



REVIEW ARTICLE



<https://doi.org/10.1057/s41599-024-03781-0>

OPEN

Impact of COVID-19 on the psychological and behavioral health of college students worldwide: a knowledge mapping approach

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The outbreak of COVID-19 had a significant impact on the psychological and behavioral health of college students. However, few studies have systematically explored the relationship between COVID-19 and psychological and behavioral health among college students worldwide. Therefore, the purpose of this study was to explore the impact of COVID-19 on college students' psychological and behavioral health using a knowledge-mapping approach. In total, 796 publications were selected and analyzed to clarify the publication volume and time distribution, core authors, major journals, research institutions, country distributions, research hotspots, and core themes. Since the outbreak of the COVID-19 pandemic in 2019, studies focused on the impact of COVID-19 on college students' psychological and behavioral health showed an increasing trend year by year. The three countries with the highest centrality were Britain (0.34), the United States (0.24), and Mexico (0.13). The five major topics of research were mental health, academic pressure, physical health risks, college students' majors, and daily living habits, with most research concerned with college students' mental health. The visualized burst detection results were combined to identify three cutting-edge research topics in this field: the sustained impact of COVID-19 on college students' mental health, the sustained impact of COVID-19 on medical college students, and the mediating role of college students' mental resilience during COVID-19. We conclude by discussing the implications of our findings.

Introduction

The outbreak of the COVID-19 pandemic created a huge shock across the world and profoundly affected all aspects of society, including education. The pandemic had a significant impact on the psychological and behavioral health of college students. Many previous studies investigated the impact of the pandemic, and a common aim was to provide necessary psychological and behavioral guidance for college students who were negatively affected by the pandemic. COVID-19 has brought many lifestyle changes for college students, including changes in time spent on electronic devices, the number of private meetings, monthly

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drinking, meal deliveries, outdoor activities, late-night and daily snacks, and daily coffee intake; these changes had different levels of impact on college student's mental health (Lee et al., 2022). The pandemic also disrupted normal teaching at universities, which posed major challenges for higher education. Furthermore, the requirements for social distancing created a surge in Internet use, given students' demand for social interaction. In addition, the chain of "online social support → self-esteem" deeply affected the amount of loneliness suffered by college students when they were unable to change their real-life situation in the context of pandemic restrictions (Luo et al., 2022). The pandemic itself was an additional stressor, which potentially increased the risk for mental disorders among college students, thereby further altering their lifestyles and compromising their mental health (Buizza et al., 2022). As a vulnerable group, college students were also at high risk for depression and suicide attributable to the outbreak. Interestingly, college students who did not have lifelong mental health disorders were at greater risk for planning suicide than college students with these disorders. Therefore, research and interventions with longer follow-up periods are required to clarify how college students should respond to such a pandemic to reduce the occurrence of these extreme behaviors (Borges et al., 2023).

Extensive studies were conducted during the pandemic on the impact on the mental and behavioral health of college students. However, there are few studies explored the relationship between COVID-19 and the mental and behavioral health of college students worldwide. Therefore, this study examined the impact of COVID-19 on college students' psychological and behavioral health using a knowledge-mapping approach. We used CiteSpace software to conduct a knowledge graph visualization analysis of the literature related to the impact of COVID-19 on college students' psychological and behavioral health. We focused on the Web of Science database and objectively analyzed the major issues and development trends in this field, providing corresponding suggestions to support the improvement of college students' psychological and behavioral health after the pandemic.

The significance and necessity of exploring the impact of COVID-19 on the psychological and behavioral health of college students on a global scale

It is significant and necessary to conduct studies regarding the impact of the pandemic on the psychological and behavioral health of college students worldwide (Borges et al., 2023; Lee et al., 2022; Gibbons, 2022). Current studies have highlighted that the impact of the pandemic on the psychological and behavioral health of college students is a challenging issue globally (Abdeahad and Mock, 2023). For example, based on a survey data sample of 30,383 students in 62 countries, the largest and most comprehensive study on college students' perception of the impact of the first wave of the pandemic crisis on different aspects of their lives has been carried out so far. This study covered multiple types of countries and regions, as well as different types of academic institutions, such as European and American countries. Samples were collected from the United States, Germany, Spain, Switzerland, Asian countries, China, India, Saudi Arabia, Vietnam, and a few other countries in Africa. It is shown that the satisfaction of college students with certain social demographic characteristics, such as gender, type of university, grade, economic problems, and so on, is different. A set of recommendations should be developed for national policymakers and higher education institutions to support students in navigating the crisis caused by this outbreak and in possible future pandemic crises (Aristovnik et al., 2020).

Although the immediate effect of the pandemic has weakened, the great changes in the psychological and behavioral patterns of college students brought about by the pandemic have left an indelible lag effect (Rohde et al., 2023). For example, this influence can be a positive change in the online learning model and bring about innovative changes in education. While due to the constant changes in learning patterns during the pandemic, college students must endure a higher risk of mental health and stress, and behaviors related to student health further deteriorate. Of course, quality of life scores on mental health do not fully account for the stress levels of online college students, and the impact of online learning on the perceived stress levels of college students needs further research (Chusak et al., 2022). It can be the strengthening of physical fitness brought about by the increase of positive forms of home exercise and campus recreational sports (CRS), the improvement of psychological quality, and further development of self-expansion brought about by the improvement of resilience to cope with major crises (Halat et al., 2022; Abdeahad and Mock, 2023). For instance, it can be the subversion of negative eating and sleeping habits, behavioral disorders stemming from excessive electronic addiction, and psychological problems arising from mental breakdown caused by great challenges in life, study, and work (Chusak et al., 2022). The spread of the COVID-19 disease has restricted many normal social life, and strict risk control will threaten people's eating habits and mental health, and susceptible college students may show more prominent eating disorders and mental health problems (Wu et al., 2023). For college students who have a certain anxiety tendency in study and life, defensive pessimism and optimism are effective in stimulating learning motivation. Further development of situational control, support, and strategies related to student personality during the pandemic can enhance students' resilience (Gibbons, 2022).

Therefore, based on long-term consideration rather than limited to the present, it is of great significance to explore different lessons from the pandemic and carry out in-depth research to face various possible major global crises and challenges for a global scale.

Impact of COVID-19 on college students' psychological and behavioral health worldwide

Many studies were conducted during the pandemic to explore the impact on contemporary college students. Now that social norms have been largely restored after the height of the pandemic, college students, whose lives and studies were greatly affected during the COVID-19, have been able to continue their study on campus, graduate, and embark on careers or further study, or have already switched to the identity of social workers.

Some studies used fear appeal theory and social learning theory to explore the impact of perceived threats on psychological anxiety among college students in China at the beginning of the COVID-19 pandemic and to clarify the intermediary role of reaction efficacy and self-efficacy (Zhang et al., 2022). Some studies used questionnaires with different scales, multiple regression models, and hierarchical analysis methods and revealed that many Chinese college students had serious mobile phone addictions during the pandemic, which were related to depression, anxiety, and insomnia. It has been found that online learning exacerbates problematic smartphone use and mental health problems, providing valuable information for targeted psychological interventions in the post-pandemic era. A study that followed different groups of college students and used generalized estimation equation models to estimate the effects of preventive behaviors and mental resilience on mental health during the pandemic found the prevalence of depression had

increased at follow-up, and that of anxiety and stress had decreased (Li et al., 2023). Other studies obtained information from students using snowball sampling and cross-sectional survey designs and concluded that the positive impact on psychological well-being may help students adapt to other negative impacts during the pandemic and alleviate the pressure on emotional well-being (Mishra and Kumar, 2023).

It was found that the pandemic had a greater negative impact on the health behavior of students in European countries and the United States compared with Asian countries, which may reflect differences in the time course of the pandemic and the number of cases (Du et al., 2021). One study compared Chinese college students in China and South Korea with their knowledge during COVID-19, pandemic defense behavior, and mental depression, and explored the key factors that contributed to these students' depression. The study found that students living in South Korea performed better in terms of preventive behavior but had a higher rate of severe depression than the mainland group. These conclusions can provide a reference for further research in different regions on different measures to reduce depressive symptoms in college students. (e.g., psychological counseling and physical activity encouragement) (Zhao et al., 2021). Another study used an online survey during the pandemic period to investigate differences among international college students in China, including gender-based differences (Li et al., 2021). In addition, a study interviewed LGBTQ college students and found that about 40% of them were not satisfied with their lives at the beginning of the pandemic, and almost all of them were worried about the threat of the coronavirus to their mental health. Some participants also feared seeking care during the pandemic because of their LGBTQ identity (Gonzales et al., 2023). That study concluded that there were significant differences in psychological distress and coping strategies among different groups. However, other studies have found no significant differences in the psychological impact of the pandemic among students of different ethnicities (domestic and international), genders, and learning levels (Yassin et al., 2021). A study that investigated different professional groups reported that pharmacy students showed depression, anxiety, stress, and low mental resilience 1 year after the outbreak of the pandemic (Halat et al., 2022). That study suggested it was necessary to investigate the long-term psychological impact of the pandemic on college students (Rohde et al., 2023).

At the national level, different countries have different policies and technical support for COVID-19 response, so the emotional responses of college students are also different (Gonzales et al., 2023). This shift in learning patterns can also lead to problems related to anxiety and mental health among students (Korneeva et al., 2022). For example, a qualitative study, that explored the impact on the mental health of young people in Jakarta, Indonesia, after a year and a half of isolation during the COVID-19 pandemic, provided important insights into the well-being of Indonesian youth following extended social restrictions during this period (Rahiem et al., 2021; Xiao, 2021). By studying the coping strategies of college students at the Polish Sports University during the second wave of COVID-19, it was found that the coping strategies of acceptance, positive coping, physical activity, and positive restructuring were most used (Guszkowska and Dabrowska-Zimakowska, 2022). Focusing on the relationship between the COVID-19 pandemic and the academic performance and health of South Asian students, it was found that South Asian students face additional challenges, including a worsening academic experience in higher education, increased mental health, the malignant spread of misinformation and an increase in religious tensions. South Asian students have a unique experience in higher education in California, and they often must deal with higher pressures to fulfill the various social responsibilities of

being first, second, or third-generation Americans (Quraishi, 2023). Religion has also become the focus of research scholars. In Saudi Arabia, due to the influence of religion, strict social norms restrict women's social gatherings and outdoor sports, etc., so it is necessary to explore the mental health symptoms of depression and the development of preventive behaviors against the pandemic in Saudi Arabian college students from a religious gender perspective (Aldhmadi et al., 2021; Edara et al., 2021).

At the institutional level, the university environment has a potential role as a target for implementing interventions to promote learning progress, build healthy study habits, and develop well-being among students. The pandemic created additional challenges for universities in terms of supporting students' study habits (Clarke et al., 2021; Xue et al., 2023; Zhou and Zhang, 2021; Xu et al., 2021). Comprehensive mental health services and targeted suicide prevention initiatives were therefore critical for college students during the pandemic (Xu et al., 2021). Physical activity was also important, as it could effectively alleviate the adverse mental health effects brought about by the pandemic. Supporting and encouraging certain groups (e.g., senior students and rural college students) to participate in a certain level of physical activity may improve their subjective well-being and help them to cope with the adverse effects of the pandemic (Yuan and You, 2022; Zhang et al., 2022). During this period, psychological problems were common among college students, especially among those who were younger, had lower grades, often skipped breakfast, had poor quality of sleep, had sluggish state of learning, and had poor dormitory relationships. Under the situation of COVID-19 containment and normalized management, college students should form good living habits to effectively promote mental health, such as eating breakfast on time, exercising regularly, going to bed early, maintaining a good relationship with roommates, participating in non-congregate interpersonal activities in a small area, and taking the initiative to seek psychological help (Xu et al., 2022).

At the individual level, being isolated for observation or treatment, death of a family member or friend due to COVID-19, seeking help from others rarely or never, low support from relatives or friends, low support from family members, poor relationships with parents at home, more time spent on electronic devices in addition to daily online learning each day, and anxiety about going back to school were risk factors for depressive symptoms among college students during the pandemic. Academic pressure and fear of the pandemic were the main causes of anxiety (Yu et al., 2021). A study involving college students attending elite Italian universities found that during the pandemic and shift of teaching to distance learning systems, college students experienced more anxiety from interference with interpersonal relationships and academic demands. However, being surrounded by supportive relationships and the motivation to cultivate personal interests reduced anxiety (Nola et al., 2023). The pandemic has limited a lot of self-care activities, including a wide range of social interactions; however, college students could potentially buffer loneliness in their busy and stressful schedules, both during and after the pandemic, by strategically prioritizing people and activities that were more likely lead to generating meaningful social interactions. Meaningful social interaction is a self-care strategy that can help improve mental health outcomes and alleviate loneliness among college students (Barankevich and Loebach, 2022).

Previous studies presented comprehensive characteristics in terms of research comparisons. The first main characteristic was the combination of multiple research methods and considering the differences in research results under different research methods. Using a hybrid design approach, researchers examined the behavioral and psychological changes among students at a

large national university in Australia during the pandemic in 2020 and at the end of the academic year 6 months later (Nicholson et al., 2023). The quantitative data showed that students' learning attitudes were poor during the pandemic, but the qualitative data found students' attitudes toward online learning were both positive and negative. Students' mental health was relatively poor at both study time points, and the format of online learning had a negative impact on their learning immersion and psychological health, reflecting universities need to prioritize students' psychological health while also prioritizing the continued development of their academic skills (Nicholson et al., 2023). The second approach was to conduct comparative studies with multi-national and multi-gender participants in different timelines to compare potential cultural and gender differences (Wang et al., 2023). The third approach comprehensively considered the common influence of psychology and behavior and provided all-round suggestions for college students' health. Some scholars provided vital baseline data when studying the behavioral health and mental health of college students in ASEAN during the pandemic. With the pandemic over, and as students fully return to their academic institutions, colleges should pay extra attention to the healthy diet and physical exercise of college students. In addition, colleges should also carefully monitor mental health, which is still hotly discussed among college students. To effectively promote the health of universities, the existing action plan should be continuously updated so that college students in the ASEAN-7 countries can achieve long-term development (Rahman et al., 2022).

Method

Research design and data sources. In this study, the Web of Science Core Collection database is used as the sample source database. During the search, this study followed the internationally common standardized literature selection and analysis process of Preferred Reporting Items for Systematic and Meta-Analyses (PRISMA) (<http://www.prisma-statement.org/>). The whole process generally includes planning, literature search, literature evaluation, data extraction, data integration, and review writing. Because of its transparent and standardized research process, this method has gradually attracted the attention of social science research peers. According to the requirements of the research theme and research standardization, this study has set the criteria for the inclusion/inclusion of selected publications.

The inclusion and exclusion criteria. The search scope is limited to the title, abstract AND keywords in the database, and the Boolean logic operator "and" is used to connect the search keywords. The results are: (university OR college) AND (student*) AND (COVID-19 OR Corona Virus Disease 2019) AND (mental OR psychology* OR emotion*) AND (behav* OR learn*) AND (health), a preliminary total of 1314 articles were obtained. The aim was to ensure that the literature included research on the physical and mental health of college students in the context of the COVID-19 pandemic. If these conditions are included in it, they are included in the scope of the document.

In January 2020, Chinese scientists identified a novel coronavirus, namely the 2019 novel coronavirus (2019 CoV). On February 11, 2020, the World Health Organization (WHO) officially named this novel coronavirus SARS CoV-2 and the disease caused by it was called the 2019 coronavirus disease (COVID-19). At the same time, the other two coronaviruses, came into public view again, and the differences between SARS CoV-2 and them in biology, epidemiology, clinical diagnosis, and treatment also became a concern. The hotspot of SARS-CoV-2 virus is a member of the coronavirus family. SARS-CoV-2 is the

seventh coronavirus that can infect humans. It belongs to the coronavirus beta family, COVID-19. The disease caused by this virus is named COVID-19 infection, reflecting the heredity and similarity with the SARS coronavirus. Since the 2019 coronavirus disease is caused by SARS-CoV-2 virus infection, there is little literature supporting the close relationship between SARS-CoV-2 infection and the psychological health consequences of college students. On the contrary, many studies have shown that the lockdown measures taken to limit the spread of the virus after the outbreak of COVID-19 have had an impact on the mental disorders and symptoms, suicidal tendencies, and access to emergency mental services of college students. Therefore, this article attempts to discover the physical and mental health of college students after the outbreak of the pandemic, focusing on the period after the outbreak. Thus, the subject of the search formula finally determined by this study is COVID-19 OR Corona Virus Disease 2019.

Screening process. The time span is from January 2020 to October 2023. According to the above search conditions, the earliest published literature is March 2020, so the start time of screening is set as January 2020 in this paper. The last time the data was retrieved was October 19, 2023. The reason for this is that COVID-19 began at the end of December 2019, and relevant research has only gradually begun since then. On 31 January 2020, WHO officially defined the pneumonia outbreak due to novel coronavirus infection as a "PHEIC" (Public Health Emergency of International Concern). On 11 March, WHO considered that the current outbreak of novel coronavirus infection could be described as a global pandemic, while on 5 May 2023, WHO declared that the COVID-19 pandemic no longer constituted a PHEIC, but the organization would continue to coordinate the global response to the outbreak. So what we studied was the impact of COVID-19 on college students during this period. To further ensure that the literature conforms to the theme, the literature type is set as academic journal Article, Early Access, Review Article, and the language is set as English, and 1258 literatures are obtained. (1 article with inconsistent year, 21 articles with inconsistent language, and 34 articles with inconsistent document type were excluded).

To ensure compatibility with the research topic, manual screening was used to review the title, abstract, keywords, and other information of all literatures: first, if in the context of COVID-19, they were included; Secondly, the research object is college students, which is included; (The students included in the study included undergraduate students, master's, and doctoral students.) Finally, the research topic of physical and mental health was included. After the first manual screening, 460 literatures that did not meet the theme were eliminated. To ensure the accuracy of the literature, the researchers conducted a secondary screening according to the above process, and then eliminated two literatures that did not meet the theme, and finally obtained 796 valid papers.

Research procedure. This study mainly used knowledge graphs and visualization methods to analyze the relevant literature. Mapping the knowledge domain produces an image that uses the knowledge domain as an object and shows the relationship between the development process and the structure of knowledge. It offers both a visual knowledge graph and a serialized knowledge lineage and has the dual characteristics of "graph" and "spectrum". In graph form, it presents the network, structure, evolution, cross, and other hidden and complex relationships between knowledge; knowledge veins that are not easily noticed reflect the generation of new knowledge. We used CiteSpace6.1 to

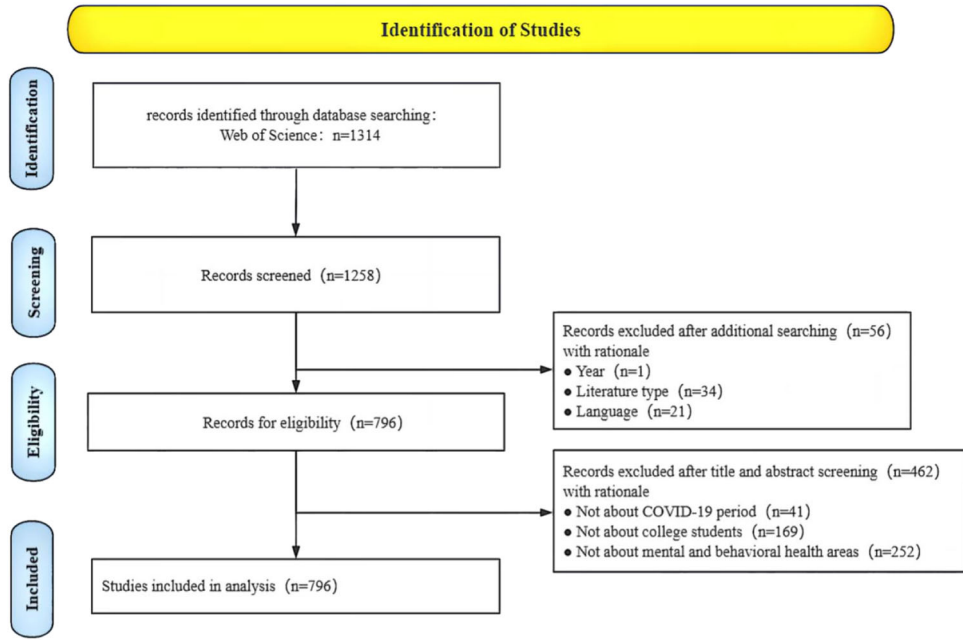


Fig. 1 A knowledge mapping flow chart of the impact of the pandemic on college students' psychological and behavioral health.

draw the knowledge map, and the relevant literature was quantitatively and qualitatively analyzed to explore the status quo, research hotspots, and research frontiers related to the continuous impact of the pandemic on college students' psychological and behavioral health. The 796 selected studies were exported as text files, and CiteSpace6.1 software was used for data conversion. In this software, we set the time span to 2020–2023, and #Year per slice to 1 year. For node types, we selected author, institution, country, and keyword as analysis objects, and used the co-occurrence graph, cluster view, and time zone view to analyze the research progress on the continuous impact of the pandemic on college students' psychological and behavioral health (Fig. 1).

Results

Time distribution analysis. Examination of publication time showed that, since the outbreak of COVID-19 in December 2019, research on the impact of the pandemic on college students' psychological and behavioral health showed an increasing trend year by year, but a decreasing trend in 2023. The number of published papers in 2020 was the lowest, at only 38 papers. This may be because the pandemic broke out globally at the end of 2019, and pandemic prevention and control began around the world. The impacts on people's lives, work, and study had not yet emerged, resulting in relatively few relevant studies. The time spent in the home office and online learning increased, especially for college students enrolled in 2019 who had experienced 3 years of pandemic containment that started soon after they entered school, this means that most of their time was spent in online courses at home or on campus. As time progressed, the uncertainty caused by the pandemic had a continuous impact on college students' psychological and behavioral health, and related research also increased. The number of studies peaked in 2022. As the virulence of the virus weakened, control conditions around the world began to relax. By the end of 2022, most countries had revoked pandemic control, people's lives had returned to a pre-pandemic state, students had returned to school, and the impact of the pandemic was slowly decreasing; therefore, related research also decreased (Appendix 1).

Table 1 Number of core authors' publications.

Core author	Number of papers	Core author	Number of papers
Goncalves, Aurelie	4	Tucker, Robin M	3
Charbonnier, Elodie	4	Abdul-mumin, Khadizah H	3
Hsiao, Pao Ying	3	Wu, Chujin	2
Ludy, Mary-Jon	3	Dechelotte, Pierre	2
Du, Chen	3	Khan, Abid Hasan	2

Sorting out the publication dates of the sample literature can, to some extent, reflect the research heat and scale of the topic.

Core author analysis. In total, 246 authors were identified, with the top four authors (not including the first and second authors) being Goncalves, Aurelie (four papers); Charbonnier, Elodie (four papers); and Hsiao and Pao Ying (three papers). The visualization map of the core authors of the reviewed literature showed that the connections between the authors were few and simple. This indicated that the connection density of the authors' cooperative relationship network was low, the connection scale was small and scattered, and only some scholars had cooperated twice or more (e.g., Liu Jin, Ha Mengying, and Liu Zhen). The calculation formula of core authors using Price's law is $mp = 0.749\sqrt[n]{(npmax)}$, where npmax is the number of papers published by the author with the largest number of publications during the statistical period, and mp is the minimum number of publications by the core author. The core author group is formed when the number of papers published by the core author is above mp, and the papers written by the core author reach 50% of all papers in the field. It showed npmax was 4 and mp was 1.5, which meant that the authors who had published more than two papers were the core authors in this research field. The statistical analysis showed that 10 authors had published more than two relevant papers and a total of 29 papers had been published, accounting for 3.6% of the sample literature. However, as this was far from 50% of the literature, a core group of authors in this research field had not yet formed (Table 1 and Appendix 2).

Table 2 Research journals and institutions.				
Research journals			Research institutions	
Journal title	Numbers	Influence factor	Research institutions	Numbers
International Journal of Environmental Research and Public Health	178	4.799	Fordham University	6
Psychiatry Research	121	11.3	Huazhong University of Science and Technology	6
Plos One	91	3.7	Sichuan University	6
Journal of Affective Disorders	57	6.6	University Washington	6
Frontiers in Psychology	43	3.8	Beijing Normal University	5
Journal of Medical Internet Research	34	7.4	Cent China Normal University	5
Lancet	33	168.9	China Medical University	5
Frontiers in Psychiatry	24	4.7	Indiana University	5
Journal of American College Health	11	2.4	Jiangxi Normal University	5
Lancet Psychiat	10	64.3	King Saud University	5
BMC Public Health	9	4.5	McGill University	5
Psychological Medicine	9	6.9	Penn State University	5
Journal of Adolescent Health	9	7.6	Shandong University	5
Frontiers in Public Health	9	5.2	Shenzhen University	5
Sustainability	8	3.9	Bowling Green State University	4
Journal of Personality and Social Psychology	8	7.6	Chinese University Hong Kong	4
BMC Psychiatry	8	4.4	De La Salle University	4
International Journal of Mental Health	8	2	Hong Kong Polytech University	4
Asian Journal of Psychiatry	8	9.5	Purdue University	4
Personality and Individual Differences	7	4.3	University of Illinois	4

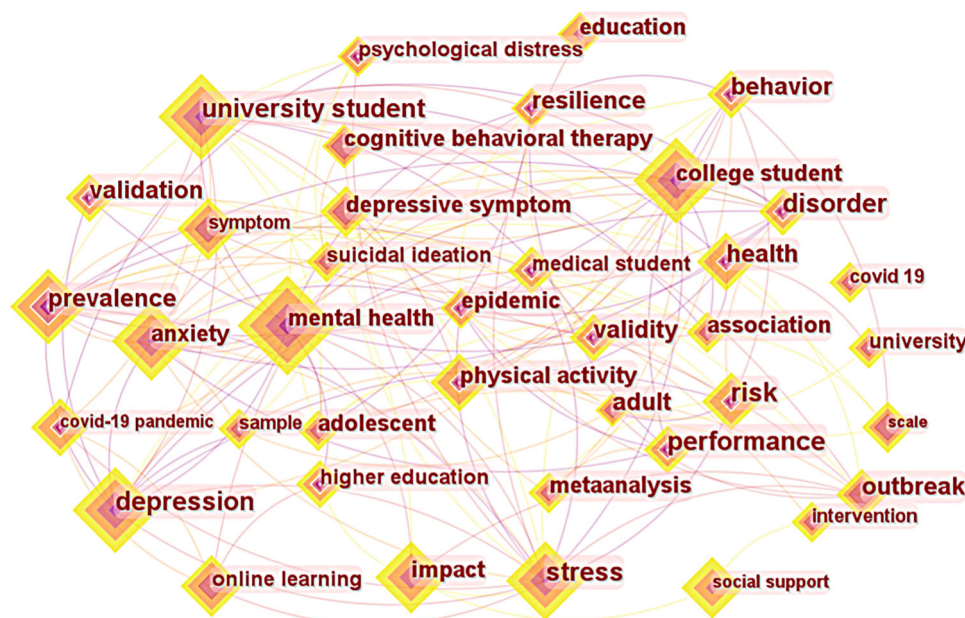
Analysis of major journals. The top 20 journals published a total of 561 relevant papers, which accounted for 70% of all identified papers. The journals with the highest number of publications were the International Journal of Environmental Research and Public Health (178 articles), Psychiatry Research (121 articles), and PLOS One (91 articles). These publications mainly covered public health, mental illness, emotional disorders, medicine, and other research fields. The journal with the highest impact factor was The Lancet, which had an impact factor of 168.9 in 2022, making it one of the top four journals in the medical field. This showed that the academic quality and influence of studies on the impact of the COVID-19 pandemic on college students' psychological and behavioral health had been recognized by authoritative international journals. The centrality of multiple journals in the journal co-occurrence graph was high, with the Journal of Affective Disorders having the highest centrality (0.08). Strong centrality journals were closely connected, indicating that there were many cases in which these journals appeared in the same literature at the same time (Table 2 and Appendices 3 and 4).

Research institution analysis. Analysis of the distribution of core research institutions can reflect the research status of college student's mental health and behavior in a particular field, and the corresponding strength and academic influence of the research team can be further reflected through statistics showing the number of published papers from each research institution. Twenty institutions published 98 core articles, accounting for 13% of all relevant literature. Chinese universities accounted for 50% of these institutions, indicating that China paid more attention to research on the impact of COVID-19 on college students' psychological and behavioral health, with Fordham University, Huazhong University of Science and Technology, and Sichuan University ranked as the top three. Among these institutions, Huazhong University of Science and Technology has a major academic influence on clinical medical research. It is in Wuhan, which had the earliest outbreak points of the COVID-19 pandemic in China; therefore, this institution had a deep concern about the impact of the pandemic, and there were many related

studies. The co-presence chart of research institutions showed that the centrality of several research institutions was high, among which Beijing Normal University had the highest centrality (0.02). The number of papers published by Beijing Normal University also ranked at the forefront, which indicated that Beijing Normal University, as the national leader in education and psychology, paid great attention to college students' psychological and behavioral health and had relatively rich research results (Appendix 4).

Country analysis. The analysis of the countries that issued publications reflected the attention paid by different countries to pandemic prevention and control and the development of college students in the field of higher education. We found that research in this field was conducted in 93 different countries. The ranking of the top 20 countries is shown in Table 2. The top three countries were the United States (215 articles), China (167 articles), and the United Kingdom (49 articles). The three countries with the highest centrality were the United Kingdom (0.34), the United States (0.24), and Mexico (0.13), which showed that a core group of countries had formed in this field, and the countries at the center of public opinion during the pandemic also included these countries. Different countries adopted different modes of fighting the pandemic; for example, the United States focused on "herd immunity," the United Kingdom tended to "co-exist with the virus," and China adopted a "zero elimination" approach of strict prevention and control. Different anti-pandemic measures also showed the differences in different countries' systems and had an important impact on the economic development of that country and the healthy lifestyles of the population. In the context of the pandemic environment, national research on the impact of the pandemic was conducive to promoting the respective countries to implement effective response and management measures (Appendix 5).

There are some potential reasons and implicit contexts for exploring why and how the United Kingdom, the United States, and Mexico are the countries with the highest concentration in this area of research. For example, during the COVID-19 period



in the UK, the degree of policy tightness has continued to repeat, and the overall prevention and control measures are gradually relaxed. The number of British adults vaccinated against the new coronavirus is among the highest in the world, but active vaccination cannot completely protect against the new strain after mutation, so the British people gradually break the prevention and control policy has begun to “coexist with the virus” (Samuolis et al., 2023). At the same time, in the process of fighting the novel coronavirus, the British economy has suffered a huge challenge. In the context of “Brexit”, especially under the impact of the COVID-19, Britain’s economic recovery has always lagged behind other large economies. The adverse effects of the new coronavirus and the difficult rebound of the economy have a very serious impact on the normal life of the British people. How to make production, life, and learning gradually get on the right track in such an environment is an urgent issue for researchers to explore. As the world’s largest economy, the United States has the most advanced medical technology and the most powerful medical system (Borges et al., 2023; Buizza et al., 2022).

Mexico still faces problems such as insufficient investment in public health, backward public health infrastructure, and a loose health system, so livelihood protection has become the biggest risk in Mexico during the COVID-19 pandemic. As a typical country with health capacity in the region, there is abundant research on pandemic prevention and control in Mexico (von Keyserlingk et al., 2022).

The top five keywords were "mental health," "college students," "depression or sadness," "stress," and "anxiety." As the topic of our analysis was "college students" and "mental health and behavior," the search terms included these words, so it was necessary to remove the words "college students" and "mental health." A research hotspot is indicated when the centrality of a keyword is above 0.1. A comprehensive consideration of the frequency and centrality of keywords in our study showed the main research hotspots in this field were psychological stress,

Table 3 Keyword frequency and centrality.			
No.	Keywords	Frequency	Centrality
1	Mental health	410	0.01
2	College student	370	0.06
3	Depression	164	0.03
4	Stress	151	0.03
5	Anxiety	131	0.01
6	Physical activity	131	0.02
7	Covid-19 pandemic	87	0.00
8	Disorder	72	0.04
9	Higher education	63	0.03
10	Online learning	61	0.03
11	Medical student	60	0.02
12	Social support	56	0.01
13	Symptom	50	0.03
14	Validity	46	0.02
15	Association	45	0.02
16	Intervention	43	0.01
17	Resilience	42	0.01
18	Suicide ideation	41	0.03
19	Cognitive behavior therapy	39	0.03
20	Model	39	0.07

behavioral disorders and mental disorders, and risk perception (Table 3 and Fig. 2).

Psychological stress. The COVID-19 introduced many stressors into college students’ daily and academic lives. Various studies explored whether learning stress among students increased after the pandemic and how individual and situational factors modulated this potential increase in stress. Based on longitudinal survey data for stress levels and self-regulation efficacy among students in a public university before and after the outbreak of the pandemic, a regression analysis showed that the level of learning-related stress generally increased after the pandemic outbreak. Students with self-efficacy reported a lower increase in stress in self-regulation than those without self-efficacy. A greater increase in stress was associated with higher levels of mental health impairment and less school time. To solve the stress problems of students, universities should provide students with resources with corresponding solutions, so that their self-psychological regulation and time management ability can be improved (von Keyserlingk et al., 2022). Another study examined stress and coping styles during a pandemic lockdown at a United States university campus and included a scale to assess coping strategies and perceived stress. The results of the study showed that the stress generated during the lockdown was related to negative coping strategies such as emotional denial and behavioral detachment. Stress was negatively correlated with positive coping strategies, such as acceptance, planning, and positive coping. Therefore, it was recommended that during the lockdown period, health education efforts should focus on stress screening for students, providing mental health services and coping skills-related information sessions to students, as well as providing virtual recreation and social opportunities (Samuolis et al., 2023).

Behavioral and mental disorders. “Disorder” has two different meanings in literature. One refers to behavioral disorders, such as sleep and eating disorders, and the other refers to various mental disorders, such as post-traumatic stress disorder (PTSD) and attention deficit hyperactivity disorder (ADHD). It has shown that periods of economic “pause” and quarantines are likely to lead to risky health behaviors, such as increased self-abuse, drinking and eating irregularly, smoking, drug use, and alcohol consumption. Although the impact of the pandemic on people

with eating disorders remains unknown, it may have contributed to increased eating disorder symptoms (e.g., dietary restriction, overeating, emotional eating) (Fila-Witecka et al., 2021). A study focused on sleep problems among Polish college students during the pandemic and the relationship between the severity of insomnia symptoms and psychopathological symptoms, PTSD, and behavioral factors showed that more than half of the students had a certain form of sleep disorder and suggested that sleep problems may be widespread among college students. In addition, although symptoms of insomnia and the severity of sleep disorders were significantly associated with all studied variables, the direction of these associations remains to be determined (Fila-Witecka et al., 2022; Takeda et al., 2023).

Risk perception. Both the absolute risk on the surface and the perception of implied risk were the focus of research on the potential risks associated with the pandemic. COVID-19 increased the risk for disease in the superficial sense (physical and mental illness), and some studies used random-effects models to calculate the combined prevalence by conducting narrative reviews to identify risk factors during the pandemic. The main risk factors identified were female gender, early school or pre-clinical years, exposure to COVID-19, academic stress, history of mental or physical illness, financial hardship, fear of impaired education, online learning difficulties, fear of infection, loneliness, low physical activity, low social support, and problematic Internet or smartphone use. During COVID-19, there has been a significant increase in mental health issues and related risk factors, which requires guidance on mental health. These findings are crucial for universities and health authorities to identify students at mental health risk and provide corresponding intervention measures (Peng et al., 2023). Furthermore, people’s perception of risk affected their preventive behavior during the pandemic. A study focused on Chinese university students and analyzed their sub-types of risk perception in COVID-19, identified the characteristics of these sub-types, and investigated the potential profile and influencing factors of risk perception. The results showed that pandemic risk cognition among Chinese college students was not ideal and had significant group characteristics and heterogeneity. Universities and public health practitioners can identify potential sub-populations to provide a theoretical and empirical basis for implementing risk perception interventions during outbreaks (Gan and Fu, 2022). People’s perception of risk also affected their emotional state during the pandemic. It is also shown that the risk and time perception of college students are significantly correlated with their mental health. Therefore, in the event of a sudden public health emergency, it is important to closely monitor the mental health status of college students, promptly adjust their attitudes towards the present and future, and consider their risk perception ability, to improve their mental health level in times of crisis (Cao et al., 2021).

Core theme analysis. The keyword clustering function in CiteSpace software is based on keyword co-word analysis; the analysis object (frequency) is subject to a clustering statistical algorithm, which simplifies the complex co-word relationships between many objects into relatively clear relationships between several class groups. This means the collection of topics with high correlation in a certain time can be intuitively summarized to reveal thematic trends in the research field. Using keyword cluster analysis and the log-maximum-likelihood rate algorithm, we drew a clustering time diagram (Fig. 3) that included 17 clustering results. Based on the similarity of clustering centers, 17 clusters were divided into five core topics (Table 4 and Fig. 3).

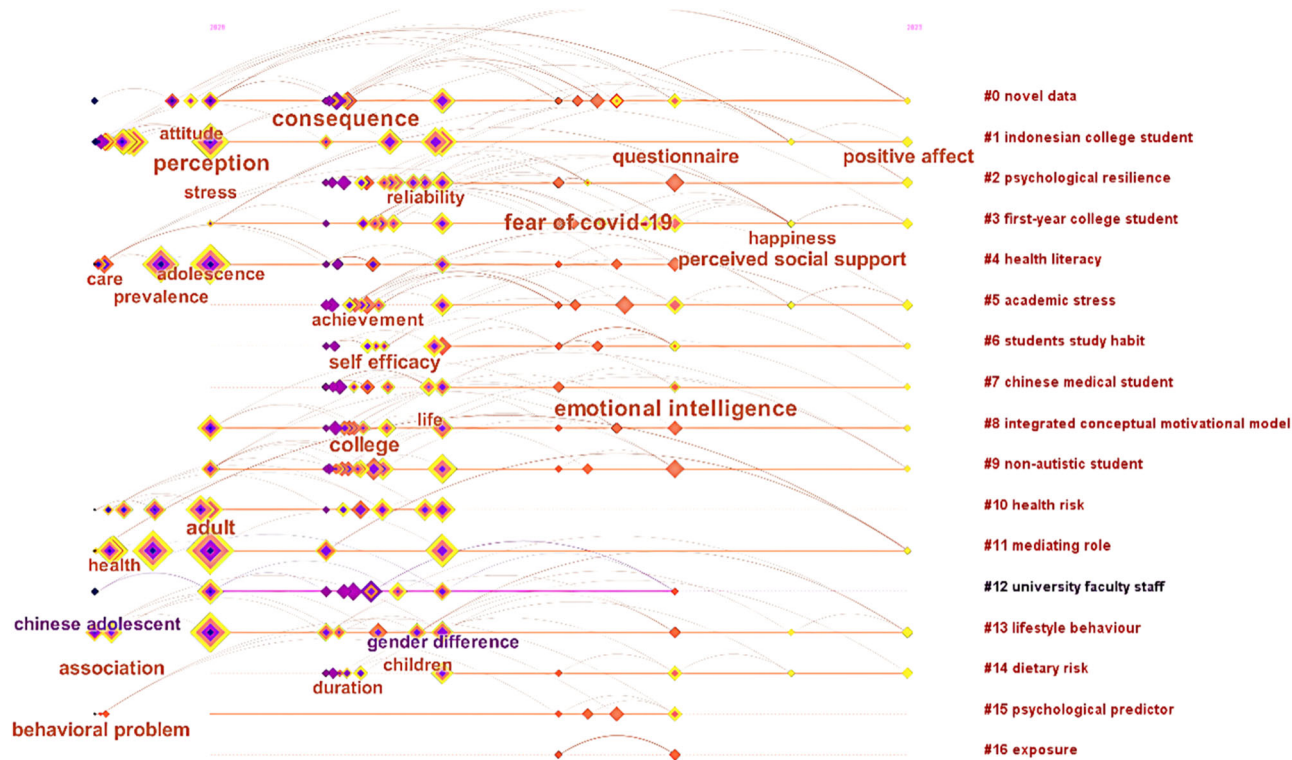


Fig. 3 Keyword timeline clustering diagram of the impact of the pandemic on college students' psychological and behavioral health. Keyword clustering analysis can simplify the co-occurrence network relationships of keywords into relatively fewer clusters through clustering statistics. Using the LLR algorithm for clustering analysis and arranging keywords in chronological order to demonstrate their evolution, each cluster has a corresponding straight line, and the nodes on the line represent the main research content covered by the cluster. Based on this, it is further condensed into five core topic clusters.

Table 4 Clustering table of core topics.		
Cluster	Sub-cluster	Keywords
Mental health	#0 #2 #4 #15 #16	Mental tolerance, mental resilience, mental adjustment, PTSD symptoms, anxiety, depression, aggressive behavior
Academic stress	#0 #5 #6 #16	Study habits, Blended Learning Environment, Cognitive engagement, stress curve, online learning, Internet addiction, online learning, impact, Coping methods
Physical health risk	#4 #10	Health literacy, systematic review, social distancing, physical activity, status quo, impact, risk factors
College major	#1 #2 #3 #7 #9	Freshman, Nursing major, Chinese Medicine major, Health Science major, junior college student, China International College Student
Daily living habits	#13 #14	Sleep quality, lifestyle, dietary risk, health anxiety, Internet consumption

Cluster one: Mental health. The keyword “mental health” had a frequency of 373. Similar research topics included “psychological tolerance” and “psychological adjustment,” which also had a high frequency. The CiteSpace cluster summary table showed that since the outbreak of COVID-19, scholars have paid continuous attention to the psychological health of university students, and research in the field of mental health showed a rapidly rising trend from 2020 to 2022. After 2023, although the overall number of publications decreased, the proportion of studies on mental health remained large. Scholars mainly focused on cross-sectional research examining college students’ psychological endurance, psychological resilience, and adjustment effect.

Cluster two: Academic stress. The word frequency and centrality of “stress,” “anxiety,” and “online learning” were all at a high level. The keyword time zone table showed that since the outbreak of COVID-19, all students were studying online at home, which caused anxiety and distress for students; therefore, research on academic stress among college students showed an increasing

trend. Research conducted in this area mainly focused on college students’ study habits, online learning satisfaction, self-efficacy, and academic pressure in the context of the COVID-19 pandemic. In addition, research focused on college students’ teaching methods, online teaching quality, and online interaction quality during the COVID-19 pandemic.

Cluster three: Physical health risks. The frequency of both “physical activity” and “health risk” were high. As shown in the keyword clustering time graph, the outbreak of COVID-19 meant people could not go out for physical exercise. Therefore, the impact of COVID-19 on health became a hot topic for many scholars and included research on college students’ physical health status, sports activity plans, and similar topics.

Cluster four: The major of college students. Since the spread of COVID-19 disease, college students have been a key area of concern, although the impact of the pandemic on various majors varied, with more words related to “medical students.” In addition, the keywords



Fig. 4 Keyword emergence rate (Top 10) of the impact of the pandemic on college students' psychological and behavioral health. Citation Burst analysis that reflects active or cutting-edge research nodes. Keyword emergence refers to the high-frequency appearance of keywords in a published article within a short period of time. From the beginning of keyword emergence to the end of emergence, a red horizontal line is formed to indicate the importance and attention of the keyword in the research field. The longer the emergence length, the longer the duration of the keyword's popularity and the stronger the research frontier.

displayed in the keyword clustering time graph involved research topics such as freshmen, non-autistic students, and sports majors.

Cluster five: Living habits. The research on living habits mainly focuses on the changes in college students' lifestyles, eating habits, and weight during COVID-19. Comparative research methods are commonly used to test and analyze the lifestyle habits of college students from different countries. Relevant research has made a comparative study on the impact of China, Spain, Indonesia, the United States, and other countries on college students' living habits during the COVID-19.

Cutting-edge research analytics. A research frontier can be described as a set of scientific issues discussed in a certain period based on burst articles. A research frontier can be identified based on an analysis of burst terms, with comprehensive judgments and detection in combination with the analysis of relevant cited documents. The visual burst detection results obtained using CiteSpace software (Fig. 4) showed 10 emergent keywords in the literature related to the impact of the COVID-19 pandemic on the psychological and behavioral health of college students from 2020 to 2022, all of which represented topics with increasing research trends. These topics included mental healthcare, mental resilience, happiness, psychological impact, and medical students (Fig. 4).

Ongoing impact of COVID-19 on college student's mental health. The COVID-19 makes people pay more and more attention to the psychological health of the disadvantaged college students. It shows that the mental health of college students during COVID-19 is worse than that of other groups. (Kang et al., 2021; Lovell et al., 2015) Not all studies indicate that the mental health problems of college students have worsened during this period. Some studies have found that the mental health problems of college students are declining or stabilizing, which is exactly the opposite of the situation mentioned earlier. Carpinelli et al. (2021) showed that disabled students and students with special learning disabilities are more satisfied with remote teaching than normal

students. Only 22% of disabled students expressed dissatisfaction with the teaching methods used due to difficulties, including those related to weak technological infrastructure. Ding et al.'s study showed that sedentary behavior, challenges of online learning, feelings of isolation, and concerns about COVID-19 infection led to poor psychological and overall health among college students, but the results showed that most respondents reported good overall health. Related studies have shown that providing face-to-face learning experiences at an accelerated pace without addressing the underlying causes of mental health issues may not necessarily have a positive impact on student's mental health. In general, although the direct impact of COVID-19 on the deterioration of college student's mental health has not been confirmed, it does have a negative impact on some college students to varying degrees.

The COVID-19 outbreak in 2019 caused deep and lasting psychological damage. Medical students were at high risk for psychiatric problems during the COVID-19 pandemic, possibly because of the high risk for infection, major lifestyle changes, severe restrictions, and disruption to education (Elmer et al., 2020). Research also showed high prevalence rates of depression, anxiety, and sleep disorders among medical students worldwide during the pandemic. These common psychological problems may lead to the abandonment of medical studies. The lockdown of medical research institutions during the COVID-19 pandemic and the new challenges facing global healthcare systems had a dramatic impact on the quantity and quality of medical education. Therefore, the COVID-19 pandemic impacted medical students' academic performance, as they were faced with learning challenges involving clinical skills and practical aspects such as laboratories. During the pandemic, medical students faced a higher risk for COVID-19 infection than other majors, which introduced additional psychological pressure for these students. Medical students have close contact with patients and their families because of their practical learning needs and work requirements. However, most young medical students lacked clinical experience, and the possibility of contact with patients with COVID-19 and the risk for infection was significantly increased compared with students from other majors. In addition to the "new" pressures brought about by the pandemic, original pressures based on exams, experiments, papers, and workloads were exacerbated by the pandemic. Students preparing for employment and graduation theses were under a greater psychological burden, as social communication was somewhat limited, traditional learning processes were disrupted, completion of expected academic work was disrupted, and heavy clinical responsibilities became a source of anxiety for students. In general, medical students, as the "reserve army" of future medical teams, should receive more attention in such situations. Relevant research focused on the psychological problems among residents, graduate students, undergraduates, and nurses at different levels. The results suggested that the COVID-19 pandemic had different degrees of impact on the psychological state of medical students, with stress stemming from fear of disease, worry about the pandemic, and anxiety about studies. Affected students showed obsessive-compulsive symptoms, interpersonal sensitivity, depression, anxiety, fear, and high scores for psychotic factors. These psychological problems in medical students occurred not only during the outbreak period but also in the post-pandemic era. Medical universities should consider the students' mental health and medical personnel during a pandemic situation, establish a prevention and treatment system for psychological problems, take effective measures to prevent the occurrence of psychological problems, identify problems early, and provide targeted psychological treatment.

Mediating role of college students' mental resilience during COVID-19. Psychological resilience refers to an individual's ability to recover from adversity, setbacks, and failures, and is the ability to adapt, regulate, and "bounce back" psychologically when facing difficulties. This ability is related to an individual's physical and mental health, career success or failure, and happiness index. The strength of psychological resilience reflects a person's ability to adapt psychologically and their perseverance and determination in the face of difficulties. Psychological resilience not only helps us overcome difficulties but also promotes the process of psychological recovery, making us stronger and more energetic. Therefore, psychological resilience plays an important role in college students' response to the changes in COVID-19. It can help college students better cope with setbacks and difficulties, enhance their self-regulation ability, and restore their mental health. When facing difficulties in academic performance, interpersonal relationships, and future planning, psychological resilience can make them more optimistic, resilient, and proactive in coping, thereby better-solving problems. In addition, the level of psychological resilience can have varying degrees of impact on individuals and directly affect the degree of anxiety and depression. People with high psychological resilience can self-regulate and relieve stress when experiencing stress, while those with low psychological resilience are more likely to experience anxiety and depression symptoms due to their weaker ability to resist adversity. Li and Xie (2022) mentioned that relevant research has investigated the mediating role of psychological resilience. Psychological resilience plays a protective mediating role in mental health issues such as stress, depression, fatigue, and anxiety, indicating that psychological resilience is a key factor in understanding stress and predicting anxiety. However, when college students face enormous pressure, it may lead to a decrease in their original level of psychological resilience. Overall, the psychological resilience of college students can be an important direction for future research, and intervening in their psychological resilience can help alleviate the impact of sudden public health emergencies on their mental health.

Discussion

The purpose of this study was to analyze the relevant literature on the impact of COVID-19 on university students' mental and behavioral health and to understand the status, core topics, and future trends of this research field. Based on the findings, this study drew several conclusions as follows.

Research on the impact of COVID-19 on college students' psychological and behavioral health is increasing. Since the outbreak of COVID-19 at the end of 2019, it has had a tremendous impact on all fields around the world, including universities, and disrupted people's normal life order. Universities around the world have ceased offline teaching and are now using online teaching methods. The changes brought about by sudden public health emergencies and the emergence of various problems in online learning have brought additional pressure on the mental health of college students.

Research focused on the impact of COVID-19 on psychological and behavioral health among college students has not yet been fully formed. Although many research keywords were identified in our analysis, the centrality of keywords according to word frequency statistics was <0.1 , which indicated that a core research topic in this research field had not yet been formed. After comprehensive consideration of the frequency and centrality of keywords, we identified three main research themes. First, we identified research on the psychological pressure on students caused by the pandemic. The outbreak of COVID-19 led to great

changes in college student's daily lives and studies, and comparative studies showed that students' study-related stress levels generally increased after the outbreak. In addition, some studies examined college students' stress coping styles and sleep quality. Second, we identified research on college students' behavior and mental disorders caused by the pandemic. A prolonged period of home pandemic prevention and control meant people were unable to work and students could not go to school, which may have resulted in a series of health behaviors. Relevant studies showed that college students suffered from eating disorders, insomnia symptoms, and PTSD symptoms after the pandemic. Although no studies showed that the occurrence of these symptoms was directly related to the occurrence of the pandemic, the pandemic can be considered one of the stressors that caused these symptoms. Third, we identified research focused on college students' perception of risk. Relevant studies showed that college students' risk perception ability was significantly related to their mental health. Therefore, we should pay attention to and improve college students' risk perception ability, which will help to improve their mental and behavioral health levels in public health emergencies (Borges et al., 2023; Buizza et al., 2022).

Core themes of the impact of COVID-19 on college students' psychological and behavioral health were formed, including mental health, academic pressure, physical health risks, college students' majors, and life habits. These five core themes covered different aspects of the COVID-19 pandemic's impact on the mental and behavioral health of college students from 2020 to 2023.

Most studies show that COVID-19 has had different effects on college students' mental health, mainly including stress, anxiety, and depression. For example, a survey of over 700,000 Chinese students (Ma et al., 2020) showed that nearly 45% of students have experienced mental health problems, with anxiety being the most common symptom. Not only in China but also in a multinational study, it was found that 61.3% of students felt they were in a high-stress state, followed closely by symptoms of depression (40.3%) and anxiety (30%). Among them, a university student in Texas, USA, had a high level of stress and anxiety of 71%, and British university students also had higher levels of anxiety and depression. Chen and Lucock studied 1173 undergraduate and graduate students at a United Kingdom university and found that more than 50% of respondents had anxiety and depression levels above clinical norms.

We found many studies focused on college students majoring in medicine and health education. A reason for this may be that medical students are future members of the medical team, and the COVID-19 pandemic impacted medical students' professional identity and chances of burnout, especially as they need a lot of clinical practice to accumulate experience. During the pandemic period, the practical needs of this major could not be met, which caused anxiety problems related to the academic pressure and professional quality of medical students. Therefore, close attention should be paid to the career development of medical students in the post-pandemic era.

The inability to go out during the pandemic impacted college students' health, lifestyle, and eating habits. Studies showed that long-term isolation at home could lead to changes in daily activities including unhealthy dietary lifestyles, such as intake of health supplements, decrease of physical activity, and increase of ST. In addition, lifestyle changes such as increased intake of sweetened beverages, increased use of healthcare products, irregular sleep rhythm, and dietary changes may disrupt the normal rhythm of life and increase mental health problems. Therefore, the COVID-19 pandemic had a broad impact on college students' daily life behaviors. It is worth noting that maintaining regular sleeping and eating rhythms is crucial for physical health.

Research frontiers on the impact of COVID-19 on the psychological and behavioral health of college students were strengthened, including research on topics such as mental healthcare, mental resilience, happiness, psychological impact, and medical students (Borges et al., 2023; Buizza et al., 2022). This study identified two frontier topics. First, we identified the continuous impact of COVID-19 on the mental health of college students, which included the impact on their mental health before COVID-19, and the continuous impact on their mental health after the end of the pandemic and corresponding intervention measures. Further research is needed to explore the true impact of the COVID-19 pandemic more fully on college students' well-being and mental health, for example, investigating the impact of COVID-19 on college dropout rates.

A survey by the Social Relations Committee of the World Health Organization shows that about 20% of adolescents worldwide suffer from varying degrees of mental health problems, with student loneliness being a global public issue. (World Health Organization, 2023). Previous studies mainly focused on the impact of COVID-19 on college students' lives, studies, and work, such as growth pressure, online course learning, remote communication, etc. Therefore, in the post-pandemic era, we not only need to continue tracking these impacts but also need to closely monitor the loneliness of college students. More than half of higher education students in Finland report an increase in loneliness (Finnish Institute for Health and Welfare THL In Swedish: Institutet för hälsa och välfärd THL, 2021); Hemberg et al. (2024) mentioned in their research that college students who experienced loneliness before the COVID-19 pandemic felt lonelier, their sense of happiness declined and became more apathetic due to the increased time spent alone during the COVID-19 pandemic. The reason may be related to reduced communication with peers, concerns, and anxiety about the unknown. In the study of related influencing factors, it was found that the loneliness of college students is related to negative events such as depression and anxiety they have experienced before. (Fegert et al., 2020). However, not all online activities will have a negative impact on students. Hemberg et al. (2024) noted in their research that online interaction through social media can help people alleviate negative emotions such as loneliness, depression, or unhappiness. Domokos et al. (2020) also found that physical activity can help adolescents and young people with depression or low mood regain energy and happiness while exploring the experiences of college students.

It is necessary to conduct long-term tracking of the physical and mental health status of college students in the post-pandemic era. It can consistently provide sufficient social support for college students in need. Based on the main findings of this study, we believe that continuous attention to the physical and mental health of college students will help us cope with potential public health emergencies in the future, take proactive measures, and help college students establish more active and healthier physical and mental defense mechanisms. Related studies have shown that after experiencing a period of social loneliness, students find it difficult to reconnect with their peers, especially those who are particularly prone to depression. External support should be provided as most students tend to hide their feelings (European Commission, 2022). We should not assume that students will automatically return to their original state. (Wright et al., 2021). Based on current research, we suggest long-term tracking of the physical and mental health of college students in the post-pandemic era to advocate for a healthier and higher-quality learning environment globally.

We identified the continuous impact of the COVID-19 pandemic on medical college students. Relevant studies on this frontier topic showed that during the COVID-19 pandemic, the

prevalence of depression, anxiety, and sleep disorders among medical students worldwide was high, with academic and employment pressure created by medical students' inability to practice clinical skills because of lockdowns. This had a major impact on the quantity and quality of medical education (Borges et al., 2023). In addition, the spread of the novel coronavirus and the mortality rate negatively affected the professional identity of some medical students. Therefore, further research should consider medical students' mental health problems, academic pressure, professional identity, and related aspects, timely detection of problems, and offer targeted interventions.

We identified the theme of mediating the psychological resilience of college students during the COVID-19 pandemic. This cutting-edge topic showed that students' psychological resilience played an important role in their coping with stress, anxiety, and depression caused by health emergencies. Further research should focus on improving the psychological resilience of college students to ensure they have psychological support and help them more effectively cope with various adverse emotions.

Contribution of this study

This study contributed to analyzing the current literature on the impact of college students' experiences during the COVID-19 pandemic on their psychological and behavioral health. It aimed to explore the impact of COVID-19 on college students' psychological and behavioral health using a knowledge-mapping approach. It was found that the three countries with the highest centrality were Britain, the United States, and Mexico. In this study, ranking the Top 20 research institutions according to the number of papers issued, it was found that the number of papers issued by Chinese research institutions accounted for 50%, of which Huazhong University of Science and Technology, located in the city where the COVID-19 first broke out, ranked second on this topic, and by analyzing the countries of the sample literature, China ranked second. It shows that China is very concerned about the impact of COVID-19 on college students' psychological and behavioral health and is committed to contributing its own strength to sudden global public health events. However, for Chinese studies on college students' experiences during the COVID-19 pandemic, there are few papers published in English and it is the reason why COVID-19 was first identified in China and does not appear on the list of countries with the highest research concentration. In addition, both Chinese scholars and foreign scholars agree that COVID-19 has a negative impact on the psychological and behavioral health of college students and call for appropriate intervention and treatment for college students who have already had psychological and behavioral impacts.

The five major topics of research were mental health, academic pressure, physical health risks, college students' majors, and daily living habits, with most research concerned with college students' mental health. The visualized burst detection results were combined to identify two cutting-edge research topics in this field: the sustained impact of COVID-19 on college students' mental health, and the mediating role of college students' mental resilience during COVID-19. Although most studies show that COVID-19 has a strong impact on college students' daily life, study, and work. During this period, they need to reduce their outings. College students respond to the government's call to stay at home for long periods of time, and they can only obtain information through television news, online media, and various social media platforms. Continuous 24-h epidemic reporting, closed home isolation environments, and other factors can cause individuals to pay excessive attention to the epidemic. In addition, some negative news and rumors that are exaggerated just to

attract attention are mixed in, which has a negative impact on the physical and mental health of college students. At present, normal social life before the epidemic is slowly recovering, which has caused some students to encounter difficulties when returning to social interaction. Therefore, in the post-pandemic era, as college students return to campus life, we need to have a clearer understanding of the risks posed by the pandemic to them, as well as other mental health and rehabilitation issues they may face. These all require further research.

Conclusion: key points of findings

This study found that the COVID-19 disease had a lot of impact on the behavior and psychology of college students, including the negative impact on the life and study of some college students as mentioned above, while relevant studies also showed that it had a positive impact on college students. During the COVID-19, college students spent more time at home. Hemberg et al. (2024) mentioned in their research that Some studies showed that this led to the decline of college students' physical and mental health, while some college students said that they felt more happy and happy moments, and students who suffered loneliness or anxiety during the COVID-19 had a new understanding of themselves and experienced greater gratitude. Because the increase in solitude time allows them to have more time to discover the small beauty of life and to have a deeper thinking and experience of life. (Nilsson et al., 2006; Eriksson, 1987; Hemberg et al., 2024). At the same time, the COVID-19 has slowed down the pace of life of people. The COVID-19 has made the relationship between people and their families closer, mainly because people stay at home more than they can go out during the epidemic, which makes families the warmest haven for people. During the days of lockdown and isolation, people had to rely on the support and care of their family members to get through that difficult time together. This intimate relationship and emotional connection make people cherish and value their families more. In addition, during the pandemic, people began to pay more attention to mutual support and understanding, knowing how to care for and understand each other in times of tension, which further deepened the emotional bond between family members. The increase in family activities, such as cooking together, watching movies, playing games, etc., not only enriches the lives of family members, but also enhances the cohesion of the family. These experiences have made people realize the importance of family in a person's life, and thus pay more attention to the harmony and happiness of the family. Although the COVID-19 pandemic has reduced the opportunities for college students to learn and interact in life, their relationships with friends and family may also become closer or more important.

Through the study on the impact of COVID-19 on the psychological and behavioral health of college students, this study draws the following important conclusions: First, governments and higher education institutions should pay attention to the impact of major public health events on the psychological and behavioral health of college students. College students in different countries around the world have been affected by the COVID-19 to varying degrees. Due to differences in economy, culture, religion, etc., the impact reflects certain heterogeneity. The impact of the COVID-19 on the psychological and behavioral health of college students is not only reflected in the COVID-19 period, but also in all aspects of future work, life, and study, with both positive and negative impacts. Whether the impact of the COVID-19 is an opportunity, or a challenge is still controversial, but we should learn from experience to take more timely and effective measures when facing major crises in the future.

Second, it is necessary to actively intervene with college students who are negatively affected by the COVID-19 disease. Firstly, by conducting active and effective psychological counseling activities for college students, we can promote their mental health growth, prevent and treat mental illnesses, and optimize their psychological qualities. Many universities have established psychological counseling centers one after another, adopting various methods to provide psychological counseling to college students, and carrying out targeted prevention and treatment of psychological problems and mental illnesses. Secondly, various forms of promotion and popularization of mental health and hygiene and epidemic prevention knowledge should be used. Physical health and mental health are interdependent and mutually transforming entities. The spread of the COVID-19 is not only closely related to the environmental health status, but also closely related to the health habits of each of us. Therefore, it is necessary to attach great importance to hygiene and epidemic prevention in daily life and correct unhealthy habits. In addition, establishing a psychological service mechanism coordinated by multiple entities such as government departments, unit groups, grassroots communities, and social organizations to provide professional psychological services and support is also very important for alleviating the psychological pressure of college students. We are currently unclear about the problems that college students face when resuming normal offline learning and social interaction. Therefore, tracking research is needed to understand the long-term impact of the COVID-19 on the mental health of college students and provide support for them to adapt to face-to-face learning and socializing.

Thirdly, the overall deterioration in the mental health of college students during the COVID-19 pandemic is a particularly important area of research. During the COVID-19 pandemic, college students don't have much social contact, and it can be a challenge to return to a "normal" daily life. This study provides those who work with college students with more insight into how college students spend their special time, while helping them stay positive during future major public health events. Finally, this study can provide policymakers with better insights into how to support college students in the future and provide mechanisms to do so.

In the meanwhile, this study also helps universities to recognize the possible negative impact of COVID-19 on college students' mental health. Colleges and universities should strengthen students' psychological coping and mental health education, establish scientific methods to prevent negative emotions, and pay attention to the progress of research after the pandemic, which will also provide ideas for further research. Research on the impact of COVID-19 on the psychological and behavioral health of college students has attracted major attention and has been considered in most medical education journals. Relevant research focuses included online teaching, anxiety, mental health, physical health, and lifestyle (Rohde et al., 2023). The COVID-19 pandemic was both a challenge and an opportunity for college students and sounded the alarm for researchers. Under the challenge of COVID-19, online teaching developed rapidly, an anti-pandemic spirit was integrated into ideological and political education, and the teaching system was improved. However, it also reminded us that major health emergencies are highly unpredictable, occur at any time, and can have a huge impact on education. Therefore, we should take this opportunity to conduct in-depth research and discuss countermeasures to better deal with the normalization of the COVID-19 pandemic, the post-pandemic era, and other major emergencies that may occur in the future, so that the adverse impact on higher education is reduced.

Data availability

The datasets generated during and/or analyzed during the current study are available in <https://doi.org/10.7910/DVN/5UWGU6>, Harvard Dataverse, V1.

Received: 14 December 2023; Accepted: 13 September 2024;

Published online: 09 October 2024

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Acknowledgements

This study is funded by 2021 National Social Science Foundation of Higher Education Ideological and Political Course Research (Key project) Ideological and Political Education System Construction System Mechanism Research in New Era (No. 21VSS004).

Author contributions

Substantial contributions to the conception or design of the work: JL and EX; the acquisition, analysis, or interpretation of data for the work: JL, EX, BL, and QH; Drafting the work or revising it critically for important intellectual content: JL, EX, BL, and QH; Final approval of the version to be published: EX and JL.

Competing interests

The authors declare no competing interests.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1057/s41599-024-03781-0>.

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