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The Impact of the COVID-19 Pandemic on Research into Chinese University Students' Mental Health: A Bibliometric Analysis

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Abstract

Background: The COVID-19 pandemic increased anxiety and depression rates, prompting heightened research activity in mental health, particularly among vulnerable populations like university students. Research activity adapted in order to address issues arising in this new landscape. **Objectives:** This study aims to explore the changes in scientific activity and response trends during a public health crisis, with a particular focus on analyzing research themes, categories, and collaboration patterns related to the mental health of Chinese university students before and after the COVID-19 pandemic. **Method:** Using bibliometric methods, data were extracted from Web of Science to analyze scientific output related to the mental health of Chinese university students from 2017 to 2022. Descriptive statistics and visual analysis tools were employed to explore publication trends and collaboration patterns. **Discussion:** After the pandemic, there is an increase in the total amount of literature and open-access publications. Research topics have shifted towards prioritizing student well-being over clinical diagnoses. Strengthened international and institutional collaboration is evident through increased cooperation with developing countries and those heavily impacted by the pandemic, as well as intensified partnerships between medical universities and prestigious academic institutions. **Conclusions:** The findings of this research can guide supportive efforts by libraries, academic journals, international partnerships, and funding bodies to address mental health challenges during future epidemics. Furthermore, they highlight the value of collaboration between bibliometrics and psychology in tackling the complex issues surrounding mental health in such contexts. Professionals in bibliometrics and psychology should collaborate to address the complex challenges posed by mental health and future epidemics.

Keywords: Bibliometric; Mental Health; COVID-19; University Students; Thematic Analysis

1. Introduction

1.1 Research background: The COVID-19 pandemic heightened focus on mental health

COVID-19, first identified in late 2019 in Wuhan, China, prompted a global response after being declared a public health emergency by the World Health Organization (WHO, 2022a). Alongside concerns about physical health, the pandemic also triggered widespread anxiety about a potential global mental health crisis, fueled by quarantines, social isolation, financial strain, and fears of contagion. The WHO (2022b) reported a 25% increase in global anxiety and depression rates during the first

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year of the pandemic, while the meta-analysis of Bueno-Notivol et al. (2021) revealed a sevenfold rise in global depression prevalence from 2017 to 2020. In response, nations worldwide ramped up mental health support for both COVID-19 patients and frontline workers, as emphasized by the WHO Assembly in May–June 2021, which stressed the need for enhancing mental health services for pandemic preparedness and resilience (WHO, 2022b). In China, schools and universities implemented varying periods of online education, following the directive to "suspend classes and not stop learning" in January 2020 (Ministry of Education of the People's Republic of China, 2021). This continued until December 7, 2022, when pandemic control measures were adjusted. During this time, the government promoted the slogan "Promote the anti-pandemic spirit and protect mental health," urging mental health professionals to focus on mitigating the adverse effects of the pandemic on mental well-being (Tian, 2020).

In this context, typical challenges of emerging adulthood, such as academic pressure, career uncertainty, decreasing parental support and social isolation (Kawashima et al., 2012; Moreta-Herrera et al., 2021; Singleton, 2007) significantly amplified mental health issues including anxiety, depression, self-harm, and suicide risk (da Silva Pitanga et al., 2024; Mejía et al., 2022). The prevalence of these mental health concerns surged, particularly, in high-risk regions like Wuhan (Holmes et al., 2020; Zhang et al., 2021). In China, the pandemic led to elevated levels of anxiety (24.0%) and depression (22.0%) among students in 2020, with university students experiencing higher rates of depression compared to their high school peers (Luo et al., 2021). Contributing factors to these adverse mental health outcomes included perceptions of pandemic control efficacy, threat perception, social stigma, and prosocial behavior (Sun et al., 2021). Taken together, these findings underscore the urgent need for targeted interventions to address the mental health challenges faced by university students during the pandemic.

The extraordinary nature of the pandemic highlighted the urgency of addressing new, pressing, and uncommon mental health challenges, driving significant research efforts. In this context, bibliometric analysis stands as valuable tools for understanding the research community's response to such exceptional crisis. Previous bibliometric studies have already examined international research output on university students' mental health during the COVID-19 pandemic. Yang et al. (2022) conducted a term co-occurrence analysis of international scientific production concerning high school students' mental health during the COVID-19 pandemic from 2020 to 2022, concluding that global research on student mental health had significantly increased. While "mental health," "anxiety," and "stress" remained dominant topics throughout, post-pandemic surge topics like "decreased self-esteem" and "Internet addiction" emerged (Yang et al., 2022). Corell-Almuzara et al. (2021) analyzed global education and student mental health during COVID-19, finding that although there was an increased focus on pedagogical methods and internet-related interventions, mental health issues especially among university students received less attention in the broader research context. During COVID-19, bibliometrics also helped to

assess key metrics like influential scholars, major publications, and leading institutions, shedding light on emerging academic priorities (Alshahrani, 2022), while mapping evolving knowledge landscapes and suggesting future directions (Rani et al., 2022). Its ability to synthesize large datasets aids in identifying underexplored areas, such as the psychological impacts of the pandemic (Arroyo Vasconcellos et al., 2023).

1.2 Objectives

Understanding the mental health impact of COVID-19 on Chinese university students offers key insights for shaping educational policies, enhancing mental health services, and preparing for future crises. Academic libraries play a central role in supporting this research by providing access to reliable data, managing resources, and fostering collaboration. In times of crisis, libraries are vital in ensuring the continuity of research activities and knowledge dissemination (Beglou & Akhshik, 2023; Mohammad Alenezi, 2022). Bibliometric methods further support this by analyzing research trends, tracking thematic shifts, and evaluating collaboration patterns, offering a comprehensive framework to study the evolution of mental health research during the pandemic (Rani et al., 2022).

While prior research highlights the value of bibliometric approaches in pandemic-related mental health studies, it still lacks specific focus on the mental health of Chinese university students. In addition, previous studies focus on short time periods and lack a more extensive perspective to look at changes (Corell-Almuzara et al., 2021). Therefore, this article aims to fill this research gap, looking at how research activity on the topic of mental health of Chinese university students changed in 2017–2022. More specifically, it addresses the following research questions:

(1) How does research output on the mental health of Chinese university students change in the period 2017–2022?
(2) After the pandemic, is there any difference in the specialization of sources publishing research on the mental health of Chinese university students compared to previous years?
(3) What kind of research themes are especially noteworthy after the onset of the health crisis? Are there any new themes that become particularly relevant in the context of the pandemic?
(4) Do researchers contributing to the subject of this study alter their patterns of international and interinstitutional collaboration after the pandemic?

This research focuses on the mental health of Chinese university students, particularly in response to significant events such as the COVID-19 pandemic. The goal is to provide insights that can inform mental health support and preparedness strategies for future health crises, with an emphasis on the role of library services and related support systems.

2. Methods

2.1 Data extraction

Data of this study were extracted on November 4, 2023, from Web of Science (WoS), a bibliographic data source widely utilized for journal selection, research evaluation, and bibliometric analysis (Pranckutė, 2021). The search strategy employed the query: ("depression" OR "anxiety") AND ("university student" OR "college student"). The search was conducted in the 'Topic' field, which includes title and

abstract to ensure precision and relevance in the retrieved results. Moreover, we applied the 'Countries/Regions' filter for "China", which in WoS specifically targets the 'Addresses' field and primarily reflects the institutional affiliations of the authors. This search question aligned with the WHO definition of mental health as a state of mental well-being, encompassing various mental disorders, psychosocial disabilities, and states associated with notable distress, impairment in functioning, or self-harm risk, with depression and anxiety being prominent (WHO, 2022b). Adopting a temporal comparison approach, data were extracted for two periods: 2017 to 2019 and 2020 to 2022, with 10,769 and 22,577 documents respectively. Subsequently, to ensure article accessibility, 4,698 open-access articles from 2017 to 2019 and 13,244 from 2020 to 2022 were considered as research data.

2.2 Data analysis

2.2.1 Descriptive statistics

To investigate research question 1, descriptive statistics were calculated for the two corpora, 2017–2019 and 2020–2022, focusing on publication-level variables: number of authors, keywords, references, and funders. Data analysis was conducted using MS Excel, Google Sheets, and IBM SPSS Statistics version 28.0.1.1. Normality tests were performed for all variables except funding acknowledgment, which comprised nominal data. As the variables did not follow normal distributions, the Mann-Whitney U test was employed to compare means, with a significance level set at $p < 0.05$. The Chi-square test was utilized for funding acknowledgment, also with a significance level of $p < 0.05$.

2.2.2 Visualizations

Various software tools, including CorText Manager, Biblioshiny and VOSviewer, were utilized for visualizations. CorText manager allowed to visualize the evolution along the period analyzed of journal subject categories, frequent keywords, terms in titles and abstracts, and collaboration patterns (CorText, n.d.). Biblioshiny, an interface of the R-based Bibliometrix package (Aria & Cuccurullo, 2017), was used to filter and summarize document information and generate strategic diagrams. VOSviewer facilitated collaboration visualization (van Eck & Waltman, 2011). Three types of visualization graphs were generated: bump graphs, strategic diagrams or thematic maps, and collaborative network maps.

Bump graphs, implemented through the Epic Epoch functionality of CorText Manager, illustrate the evolution of frequency and ranking over time for selected entities, based on their frequency occurrence in each period (CorText, n.d.). This study generated bump graphs for 3 entities: subject category, author keywords, and terms extracted from the title and abstracts of each record.

Since this study uses data collected in 2023, it relies on the 2023 version of the WoS Core Collection: Category list, comprising a total of 254 categories that can be considered approximations to main disciplines (Wang & Waltman, 2016; Web of Science Help, n.d.-b). Among these, psychology can be considered interdisciplinary, as it integrates natural and social sciences (Schwartz et al., 2016), with journals spanning multiple thematic categories. This study utilized CorText Manager to explore the research question 2, specifically the changes in WoS subject categories of journals published before and after the pandemic.

On the other hand, an additional analysis was conducted on keywords, which are crucial elements for expressing research topics that serve as essential indicators when analyzing research trends within a given period (Huang & Zhao, 2019; Lu et al., 2021; Peset et al., 2020). In WoS database, two categories of keywords are distinguished: Keywords Plus and author keywords. Keywords Plus are automatically generated by computational algorithms, representing words or phrases frequently found in the titles of bibliographic references of articles but not in the titles of the articles themselves (Garfield & Sher, 1993). Author keywords are selected by authors themselves, based on their perceived relevance to encapsulate the content of their articles (Huang & Zhao, 2019; Kevork & Vrechopoulos, 2009). Both Keywords Plus and author keywords are widely used in bibliometric literature to analyze keyword frequency (Zhang et al., 2016). Following comparative chart analysis, it was found that author keywords contained more relevant psychological terms and valuable information than Keywords Plus. Therefore, only the visualizations generated from author keywords were retained.

An additional category of keywords analyzed in this article comes from the term extraction function of CorText Manager, which allows the most relevant terms to be selected from titles and abstracts through natural language processing (NLP) techniques. The term extraction methodology in this study utilizes CorText Manager's NLP algorithms, focusing on multi-term expressions (n-grams) that represent core concepts. The process involves linguistic pre-processing, including POS-tagging, chunking, and stemming, to identify and standardize noun phrases (CorText, n.d.). POS-tagging (using TreeTagger for non-English languages) identifies multi-term expressions like "mental health," while chunking can group relevant nouns and adjectives (Schmid, 1999), and stemming can normalize variations of terms such as "depression" and "depressions" (Porter, 1980). Rankings are organized based on the specificity index measured by the chi-square value (χ^2), balancing specificity and frequency. Terms are ranked using the C-value method (Frantzi et al., 2000), which evaluates the unithood of multi-terms, ensuring that only the most meaningful terms are retained. Irrelevant terms like "review of literature" are filtered out, and frequency is computed at the document level to ensure broader representation. Relevance is further ensured through chi-square or G2 scores, prioritizing terms with high occurrence and contextual significance (van Eck & Waltman, 2011). Following this, the study conducted further data cleaning based on the terminology results generated by CorText Manager. Synonyms were consolidated manually, and irrelevant or unrelated terms to the research topic were removed. For example, synonymous or variant spellings, such as "mice" and "mouse," "quality of life" and "life quality," were consolidated into one form. The process eliminates irrelevant, frequent terms like "review of literature" that are common but not informative for the research focus (Kageura & Umino, 1996). Finally, to respect the specific meaning within the area of psychology, Medical Subject Headings (MeSH, https://www.ncbi.nlm.nih.gov/mesh/) was consulted during the data cleaning process. This approach ensures that the extracted

terms are both relevant and domain-specific, supporting the research's focus.

Moreover, this study utilizes network analysis and thematic mapping techniques through the Biblioshiny package in Bibliometrix, which clusters keywords based on their co-occurrence patterns and their connectivity within the research domain. Accordingly, the keywords illustrated are not determined solely by their frequency of appearance in the dataset, but rather by their structural roles within the research network. The Biblioshiny package is grounded in the theoretical framework for thematic maps proposed by Cobo et al. (2011), utilizing the Louvain algorithm to identify keyword clusters with high internal connectivity while minimizing external links, thereby optimizing modularity (Blondel et al., 2008; Cobo et al., 2011). The Louvain algorithm has been widely recognized for its effectiveness in community detection. It consistently delivers high performance across various benchmarks (Aria et al., 2021) and is particularly noted for its ability to group vertices into highly cohesive subgraphs, functioning similarly to clustering (Aria et al., 2022). This characteristic has made the Louvain algorithm a popular choice in real-world applications of community detection (Anuar et al., 2024). Thematic maps, also referred to as "strategic diagrams," visually represent keywords in a four-quadrant chart, facilitating the exploration of relationships between research themes (Petrovich, 2022). Keywords in the maps are classified based on 2 key metrics: centrality and density. Centrality, calculated as the sum of a term's external link values, indicates a theme's importance within the network, with higher values reflecting stronger connections to other clusters (Coulter et al., 1998; He, 1999). Density, on the other hand, measures the internal cohesion of a cluster by assessing the strength of connections among terms, reflecting the development and coherence of a theme (Callon et al., 1991; Coulter et al., 1998; He, 1999). In thematic maps, the horizontal axis represents centrality, while the vertical axis represents density (Cahlik, 2000; Cobo et al., 2011). Themes in the upper-right quadrant are mature and influential, and those in the upper-left are highly specialized. Themes in the lower-left quadrant are emerging, and the lower-right quadrant contains foundational yet evolving themes (Aria & Cuccurullo, 2022). This framework provides a visualization of the structural and developmental roles of research themes within a field.

Based on Bump graphs and networks, shifts in the main research themes before and after the pandemic are analyzed to address research question 3.

As the final step addressing research question 4, our study employs VOSviewer for network clustering (van Eck & Waltman, 2010) and Gephi for advanced visualization (Bastian et al., 2009). The raw network files generated by VOSviewer were imported into Gephi 0.10.1 to refine the visual representation of the network. Because the dataset is restricted to literature with Chinese affiliations, we employed an ego network analysis to generate the country-level collaboration network diagram. An ego network isolates a focal node—in this instance, China—and its immediate collaborative partners (alters), thereby excluding indirect ties that might otherwise obscure the interpretation of direct interactions (Borgatti et al., 2013). This methodology aligns with the nationally bounded scope of our investigation (Ellegaard & Wallin, 2015) by emphasizing China's primary channels of international research

collaboration. Using Gephi's ego network filter, China's direct collaborators were extracted, and the edge weights were normalized to reflect the co-authorship frequency.

In the resulting country and institution collaboration network diagram, countries or organizations are represented as nodes, with node size corresponding to the number of documents published by each entity. Connections between nodes denote collaborative ties, with thicker lines indicating higher frequencies of collaboration. It is also important to consider the giant component of the graph—the connected subgraph containing the largest number of nodes (McAllister et al., 2022; Petrovich, 2022)—which typically represents a densely interconnected research subgroup where collaborative relationships are more intense.

2.3 Limitations

This study has several limitations. To ensure data quality and accessibility, only open-access documents were included in the sample, and the rapid growth of such publications after the pandemic may introduce a bias favoring the post-pandemic period. This approach, combined with the focus on only 2 keywords— "depression" and "anxiety"—may have limited variability in the sample by overlooking related terms and additional sources.

Another potential limitation of this study is the publication lag. Studies conducted during the pre-pandemic period may have been included in the post-pandemic corpus due to delays in publication. While this lag could affect the comprehensiveness of the literature reviewed, it also provides continuity to the research area, highlighting further the significant changes that occurred after 2020.

3. Results

The results are structured as follows. First, descriptive statistics for the 2 corpora are presented. Secondly, the thematic analysis includes an overview of the most frequent categories of journals publishing research on the topic, an examination of the evolution of author keywords and terms extracted from abstract subtitles, and thematic maps illustrating the development of the most researched topics. Lastly, research collaboration is analyzed at both international and institutional levels.

3.1 General data about the two corpora analyzed and descriptive statistics

In Figure 1, the total number of articles and open-access articles on the mental health of Chinese university students shows a consistent annual increase. Between 2017 and 2019, the annual average total number of documents was 3,589.67, which more than doubled to 7,525.67 in the subsequent period from 2020 to 2022. Similarly, the annual average count of open-access articles increased from 1,566 to 4,414.67, indicating a significant three-fold escalation in open-access publishing. Table 1 provides additional fundamental data regarding the documents, exclusively comprising open-access articles.

After the pandemic, the proportion of open-access documents increased significantly from 43.62% to 58.67%. Although there was a slight decrease in the mean number of co-authors per document, this change lacked statistical significance ($Z = 0.580$, $p = 0.562$). However, there were statistically significant decreases in the average number of references per document

Figure 1. Evolution of Production Over Time

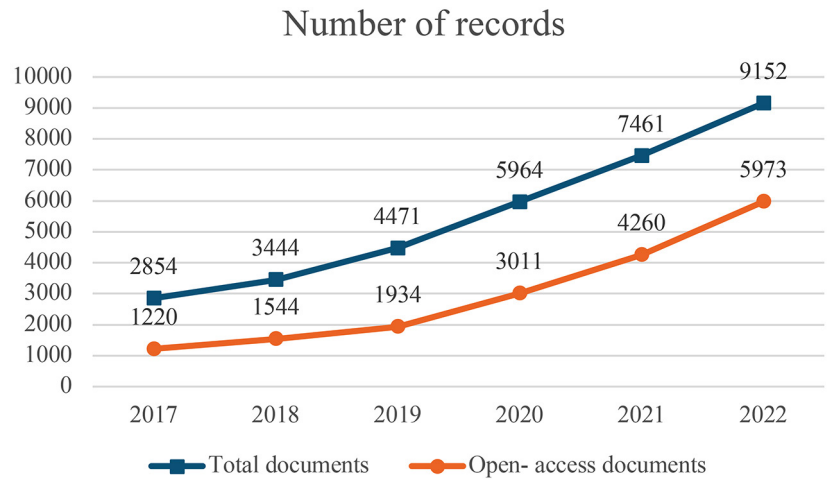


Table 1. Statistics of Publications in the Two Periods

	2017–2019	2020–2022
No. of open-access documents	4,698	13,244
% of open-access documents	43.62	58.67
Average of co-authors per document	7.91	7.55
No. of journals	1,248	1,931
No. of references	179,382	444,127
Average of references per document	38.18	33.53
No. of author keywords	10,139	22,621
Average of author keywords per document	2.16	1.71
No. of documents acknowledging funding	4,000	9,989
% of documents acknowledging funding	85.14	75.42
Average number of funding institutions	2.78	2.30

(Z = 8.269, p = 0.00 < 0.01), the mean number of author keywords per document (Z = 21.001, p = 0.00 < 0.01), the proportion of articles acknowledging funding (χ^2 = 154.41, df = 1, p = 0.00 < 0.001), and the average number of funding acknowledged per article (Z = 11.839, p = 0.00 < 0.01). However, when considering the absolute number of funded studies, there was a notable increase, with the number more than doubling from 4,000 before the pandemic to 9,989 afterward.

3.2 Thematic analysis

3.2.1 Analysis of journal subject categories

Figure 2 displays the changing of thematic journal categories over time, with each category represented by a different color block and the thickness of each color block indicating the corresponding percentage. Table 2 details the frequency and percentage of occurrence for each specific category.

Figure 2. Temporal Trends in Journal Subject Categories Generated with CorText Manager

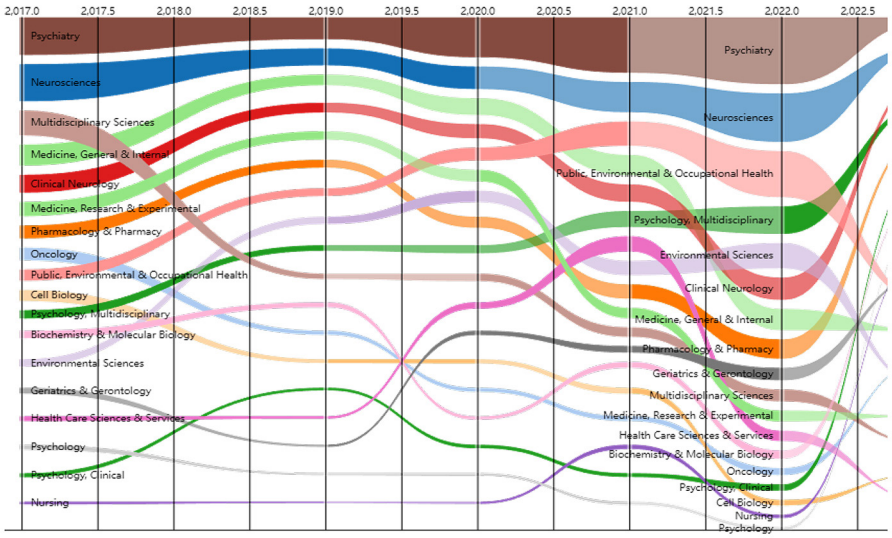


Table 2. Frequency and Proportion of Top 10 Subject Categories

Categories	2017–2019		2020–2022	
	Frequencies	%	Frequencies	%
Psychiatry	713	14	2,398	17
Neurosciences	663	13	1,492	11
Medicine General & Internal	382	7	895	6
Clinical Neurology	324	6	806	6
Multidisciplinary Sciences	294	6	-	-
Medicine Research & Experimental	279	5	506	3
Pharmacology & Pharmacy	240	5	659	4
Public Environmental & Occupational Health	240	5	1,229	9
Oncology	193	4	-	-
Environmental Sciences	191	4	777	5
Health Care Sciences & Services	-	-	467	3
Psychology Multidisciplinary	-	-	786	5

During the period 2017–2019, the predominant subject categories are Psychiatry (14%), Neuroscience (13%), and Medicine research & Experimental (7%). In contrast, in 2020–2022, the prevalent subject categories are Psychiatry (17%) and Neuroscience (11%), followed by Public Environmental & Occupational health (9%). Psychiatry increased from 14% in 2017–2019 to 17%, while Public Environmental & Occupational Health increased from 5% to 9%. On the other hand, Neurosciences declined from 13% to 11%, and Medicine Research & Experimental dropped from 5% to 3%. The two categories of Multidisciplinary Sciences (6% in 2017–2019) and Oncology (4% in 2017–2019) do not appear among the most representative categories of 2020–2022. After the pandemic, their prominent position was quickly replaced by new categories: Psychology Multidisciplinary (5%) and Health Care Sciences & Services (3%).

These findings suggest a marked focus on clinical psychology, neurobiology, and medical research during the period 2017–2019, emphasizing the significant scholarly attention to mental health and neurobiological perspectives. However, following the COVID-19 pandemic, there was a noticeable reduction in the prominence of categories related to clinical and fundamental disciplines, particularly in Medicine, Research & Experimental. This category places special emphasis on technologies and clinical interventions across different medical disciplines and applications, including those in an early stage of development and in vitro models, animal models, and small-scale clinical trials (Web of Science Help, n.d.-a). On the other hand, Oncology, addressing topics related to the mechanisms, causes, and treatments of cancer, and Multidisciplinary Sciences, which spans a broad spectrum of scientific disciplines including physics, chemistry, mathematics and biology (Web of Science Help, n.d.-a) also decrease. Conversely, the upward trend in the Public Environmental & Occupational Health category is especially notable. A second prominent category, Health Care Science & Service, covers a wide range of research related to health services, hospital management, healthcare administration, healthcare financing, health policies and planning, and health education (Web of Science Help, n.d.-a). Research in this category can help inform and improve public health policies and planning, including resource distribution and response to health emergencies.

3.2.2 Author keywords

According to Figure 3 and Table 3, during the first period (2017–2019), the most frequent terms were “depression” (32%), “anxiety” (8%), “China” (5%), “meta-analysis” (4%), “major depressive disorder” (4%), and “mental health” (4%). However, in the second period (2020–2022), these terms underwent a significant transformation, with “depression” (27%), “anxiety” (12%), “COVID-19” (11%), “mental health” (7%), and “China” (4%). Regarding temporal changes, it is observed that the frequency of the term “anxiety” increased from 8% in 2017–2019 to 12%, while “mental health” experienced an increase from 4% to 7%. In contrast, “depression” experienced a moderate decrease, dropping from 32% to 27%. Other terms such as “major depressive disorder,” “meta-analysis,” “quality of life,” and “depressive symptoms” also showed decrements of 1% in their occurrence. As time progresses, it is interesting to note that terms such as “inflammation” (3% in

Figure 3. Temporal Trends in Author Keywords Generated with CorText Manager

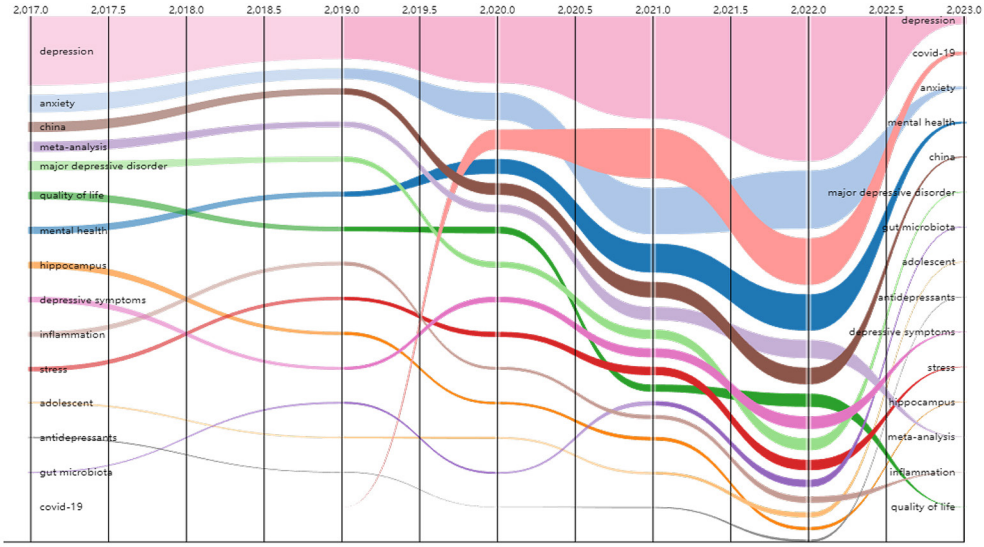


Table 3. Frequency and Proportion of Top 10 Author Keywords

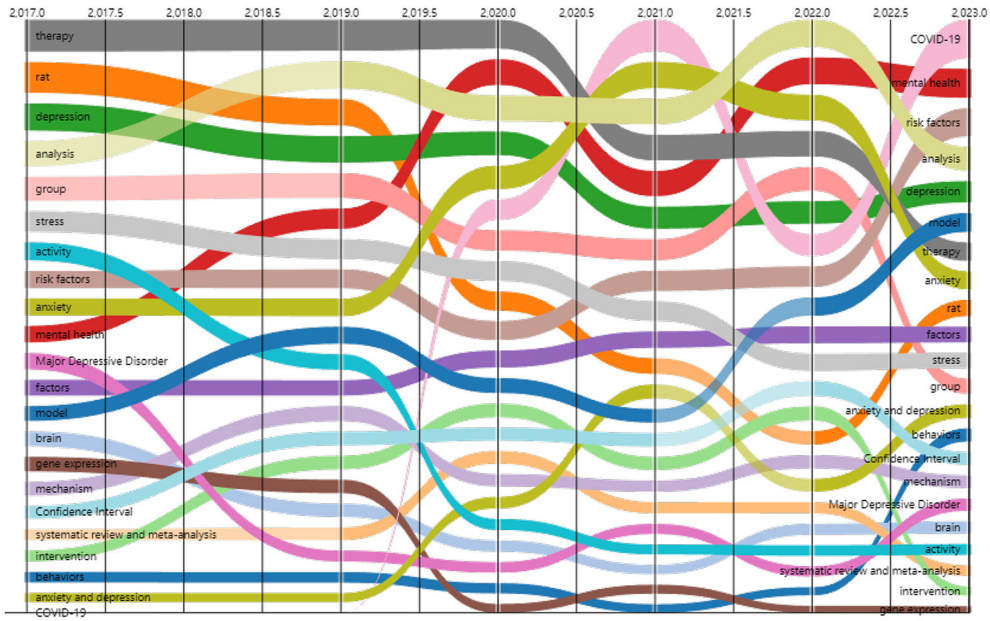
Author keywords	2017–2019		2020–2022	
	Frequencies	%	Frequencies	%
depression	863	32	2,852	27
anxiety	217	8	1,208	12
China	141	5	407	4
meta-analysis	119	4	360	3
major depressive disorder	109	4	267	3
mental health	100	4	752	7
quality of life	89	3	260	2
inflammation	76	3	-	-
hippocampus	75	3	-	-
depressive symptoms	71	3	258	2
COVID-19	-	-	1,112	11
stress	-	-	216	2

2017–2019) and "hippocampus" (3%) (concepts related to neuroscience and psychobiology) disappear from the table, while "COVID-19" (11% in 2020–2022) and "stress" (2%) emerge on the list.

3.2.3 Terms extracted with cortex manager

The first set of terms pertains to treatment, including "therapy" and "intervention." Therapy typically refers to non-medication therapeutic interventions, while intervention in psychology refers to psychosocial treatments for mental disorders (National Library of Medicine, n.d.). A decrease can be observed in the frequency of occurrence of these terms, along with a decreasing trend in related psychological disorders such as severe depressive disorder. The second type of terms points to neuropsychology and physiological psychology, such as "brain" and "gene expression," relating to the biological basis of cognitive processes and behavior. However, there is a gradual decrease in content related to this theme. Thirdly, terms related to experimental psychology, such as "rat" (used in experiments) and "group" (for subject assignment to control variables) also decreased from one period to the other. Conversely, aside from a slight decrease in the frequency of the term "stress," "depression" and "anxiety" have consistently maintained notable occurrence rates. Representing crucial research directions, these terms continue to receive academic attention following the pandemic outbreak, where the frequency of "anxiety" peaked. Additionally, amid the pandemic, a notable surge in terms like "mental health" and "sleep" can be observed, signaling an increased emphasis on preserving psychological well-being.

Figure 4. Temporal Trends in Terms Generated with CorText Manager



3.2.4 Thematic map

Thematic maps of keywords were generated for 4 quadrants before and after the pandemic, as illustrated in Figure 5 and 6.

It can be observed that during 2017–2019, the set of themes in the first quadrant includes "China," "mental health," and "quality of life." The "highly specialized or niche themes" of the second quadrant include "reliability" and "validity" maintaining their position in both periods. These 2 terms are generally used in the context of psychometrics and psychological experimentation. The cluster comprising "inflammation," "hippocampus," and "stress" has shown a decline in relative prominence during the second period, giving rise to a novel combination involving "major depressive disorder," "gut microbiota," and "inflammation." The third quadrant, which includes "emerging or declining themes," evolves from "functional connectivity," "fMRI," and "functional magnetic resonance imaging" in 2017–2019, to no notable themes in 2020–2022. The fourth quadrant includes topics often referred to as "basic themes" with potential development trends. In the period 2017–2019, one of the groups consists of "major depressive disorder," "bipolar

Figure 5. Thematic Map in 2017–2019 Generated with Biblioshiny

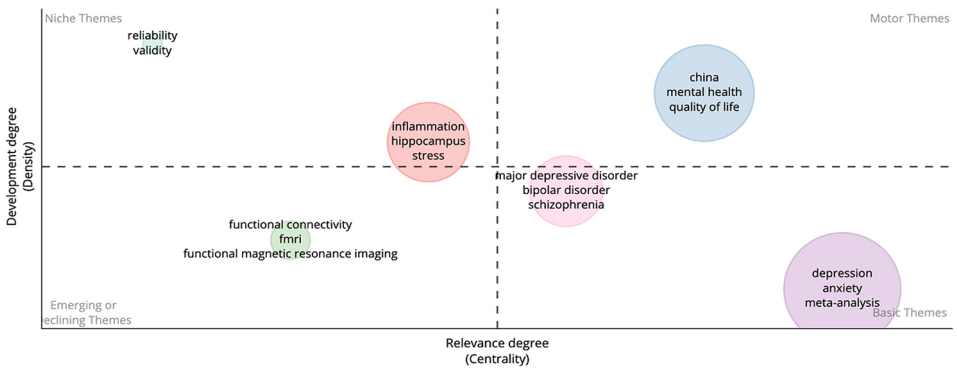
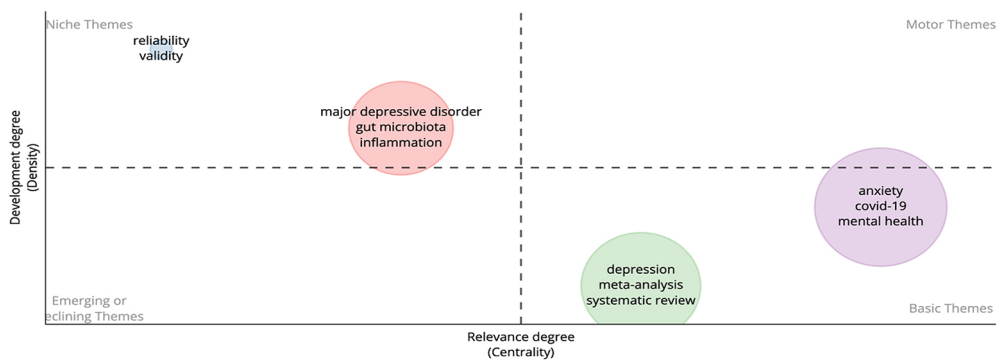


Figure 6. Thematic Map in 2020–2022 Generated with Biblioshiny



disorder," and "schizophrenia." The other group includes "depression," "anxiety," and "meta-analysis." Over time, reaching 2020–2022, these groups evolve into sets containing "anxiety," "COVID-19," and "mental health," as well as "depression," "meta-analysis," and "systematic review." The topics on depression and anxiety still exist but are divided into two groups.

Based on a comprehensive analysis of keyword-based trends, the following research topic trends are identified. Both pre- and post-pandemic, anxiety and depression remain predominant areas of research, with a notable increase in the focus on anxiety studies in the post-pandemic period. In contrast to pre-pandemic research, there has been a decrease in the proportion of studies related to organic psychological disorders and physiological issues. Instead, there is a growing interest in investigating more common, widespread, and persistent adverse emotional states. Methodologically, there has been a decrease in the number of articles focusing on clinical trials in psychology, while the number of research employing psychological measurement methods such as surveys and questionnaires has increased. Finally, post-pandemic research has seen a rise in topics related to health sciences and public health policies. Researchers are increasingly focusing on how university students maintain positive emotions during the pandemic, with particular emphasis on psychological interventions and mental health policy issues.

3.3 International collaboration

This section employs VOSviewer to generate diagrams illustrating international collaboration (Figure 7 and 8) and institutional-level collaboration networks (Figure 9 and 10). Table 4

Figure 7. International Collaboration Networks of 2017–2019 Generated with VosViewer and Gephi

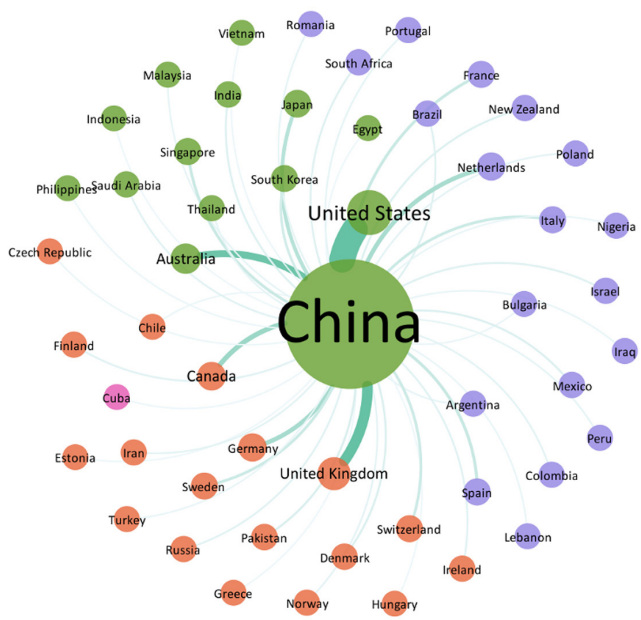


Figure 8. International Collaboration Networks of 2020–2022 Generated with VosViewer and Gephi

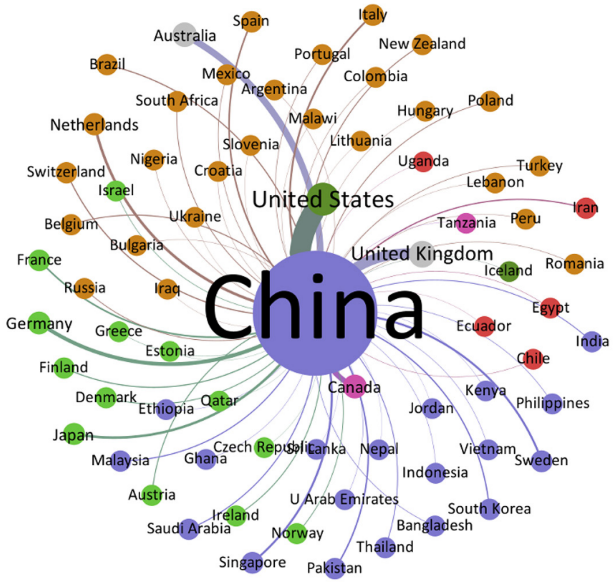


Table 4. Frequency and Proportion of Top 10 International Collaboration

Nation	2017–2019		2020–2022	
	Frequencies	%	Frequencies	%
United States	838	27	1507	24
United Kingdom	319	10	721	12
Australia	202	6	463	7
Canada	133	4	374	6
Germany	120	4	256	4
Netherlands	109	3	179	3
Japan	91	3	172	3
Spain	69	2	-	-
France	66	2	-	-
Sweden	63	2	138	2
Italy	-	-	125	2
Singapore	-	-	142	2

provides corresponding data on the frequency and proportion of collaboration with China by countries.

From 2017 to 2019, collaboration networks between China and other countries formed 3 main clusters. The first cluster consists of China's research partners in the Asia-Pacific region, including major economies such as the United States (27%), Japan (3%), South Korea, India, and Australia (6%), as well as several Southeast Asian countries like Vietnam, Malaysia, Singapore, the Philippines, and Thailand. The second cluster comprises a diverse set of countries spanning Europe, Latin America, and Africa, including France (2%), Spain (2%), Portugal, Brazil, the Netherlands (3%). The third cluster includes the United Kingdom (10%), Germany (4%), Canada (4%), and several Nordic and Eastern European countries such as Finland, Estonia, Sweden (2%), and Hungary.

From 2020 to 2022, China's academic collaboration network expanded significantly, with an increasing number of partner countries and a more complex network structure characterized by a greater number of distinct clusters. The United States remained China's most prominent research partner, though its relative share decreased from 27% to 24%. The United Kingdom and Canada exhibited notable growth, increasing from 10% to 12% and 4% to 6% respectively, reflecting strengthened bilateral research ties. European collaborations, particularly with Germany (4%), the Netherlands (3%), and Sweden (2%), remained stable, highlighting Europe's continued significance in China's research network. Meanwhile, new clusters emerged, notably involving African, Middle Eastern, and Latin American countries such as Uganda, Iran, Ecuador, Egypt, and Chile, indicating China's expanding academic engagement with non-traditional partners. In addition, countries in intensive collaboration with China post-pandemic, such as the United States, Germany, Japan, Italy, and the United Kingdom, were also among the top 10 countries with the highest number of confirmed cases according to the WHO dashboard on COVID-19 (WHO, n.d.).

3.4 Institutional Collaboration

During the period 2017–2019, collaboration networks among institutions in China showed 5 clusters. However, from 2020 to 2022, the number of clusters increased to 8, with a significant increase in the number of collaborating institutions, indicating a more complex collaboration network.

Moreover, both before and after the pandemic, collaboration patterns were characterized by geographical proximity. This trend intensified after 2020–2022, particularly evident in increased collaboration among institutions in the Wuhan region and its surroundings, deeply affected by the pandemic.

Furthermore, after the pandemic, collaboration among medical institutions became more prominent, emphasizing partnerships among medical universities, hospitals, and institutions excelling in medical research. Both in Figure 9 and Figure 10, medical universities from various provinces and cities are included, along with those have affiliated hospitals, as well as universities with a prominent position in the disciplines of medicine and psychology, according to the 2023 Best Chinese Universities Ranking from the Shanghai Ranking's (Shanghai Ranking, n.d.).

Figure 9. Institutional Collaboration Networks of 2017–2019 Generated with VOSviewer and Gephi

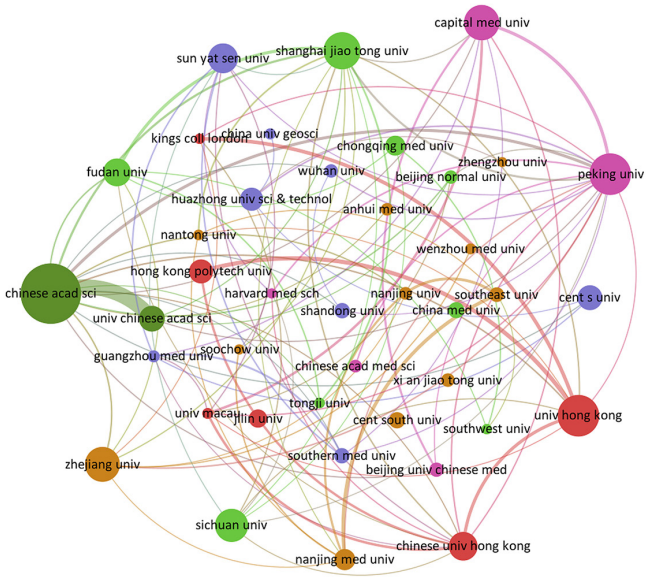
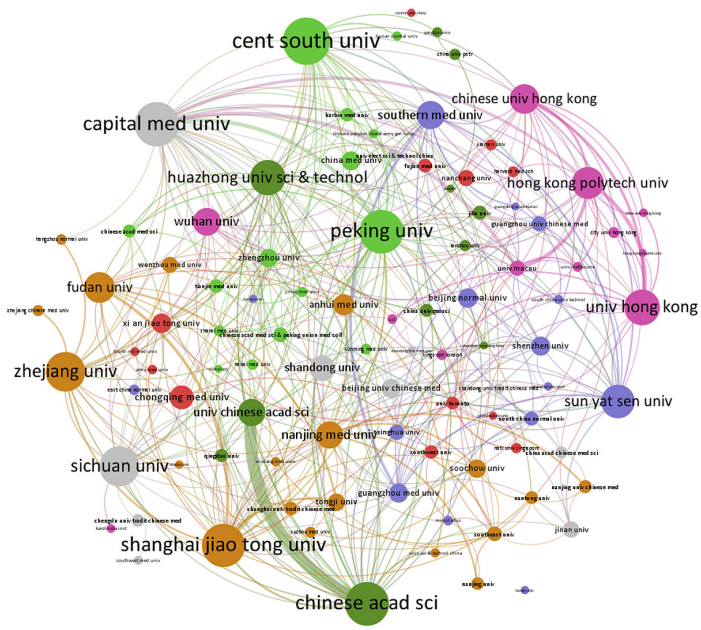


Figure 10. Institutional Collaboration Networks of 2020–2022 Generated with VOSviewer and Gephi



Finally, collaboration with foreign institutions has existed throughout the entire period, although its number increased after the pandemic. This reflects a greater emphasis on international collaboration in research, highlighting the importance of global health issues.

4. Discussion

This study explores the dynamic shifts in research output, thematic focuses, and collaboration patterns on the mental health of Chinese university students across the pre- and post-pandemic periods. Existing bibliometric studies have primarily focused on the mental health of healthcare workers and vulnerable populations, such as the elderly, during the pandemic (Akintunde et al., 2021; Chen et al., 2021; Wang et al., 2024). However, the mental health challenges faced by university students have been largely neglected. Additionally, previous bibliometric research (Akintunde et al., 2021; Dong et al., 2022; Pajić, 2022) typically concentrate on short post-pandemic timeframes without comparing these to pre-pandemic trends. In contrast, this study fills this gap by providing a comparative analysis of two distinct time periods, highlighting the dynamic shifts in research output, thematic focuses, and collaboration patterns. By analyzing multiple aspects beyond citation counts, this study avoids the time accumulation effect or cumulative advantage model that is often present in COVID-related research (Pajić, 2022). This approach offers a more nuanced and comprehensive understanding of the evolving landscape of mental health research among university students.

This research observed a significant increase in the total number of studies related to college students' mental health following the onset of the pandemic, as evidenced by previous studies (Maalouf et al., 2021; Yang et al., 2022; Zhang et al., 2020), demonstrating a heightened emphasis not only on combating the virus itself but also on prioritizing mental health concerns. The quantity and proportion of open-access articles have significantly increased, likely due to researchers' desire to widely disseminate their findings and accelerate COVID-19-related research progress (Maalouf et al., 2021, Palayew et al., 2020; Tse et al., 2020). Additionally, there's a decrease in the number of references cited in articles, also indicating scientists' inclination to swiftly publish results. This trend may be attributed to the prevalent use of preprints during the pandemic, which undergo faster review processes and have fewer references (Costas et al., 2012; Fraser et al., 2021).The reduction of references further underscores the novel challenges posed by the pandemic, suggesting that existing research may not fully address the mental health concerns specific to Chinese university students, such as the long-term psychological effects of lockdowns, social isolation, and the shift to online learning.

However, this rapid and voluminous academic output occurred amidst a backdrop of constrained funding. According to the data presented in this study, after the pandemic, there was a decline in the proportion of articles receiving funding and the average number of funders per article. During the pandemics, funders prioritized research aimed at combating the virus, particularly within the STEM (Science, Technology, Engineering, and Mathematics) and health domains (Beech &

Anseel, 2020; Myers et al., 2020), while mental health issues were accorded lower priority in funding for not directly threatening lives. However, facing constraints in funding and diminished engagement opportunities, researchers continued to develop their studies through toughness and adaptability to meet the needs of the post-pandemic landscape. Notably, while there was a relative decline in the proportion of funded research, the absolute number of funded studies more than doubled, increasing from 4,000 to 9,989. This growth reflects an overall expansion in research activity, even if it competed for resources with other urgent priorities.

Another significant post-pandemic shift is the specialization of journals publishing research on the mental health of Chinese university students. Although previous bibliometric studies have primarily focused on broader population groups, this study provides a unique perspective. For instance, Wang et al. (2024) observed that more than half of the top 10 most-cited journals were from the psychiatry category, while Akintunde et al. (2021) noted that psychiatry and psychology articles accounted for approximately half of the total publications analyzed, with relatively limited focus on other fields. In contrast, this study found that, while journals in Psychiatry and Neuroscience continued to dominate in terms of publication volume, there was a significant increase in journals categorized under Public, Environmental & Occupational Health, and Health Care Sciences & Services. This shift aligns with broader trends highlighted by Roychowdhury et al. (2022), who observed that COVID-19 research increasingly focused on psychology, social sciences, public health, and social work, reflecting a growing alignment with societal needs. These evolving trends demonstrate the dynamic nature of academic research during the pandemic, as it shifted towards addressing psychological changes, university students' mental health, community well-being, and rehabilitation. Consequently, these developments highlight the importance of aligning library collections with both academic and societal priorities, ensuring they not only reflect but also support the creation of effective psychological strategies to address emerging mental health challenges (Priyadi et al., 2020; Visintini et al., 2018).

In examining thematic shifts in research on the mental health of university students over time, this analysis incorporated high-frequency keywords and thematic maps. Results show that post-pandemic, anxiety and depression have remained focal points, with anxiety research experiencing a notable surge. The heightened focus on anxiety post-pandemic, as suggested by Wu et al. (2021) and Zhang et al. (2021), can be attributed to the fear induced by COVID-19 and the added stress of job hunting, while emphasizing the new learning difficulties brought about by online teaching during periods of isolation. Moreover, the thematic analysis highlights methodological changes, particularly a decline in clinical psychology trials during the pandemic and an increased reliance on surveys and questionnaires. This shift towards quantitative, data-driven approaches to student mental health, as opposed to experimental methods, is a meaningful finding of this study. During the pandemic, traditional clinical research requiring medical examinations and laboratory testing was hindered by isolation measures, regional restrictions, and reduced

research funding, prompting researchers to turn to online surveys as a feasible alternative. Many researchers have shifted to online surveys to reduce COVID-19 transmission risk, minimizing contact with clinical samples while maintaining participant communication (Chen & Lucock, 2022; Kar et al., 2021).

This shift has also garnered attention from academic libraries, who have supported the transition to remote research by offering tools for survey implementation, data analysis, and participant access. Over 94% of Chinese academic libraries, for example, began publishing COVID-19-related information on their websites, shifting to remote services such as virtual reference, e-resources, and research support (Guo et al., 2021). Similarly, libraries globally, as noted by Martzoukou (2020) and Puspita and Ilmi (2022), adapted by adopting digital platforms to offer essential online services, bridging gaps in information access and supporting data-driven research approaches. These developments highlight the evolving role of libraries in facilitating remote, quantitative research methods.

While previous research, such as Dong et al. (2022) and Wang et al. (2024), provide valuable insights into thematic changes in mental health research, they do devote little attention to methodological adaptations. Although some mention teletherapy (Dong et al., 2022), broader changes, such as the increased use of remote or online research methods, remain underexplored. This study complements previous findings by offering insights into how the pandemic reshaped research practices to meet the demands of social distancing and mobility restrictions, and tackle such a prevalent issue during the pandemic as anxiety.

Moreover, scales such as the Fear of COVID-19 scale and the COVID-19 anxiety syndrome scale (Nikčević & Spada, 2020; Tzur Bitan et al., 2020) have been developed and utilized, advancing psychometrics. Furthermore, corresponding to the shifts observed in the specialization of journals, the thematic analysis also reveals a transition in research focus from investigating the etiology, diagnosis, and treatment of mental disorders to prioritizing the preservation of students' positive emotional well-being during the pandemic. This emphasis signifies a broader recognition of the holistic needs of individuals during times of crisis and underscores the importance of fostering resilience and promoting mental wellness as integral components of post-pandemic public health initiatives.

In addition to the above findings, this study also examined shifts in international and institutional collaboration models and their relevance to the mental health research of Chinese university students. China has maintained substantial collaboration with developed countries both pre- and post-pandemic, while collaboration with developing countries has increased after the outbreak. This finding contrasts with the conclusions of some studies, such as Chen et al. (2021), who observed a lower frequency of international collaboration in research focusing on general populations, with a greater emphasis on institutional collaboration. Notably, the United States and the United Kingdom remain China's top collaborators, but the pandemic has led to a decline in co-authored articles between China and the United States. Meanwhile, collaboration with countries in Asia and Latin America has grown, consistent with the broader post-pandemic trend of

increased collaboration across disciplines between China and these regions (Wang & Huang, 2021). Regions severely affected by the pandemic, such as Italy, have also deepened their collaboration with China. This pattern reflects the tendency of resource-constrained countries to rely on data-sharing partnerships with major academic hubs like China for insights into pandemic response and psychological support policies (Lee & Haupt, 2021). In the context of university student mental health, these collaborations have facilitated the exchange of tools, methodologies, and data essential for understanding the psychological toll of the pandemic on this vulnerable group.

Institutional collaboration also evolved, with a significant increase in the number of collaborating institutions observed between 2020 and 2022. This trend suggests enhanced interconnectedness, particularly in studies focused on university student populations. Post-pandemic collaborations between universities specializing in medicine, institutions with affiliated hospitals, and psychology-focused academic centers became more prominent. These institutions possess both the clinical expertise and access to university student populations, enabling targeted research on their mental health. For instance, such institutions were well-positioned to conduct psychological surveys and longitudinal studies that captured the evolving mental health needs of university students during and after the pandemic (Cao et al., 2020; Padrón et al., 2021).

Moreover, the global reorganization of research structures, as noted by Fry et al. (2020), has led to the concentration of research resources in elite institutions, favoring teams with greater financial and scientific capabilities. While this structure resulted in high-quality studies on university student mental health in China, it also risked sidelining smaller institutions and their unique contributions. This uneven distribution of research opportunities underscores the need for inclusive approaches that ensure all facets of university student mental health are addressed, irrespective of institutional prestige or resources.

5. Conclusions

This article highlights the evolving nature of research on college students' mental health in response to health crises, with the importance of adapting research themes, methodologies, and collaboration models. Findings from China not only benefit domestic efforts but also offer insights for similar populations globally.

To address future health crises, libraries and academic journals play a critical role in the timely dissemination of research findings. Furthermore, collaborations across regions, institutions, and universities—particularly at the international level—are essential for supporting research efforts. Such partnerships help disseminate research outcomes globally and extend aid to countries facing similar challenges, necessitating coordinated international science policies. Adequate funding remains a key element for sustaining research initiatives, and it is important that funding agencies and governments should strive to ensure balanced resource allocation to support diverse areas of mental health research.

Future research should prioritize the integration of a wide range of data sources and bibliometric indicators to enhance the robustness and comprehensiveness of analyses. Cross-

disciplinary collaboration will be key in ensuring the relevance, rigor, and objectivity of research outcomes. Libraries have a pivotal role in fostering such collaboration by providing access to diverse data resources and supporting engagement across academic disciplines. In doing so, libraries can contribute significantly to addressing the complex mental health challenges posed by global health crises, ultimately facilitating the development of more effective research strategies and interventions.

Conflict of interest statement

The authors report there are no competing interests to declare.

Data availability statement

All data that support the findings of this study are included in this manuscript and its supplementary information files.

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以書目計量法分析新冠疫情對中國大學生心理健康研究的影響

The Impact of the COVID-19 Pandemic on Research into Chinese University Students' Mental Health: A Bibliometric Analysis

Zhexian Zhu[1], Michela Montesi[2]

摘　要

新冠疫情加劇了焦慮與抑鬱發生率，促使心理健康研究增多，其中大學生作為易感群體成為研究焦點。為了解公衛危機下科研活動的演變，本研究運用書目計量學方法分析2017至2022年間中國大學生心理健康相關文獻，檢視研究趨勢及協作網絡，探討疫情前後研究主題、領域與合作模式的變化。疫情後文獻量與開放取用比例有顯著成長，研究興趣從「臨床診斷」轉向「身心福祉」；中國與疫情重災區、發展中國家的國際合作，以及醫學院校與頂尖學術單位之間的機構合作密度都有明顯提升。本研究凸顯書目計量學與心理學在心理健康議題的跨學科合作價值，圖書館、學術期刊、國際聯盟及資助機構也可據此改善未來疫情期間的支持體系，為應對複合型公衛挑戰提供方法論參考。

關鍵字：書目計量學、心理健康、新冠疫情、大學生群體、主題分析

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