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Changes in network centrality of anxiety and depression symptoms associated with childhood trauma among Chinese college students

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Abstract

Background Childhood trauma is strongly linked to anxiety and depression, significantly increasing the risk of negative outcomes in adulthood. This study employed network analysis to investigate the complex interplay of anxiety and depression symptoms among Chinese college students, focusing on identifying the core symptoms most directly affected by childhood trauma and those exerting the greatest influence on others.

Methods Data were collected from December 2020 to January 2021 from 2,266 college students at 16 institutions in southwestern and eastern coastal China. Depression, anxiety, and childhood trauma were assessed using the Patient Health Questionnaire-9, Generalized Anxiety Disorder-7, and Childhood Trauma Questionnaire-28, respectively. Separate symptom networks were constructed for participants with and without childhood trauma experiences. Central indices were employed to identify the central symptom within each network. The accuracy and stability of the networks were then evaluated. Finally, a network comparison test was used to analyze differences in network properties between the trauma and non-trauma groups.

Results Loss of Energy and Worry too much were the central symptoms in the non-trauma group, while anhedonia and nervousness were the central symptoms in the trauma group. There was a significant difference in the global strength of the network between the trauma group and the non-trauma group ($p_{FDR} < 0.01$), but no significant difference in the distribution of edge weights between the two networks ($p_{FDR} = 0.14$). Anhedonia, Suicide ideation and Feeling afraid in the trauma group showed increased network centrality compared with the non-trauma group.

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Conclusions This study demonstrates the profound impact of childhood trauma on the central symptoms of anxiety and depression in college students. Further research is warranted to investigate the specific pathways through which these symptoms develop, with the goal of developing targeted interventions for this vulnerable population.

Clinical trial number
Not applicable.

Keywords Childhood trauma, Anxiety, Depression, Network analysis, College students

Background

Childhood trauma refers to adverse life events experienced during childhood, including various types of abuse or neglect, and severe family dysfunction [1]. Despite global variations in the incidence rate of childhood trauma, its prevalence remains a significant concern across populations. Approximately two-thirds of individuals experience at least one trauma during childhood, and nearly a quarter experience three or more types of childhood trauma [2]. Previous studies have found that childhood trauma is closely related to a higher incidence of mental disorders and poorer social functioning in adulthood [3–5]. Moreover, childhood trauma has a cumulative effect, which means that individuals exposed to more childhood trauma tend to exhibit more severe mental health issues [6]. Studies have revealed that childhood trauma frequently serves as a potential risk factor for depression and anxiety, correlating not just with heightened symptoms of these disorders, but also with enduring comorbidities and a poorer prognosis at follow-up [7–9]. Previous studies suggest that this may be related to the maladaptive schemas caused by childhood trauma [10]. Specifically, individuals who have experienced childhood trauma may lead them to believe that they are unworthy of love and unwelcome. In this case, they develop maladaptive coping schemas, such as vulnerability to harm, shame, and self-sacrifice, to deal with the trauma they have experienced, but this will damage their normal intimate relationships, affect their perception and behaviors, and then lead to more mental problems [11, 12].

Depression and anxiety disorders are the two most disabling mental disorders, especially in the 10–24 age group, and both ranked among the top 25 leading causes of global burden [13]. The emergence of the COVID-19 pandemic has increased the burden of mental illness. Studies have found that the COVID-19 pandemic has led to a significant increase in the incidence of anxiety and depression disorders, which are mainly related to the restriction of human mobility and the infection of the SARS-CoV-2 [14]. Furthermore, anxiety and depression exhibit a high comorbidity rate, and patients with comorbid disorders tend to have lower remission rates and more enduring disease courses compared to those with pure depression or pure anxiety [15]. In the

Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition), the diagnosis of depression and anxiety encompasses a wide range of symptoms, and the current scales usually use threshold scores to classify individuals as healthy or depressed and anxious, in which case there can be great heterogeneity in the symptoms of patients [16]. Therefore, there is a perspective that relying solely on total scores to assess the severity of the disease could potentially conceal vital information, thereby impeding progress in crucial research areas, including identification and treatment [17].

Network analysis is considered a new approach that can address the limitations of traditional mental illness diagnosis [18]. In the network, symptom relationships are observable, with the central symptom demonstrating the strongest connections and potential to activate other symptoms. This suggests an important role of the central symptom in syndrome development and persistence. Clinically, changes in one symptom have been observed to trigger changes in others [19, 20]. Therefore, targeting central symptoms could potentially reduce the activity of the entire network, leading to more effective treatment outcomes [21]. In symptom networks, symptoms can be activated by external factors, such as adverse life events, and thus exhibit different patterns of correlation [22].

Anxiety and depression disorders are the most common mental disorders among college students [23], likely due to the numerous stressors and transitional events they encounter, as well as being within the peak age range for the development of emotional disorders [24]. A global meta-analysis estimated the prevalence of anxiety and depression among college students to be 39% and 34%, respectively [25]. Emotional disorders in this population can lead to negative consequences, including lower self-esteem, social withdrawal, poor academic performance, substance abuse, and suicide, while also adversely affecting future career trajectories and economic well-being [24, 26]. In China, a national cross-sectional study revealed that approximately 86.4% of college students reported experiencing at least one childhood trauma, which was significantly associated with anxiety and depression disorders [27]. Chinese college students face unique cultural and societal challenges, including intense academic pressures, familial expectations, and the influence of rapid social and economic changes [28, 29]. These

factors may amplify the effects of childhood trauma on emotional disorders, creating distinct patterns compared to other populations.

Given the large population of Chinese college students and their critical role in the country's future socio-economic development, understanding their mental health challenges is of significant importance. Previous studies have employed network analysis to explore emotional challenges such as anxiety and depression in college students [30, 31]. However, the specific ways in which childhood trauma influences the intricate network of symptoms within and across these disorders remain understudied. Building on prior research, this study aimed to address this gap by comprehensively analyzing the symptom network to identify central symptoms, and provided critical insights to guide the development of targeted and personalized interventions for college students affected by childhood trauma.

Methods

Data collection

This study was conducted to collect relevant information by an online questionnaire evaluation platform (www.wjx.cn). Participants were college students from 16 universities in southwestern and eastern coastal China, recruited between December 2020 and January 2021. All participants were provided with a comprehensive study description and provided informed consent online. Ethical approval for this study was obtained from the Ethics Committee of West China Hospital, Sichuan University. The research had been performed in accordance with the Declaration of Helsinki.

Depression symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9) [32]. Each item ranges from 0 (none at all) to 3 (nearly every day), with higher scores indicating more severe depression symptoms. We used a cutoff score of 5 to determine whether participants had mild depression symptoms [32]. This scale has good reliability and validity in China, and the Cronbach's α coefficient in this study was 0.906 [33].

Anxiety symptoms were assessed using the Generalized Anxiety Disorder Scale-7 (GAD-7) [34]. Each item ranges from 0 (none at all) to 3 (nearly every day), with higher scores indicating more severe anxiety symptoms. We used a cutoff score of 5 to determine whether participants had mild anxiety symptoms [35]. This scale has good reliability and validity in China, with a Cronbach's α coefficient of 0.925 in this study [36].

The Childhood Trauma Questionnaire-28 (CTQ) is one of the most widely recognized tools for measuring childhood trauma [37]. CTQ was used to evaluate childhood trauma in all participants, focusing on five major dimensions: emotional abuse, physical abuse, sexual abuse, emotional neglect, and physical neglect. Scores indicating childhood trauma in each dimension were set as follows: emotional abuse ≥ 13, physical abuse ≥ 10, sexual abuse ≥ 8, emotional neglect ≥ 15 and physical neglect ≥ 10 [37]. Participants who scored above these thresholds in any dimension were considered to have experienced childhood trauma. Based on this criterion, participants were divided into trauma group and non-trauma group. The scale has good reliability and validity among Chinese undergraduate students [38]. The Cronbach's α coefficient for the total score was 0.808 in this study.

Data analysis

Statistical analysis of demographic information and scale data was performed using a two-tailed independent t-test in SPSS 26.0 software, with a significance level set at 0.05.

Network Estimation

Using Gaussian graphical models to construct symptom networks of depression and anxiety separately in trauma and non-trauma groups [39]. The least absolute shrinkage and selection operator is used to regularize the network model in order to generate a more interpretable sparse network model [40]. In the network, each symptom of depression and anxiety is defined as a "node", and the thickness of the line between the two nodes indicates the strength of the relationship between the two symptoms. The blue and red of the lines indicate positive and negative correlations between the two nodes, respectively [41].

Estimation of network centrality

Centrality indices are used to assess the importance of nodes within a network. A higher centrality value indicates that a node plays a more significant role in the network and has a greater influence on its overall structure [42]. In this study, we used four centrality measures to evaluate symptom importance: strength, closeness, betweenness and expected influence [43]. Strength is the sum of the edge weights directly connected to a node, which measures the importance of the node in the network. Closeness is the reciprocal of the average shortest path length between a node and other nodes, while betweenness quantifies the number of times a node acts as a bridge on the shortest path between two other nodes [19]. Expected influence assesses the sum of the edge weights directly connected to other nodes, accounting for both positive and negative relationships [44]. Edge weight quantifies the strength of the relationship between two nodes connected by an edge. In network visualizations, the thickness of an edge typically reflects its weight, with thicker edges signifying stronger associations [19]. This intuitive visualization highlights the most important connections within the network. We used the 'qgraph' package in R (version 4.0.3) to construct and analyze the

network, ensuring that the relationships and centrality indices were robust and interpretable.

Estimation of network accuracy and stability

This study evaluated the edge accuracy and stability of symptom networks [45]. First, the accuracy of the edge was estimated by calculating the 95% confidence interval using the non-parametric bootstrap method [46]. A

Table 1 Demographic and clinical characteristics

	non-trauma group($n = 1484$)	trauma group($n = 782$)	F/χ^2	p
Age (years)	19.51 ± 1.19	19.78 ± 1.42	-4.95	**< 0.001**
Sex (Female%)	43.19%	47.57%	3.97	0.05
Education (years)	13.78 ± 0.81	13.87 ± 0.85	0.49	**0.012**
Mild anxiety (%)	26.48%	40.54%	47.02	**< 0.001**
Mild depression (%)	41.37%	53.20%	28.87	**< 0.001**
CTQ total score	30.13 ± 4.27	48.71 ± 11.97	-53.69	**< 0.001**
emotional abuse	5.98 ± 1.43	8.16 ± 3.89	-19.27	**< 0.001**
physical abuse	5.23 ± 0.68	6.84 ± 3.50	-17.23	**< 0.001**
sexual abuse	5.09 ± 0.36	6.48 ± 3.33	-15.96	**< 0.001**
emotional neglect	7.58 ± 2.65	15.68 ± 5.97	-44.56	**< 0.001**
physical neglect	6.26 ± 1.43	11.54 ± 2.77	-59.95	**< 0.001**
GAD-7 total score	2.77 ± 3.34	4.05 ± 4.54	-6.96	**< 0.001**
Nervousness	0.50 ± 0.63	0.64 ± 0.74	-4.68	**< 0.001**
Uncontrolla-ble worrying	0.35 ± 0.57	0.55 ± 0.72	-6.65	**< 0.001**
Worry too much	0.52 ± 0.68	0.68 ± 0.79	-4.82	**< 0.001**
Trouble relaxing	0.41 ± 0.63	0.60 ± 0.78	-5.69	**< 0.001**
Restlessness	0.24 ± 0.51	0.44 ± 0.69	-7.06	**< 0.001**
Irritability	0.46 ± 0.63	0.63 ± 0.77	-5.30	**< 0.001**
Feeling afraid	0.28 ± 0.54	0.51 ± 0.75	-7.50	**< 0.001**
PHQ-9 total score	4.21 ± 3.94	5.79 ± 5.47	-7.20	**< 0.001**
Anhedonia	0.67 ± 0.65	0.80 ± 0.75	-4.14	**< 0.001**
Sad	0.51 ± 0.60	0.66 ± 0.72	-4.92	**< 0.001**
Sleep	0.51 ± 0.70	0.68 ± 0.81	-4.81	**< 0.001**
Energy	0.62 ± 0.67	0.76 ± 0.77	-4.11	**< 0.001**
Appetite	0.48 ± 0.64	0.67 ± 0.78	-5.71	**< 0.001**
Guilty	0.54 ± 0.68	0.71 ± 0.79	-5.23	**< 0.001**
Concentration	0.48 ± 0.69	0.63 ± 0.77	-4.49	**< 0.001**
Motor	0.25 ± 0.51	0.51 ± 0.72	-8.70	**< 0.001**
Suicide ideation	0.13 ± 0.39	0.38 ± 0.67	-9.80	**< 0.001**

Values are expressed as n% or as means ± standard errors. The P-values of CTQ, GAD-7 and PHQ-9 were corrected by FDR

narrower confidence interval indicates a more reliable network [45]. Second, the case-dropping subset bootstrap approach was used to evaluate the stability of the centrality indices by correlation stability coefficient (CS-C) [47]. The CS-C indicates that after excluding the largest proportion of samples, the correlation between the central indices remains at least 0.7 with 95% probability [45]. Generally, CS-C should be above 0.25, preferably above 0.5 [48].

Network comparison by CTQ

The R package "Network Comparison Test (NCT)" was used to compare networks with and without childhood trauma [49]. The NCT is a permutation test that compares the difference between two networks through 1,000 iterations [50]. The overall network strength was evaluated by comparing the absolute sum of all edge weights between the two networks, then the edge weight distribution of each network was compared. Finally, differences in strength and expected influence for each symptom were compared between the two networks using the False Discovery Rate (FDR) correction to control for multiple tests. A p-value less than 0.05 after FDR correction suggests a statistically significant difference between the two groups.

Results

Descriptive statistics

A total of 2,302 participants completed the questionnaire, and 36 questionnaires of poor quality were removed according to the three validity items of CTQ, and finally 2,266 college students were included. Among them, 1484 (64.5%) college students had not experienced childhood trauma, while 782 college students had experienced childhood trauma. The average age of participants in the trauma group was 19.78 ± 1.42, significantly higher than that of the non-trauma group at 19.51 ± 1.19, with statistical significance ($p_{FDR} < 0.001$). There were no significant differences in sex between the two groups ($p_{FDR} = 0.05$). However, there was also a difference in years of education between the two groups. The CTQ scores across all dimensions were significantly elevated in the trauma group compared to the non-trauma group ($p_{FDR} < 0.001$), as detailed in Table 1.

In the trauma group, 416 participants (50.20%) exhibited mild depressive symptoms and 317 participants (40.54%) exhibited mild anxiety symptoms. In contrast, the non-trauma group had 614 participants (41.37%) with mild depressive symptoms and 393 participants (26.48%) with mild anxiety symptoms. The incidence of mild depression and anxiety was significantly higher in the trauma group compared to the non-trauma group ($p_{FDR} < 0.001$). The trauma group displayed significantly higher PHQ-9 total score (Mean: 5.79 vs. 4.21) and GAD-7 total

score (Mean: 4.05 vs. 2.77), indicating greater severity of depression and anxiety symptoms compared to the non-trauma group ($p_{FDR} < 0.001$). Symptoms assessed by PHQ-9 and GAD-7 also showed significant differences between the two groups. In both the trauma group and the non-trauma group, the mean scores of Anhedonia, Energy and Guilty were higher, while the mean scores of Suicide ideation, Motor and Concentration were lower, as detailed in Table 1.

Network structure

In the non-trauma group, the symptom network showed that Energy in depression symptoms and Worry too much in anxiety symptoms were central symptoms (Fig. 1a). Among depression symptoms, there existed a strong positive correlation between Energy and Anhedonia as well as Sleep, Anhedonia and Sad, Motor and Concentration as well as Suicide ideation. Among anxiety symptoms, there existed a strong positive correlation between Worry too much and Nervousness, Uncontrollable worrying, Trouble relaxing, and Irritability, as well as between Nervousness and Uncontrollable worrying.

In the trauma group, the symptom network showed that Anhedonia in depression symptoms and Nervousness in anxiety symptoms were central symptoms (Fig. 1b). Among depression symptoms, there existed a strong positive correlation between Anhedonia and Sad as well as Energy, Energy and Sleep, Motor and Concentration as well as Suicide ideation. Among anxiety symptoms, there existed a strong positive correlation between Nervousness and Worry too much, Uncontrollable worrying, Trouble relaxing, as well as Restlessness and Feeling afraid.

Network Estimation

In the non-trauma group, Energy in depression and Worry too much in anxiety exhibited the highest strength and expected influence, indicating their significant impact on the overall symptom network. Irritability in anxiety showed the highest closeness and betweenness, suggesting its central role in connecting different symptom clusters (Fig. 2a).

In the trauma group, Nervousness in anxiety and Anhedonia in depression were the most influential symptoms. Energy and Motor symptoms in depression exhibited the highest expected influence, indicating their potential to drive the progression of depressive symptoms. Motor and Suicidal ideation in depression also showed the highest closeness and betweenness, suggesting its central role in the trauma-related symptom network (Fig. 2b).

The gray area in Fig. 3 represented the 95% confidence interval of the edge weights obtained using the non-parametric bootstrap method. The results showed that the edge weights of 95% confidence interval were small, indicating that the edges of the whole estimated network were stable. The case-dropping subset bootstrap procedure results showed that in the non-trauma group, strength and expected influence remained stable and credible even after most samples were removed (Fig. 4a). A similar pattern was observed in the trauma group (Fig. 4b). Therefore, this study is mainly based on the interpretation of strength and expected influence of this network analysis.

Network comparison

This study compared the network models between the trauma group and the non-trauma group. The results showed that the global strength of the network was significantly different (trauma group: 7.97 vs. non-trauma group: 7.27; global strength difference = 0.70, $p_{FDR} <$
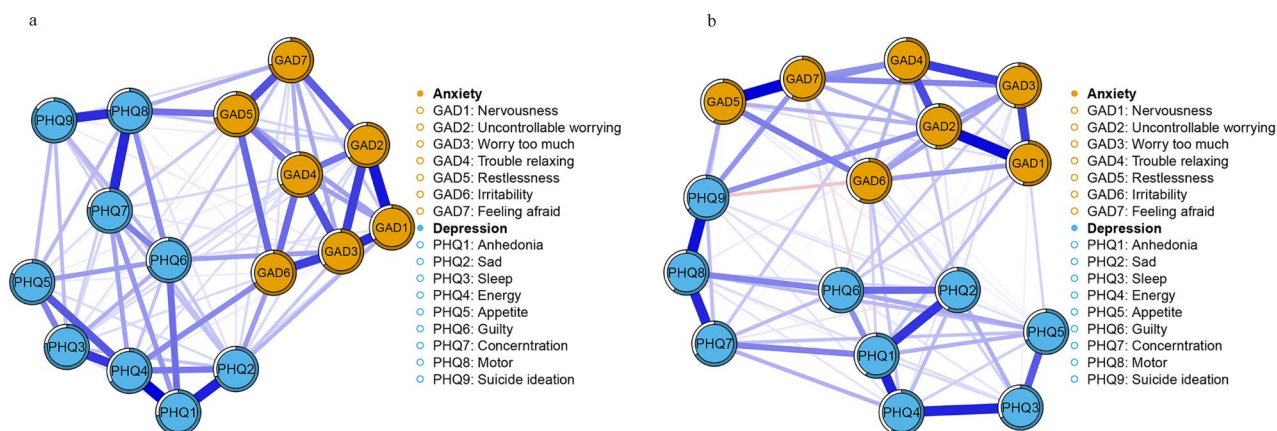

Fig. 1 Estimated network plot for depression and anxiety symptoms. The orange nodes denote the GAD-7 items and the blue nodes denote the PHQ-9 items. Meanwhile, the blue edges denote the positive correlations and the red edges denote the negative correlations. (**a**) college students in non-trauma group. (**b**) college students in trauma group
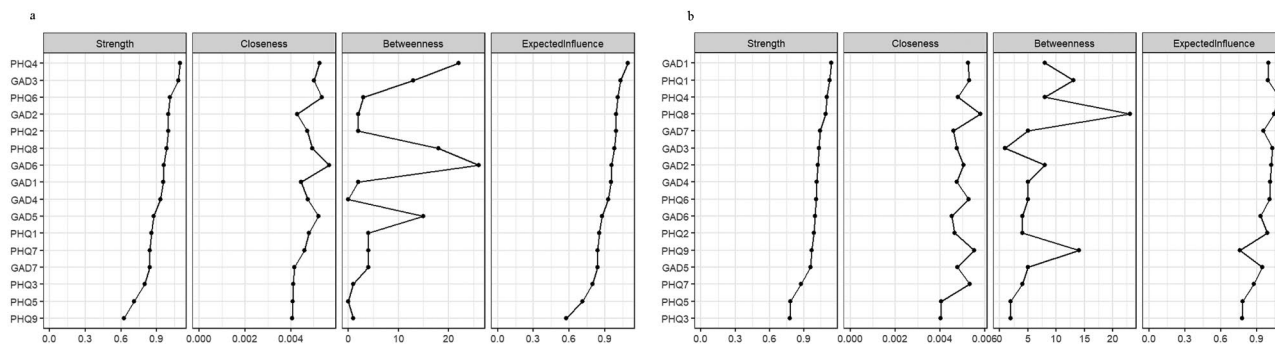
Fig. 2 Evaluation of the centrality indices of all symptoms in the network. The figure shows centrality indices (i.e., strength, betweenness, and closeness, expected influence) of all symptoms within the network. (**a**) college students in non-trauma group. (**b**) college students in trauma group. GAD1, Nervousness; GAD2, Uncontrollable worrying; GAD3, Worry too much; GAD4, Trouble relaxing; GAD5, Restlessness; GAD6, Irritability; GAD7, Feeling afraid; PHQ1, Anhedonia; PHQ2, Sad; PHQ3, Sleep; PHQ4, Energy; PHQ5, Appetite; PHQ6, Guilty; PHQ7, Concentration; PHQ8, Motor; PHQ9, Suicide ideation
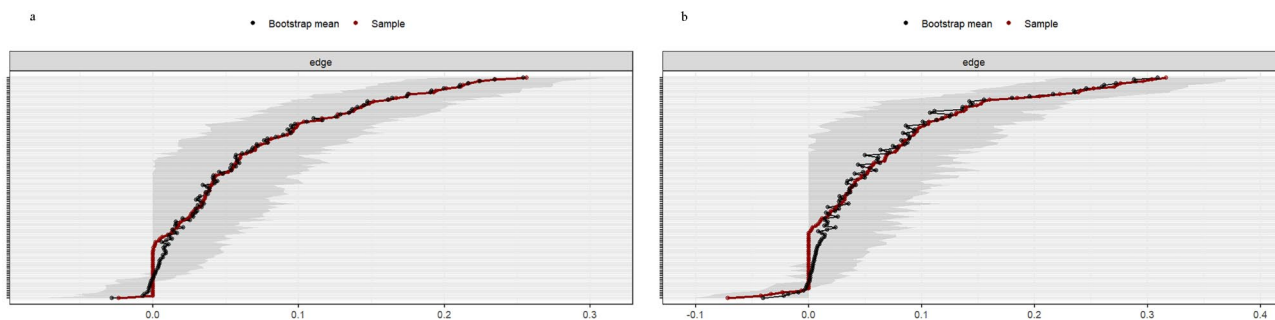

Fig. 3 Edge accuracy plot depicting 95% confidence obtained from 1000 bootstrap samples. (**a**) college students in non-trauma group. (**b**) college students in trauma group. The gray area represented the 95% confidence interval of the edge weights obtained using the non-parametric bootstrap method
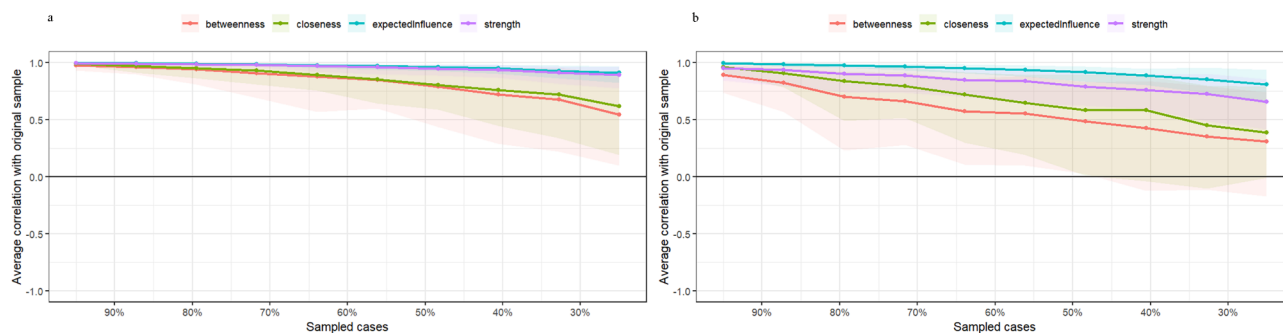

Fig. 4 Stability of centrality indices. (**a**) college students in non-trauma group. (**b**) college students in trauma group. The x-axis represents the percentage of cases of the original sample used at each step. The y-axis represents the average of correlations between the original centrality indices and the estimated centrality after dropping part of the cases. Each line indicates the correlations among betweenness, closeness, expected influence, and strength

0.01), but there was no significant difference in the distribution of edge weights between the two networks (M = 0.16, $p = 0.14$). However, local differences between the two networks were found. Compared with the non-trauma group, Anhedonia in the trauma group showed an increase in both strength and expected influence ($diff_{strength}$=0.27, $p_{strength}$=0.03; $diff_{expected\ influence}$=0.14, $p_{expected\ influence}$=0.04). Meanwhile, Suicide ideation also showed an increase in terms of both strength and expected influence ($diff_{strength}$=0.34, $p_{strength}$=0.04; $diff_{expected\ influence}$=0.18, $p_{expected\ influence}$=0.03). Feeling Afraid

in anxiety symptoms showed an increase in strength in the trauma group compared to the non-trauma group ($diff_{strength}$=0.20, $p_{strength}$=0.03), however, no increase in expected influence was observed ($diff_{expected\ influence}$=0.12, $p_{expected\ influence}$=0.21), as detailed in Supplementary Table 1.

To control for the potential influence of age and years of education, we included these factors in the network analysis and re-compared the network models between the trauma and non-trauma groups. The results showed that there were no significant differences in the global

strength of the network (trauma group: 7.88 vs. non-trauma group: 8.14; global strength difference = 0.26, p_{FDR}=0.10) and the distribution of edge weights (M = 0.14, p = 0.27) between the two networks. However, local differences in Anhedonia and Suicide ideation between the two networks remained, as detailed in Supplementary Table 2.

Discussion

This study uniquely characterized the network structures of depression and anxiety symptoms among Chinese college students with and without childhood trauma, comparing the two networks to identify central symptoms and explore the impact of trauma on symptom changes. The goal was to identify more effective intervention targets for patients with a history of childhood trauma. Our findings revealed that the trauma group exhibited significantly higher severity and incidence of anxiety and depression compared to the non-trauma group, aligning with prior longitudinal research indicating childhood trauma as a risk factor for various anxiety and depression symptoms, with enduring effects spanning multiple years [51]. In addition, a previous longitudinal study involving college students found that any type of childhood trauma is consistently linked to depression and anxiety symptoms over time [52], indicating that childhood trauma may be a powerful predictor of emotional disorders in this population. Early identification of risk factors and timely intervention are essential for promoting the mental health of college students.

In college students without childhood trauma experiences, Energy and Worry too much were central symptoms. Depression and anxiety disorders are common among college students [53], potentially influenced by factors such as navigating a new environment, forming new relationships, family financial concerns, and academic pressures [25]. Notably, this study was conducted during the COVID-19 pandemic, a period that has disrupted the lives of individuals worldwide, further complicating existing challenges and forcing many Chinese to adapt to new circumstances. A meta-analysis of 89 studies confirmed that the prevalence of depression and anxiety symptoms among college students was significantly higher during this period compared to pre-pandemic times [54]. College students experienced more fatigue during the COVID-19 pandemic, potentially due to factors like prolonged exposure to COVID-19 news, shifts in learning styles and environments, and associated restrictions [55, 56]. Wu et al. found a strong link between fatigue and depression, potentially due to feelings of reduced control and intolerance of uncertainty [57]. Worry too much was prevalent among college students during the COVID-19 epidemic, which may be related to their fear of infection and concerns about their studies,

financial situation and future employment prospects [58]. These studies have emphasized the profound impact of both the university experience and the COVID-19 pandemic on student mental health, highlighting the critical need for ongoing, psychological and educational support for this vulnerable group.

Anhedonia and nervousness were central symptoms among college students who had experienced childhood trauma. Research on childhood trauma has shown that it can independently predict anhedonia, with this effect increasing with age [59]. Anhedonia, defined as a significant decline in interest in once-pleasurable activities, is a core symptom of depression, according to the Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition) [60]. Studies have found that 68% of individuals with depression experience anhedonia, which is often observed before the onset of various debilitating clinical conditions, highlighting its potential as a predictor of future depression [61–63]. Nervousness, characterized by an uneasy reaction to future events and a primary manifestation of anxiety disorders, is a significant negative emotion [64]. Previous research on Chinese middle school students found that nervousness was a central symptom in their anxiety symptom network [65]. Furthermore, other studies have linked nervousness to an increased risk of suicide attempts and mental illness over the next five to ten years [66].

We compared the symptom networks between the trauma group and the non-trauma group. Our findings revealed that childhood trauma leads to a decrease in the centrality of energy within depressive symptoms, while increasing the centrality of anhedonia and suicidal ideation. Similarly, in anxiety symptoms, the centrality of worry too much decreased, while the centrality of feeling afraid increased. These findings highlight the significant impact of childhood trauma on anhedonia, suicidal ideation, and feeling afraid [67]. Studies have demonstrated that childhood trauma can have profound neurobiological and cognitive consequences. For instance, research has shown a negative correlation between childhood trauma and cortical thickness in the left middle temporal gyrus [68]. This reduction in cortical thickness may impair the processing of rewards, leading to diminished hedonic capacity [68]. Furthermore, Fan et al. found that the left nucleus accumbens - right orbital frontal cortex resting-state functional connectivity mediates the relationship between childhood trauma and anhedonia [67]. These findings suggest that the blunted hedonic response caused by changes in the core reward system may be related to the occurrence of MDD following childhood trauma.

Childhood trauma is also a significant risk factor for suicide. This association may be partly explained by its detrimental impact on executive function and an

increase in impulsivity [69]. Doba et al. have proposed that individuals who have experienced childhood trauma often adopt maladaptive emotion-regulation strategies, such as avoidance behaviors, to cope with distressing emotions [70, 71]. These strategies can increase the risk of suicide. Additionally, childhood trauma may hinder the development of mental resilience, thereby increasing vulnerability to suicide [72]. Cognitive biases may also play a crucial role. Individuals with a history of childhood trauma are more likely to engage in repetitive negative thoughts, such as rumination and worrying, which are associated with depression, anxiety, and suicidal ideation [73]. Although suicidal ideation is a well-documented hallmark of severe depression and is observed across diverse populations, its heightened centrality in trauma-exposed individuals warrants further exploration. Future research should investigate whether trauma-specific mechanisms, such as increased impulsivity or pervasive negative thought patterns, contribute to suicidal ideation in this population. Such insights would provide stronger evidence for designing trauma-specific interventions and improving treatment outcomes.

Individuals with a history of childhood trauma also report experiencing higher levels of fear compared to those without such trauma [51]. This heightened fear may be associated with cognitive bias, particularly the overestimation of negative consequences, which is a key factor in the development and maintenance of mental health symptoms [74, 75]. Research has shown that childhood trauma reduced functional connectivity between the amygdala and ventromedial prefrontal cortex [76]. The amygdala plays a central role in the fear conditioning circuit, while activation of the ventromedial prefrontal cortex is closely linked to fear extinction and the down-regulation of amygdala-dependent fear responses [77]. This suggests that childhood trauma may contribute to emotional regulation failure and increase the risk of emotional disorders through its influence on the fear regulation circuit.

In summary, it is essential to focus on core symptoms such as anhedonia, suicidal ideation, and feeling afraid in high-risk populations with a history of childhood trauma. Tailored early screening systems should be developed for college students affected by childhood trauma to enable timely identification and intervention. A range of practical interventions, including cognitive-behavioral therapy, mindfulness training, group therapy and structured exercise programs, should be readily available to address the specific needs of these students [24, 30]. Additionally, the recovery of core symptoms is vital for the overall improvement of symptoms throughout the network [50]. Therefore, dynamic monitoring of these core symptoms is essential, as it can indicate the severity of the condition

and the potential for remission, while also guiding adaptive treatment strategies [73].

There are still some limitations in this study. First, symptoms of depression and anxiety were assessed through questionnaires rather than clinical interviews. Second, this study was conducted among college students, and its findings cannot be directly generalized to other populations. Previous studies have demonstrated significant impacts of childhood trauma on anhedonia and suicidal ideation in non-college populations [78, 79], aligning with the observations in this study among college students. This suggests that childhood trauma may trigger depression and anxiety symptoms through comparable mechanisms, such as impairments in brain function or maladaptive cognitions [67, 80]. Consequently, future research should include a broader range of participants to examine the robustness of our findings and their applicability to a wider population. Third, this study was conducted during the COVID-19 pandemic, which likely introduced additional psycho-social stressors that may have influenced the observed symptomatology and network structures [81, 82]. These contextual factors could limit the generalizability of our findings to other time periods or populations. Future research should consider controlling for pandemic-related variables and replicating the analysis in post-pandemic contexts to validate the robustness of these findings. Fourth, this study simply divided the participants into trauma and non-trauma groups for network analysis. Future studies should expand the sample size and explore the unique effects of different childhood trauma subgroups on depression and anxiety symptoms. Fifth, severity differences in anxiety and depression between trauma and non-trauma groups may have impacted the findings. Therefore, it is essential for future research to take into account and effectively control these differences in order to eliminate their potential effects on the results. Finally, as this study is cross-sectional, it cannot evaluate the dynamic changes in anxiety and depression symptoms following childhood trauma, nor their relationship with disease severity. Future longitudinal studies should focus on the longitudinal changes and corresponding mechanisms.

Conclusions

Through network analysis, this study found that childhood trauma significantly affected the emergence and development of core symptoms of depression and anxiety. In students without a history of trauma, energy and worry emerged as central symptoms, while anhedonia and nervousness were more prominent in those with a history of trauma. These findings highlight the profound impact of childhood trauma on mental health and underscore the necessity for tailored early screening systems for college students with a history of childhood trauma,

along with dynamic monitoring of these core symptoms and their changes. Timely interventions are crucial for preventing the development of future mental health issues.

Abbreviations
PHQ-9   Patient Health Questionnaire-9
GAD-7   Generalized Anxiety Disorder Scale-7
CTQ   Childhood Trauma Questionnaire-28
CS-C   Correlation stability coefficient
NCT   Network Comparison Test
FDR   False Discovery Rate

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s12888-025-06793-5.

> Supplementary Material 1

Data availability
Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate
The study was approved by the Ethics Committee of West China Hospital of Sichuan University. All participants were provided with a comprehensive study description and provided informed consent online. The research had been performed in accordance with the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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