

Research Article

Research Trends in Mindfulness for Adolescents: Based on CiteSpace Visualization Analysis

Lei Qian¹, Fang Ye², Yali Zhang², Lilan Luo², Jialin Jin², Ke Jiang², Huilin Qiu³, Ping Xu⁴

1. University of Alberta, Canada; 2. Wenzhou Medical University (WMU), Wenzhou, China; 3. Sichuan University, China; 4. Wenzhou University, China

Mindfulness has been increasingly used to improve the mental health of adolescents. This study focused on evaluating the latest research status of mindfulness for adolescents through CiteSpace and on identifying research hotspots and frontiers. We extracted English literature on mindfulness for adolescents from the Web of Science (WoS) and Chinese literature from the China National Knowledge Infrastructure (CNKI) databases, covering the period from 1999 to 2022. A total of 1317 papers were obtained. CiteSpace was used to generate online maps of worldwide cooperation among countries, institutions, and authors. Hotspots and frontiers were systematically summarized. There is a paucity of collaboration among institutions in the Chinese literature compared to the English literature. The research themes in the literature of the two languages overlap and also exhibit discrepancies at different times. Future research in mindfulness for adolescents may focus on the mechanisms and applications. Collaboration among authors should be strengthened.

Correspondence: papers@team.qeios.com — Qeios will forward to the authors

1. Introduction

Mindfulness is an ancient and modern research topic related to the cross-cultural exchange between the East and West. The origin of mindfulness can be traced back to the teachings of the Buddha, Sakyamuni, 2500 years ago ^[1]. By observing and acknowledging our physical and mental states in the present moment, without judgment, we cultivate an impartial mind that fully accepts all feelings without attachment and aversion, allowing us to reach the ultimate awareness ^{[2][3]}. In cognitive psychology,

mindfulness is a set of habituation training programs that promote intentional attention, with positive effects on memory, attention regulation, executive function, and emotion regulation ^{[4][5]}.

At present, mindfulness training has been widely applied to clinical treatment and practical research in many fields and has attracted the research interests of cognitive psychologists ^{[6][7]}. Research has shown that focusing one's awareness and attention can provide real sensations and perceptions, thereby reducing physical and psychological distress, improving coping skills, and increasing an individual's subjective vitality ^{[8][9]}. Wang and Huang analyzed the psychological mechanisms of mindfulness in areas such as emotions ^[10]. The findings suggest that during the process of mindfulness, individuals' perception, attention, and emotions undergo adaptive changes.

The word "adolescence" comes from the Latin "adolescere" – to grow up. Although the definition of adolescence varies across different cultures, adolescence generally refers to the transitional stage of life between childhood and adulthood. For adolescents, the ability to integrate perception, focus attention, and regulate emotions is critical. Erbe and Lohrmann searched the literature on mindfulness up to autumn 2014 for terms such as adolescent, meditation, mindfulness, and stress ^[11]. The study demonstrates that mindfulness has a positive impact on the mental health of adolescents, highlighting the feasibility, acceptability, and effectiveness when applied to adolescent groups across various cultural contexts. Research has shown that mindfulness can improve subjective well-being and quality of life by increasing an individual's experience of positive emotions and decreasing the experience of negative emotions ^{[12][13]}.

Adolescents are at high risk of depression and anxiety due to factors like developmental disorders, academic stress, and the socialization transition of adolescent growth ^[14]. There has been considerable practical exploration of mindfulness training for adolescent rehabilitation in clinical settings. Researchers have examined the effectiveness of mindfulness interventions in addressing mental and physical health issues in adolescents from diverse backgrounds, and their efficacy has been confirmed by numerous studies ^{[15][16][17]}. However, we have questions about how to evaluate the effectiveness of mindfulness interventions among adolescents, what topics adolescent mindfulness studies focus on, what areas of interaction are sources of information for youth-positive thinking research, and what are the contraindications to adolescent mindfulness training.

Literature is an invaluable resource for learning about specific research topics and a crucial component of scientific research worldwide. Bibliometrics is a technique for quantitatively analyzing publications using

mathematical and statistical tools, forming the basis for researchers to assess hotspots and trends in their discipline and to predict the direction of their discipline.

Based on the approach of bibliometrics and using the visualization analysis software CiteSpace ^{[18][19]}, this study comprehensively analyzes the development status, research hotspots, and evolutionary paths of adolescent mindfulness research in China by combining the domestic and international adolescent mindfulness-related literature, in order to provide a scientific guideline for further strengthening the research of adolescent mindfulness.

2. Methods

We conducted the literature search online through the Web of Science (WoS) database and the China National Knowledge Infrastructure (CNKI) database.

The period of English literature spanned from January 1, 1991, to December 31, 2022. The following search terms were used: (TS = ('mindful*') AND ('child*' OR 'adolescen*' OR 'school' OR 'youth' OR 'young' OR 'teenage*' OR 'juvenile*' OR 'puberty' OR 'kid*') AND Language = English AND Document type = Article). The earliest English literature on adolescent mindfulness research was published in 1991. The period of Chinese literature spanned from January 1, 2011, to December 31, 2022. We used the following search terms in the Chinese language: subject (TS) = (mindful) and TS = (children + adolescence + pupil + junior high school student + senior high school student + school + primary school + middle school + junior high school + senior high school). Certain types of literature, such as book chapters, conference papers, or review papers, were excluded because of the different ways in which mindfulness can be applied in different fields. Chinese journals, conferences, and dissertations were included due to the limited number of documents. The earliest Chinese literature on adolescent mindfulness research was published in 2011.

Finally, we extracted 1121 documents from the WoS database and 196 documents from the CNKI database.

3. Analysis of the current situation of adolescent mindfulness research

3.1. General analysis of the literature

The earliest literature on adolescent mindfulness research was published in 1991. As indicated in Figure 1, the number of yearly publications can be roughly divided into the following three stages: 1) The slow start

phase from 1991 to 2009. The literature from these 19 years was all in English, comprising a total of 19 articles. 2) The rapid growth phase from 2010 to 2016. There was a significant increase in the overall number of yearly publications, reaching double digits. Notably, the first Chinese literature on adolescent mindfulness was published in 2011. 3) The high growth phase from 2017 to 2021. The number of articles published globally exceeded 100 per year, and in 2021, the number was close to 200. 4) In 2022, there was a slight decrease in the number of articles published globally, whereas Chinese literature remained increasing. The number of published articles in Chinese consistently reached double digits each year, experiencing a year-on-year increase.

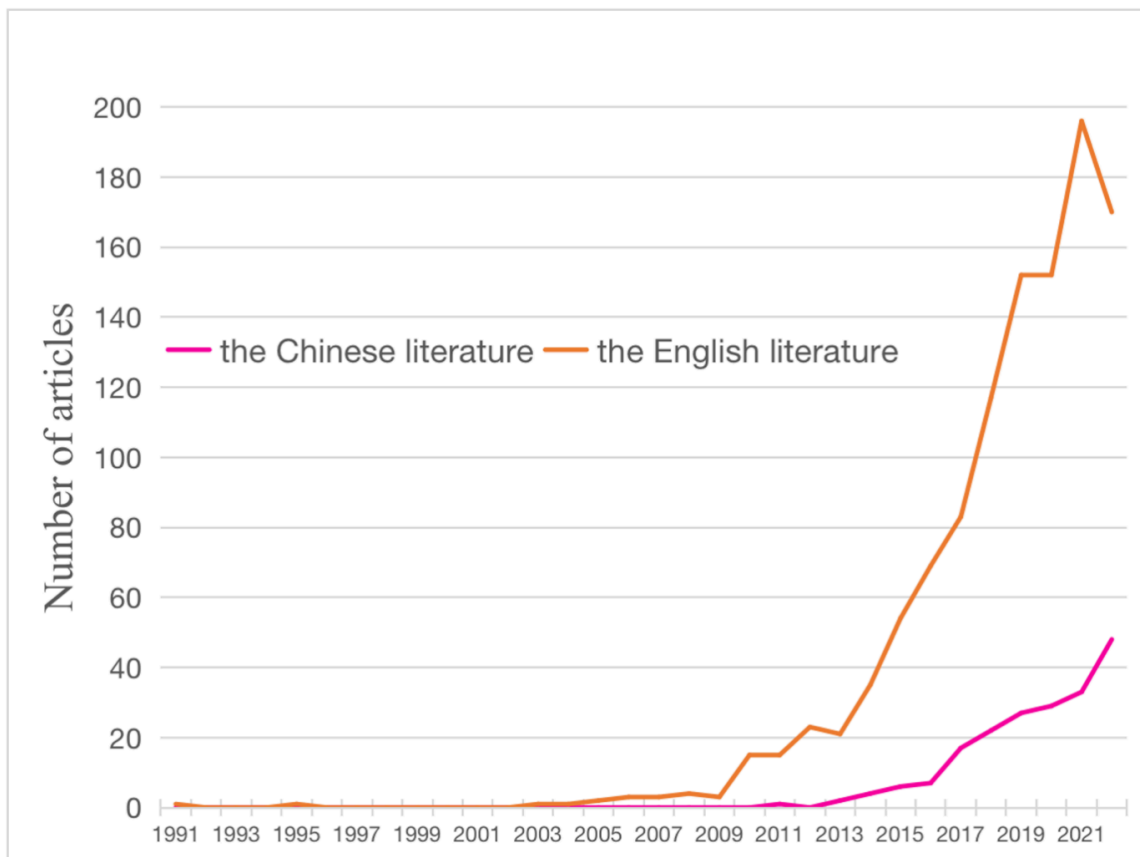


Figure 1. The number of English and Chinese literature by year (1991-2022).

3.2. Analysis of countries, institutions, and authors

We used the volume of publications and mutual collaborations between different countries, research institutions, and leading authors to form a cooperation network between countries, where the size of each node represents the volume of publications and the connecting lines represent the cooperation between

countries. The country cooperation network shows that the United States (505 articles), China (134 articles), Canada (111 articles), Australia (101 articles), the United Kingdom (87 articles), Spain (63 articles), the Netherlands (46 articles), Italy (33 articles), Germany (28 articles), and Iran (27 articles) were the top ten countries in terms of the total number of articles published. Figure 2 illustrates that the studies formed 56 nodes and 149 links between 1991 and 2022.

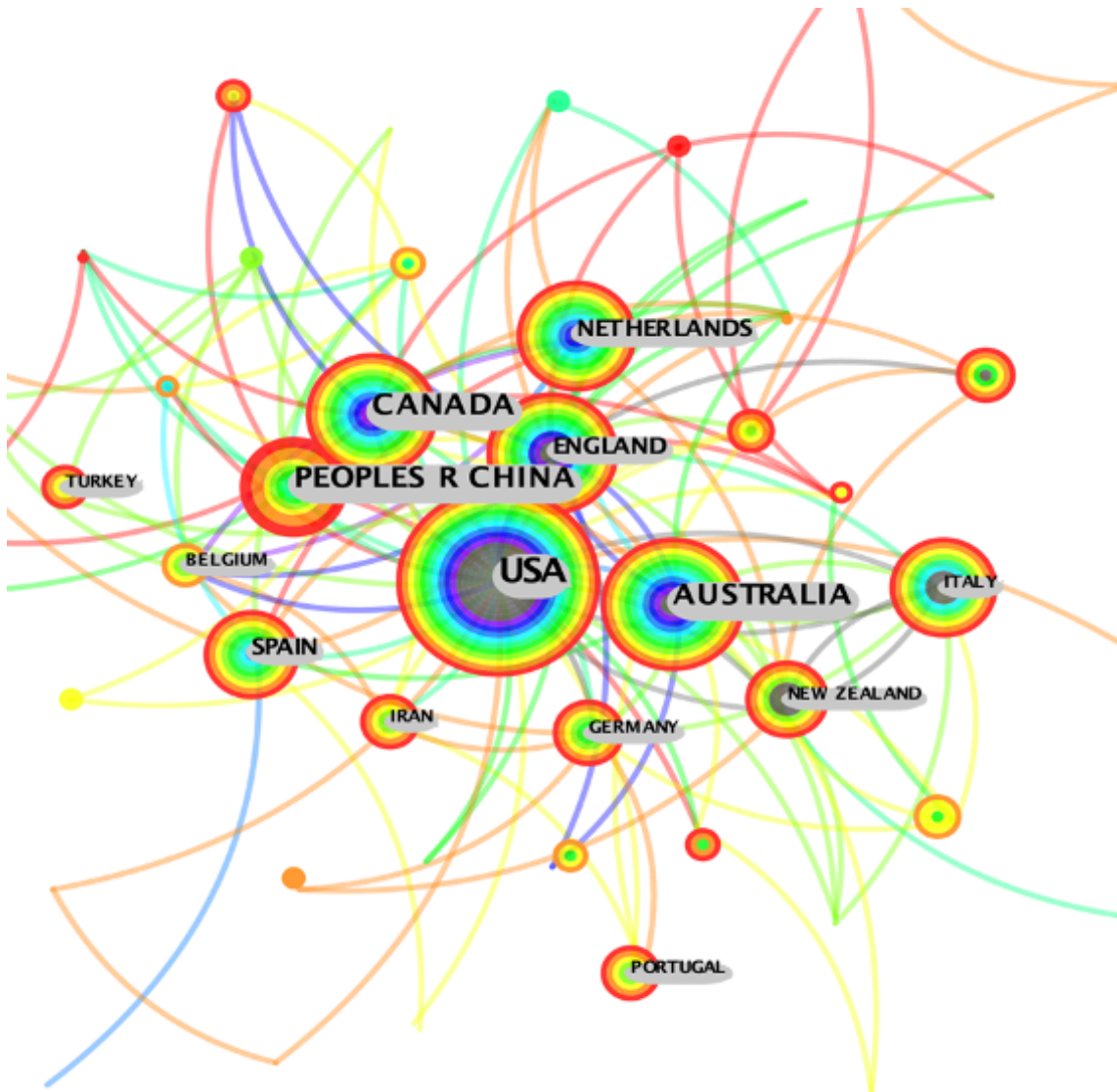


Figure 2. Country cooperation network (English literature).

Figure 3 shows the spatial network of 434 nodes and 776 links between research institutions corresponding to the English literature. The institution cooperation network shows that the Pennsylvania

State University (47 articles), University of Amsterdam (32 articles), Colorado State University (28 articles), University of Toronto (24 articles), Beijing Normal University (17 articles), University of North Carolina (17 articles), University of Deusto (17 articles), University of Melbourne (17 articles), University of Hong Kong (16 articles), and University of Oxford (16 articles) accounted for 21% of the total number of articles published. The spatial network of research institutions corresponding to the Chinese literature has 144 nodes and 51 links (Figure 4). Chongqing Normal University (8 articles), Nanjing Normal University (6 articles), Hebei Normal University (6 articles), Central China Normal University (6 articles), Zhengzhou University (5 articles), and Tianjin Normal University (5 articles) are the leading institutions. The remaining institutions all published less than five articles. Thus, in the Chinese literature, there is a low concentration of institutions in adolescent mindfulness research and a limited amount of cooperation between institutions. This indicates a considerable gap in adolescent mindfulness research in Chinese literature.

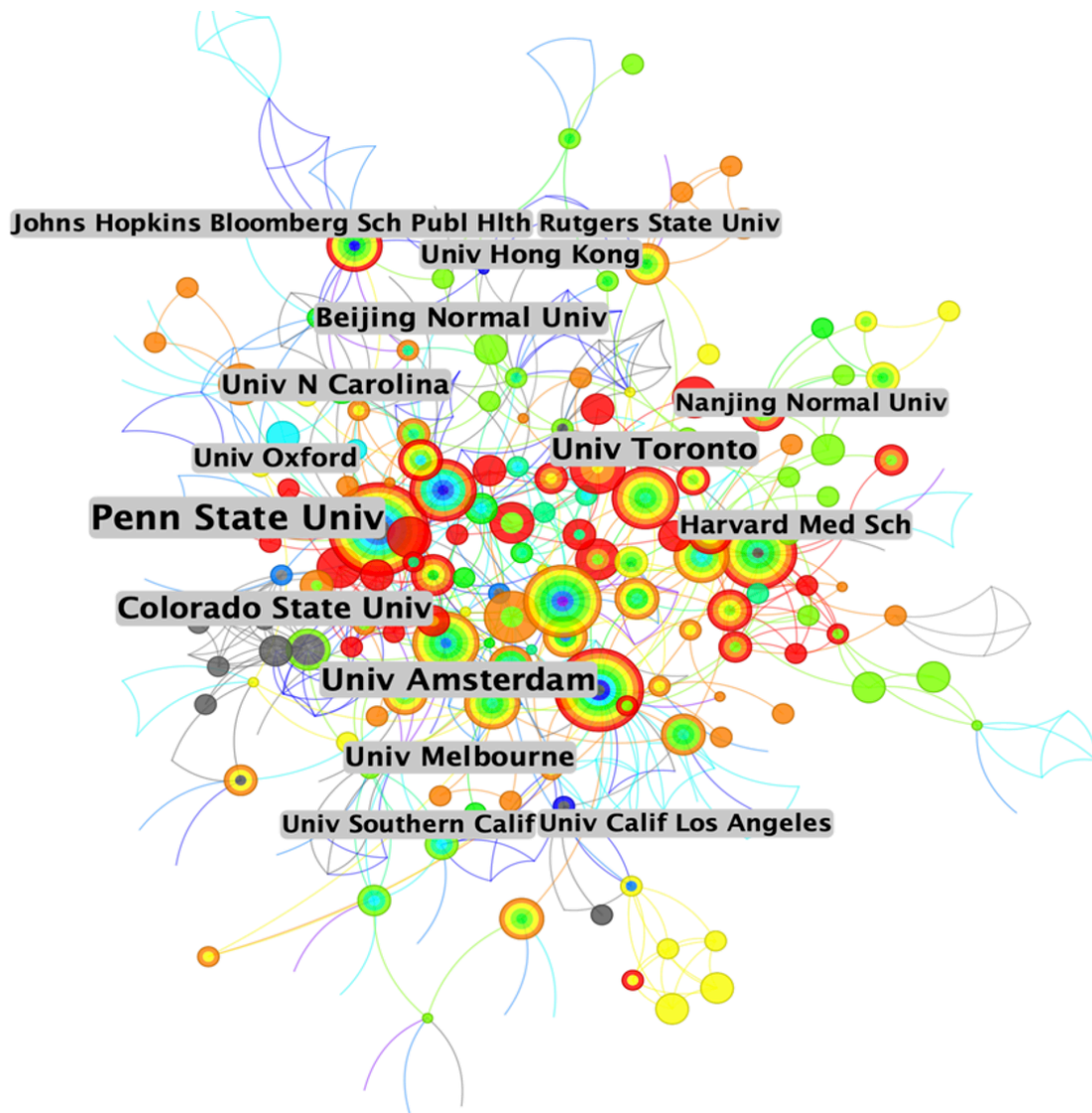


Figure 3. Institution cooperation network (English literature).



Figure 4. Institution cooperation network (Chinese literature).

Figures 5 and 6 illustrate the volume of author postings in the English and Chinese literature, as well as the collaborative relationships between authors, respectively. The top 5 authors in the English literature include Mark T. Greenberg (24 articles), Susan M. Bogels (24 articles), Nirbhay N. Singh (18 articles), Esther Calvete (15 articles), and Wei Xu (13 articles). Twenty-two authors have published more than five articles. They accounted for 20% of the total number of articles published. Figure 5 shows that authors who published more articles had more collaborative relationships with other authors. Figure 6 shows that the top 5 authors in the Chinese literature are Xu Wei (4 articles), Duan Wenjie (3 articles), Zhou Zongkui (3 articles), Zhang Jieting (3 articles), and An Yuanyuan (3 articles). In the Chinese literature, there are fewer published articles and fewer collaborative relationships among authors than in the English literature.

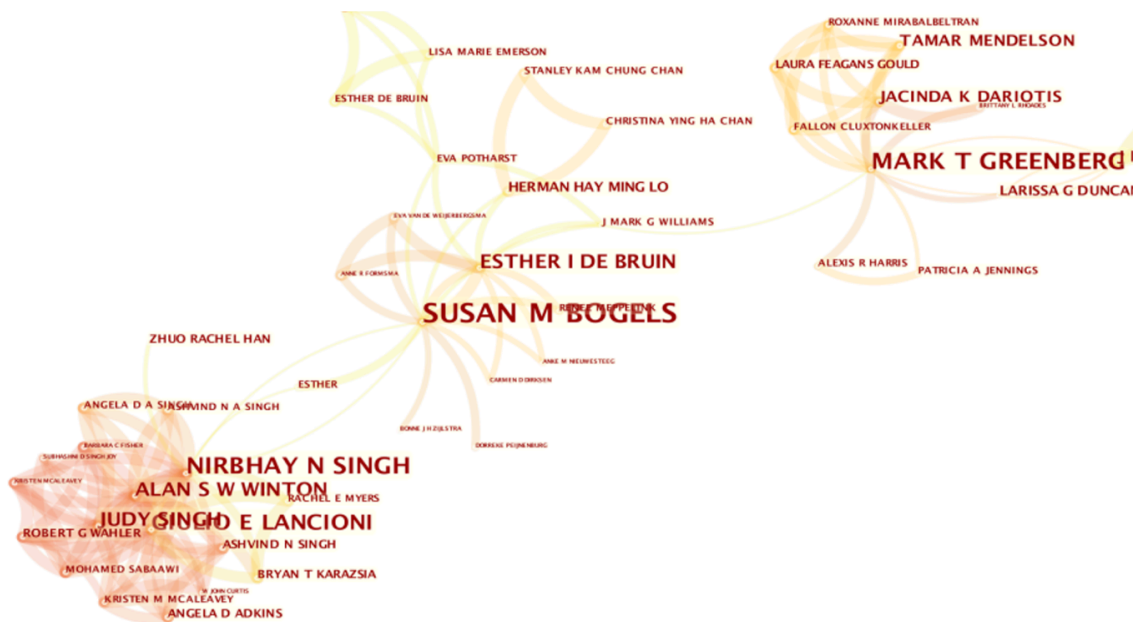


Figure. 5. Author cooperation network (English literature).

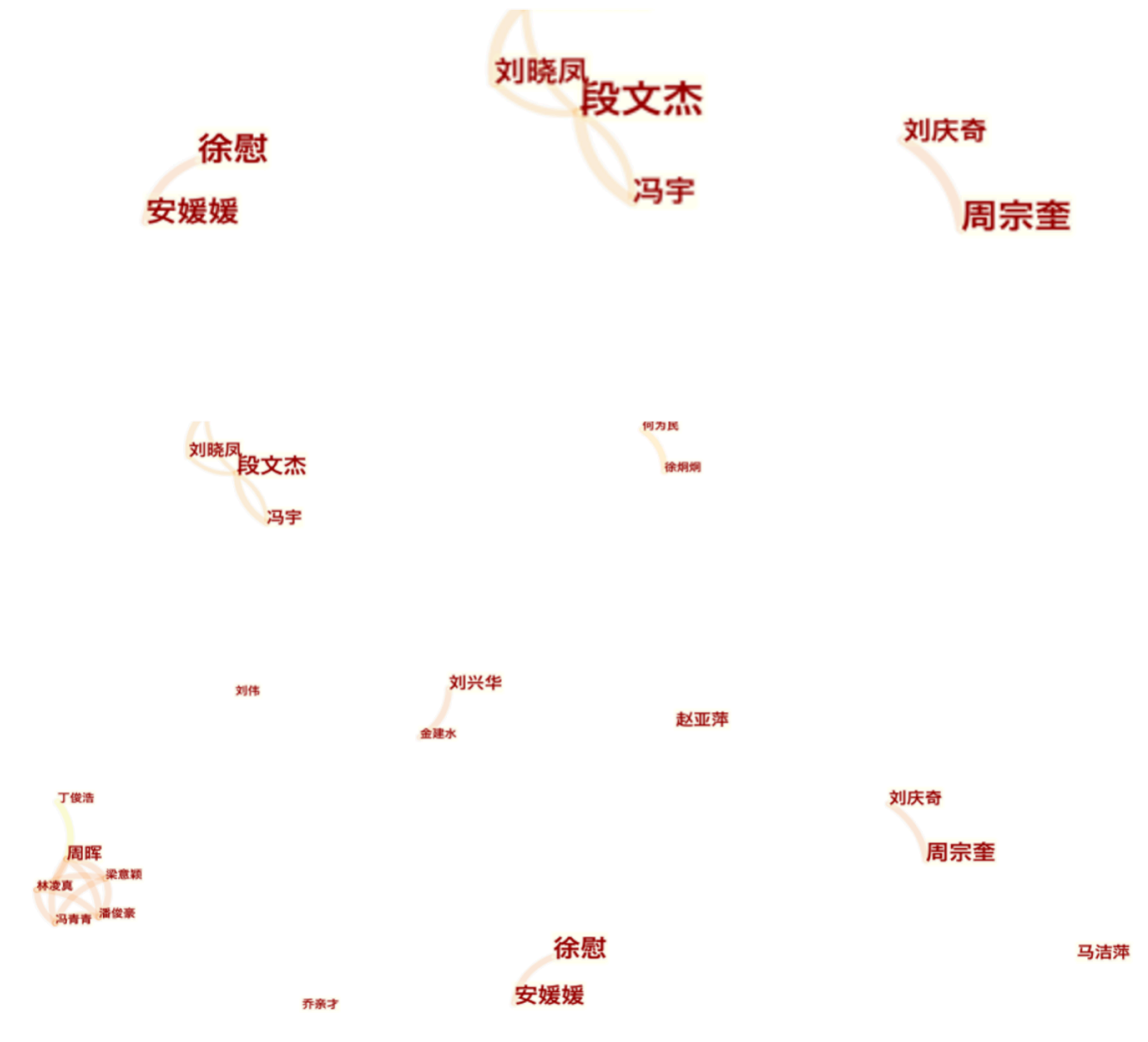


Figure 6. Author cooperation network (Chinese literature).

3.3. Analysis of subject areas

Figure 7 shows the disciplinary copolymerization graph, which is a network of the distribution of disciplinary areas and relationships in adolescent mindfulness studies. The analysis revealed 87 nodes and 305 connections between them, with a network density of 0.0815. Each node is a subject name, and the connecting lines indicate the association between subjects. The top 10 disciplines are research hotspots in the field of adolescent mindfulness, among which the top 5 disciplines were psychology, psychiatry, clinical psychology, developmental psychology, and multidisciplinary psychology. The field with the highest number of research outputs was psychology, with 536 articles accounting for 26% of the total number of publications. The second most productive field was psychiatry, with 307 articles. 247 articles

were published in the field of developmental psychology, and 90 articles were published in that of multidisciplinary psychology. The distribution of disciplinary areas and relationships in the Chinese literature was not presented due to the unavailability of data analysis methods in CiteSpace.



Figure 7. Subject areas distributions and relationships network (English literature).

3.4. Discussion

The results of the descriptive analysis illustrate research progress on mindfulness in adolescents over three decades, with a notable surge in the latter half of the first decade of the 21st century. This suggests that research on mindfulness in adolescents is becoming a growing area of interest for researchers and that the practice of clinical interventions and training using mindfulness as a primary tool has gained

widespread acceptance. As more young people become involved in the practice of mindfulness, a sufficient number of participants are available for mindfulness studies.

In terms of the regional and linguistic distribution of publications, English and Chinese were the main languages of publication for research on mindfulness in adolescents in our data analysis. The United States was the primary English-language publishing region, with Canada, the Netherlands, and China among the countries with a high number of publications. The Pennsylvania State University, the University of Amsterdam, the University of Toronto, and the Chinese University of Hong Kong were the central publishing institutions. From an authorial perspective, three important clusters of authors emerged. They were centered on Susan M. Bogels, Mark T. Greenberg, Nirbhay N. Singh, and Giulio E. Lancioni, respectively. These three author clusters collaborated frequently with one another. This shows that a concentrated academic community of mindfulness research has formed on a global scale. Interaction among academic groups is contributing to the formation of an academic community devoted to this research theme.

The total number of relevant literature published in the Chinese language in China was smaller than that abroad. There were also fewer institutions in mainland China engaging in relevant research, with only a few universities, such as Nanjing Normal University and Sun Yat-sen University, actively conducting such studies. As for the core authors, Wei Xu, along with An Yuanyuan, Zhou Zongkui, Zhou Hui, Duan Wenjie, and Zhang Jieting, formed a relatively concentrated group of authors. Wei Xu was one of the top 5 authors who published research articles in Chinese. However, there was limited interaction among research institutions and author communities, suggesting that a community atmosphere for adolescent mindfulness research has not yet formed in mainland China, as evidenced by the research outcomes in the Chinese language.

In terms of subject areas, the discipline that dominated the study of adolescent mindfulness was psychology. Disciplines related to psychology, such as developmental psychology and clinical psychology, were also prominent disciplines. Another dominant discipline was psychiatry. This indicates that research on adolescent mindfulness has been primarily approached by researchers from a developmental, clinical, and therapeutic perspective. There was less research in the fields of experimental psychology, cognitive psychology, and neuroscience. Based on the distribution of disciplines, the current research on adolescent mindfulness focuses more on application.

4. Analysis of adolescent mindfulness research hotspots

4.1. High-frequency keyword co-occurrence analysis

To explore and identify research hotspots in the field of adolescent mindfulness research, we extracted the keywords from each article and conducted a co-occurrence analysis. Figure 8 illustrates the keyword co-occurrence analysis of the English literature on mindfulness research, comprising 354 nodes, 2066 connections among the nodes, and a network density of 0.0331. The top 10 keywords were identified as hotspots (Table 1). The top 5 keywords were “intervention” (266 times), “children” (215 times), “depression” (177 times), “stress” (173 times), and “adolescent” (168 times). Those keywords in the rankings all appeared more than 100 times.

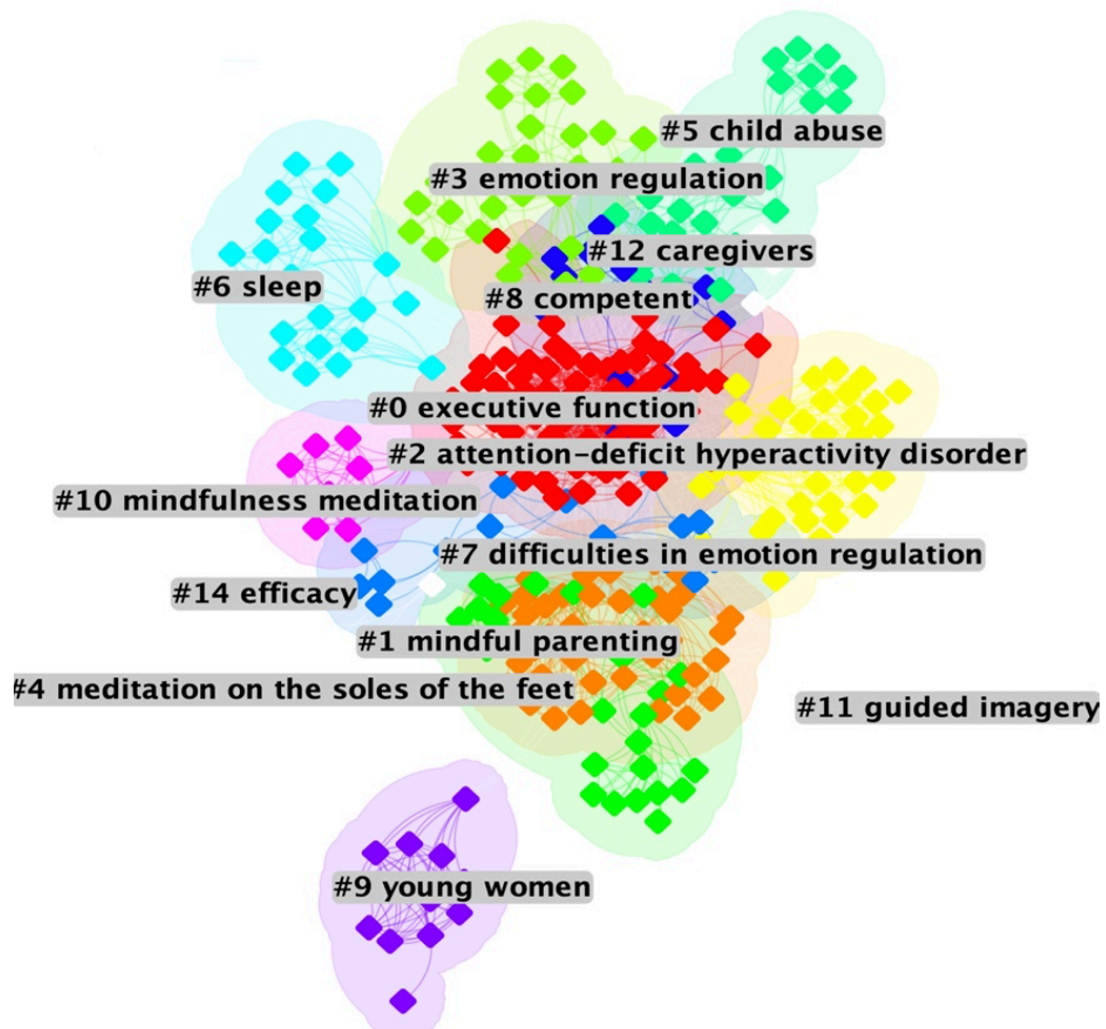


Figure 8. The co-occurrence graph of keywords (English literature).

Rank	The English literature			The Chinese literature		
	Keyword	Frequency	Centrality	Keyword	Frequency	Centrality
1	intervention	266	0.11	mindfulness	75	1.03
2	children	215	0.23	mindfulness training	32	0.22
3	depression	177	0.04	teenager	29	0.27
4	stress	173	0.09	junior high student	24	0.18
5	adolescent	168	0.11	senior high student	22	0.11
6	stress reduction	161	0.02	depression	14	0.06
7	mental health	160	0.11	mindfulness level	11	0.09
8	meditation	159	0.05	attention	11	0.03
9	anxiety	139	0.03	mental resilience	11	0.03
10	validation	134	0.06	mindful parenting	10	0.09

Table 1. Top 10 keywords related to adolescent mindfulness.

The keyword co-occurrence analysis of Chinese literature on mindfulness research is shown in Figure 9. There were 157 nodes and 393 connections among the nodes, and the network density was 0.0321. The top 10 keywords are considered to be the most prominent (Table 1). The top 5 keywords were “mindfulness” (75 times), “mindfulness training” (32 times), “teenager” (29 times), “junior high students” (24 times), and “senior high students” (22 times).

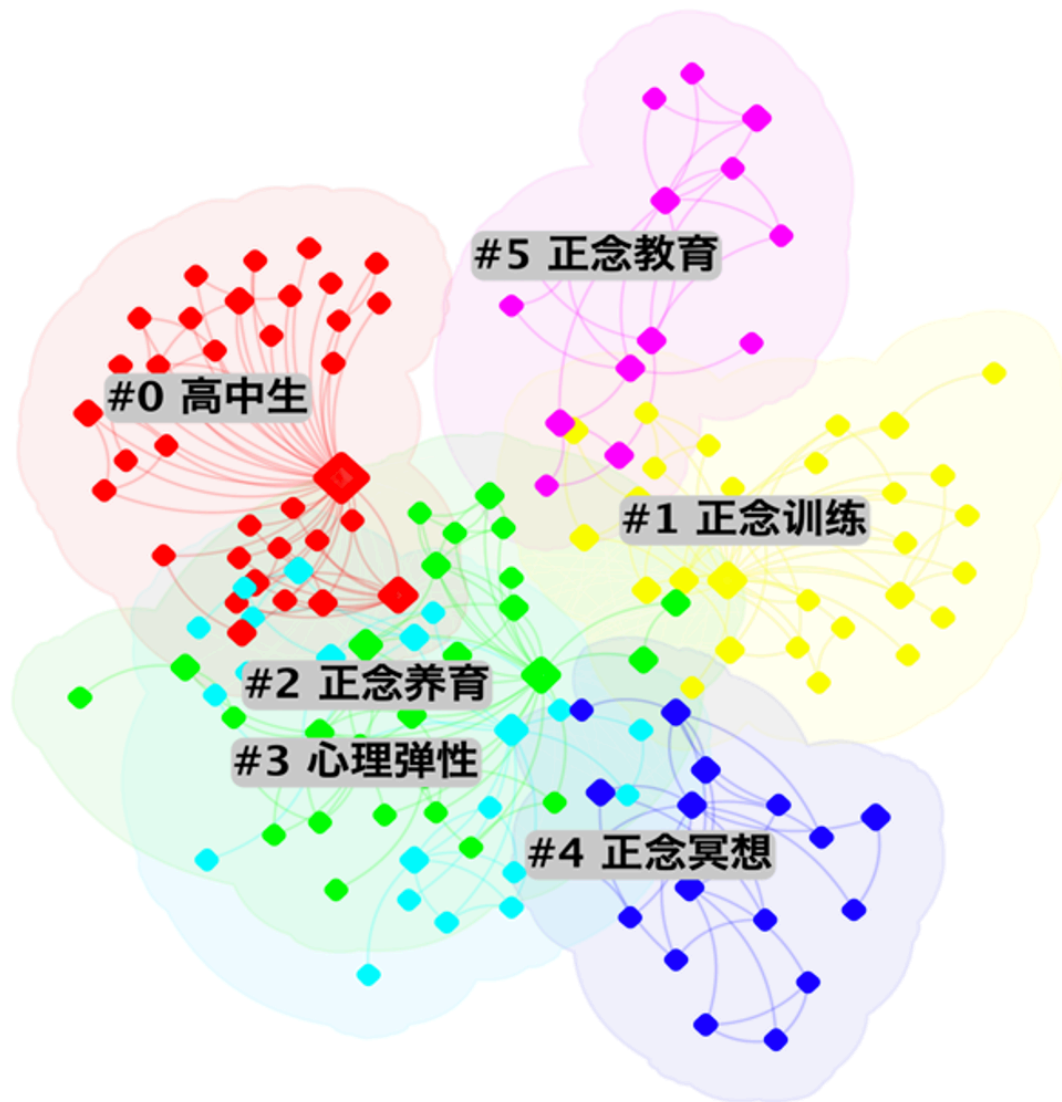


Figure 9. The co-occurrence graph of keywords (Chinese literature).

4.2. High-frequency keyword clustering analysis

CiteSpace further measures the quality of clustering graphs by describing the level of clustering and clarity of the network structure through two metrics: modularity (Q) and silhouette (S). The S values represent the homogeneity among the members of a cluster, and when S is greater than 0.7, the clustering result is convincing [20].

The keyword clustering diagram for English literature (Figure 8) displays a total of 15 clusters. The Q value is 0.5797, and the S value is 0.8634, indicating that the class cluster results were significant. The results

showed that the current English keywords focused on “executive function,” “competent,” “mindful parenting,” “caregivers,” “young women,” “efficacy,” “emotion regulation,” “sleep,” and “attention-deficit hyperactivity disorder.”

The keyword clustering diagram for the Chinese literature (Figure 9) shows that a total of 6 clusters were formed in large size. The Q value was 0.5142, and the S value was 0.876, indicating that the findings were reliable and significant. The results showed that the main keywords in the current domestic research on mindfulness were “mindfulness training,” “senior high students,” “mindful parenting,” “mental resilience,” “mindfulness meditation,” and “mindfulness education.”

4.3. Discussion

The results of the co-occurrence analysis of high-frequency keywords indicated that current national and international research on mindfulness focused on selecting adolescents or younger age groups as research subjects. The keywords “stress reduction,” “stress,” and “anxiety” were high-frequency words in English literature. At the same time, “depression” ranked as the sixth and seventh most frequent word in Chinese and English literature, respectively. This shows that researchers have seen the positive effects of mindfulness as an intervention for emotion regulation. In addition, Chinese literature focused more on attention and positive parenting than English literature, while mental health was covered more extensively in English literature than in Chinese literature.

The results of the cluster analysis of high-frequency keywords also confirm the importance of mental health in the English literature. The clusters “sleep,” “child abuse,” and “executive function” appeared in English literature but not in Chinese. Internationally, researchers have studied adolescent mindfulness more from a clinical and therapeutic perspective. The clustering of Chinese literature suggested a strong focus on the application of mindfulness in parenting and education for improving mental health in adolescent mindfulness research by domestic researchers.

5. Analysis of the emerging words from citation burst history

Keywords from the citation burst history are words that appear more frequently or are used more frequently in a shorter period. The frequency of keywords can be used to determine the frontiers and trends in the field of study. Figure 10 identifies several key areas across three distinct periods of English literature. Keywords from the citation burst history included “stress reduction” (2012 to 2015), “association” (2020 to 2022), “working memory” (2020 to 2022), “decreases aggression” (2021 to 2016),

“abuse” (2021 to 2016), “controlled trial” (2020 to 2022). The keywords from the citation burst history in Chinese literature were not presented due to the unavailability of the data analysis method in CiteSpace.

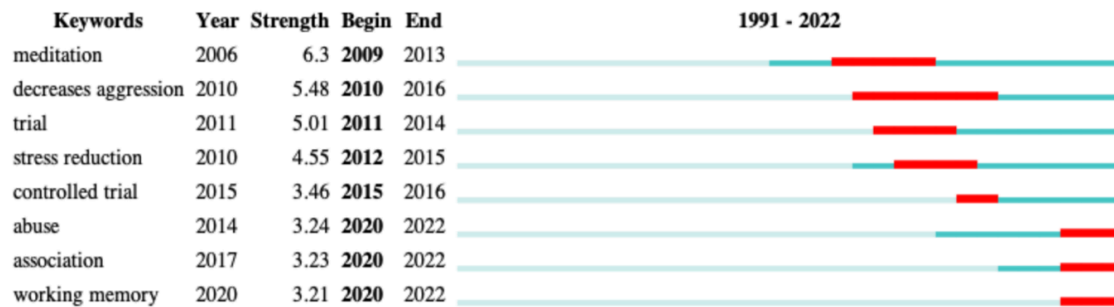


Figure 10. Emerging words from the citation burst history (English literature).

6. General discussion

In this study, we utilized CiteSpace software to visualize and analyze a collection of 1,105 papers on the adolescent mindfulness theme, spanning from 1991 to 2021, drawn from core journals in the CNKI and WoS databases. We can draw three conclusions: (1) Through the analysis of the annual changes in the literature, authors, and research institutions in this field, we clarified the current situation of research in the field of adolescent mindfulness: the research enthusiasm of adolescent mindfulness in academia has reached a high level since 2017, and the attention to mindfulness meditation for adolescents has been increasing. The area of adolescent mindfulness remains underdeveloped in the domestic context. (2) While the domestic literature focused primarily on emotional problems and attention issues, the foreign literature was more clinically and therapeutically oriented. Future research could build on existing studies and explore adolescent mindfulness practices in diverse cultures. (3) The theme of the literature on adolescent mindfulness overlaps and focuses at different times. In general, the study of adolescent mindfulness has evolved from studies of interventions to an examination of psychological mechanisms.

6.1. Psychotherapy based on mindfulness

Originating from Eastern Buddhism, mindfulness has been developed by Western clinical counselors and has been combined with the field of psychology to produce several psychotherapeutic approaches. Mindfulness meditation was introduced from the realm of religion into mind-body healthcare and established as Mindfulness-Based Stress Reduction (MBSR) in 1979 ^{[1][3]}. The therapy was an 8-10 week

course conducted in small groups of 30 participants. They met for 2-2.5 hours a week and were guided to practice positive meditation and discuss stress, coping, and homework. There was usually a full-day (7-8 hours) intensive mindfulness session around the sixth week, during which they were taught some mindfulness techniques [21][22].

Following the application of MBSR, Segal, Williams, and Teasdale adapted mindfulness to cognitive therapy, creating mindfulness-based cognitive therapy (MBCT), a therapy primarily used for treating depression and depressive relapse, also in an 8-week group therapy format [23][24]. They argued that the key to mindfulness techniques was the ability to cope with unpleasant cognitions, feelings, and emotions with an attitude of non-evaluation, acceptance, and awareness of the present moment [23]. Negative perceptions were treated as beings that would appear and disappear, unrelated to oneself [25].

Mindfulness has also been used in other therapeutic approaches. For example, Linehan et al. included mindfulness as one of the key elements in the construction of Dialectical Behavior Therapy (DBT) for people with borderline personality disorder (BPD) [26]. They believed that patients with BPD had a pathological fear of emotions. Because patients with BPD were so afraid of their negative feelings, they were eager to use negative adaptation methods to avoid them. Therefore, positive meditation helped them increase their tolerance of negative feelings, thereby reducing impulsivity and enhancing their ability to cope effectively. Mindfulness, as one of the stabilization techniques, has become an important adjunct in trauma therapy. Shapiro, the founder of rapid eye movement desensitization (EMDR), one of the trauma therapies, argued that the mechanism by which EMDR works is to induce a state of “mindfulness” that allows the patient to take a non-judgmental observer’s view of various psychosomatic reactions [27].

6.2. The mechanism of mindfulness

The mechanism of mindfulness is an ongoing subject of study that researchers have explored in depth, examining both psychological and brain mechanisms. In terms of the psychological mechanism, the changes that mindfulness training produces are mainly through the influence of basic perceptual functions, attention, memory, emotion, and emotion regulation [28]. In terms of the relationship between mindfulness and attention, research has shown that the core mechanism of mindfulness is the regulation of attention [29]. Grant and Rainville showed that nociceptive perception of thermal stimuli was significantly reduced after prolonged mindfulness training [30]. The intensity of thermal pain stimuli tolerated by the trained individuals was significantly greater than that of the average individual. Mindfulness training can enhance alertness, attentional processing, and cognitive processing in the

brain [31]. Mindfulness training has been shown to maintain and protect working memory capacity [32]. Mindfulness can increase subjective well-being and quality of life by increasing individuals' positive emotional experiences and decreasing negative emotional experiences [12]. The psychological mechanism of mindfulness may be through altered attention to adverse events and increased tolerance of negative stimuli. The trainee's attention is more focused on the immediate experience of the moment, which contributes to an open attitude. Mindfulness training yields a range of clinical and non-clinical benefits by regulating emotions.

Numerous studies have confirmed significant differences in neurophysiological activity, brain function, and structure between regular mindfulness training practitioners and the general population [28]. For example, mindfulness induces asymmetric changes in alpha waves in the frontal areas of the brain, with a significant increase in activity on the left side. This finding is consistent with research on emotional lateralization. Mindfulness leads to greater activation of the left hemisphere, which is responsible for positive emotions [33]. Research on brain structure has found that mindfulness is associated with changes in cortical thickness or grey matter density in brain areas related to attention, learning, memory, and emotion (insula, hippocampus, cingulate gyrus, prefrontal lobe, etc.) [28]. Numerous studies suggest that the temporal lobe plays a crucial role in the practice of mindfulness. For example, Sun and Wang confirmed that the complex structure of the temporal lobe allowed for the evaluation of external emotional stimuli, the generation of self-emotional experiences, and the regulation of the external presentation of emotional experiences [24]. Mindfulness meditation is efficacious in improving individual concentration and increasing grey matter density in the prefrontal cortex, which is associated with attention [34][35]. People who engage in prolonged mindfulness meditation exhibit reduced state connectivity between the prefrontal control network and the cuneus and occipital gyrus regions during the resting state. At the same time, connectivity within the attentional network and between the attentional and medial frontal regions is enhanced [36].

6.3. Mindfulness in the adolescent population

Therapies related to mindfulness have been widely used in the adolescent population and are effective in improving the psychological functioning of junior and senior high school students. Trait mindfulness allows junior high school students to enhance their emotion prediction ability and reduce emotion prediction bias by expanding their attention span and open-mindedness [37]. Zhang et al. found that mindfulness training could significantly increase the level of mindfulness and reduce the level of state

anxiety and trait anxiety in junior high school students [38]. Middle school students can improve their levels of mindfulness and reduce anxiety through mindfulness training. Zhu and Li concluded that mindfulness training was beneficial in increasing the level of mindfulness, reducing procrastination behavior, and improving self-esteem and self-efficacy in junior high school students [39]. Mindfulness not only has a direct effect on adolescent self-esteem but can also have an impact on adolescent self-esteem through self-efficacy [40]. Sun et al. found that adolescents with a high propensity for mindfulness were better able to tolerate negative emotions associated with mobile phone addiction and were better able to deal with negative emotions [41]. Mindfulness not only directly contributes to psychological development and recovery in academically oriented adolescents but also indirectly affects students' academic performance through the learning quality quotient [42].

6.4. Implications for future research in adolescent mindfulness

This study has several implications for future research directions in adolescent mindfulness. Firstly, the use of mindfulness training in the youth population is increasing. However, there are some problems with related practices and theories. There is currently no universally accepted operational definition of mindfulness, and the core psychological factors underlying mindfulness are not yet fully understood. This poses a significant challenge to the study of mindfulness, which requires future research to be based on a clear operational definition that fully recognizes the essential characteristics of mindfulness.

In addition, the mechanism of the role of mindfulness in mental disorders such as anxiety and depression in adolescents needs further probing. As shown in Figures 1 and 2 above, there is a relative lack of research on the efficacy of mindfulness in China and abroad. Research on the mechanism of mindfulness is less numerous and less in-depth than research on efficacy. For example, studies have found activation in some brain regions or changes in brain structure [28][33][36], but the psychological significance of these changes is unclear. Research has shown that many brain regions and cortical structures such as the cingulate gyrus, hippocampus, insula, amygdala, prefrontal and temporal lobes are involved in mindfulness and that these structures are involved in many mental functions like learning, memory, attention, perception, awareness, emotion, and executive control [43]. In other words, the relationship between mindfulness and these brain structures is limited to the degree of correlation, and the findings lack specificity and certainty. The evidence on which brain regions are involved in mindfulness and whether there is a causal relationship between them is not clear [43][10].

Lastly, the value of applying mindfulness requires further research and development. Although meditation training has been shown to have positive effects on most groups, Jaseja's studies found that meditation might lead to an increased incidence of epilepsy in epileptic patients ^{[44][45][46]}. Therefore, further research is needed to determine whether mindfulness is appropriate for all groups. Researchers have found that mindfulness training significantly improves the attention span of both children and adults ^{[47][48]}. Mindfulness can also improve memory and attention span. Whether these findings can be applied to adolescents with learning disabilities and used for individualized teaching and whether they offer possible directions for scholars to explore remains to be seen. Besides the educational application, could mindfulness be applied to a larger social group? Originating from Eastern meditation, mindfulness is not only a conscious, non-judgmental method of paying attention to the present state but also a state of consciousness or a mental process ^[35]. Meditation and mindfulness can both reduce anger and aggressive behavior in individuals. Therefore, the use of mindfulness enhances an individual's capacity for empathy and tolerance, which undoubtedly plays an important role in promoting social harmony. In addition, Figures 4 and 6 reveal that the lack of research on mindfulness in China is not only reflected in the number of articles but also the collaborative relationships among authors.

6.5. Limitations

This study has a few limitations. The inclusion criteria for English literature were articles, whereas those for Chinese literature were journals, conferences, and dissertations. This difference may impact the characteristics and extent of the literature, such as the depth and detail of the different types of literature. Additionally, we did not determine the specific age group of the children and youth subjects in our literature search strategies. This study relied solely on CiteSpace, which employs a quantitative analysis method but did not integrate other qualitative methods for interpreting the findings.

7. Conclusions

According to CiteSpace's data analysis, researchers' interest in the area of mindfulness for adolescents is increasing year by year. Research on adolescent mindfulness has been found to be generally immature, and future studies may focus on the mechanisms and identifying appropriate groups for application. Collaboration among authors should be strengthened where necessary. This study provides valuable insights for mindfulness researchers and practitioners to understand the achievements, collaborative networks, and key topics in the research field of mindfulness for adolescents. In terms of future research

directions, we need to build on our cultural roots and conduct a psychological interpretation of mindfulness in the Chinese context.

Statements and Declarations

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The datasets analyzed during the current study are available in the Web of Science (WoS) and the China National Knowledge Infrastructure (CNKI). All data generated during this study are included in this published article.

Acknowledgments

We would like to thank the participants for their time and efforts in this study.

References

1. ^a^bKabat-Zinn J (2003). "Mindfulness-Based Interventions in Context: Past, Present, and Future." *Clin Psychol Sci Pract.* **10**(2):144–156.
2. ^ΔBishop SR, Lau M, Shapiro S, Carlson L, Anderson ND, Carmody J, ... & Devins G (2004). "Mindfulness: A Proposed Operational Definition." *Clin Psychol Sci Pract.* **11**(3):230.
3. ^a^bLi Y, Xi MN, & Shen HY (2009). "Mindfulness Meditation and Its Application in Psychotherapy and Medicine." *J Psychol Sci.* **32**(2):397–398.
4. ^ΔMak C, Whittingham K, Cunningham R, & Boyd RN (2018). "Efficacy of Mindfulness-Based Interventions for Attention and Executive Function in Children and Adolescents—A Systematic Review." *Mindfulness.* **9**:59–78.

5. [△]Zhang Q, Wang Z, Wang X, Liu L, Zhang J, & Zhou R (2019). "The Effects of Different Stages of Mindfulness Meditation Training on Emotion Regulation." *Front Hum Neurosci.* **13**:208.
6. [△]Salmon P, Sephton S, Weissbecker I, Hoover K, Ulmer C, & Studts JL (2004). "Mindfulness Meditation in Clinical Practice." *Cogn Behav Pract.* **11**(4):434–446.
7. [△]Duncan LG, Coatsworth JD, & Greenberg MT (2009). "A Model of Mindful Parenting: Implications for Parent–Child Relationships and Prevention Research." *Clin Child Fam Psychol Rev.* **12**:255–270.
8. [△]Duan W (2016). "Mediation Role of Individual Strengths in Dispositional Mindfulness and Mental Health." *Pers Individ Dif.* **99**:7–10.
9. [△]Marchand WR (2012). "Mindfulness-Based Stress Reduction, Mindfulness-Based Cognitive Therapy, and Zen Meditation for Depression, Anxiety, Pain, and Psychological Distress." *J Psychiatr Pract.* **18**(4):233–252.
10. [△]Wang F, & Huang YX (2017). "Why Does Journaling Improve Mood?" *New Educ.* (27):20.
11. [△]Erbe R, & Lohrmann D (2015). "Mindfulness Meditation for Adolescent Stress and Well-Being: A Systematic Review of the Literature with Implications for School Health Programs." *Health Educ.* **47**(2):12–19.
12. [△]Carmony J, & Baer RA (2008). "Relationships Between Mindfulness Practice and Levels of Mindfulness, Medical and Psychological Symptoms and Well-Being in a Mindfulness-Based Stress Reduction Program." *J Behav Med.* **31**(1):23–33.
13. [△]Greeson JM, Smoski MJ, Suarez EC, Brantley JG, Ekblad AG, Lynch TR, & Wolever RQ (2015). "Decreased Symptoms of Depression After Mindfulness-Based Stress Reduction: Potential Moderating Effects of Religiosity, Spirituality, Trait Mindfulness, Sex, and Age." *J Altern Complement Med.* **21**(3):166–174.
14. [△]Parker G, & Roy K (2001). "Adolescent Depression: A Review." *Aust N Z J Psychiatry.* **35**(5):572–580.
15. [△]Van Vliet KJ, Foskett AJ, Williams JL, Singhal A, Dolcos F, & Vohra S (2017). "Impact of a Mindfulness-Based Stress Reduction Program From the Perspective of Adolescents With Serious Mental Health Concerns." *Child Adolesc Ment Health.* **22**(1):16–22.
16. [△]Biegel GM, Brown KW, Shapiro SL, & Schubert CM (2009). "Mindfulness-Based Stress Reduction for the Treatment of Adolescent Psychiatric Outpatients: A Randomized Clinical Trial." *J Consult Clin Psychol.* **77**(5):855.
17. [△]Yuan Y (2021). "Mindfulness Training on the Resilience of Adolescents Under the COVID-19 Epidemic: A Latent Growth Curve Analysis." *Pers Individ Dif.* **172**:110560.
18. [△]Chen C (2004). "Searching for Intellectual Turning Points: Progressive Knowledge Domain Visualization." *Proc Natl Acad Sci U S A.* **101**(suppl1):5303–5310.

19. [△]Cai JD, & Ma J (2012). "Knowledge Mapping Research on Web 2.0 in Education." *J Distance Educ.* **30**(02):57–62.
20. [△]Chen C (2006). "CiteSpace II: Detecting and Visualizing Emerging Trends and Transient Patterns in Scientific Literature." *J Am Soc Inf Sci Technol.* **57**(3):359–377.
21. [△]Kabat-Zinn J, Lipworth L, & Burney R (1985). "The Clinical Use of Mindfulness Meditation for the Self-Regulation of Chronic Pain." *J Behav Med.* **8**:163–190.
22. [△]Baer RA (2003). "Mindfulness Training as a Clinical Intervention: A Conceptual and Empirical Review." *Clin Psychol Sci Pract.* **10**(2):125.
23. [△][‡]Segal ZV, Teasdale JD, & Williams JMG (2004). "Mindfulness-Based Cognitive Therapy: Theoretical Rationale and Empirical Status." In Hayes SC, Follette VM, & Linehan MM (Eds.), *Mindfulness and Acceptance: Expanding the Cognitive-Behavioral Tradition*. pp. 45–65. The Guilford Press.
24. [△][‡][‡]Coelho HF, Canter PH, & Ernst E (2007). "Mindfulness-Based Cognitive Therapy: Evaluating Current Evidence and Informing Future Research." *J Consult Clin Psychol.* **75**(6):1000–1005.
25. [△]Ye LP, Xiao MR, Shi L, & Tang H (2021). "Psychological and Brain Mechanisms of Mindfulness-Based Cognitive Therapy for Depression." *J Gannan Med Univ.* **41**(7):698–702.
26. [△]Linehan MM, Cochran BN, & Kehrer CA (2001). "Dialectical Behavior Therapy for Borderline Personality Disorder." *Clin Handb Psychol Disord.* **3**:470–522.
27. [△]Shapiro F, & Maxfield L (2002). "Eye Movement Desensitization and Reprocessing (EMDR): Information Processing in the Treatment of Trauma." *J Clin Psychol.* **58**(8):933–946.
28. [△][‡][‡][‡]Wang F, & Huang YX (2011). "Psychological and Neural Mechanisms of Mindfulness." *Adv Psychol Sci.* **19**(11):1635–1644.
29. [△]Peng YQ, & Ju MZ (2013). "The "Heart" of the Working Mechanism of Mindfulness: Attention or Attitude?" *J Psychol Sci.* **36**(4):1009–1013.
30. [△]Grant JA, & Rainville P (2009). "Pain Sensitivity and Analgesic Effects of Mindful States in Zen Meditators: A Cross-Sectional Study." *Psychosom Med.* **71**(1):106–114.
31. [△]Fletcher LB, Schoendorff B, & Hayes SC (2010). "Searching for Mindfulness in the Brain: A Process-Oriented Approach to Examining the Neural Correlates of Mindfulness." *Mindfulness.* **1**(1):41–63.
32. [△]Jha AP, Stanley EA, Kiyonaga A, Wong L, & Gelfand L (2010). "Examining the Protective Effects of Mindfulness Training on Working Memory Capacity and Affective Experience." *Emotion.* **10**(1):54.
33. [△][‡][‡]Barnhofer T, Duggan D, Crane C, Hepburn S, Fennell MJ, & Williams JMG (2007). "Effects of Meditation on Frontal α -Asymmetry in Previously Suicidal Individuals." *Neuroreport.* **18**(7):709–712.

34. [△]Rahl HA, Lindsay EK, Pacilio LE, Brown KW, & Creswell JD (2017). "Brief Mindfulness Meditation Training Reduces Mind Wandering: The Critical Role of Acceptance." *Emotion*. 17(2):224.
35. [△][△]Hölzel BK, Lazar SW, Gard T, Schuman-Olivier Z, Vago DR, & Ott U (2011). "How Does Mindfulness Meditation Work? Proposing Mechanisms of Action From a Conceptual and Neural Perspective." *Perspect Psychol Sci*. 6(6):537–559.
36. [△][△]Hasenkamp W, & Barsalou LW (2012). "Effects of Meditation Experience on Functional Connectivity of Distributed Brain Networks." *Front Hum Neurosci*. 6:38.
37. [△]Sun L, Duan T, Liu W, & Shen N (2021). "The Influence of Dispositional Mindfulness on the Academic Affective Forecasting Biases of Middle School Students." *Acta Psychol Sin [Acta Psychologica Sinica]*. 53(11):1203–1214.
38. [△]Zhang JT, Yang CM, Wu SY, Zhang JF, Kang W, & Chi XL (2021). "The Effectiveness of 4-Week Mindfulness-Based Stress Reduction Improving Anxiety Among Junior School Students." *Stud Psychol Behav [Studies of Psychology and Behavior]*. 19(01):104–110.
39. [△]Zhu JM, & Li YW (2022). "Influence of Mindfulness Group Training on Procrastination, Self-Esteem, Self-Efficacy of Middle School Students." *Chin J Sch Health [Chinese Journal of School Health]*. 43(01):72–76.
40. [△]Zheng XL, Zhu XY, Wang ZY, & Yuan QX (2019). "The Impact of Positive Thinking on Adolescent Self-Esteem: The Mediating Role of Self-Efficacy." *Chin J Behav Med Brain Sci [Chinese Journal of Behavioral Medicine and Brain Science]*. (09):793–796.
41. [△]Sun XP, Liu XX, & Li YH (2022). "Relationship Between Mobile Phone Addiction, Mindfulness Level, Emotional Regulation Self-Efficacy and Taijiquan Intervention in College Students." *Summary of the 12th National Sports Science Congress -- Special Report (Sports Psychology Branch)*. 3481–3482.
42. [△]Zhang Y (2018). "Focus and Endogenousness: An Exploration of Positive Meditation for the Development of Learning Quality and Mental Health of Senior Students." *Ment Health Educ Prim Second Sch [Mental Health Education in Primary and Secondary School]*. (09):25–29+32.
43. [△][△]Tang YY, Hölzel BK, & Posner MI (2015). "The Neuroscience of Mindfulness Meditation." *Nat Rev Neurosci*. 16(4):213–225.
44. [△]Jaseja H (2005). "Meditation May Predispose to Epilepsy: An Insight Into the Alteration in Brain Environment Induced by Meditation." *Med Hypotheses*. 64(3):464–467.
45. [△]Jaseja H (2006). "A Brief Study of a Possible Relation of Epilepsy Association With Meditation." *Med Hypotheses*. 5(66):1036–1037.

46. [△]Jaseja H (2006). "Meditation Potentially Capable of Increasing Susceptibility to Epilepsy—A Follow-Up Hypothesis." *Med Hypotheses*. **66**(5):925–928.
47. [△]Tang YY, Ma Y, Wang J, Fan Y, Feng S, Lu Q, & Posner MI (2007). "Short-Term Meditation Training Improves Attention and Self-Regulation." *Proc Natl Acad Sci U S A*. **104**(43):17152–17156.
48. [△]Tang YY, & Posner MI (2009). "Attention Training and Attention State Training." *Trends Cogn Sci*. **13**(5):222–227.

Declarations

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.