for those time points, which brings the total number of time points to 33. We determined the final intervention models by evaluating the plots of Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF), estimating the intervention components, and

subjecting models to diagnostic tests (e.g., Bayesian information criterion [BIC], Ljung-Box, Stationary R^2) (Pridemore et al., 2013; Schaffer et al., 2021; Wyatt et al., 2013). In the final ARIMA models, the intervention variable was included as an independent dummy variable (coded "0" for 18 months prior to the COVID-19 emergency declaration [September 2018-February 2020] and coded "1" for the next 15 months starting with March 2020 during which COVID-19 was declared a national emergency and thereafter [March 2020-May 2021]). Given that ARIMA procedures take the mean values at all previous time points into account, we were able to assess whether the COVID-19 emergency declaration was associated with a significant change in SI, SP, and SA from prepandemic to peripandemic.

At the peripandemic assessment, we performed sample-weighted multivariable logistic regression for each outcome variable (i.e., SI, SP, SA) to compute adjusted odds ratios (AOR) and 95% CIs, controlling for covariates. Based on previous studies (Choi et al., 2021; DeVlyder et al., 2021; Greydanus et al., 2010; Oh et al., 2022; Tobore, 2019; Tubas et al., 2022), covariates included demographic variables (i.e., age, sex, gender, race/ethnicity, disability status, international, relationship, residence) and plausible risk factors (i.e., smoking and vaping status, chronic diseases). A 2-sided $p < .05$ was considered statistically significant. Analyses were conducted with SPSS (version 25). The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

3. Results

Of 354,473 students, 56.06% (weighted) were women. The prevalence of SI, SP, and SA significantly decreased from 2017 to 2021. The

prevalence of SI decreased significantly from 13.4% in 2017–2018 to 13.2% in 2020–2021, $\chi^2(3, N = 318,869) = 46.01, p < .001$. There was a 6.4% decrease in SI from 2019–2020 to 2020–2021, though an upward trend in SI was observed during the prepandemic period (2017–2020 winter/spring). Moreover, the prevalence of SP decreased significantly from 5.8% in 2017–2018 to 5.4% in 2020–2021, $\chi^2(3, N = 317,907) = 64.88, p < .001$, and there was a 6.9% decrease in SP from 2019–2020 to 2020–2021. Likewise, the prevalence of SA decreased significantly from 1.5% in 2017–2018 to 1.3% in 2020–2021, $\chi^2(3, N = 317,704) = 16.31, p < .001$, and there was a 7.1% decrease in SA from 2019–2020 to 2020–2021.

Although these raw data revealed overall decreases in prevalence of SI, SP, and SA from prepandemic (2017–2020 winter/spring) to peripandemic (2020–2021), it was essential to estimate ARIMA models to determine if and what proportion of such changes were attributable to the effect of the pandemic. The results of the Ljung-Box test for the final ARIMA models for SI ($Q = 18.59; df = 16; p = .29$), SP ($Q = 15.81; df = 17; p = .54$), and SA ($Q = 13.88; df = 17; p = .68$) met the criterion that none of the autocorrelations was significant at the 0.05 level, suggesting good fit of these specified models. Fig. 1 displays the time-series data for the September 2018–May 2021 time period. The results revealed that the COVID-19 emergency declaration was statistically significantly associated with a 1.33 percentage points reduction in SI (ARIMA [2, 0, 0], Stationary $R^2 = 0.18$) and a 0.85 percentage points reduction in SP (ARIMA [1, 0, 0], Stationary $R^2 = 0.23$) but was not associated with a significant reduction in SA (ARIMA [1, 0, 0], Stationary $R^2 = 0.24$) among U.S. college students.

Table 1 presents the results from logistic regression at the peripandemic assessment. Test-confirmed COVID-19 was not significantly

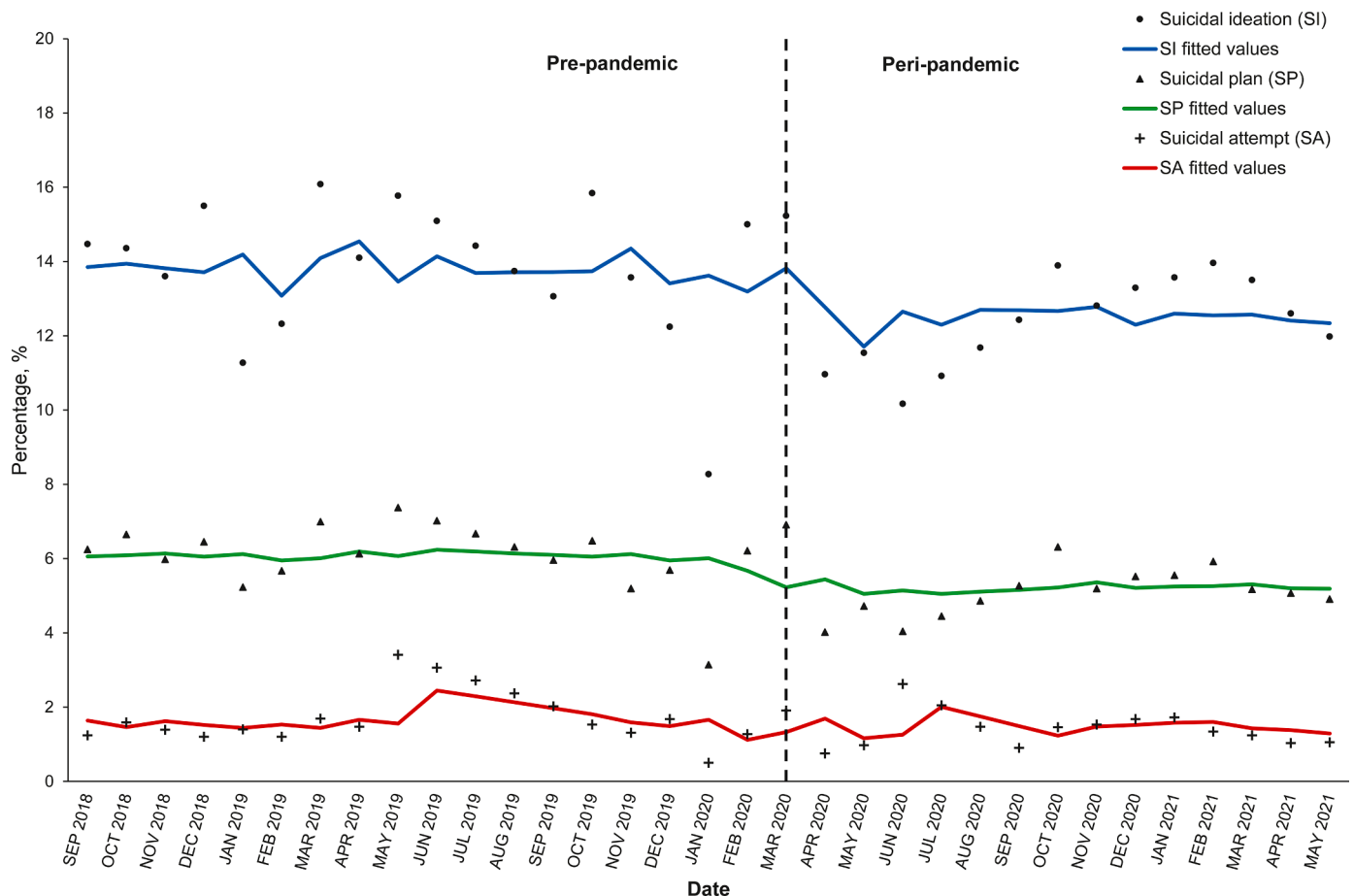


Fig. 1. Monthly prevalence of suicidal ideation, plan, and attempt among college students in the United States, September 2018–May 2021. Note. The vertical dashed line represents the month in which COVID-19 was declared a national emergency.

Table 1Multivariable logistic regression analysis of risk factors for suicide ideation, plan, and attempt at peripandemic assessment in 137,882 US college students^a.

Variable	Suicidal ideation AOR (95% CI)	p value	Suicidal plan AOR (95% CI)	p value	Suicidal attempt AOR (95% CI)	p value
COVID-19 History						
No symptom	1 (reference)	NA	1 (reference)	NA	1 (reference)	NA
Test-confirmed COVID-19	0.95 (0.87–1.02)	.16	1.00 (0.89–1.12)	>.99	1.10 (0.88–1.38)	.39
Physician-diagnosed COVID-19	1.21 (1.08–1.35)	.001	1.17 (0.99–1.39)	.06	1.05 (0.74–1.49)	.79
Suspected COVID-19	1.33 (1.24–1.42)	<.001	1.22 (1.10–1.35)	<.001	1.32 (1.08–1.60)	.006
Severe depression	6.39 (6.16–6.64)	<.001	6.63 (6.26–7.01)	<.001	5.63 (5.03–6.29)	<.001
Severe anxiety	3.66 (3.52–3.81)	<.001	3.62 (3.43–3.83)	<.001	3.60 (3.23–4.01)	<.001
COVID-19-related financial stress	1.35 (1.32–1.38)	<.001	1.34 (1.30–1.38)	<.001	1.48 (1.38–1.57)	<.001
Food insecurity	2.12 (2.04–2.20)	<.001	2.13 (2.02–2.25)	<.001	2.79 (2.50–3.11)	<.001
Academic impairment	2.07 (2.03–2.11)	<.001	2.05 (1.99–2.12)	<.001	2.14 (2.01–2.29)	<.001

Abbreviations: NA, not applicable; AOR, adjusted odds ratio.

^a Covariates include age, sex, gender, race/ethnicity, disability status, international, relationship, residence, smoking and vaping status, chronic diseases (i.e., diabetes, hypertension, asthma, thyroid disease, gastrointestinal disease, arthritis, sickle cell anemia, seizure disorders, cancers, high cholesterol, HIV/AIDS, other autoimmune disorders, other chronic diseases).

associated with SI, SP, or SA. Physician-diagnosed COVID-19 was only associated with significantly greater odds of SI but was not associated with SP or SA. However, suspected COVID-19 infection, severe depression/anxiety, COVID-19-related financial stress, food insecurity, and academic impairment were associated with significantly greater odds of SI, SP, and SA.

4. Discussion

Findings of this cohort study showed overall decreases in suicidal thoughts and behaviors among college students from the prepandemic to peripandemic period. Particularly, the prevalence of SI and SP statistically significantly dropped following the COVID-19 emergency declaration and associated mitigation policy. These findings align with previous studies suggesting decreases in suicide as a function of the pandemic (Pirkis et al., 2021; Travis-Lumer et al., 2021). During the first year of this pandemic, governments and universities timely responded to the threat to collegiate wellness, implementing various measures, such as promoting mental health services, providing relief for federal student loans, and offering academic accommodations and online instruction. Students might experience less everyday stress and gain more support from families and communities during stay-at-home periods (Pirkis et al., 2021; Travis-Lumer et al., 2021). Such protective factors might prevent some students from suicide (Pirkis et al., 2021; Travis-Lumer et al., 2021). Further, college students might perceive less risk of COVID-19 because of the low percentage of COVID-19-related hospitalization and death in young adults (Kollmann et al., 2022). They might focus more on the disaster response but not themselves during the pandemic, demonstrating positive affect (e.g., optimism, relief) and social cohesion, which provided students with an additional layer of protection against suicide (Travis-Lumer et al., 2021; Zunin and Myers, 2000). Worthy to note is that the COVID-19 emergency declaration, however, did not appear to have an impact on the modestly downward trend in SA. Unobserved confounding factors, instead, might have contributed to the decline in SA over time (i.e., before and during the pandemic). Research also suggests that changes in SA can be discrepant from variation in SI because there may be changes in SA that are only evident several years after infectious disease outbreaks (Batterham et al., 2022; Cheung et al., 2008). Additionally, given that SAs were rare among college students (Oh et al., 2022), low numbers of monthly SAs might have led to models with relatively inadequate power to detect decreases in SA attributed to the effect of the pandemic (Pirkis et al., 2021).

When compared with students without histories of COVID-19 infection/symptoms, those with suspected infection were at elevated suicide risk, but not those with test-confirmed infection. One potential explanation is that fear and anxiety fueled by uncertainty of COVID-19 infection and restrictions might exacerbate suicidal thoughts and

behaviors (Quadros et al., 2021). Students with suspected COVID-19 infection might endure persistent worry and fear about the uncertain biopsychosocial consequences of COVID-19 (Berardelli et al., 2021). Consequently, such psychological burden and distress might exacerbate suicidal thoughts and behaviors (Mamun and Griffiths, 2020; Quadros et al., 2021). Surprisingly, students with histories of COVID-19 infection confirmed by COVID-19 testing were not found to be at significantly higher risk for suicide. It is possible that as a result of confirmed COVID-19 infection, some students benefitted from additional protective factors, such as timely mental health care, targeted suicidal prevention, financial assistance, and family support (Gunnell et al., 2020).

The peripandemic assessment results revealed additional risk factors for suicidal thoughts and behaviors, which are severe depression/anxiety, COVID-19-related financial stress, food insecurity, and impaired academic performance. It is noteworthy that bipolar disorders may also serve as a risk factor for suicide (Fornaro et al., 2021) because people who have bipolar disorders may be screened for unipolar depression (i.e., major depressive disorder) via PHQ-9 (Inoue et al., 2012). During the early pandemic, some college students experienced increased severities of depression and anxiety due to the psychosocial influences of COVID-19, such as disruptions of education, reduced social connectedness, and financial concerns (Cao et al., 2020; King et al., 2022; Oh et al., 2022; Sahu, 2020). Marginalized students (e.g., racial/ethnic and sexual minorities) might struggle with poor social determinants of mental health, such as discrimination and food insecurity (Gratz et al., 2021; Oh et al., 2022; Shim and Compton, 2020). Such deleterious psychosocial influences of COVID-19 have strikingly underscored the need for ongoing public health and suicide prevention efforts targeted to vulnerable college students to mitigate risk of suicide and psychosocial effects of COVID-19 (CDC, 2022). As an integral workforce in public health, mental health professionals are well-trained to address pressing mental health needs and crises and should be poised to support students affected by the COVID-19 pandemic.

This study has several limitations. First, the study is limited by the retrospective, self-reported data introducing the possibility of recall bias. Second, the results might not be generalized beyond this current student population. The response rate of the Healthy Minds Study has declined in the past five years (from 23% in 2017–18, to 15% in winter/spring 2021), which might introduce non-response bias, though sample weights were used to adjust non-response. Additionally, institutions that participated in the Healthy Minds Study varied each year; however, the variation in institution characteristics between survey waves was random, and previous research indicates that this limitation is very unlikely to invalidate study results (Lipson et al., 2022). Third, we had to impute data for time points with missing values, although data imputation is common in time series analysis (Hyndman and Athanasopoulos, 2018; Jones, 1980; Wyatt et al., 2013; Yaffee and McGee, 2000). Fourth, variables included in the logistic regression models were

measured spontaneously, which did not permit us to assess temporal links. It is plausible that students who had suicidal thoughts/behaviors might struggle with mental health issues, such as anxiety and stress, so they were more likely to worry about COVID-19 and suspect infections. Future longitudinal studies are needed to evaluate associations of suicide risk with histories of COVID-19 infection and psychosocial factors across different groups of students. Lastly, PHQ-9 was administered to assess depressive symptoms, and it did not take into account the occurrence of bipolar disorders (Inoue et al., 2012). Among 24,541 participants who reported severe depression at the peripandemic assessment, some might meet the diagnostic criteria for bipolar disorders. Thus, studies using diverse screening instruments are needed to appropriately estimate prevalence of bipolar disorders and major depressive disorder among college students (Fornaro et al., 2021). Despite limitations, this current study provides empirical evidence on the impact of the COVID-19 pandemic on trends in suicide and the association of suicide with suspect COVID-19 infection and psychosocial factors through a large national cohort of college students.

Data access

The data that support the findings of this study are openly available upon request in The Health Minds Network at <https://healthymindsnet.work.org>.

Author contributions statement

The first author (Yusen Zhai) conceived of the presented idea and conducted the literature review and data analysis. Both authors (Yusen Zhai & Xue Du) contributed to the final manuscript.

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Ethics approval statement

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human participants were approved by the institutional review board (IRB-300008474) of the University of Alabama at Birmingham.

Declarations of competing interest

none.

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