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The complexity of associations between emotion regulation, interpersonal sensitivity, cognitive insight, and non-suicidal self-injury: a study based on network analysis

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Abstract

Background Adolescence is a period marked by emotional volatility, interpersonal vulnerability, and underdeveloped cognitive control, making youths especially susceptible to non-suicidal self-injury. Distinct forms of NSSI may differ in psychological function and clinical relevance. This study is the first to employ network analysis with dual network models to examine the complex interplay among emotion regulation, interpersonal sensitivity, cognitive insight, and 18 specific NSSI behaviors in adolescents. The primary goal was to identify key psychological nodes and central NSSI behaviors within the network structure to inform more targeted prevention and intervention strategies.

Methods A total of 5572 adolescents (ages 12–18; 53.9% male) from three urban secondary schools in Nanning, Guangxi Zhuang Autonomous Region, China, participated in self-report surveys conducted between September and November 2023. Standardized and previously validated instruments were used to assess NSSI behaviors, emotion regulation, interpersonal sensitivity, and cognitive insight. Network analysis using mixed graphical models and LASSO regularization was conducted to identify central and bridging nodes across binary-level and symptom-level NSSI networks.

Results Network analysis revealed robust interconnections between emotion regulation, interpersonal sensitivity, cognitive insight, and various NSSI behaviors. In the binary-level network, the fragile inner-self (strength = 1.5) dimension of interpersonal sensitivity exhibited the highest strength, while cognitive reappraisal(bridge strength = 0.88) and expressive suppression(bridge strength = 0.73) showed the strongest bridge strength. Self-reflection was directly associated with NSSI behaviors, and self-certainty was linked to both emotion regulation and interpersonal sensitivity. In the symptom-level network, the most central NSSI behaviors included deliberately scraping the skin to cause bleeding, tying objects around the body, punching hard surfaces, banging the head, and cutting the skin. Fragile inner-self (bridge strength = 0.79) emerged as the strongest bridge node in this network.

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Conclusions This study suggests that emotion regulation, interpersonal sensitivity and cognitive insight are closely associated with adolescent NSSI behaviors, highlighting their potential relevance for intervention strategies.

Keywords Network analysis, Non-suicidal self-injury, Emotion regulation, Interpersonal sensitivity, Cognitive insight

Introduction

Non-suicidal self-injury (NSSI) refers to the repeated, direct, and intentional damage to one's own body tissue in the absence of suicidal intent, with common forms including cutting, burning, biting, and scratching [1, 2]. NSSI typically emerges in early adolescence. A recent study estimated a global lifetime prevalence of approximately 17.2% among adolescents, and previous studies in China have reported a prevalence of approximately 22.4%, with lifetime rates ranging from 13.0–23.2% [3–5]. As an increasingly prominent public health concern in youth, NSSI poses serious threats to both physical and mental well-being and may increase the risk of future suicide [6].

Adolescence is marked by heightened self-awareness and emotional reactivity, yet many youths lack sufficient coping and decision-making abilities, rendering them especially vulnerable to emotional dysregulation under stress [7, 8]. Within this context, NSSI is often viewed as a functional strategy for adolescents to regulate emotional and cognitive experiences and may also serve as a maladaptive form of interpersonal communication in certain contexts [9]. Emotion regulation difficulties has been identified as a core psychological mechanism contributing to the development of NSSI [10, 11]. According to the experiential avoidance model, individuals who struggle to recognize, tolerate, and regulate negative emotions may turn to NSSI as a maladaptive means of reducing internal distress or avoiding aversive affect [12]. Gross categorized cognitive reappraisal and expressive suppression as two of the most common emotion regulation strategies [13, 14]. Prior studies have shown that adolescents with lower cognitive reappraisal capacity or a stronger tendency to rely on expressive suppression are more likely to engage in NSSI to manage overwhelming emotional experiences [15].

In addition, interpersonal sensitivity is a personality trait characterized by heightened sensitivity to social rejection, criticism, and negative evaluation, which can provoke intense emotional responses [10]. This vulnerability is especially pronounced during adolescence, a developmental period marked by heightened sensitivity to peer evaluation and the need for social belonging [16, 17]. Adolescents with elevated interpersonal sensitivity tend to experience intense emotional reactions in response to perceived rejection or criticism. These exaggerated emotional reactions may impair adolescents' ability to engage in adaptive regulatory strategies [17]. Moreover, neurobiological research suggests that elevated interpersonal sensitivity may activate brain regions involved in physical pain processing, rendering adolescents more susceptible to maladaptive behaviors like NSSI as a way to alleviate overwhelming interpersonal and emotional distress [9, 12, 18].

However, the occurrence and maintenance of NSSI are not solely driven by Emotion regulation difficulties or interpersonal factors; cognitive processes also play a critical role. According to Hasking's cognitive-emotional model, individuals' cognitive interpretations and beliefs about negative emotions significantly increase their risk of engaging in self-injurious behavior [19, 20]. Distinct from traditional conceptualizations of insight, cognitive insight developed by Beck, which refers to the individual's capacity to reflect on and reassess their own thought processes, including the ability to question cognitive distortions and consider alternative explanations for subjective experiences [21]. Adolescents with reduced cognitive insight may have difficulty identifying and correcting irrational or overly negative self-beliefs, making them more susceptible to adopting NSSI as a maladaptive coping strategy [22, 23].

Although prior studies have documented independent associations between emotion regulation, interpersonal sensitivity, and NSSI, limited research has explored how these psychological factors interact within an integrative, multivariate framework, such as network analysis. In addition, many existing studies have treated NSSI as a unitary construct by simply categorizing individuals as engaging or not engaging in NSSI, without differentiating specific behavioral forms of NSSI or examining how distinct particular psychological factors may relate differentially relate to distinct NSSI behaviors [24, 25].

However, emerging evidence suggests that different forms of NSSI vary in their psychological functions, clinical severity, and suicide risk [25]. For instance, cutting has been uniquely linked to more severe suicide attempts compared to other NSSI methods [25–27]. These findings highlight the importance of disaggregating NSSI into specific behavioral forms to better identify high risk NSSI behaviors and underlying psychological mechanisms.

Importantly, to our knowledge, this study is the first to incorporate the construct of cognitive insight into the investigation of adolescent NSSI. While cognitive insight has been studied in other serious mental illness, its role in understanding NSSI behavior in youth remains unexplored. Thus, building on prior research, there is a critical need for an integrative analytic approach that systematically incorporates emotion regulation, interpersonal

sensitivity, and cognitive insight to better elucidate their interactive contributions to specific NSSI behaviors among adolescents.

Network analysis, an increasingly utilized statistical approach in psychological research, offers a compelling framework for modeling the direct and indirect connections among multiple psychological factors and diverse NSSI behaviors [28]. While traditional models often attribute psychopathology to latent variables, network analysis provides an alternative framework that views psychological symptoms and traits as components of systems that mutually influence one another [29, 30]. This method enables the identification of central nodes—elements that exert strong influence within the network—as well as bridge nodes that serve as key connectors between different symptom or trait clusters [31].

Building on this framework, the present study employed network analysis to investigate the complex interrelations between emotion regulation, interpersonal sensitivity, cognitive insight, and 18 specific NSSI behaviors in a large adolescent sample. The primary aim was to to clarify the complex interplay among these psychological domains and specific self-injurious behaviors, offering a theoretically informed basis for refining early identification and intervention strategies targeting adolescent NSSI. We hypothesized that emotion regulation and interpersonal sensitivity would demonstrate high centrality in the network and show strong associations with particular NSSI behaviors. Furthermore, distinct NSSI behaviors were expected to vary in their network connectivity, with some behaviors emerging as central symptoms. Cognitive insight was also included to explore its potential role in this adolescent sample.

Methods

Participants and study design

This cross-sectional study was conducted from September to November 2023 in Nanning, Guangxi Zhuang Autonomous Region, China. A total of 5976 questionnaires were distributed to adolescents aged 12 to 18 years from three urban secondary schools selected through convenience sampling. Participants were included if they were within the eligible age range, enrolled in the participating schools, and provided informed assent along with parental consent. Questionnaires were excluded if they were incomplete or exhibited clear response invalidity (e.g. repetitive patterns or random selection). After applying these criteria, 5572 valid questionnaires were retained, yielding a response rate of 93.4%. Due to the anonymous nature of data collection and the lack of identifiable information from non-respondents, a non-response analysis could not be conducted. However, the high response rate minimizes the likelihood of systematic non-response bias.

Prior to the implementation of the study, the research protocol was reviewed and approved by the Ethics Committee of The Third Hospital of Mianyang (Approval Number: 2023–123). The study strictly followed the principles of the Declaration of Helsinki. Written informed consent was obtained from both the adolescents and their parents or legal guardians prior to participation.

To ensure adherence to research procedures and ethical standards, the research team collaborated with school staff, who received structured training on survey administration. Paper questionnaires were collected in a classroom setting under the guidance of trained staff, who assisted participants and answered questions to ensure comprehension.

After collection, all paper questionnaires were manually entered into electronic datasets using EpiData, with coded values assigned to each item. Strict confidentiality and privacy protection measures were implemented throughout the data management process. No personally identifiable information was collected or stored. All paper questionnaires were stored in locked cabinets, and electronic data were saved on encrypted, password-protected computer. The study adhered to relevant national regulations, including China's Personal Information Protection Law and Law of the People's Republic of China on the Protection of Minors. All staff involved signed confidentiality agreements and received training on ethical data handling. Participants were informed of their right to withdraw at any time, and data were used exclusively for research purposes with prior informed consent.

Additionally, the research team conducted regular quality checks and provided timely feedback to school personnel to maintain the consistency and accuracy of data collection.

Measures

Demographic information

Participants completed a survey on sociodemographic characteristics, including gender, grade (junior high school, senior high school), residence (rural, urban) and ethnic minority status (whether ethnic minority).

Adolescent Self-Harm Scale (ASHS)

The ASHS, originally developed by Ying Zheng and revised by Feng Yu, was used to assess NSSI behaviors in adolescents over the past year [32, 33].The ASHS includes 18 items assessing specific NSSI behaviors (e.g., cutting, burning, hitting oneself) and one open-ended item to capture any additional NSSI behaviors. For each behavior, participants reported the number of times they engaged in that behavior during the past year using a 4-point frequency format: 0 times, 1 time, 2–4 times, and 5 or more times. Widely applied in research on adolescent NSSI in China, the scale has demonstrated strong

reliability and validity. In the present study, it showed good internal consistency coefficients with a Cronbach's α of 0.894. Detailed ASHS items is provided in Additional File Additional file 2 (Table 1).

Emotion Regulation Questionnaire (ERQ)

The Emotion Regulation Questionnaire (ERQ) was originally developed by Gross and John in 2003 to assess individuals' emotion regulation strategies [34]. The Chinese version of the ERQ was translated and adapted by Wang Li in 2007 [35]. The scale consists of 10 items, including 6 items measuring cognitive reappraisal and 4 items measuring expressive suppression. All items are rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), with higher scores indicating greater use of the corresponding strategy. The Chinese version has been widely used in research with Chinese adolescents and demonstrated satisfactory psychometric properties. In the present study, it showed good internal consistency reliability with a Cronbach's α of 0.859 for the total scale, 0.891 for cognitive reappraisal, and 0.804 for expressive suppression.

Table 1 Demographic and NSSI behaviors of the participants ($n = 5572$)

Variables	NSSI ($n = 2017$)	Non-NSSI ($n = 3555$)	χ^2/t/Z	Effect size	*P*
Age	14.75 (1.71)	15.11 (1.75)	−7.51	−0.10	<0.001
Gender					
Male	943 (46.8%)	2058 (57.9%)	64.24	0.11	<0.001
Female	1074 (53.2%)	1497 (42.1%)			
Grade					
Junior high school	1008 (50.0%)	1446 (40.7%)	45.16	0.09	<0.001
Senior high school	1009 (50.0%)	2109 (59.3%)			
Residence					
Urban	1325 (65.7%)	2249 (63.3%)	3.30	0.02	0.072
Rural	692 (34.3%)	1306 (36.7%)			
Ethnic minority					
No	694 (52.5%)	1278 (35.9%)	1.34	0.02	0.247
Yes	1323 (47.5%)	2277 (64.1%)			
Cognitive reappraisal	27.22 (7.38)	28.23 (8.13)	4.69	0.13	<0.001
Expressive suppression	17.54 (5.52)	15.40 (5.70)	−13.12	−0.18	<0.001
Interpersonal awareness	20.32 (4.19)	18.72 (4.58)	−13.24	−0.38	<0.001
Need for approval	22.35 (4.24)	21.02 (4.73)	−10.52	−0.29	<0.001
Separation anxiety	19.72 (4.61)	17.15 (4.94)	−19.44	−0.53	<0.001
Friendliness	20.58 (4.43)	17.98 (4.57)	−19.73	−0.26	<0.001
Fragile inner-self	11.54 (3.56)	9.54 (3.30)	−20.68	−0.59	<0.001
Self-certainty	9.28 (3.06)	8.67 (3.47)	−6.88	−0.19	<0.001
Self-reflection	11.28 (4.21)	9.25 (4.32)	−16.48	−0.22	<0.001

Interpersonal Sensitivity Measure (IPSM)

The IPSM was used to assess adolescents' sensitivity in interpersonal interactions. The scale was first proposed by Boyce and Parker in 1989 to measure an individual's emotional responses [36]. The Chinese version of the scale was revised by Li Qinglei in 2019, demonstrating good reliability and validity [37]. The questionnaire consists of 36 items, covering five dimensions: interpersonal awareness, separation anxiety, fragile inner-self, need for approval, and friendliness. Each item is rated on a 4-point scale, where 1 indicates "strongly disagree," 2 indicates "somewhat disagree," 3 indicates "somewhat agree," and 4 indicates "strongly agree." Higher scores indicate a greater degree of sensitivity in interpersonal interactions. In the present study, the five subscales were treated as separate variables in subsequent analyses to capture distinct aspects of interpersonal sensitivity. The internal consistency reliability was satisfactory, with a Cronbach's α of 0.929 for the total scale, 0.827 for interpersonal awareness, 0.767 for separation anxiety, 0.759 for fragile inner-self, 0.862 for need for approval, and 0.759 for friendliness.

Simplified Chinese version of the Beck Cognitive Insight Scale (SC-BCIS)

The SC-BCIS assesses adolescents' ability to reflect on their cognitive processes and flexibility. Originally developed by Beck in 2004, it was revised into a simplified Chinese version by Menghan Hao in 2023 and has demonstrated strong reliability and validity in China [21, 38]. The scale consists of 15 items measuring two dimensions: self-reflection and self-certainty. Each item is rated on a 0 (disagree) to 3 (strongly agree) scale, with higher SR and lower SC scores indicating stronger cognitive insight. In the present study, it showed good internal consistency reliability with a Cronbach's α of 0.770 for the total scale, 0.721 for self-reflection, and 0.732 for self-certainty.

Data analysis

All statistical analyses were conducted using R version 4.4.1, ensuring that there were no missing values among the input variables. To examine the complex relationships among emotion regulation, interpersonal sensitivity, cognitive insight, and NSSI behaviors, we constructed two network models to address the heterogeneity of NSSI. The first model treated NSSI as a binary variable, based on participants' endorsement of any one of the 18 NSSI behaviors at least once in the past year, and included the entire sample ($N = 5572$). The second model disaggregated NSSI into 18 specific behaviors, based on responses from participants who had engaged in NSSI ($n = 2017$), allowing for a more granular symptom-level network analysis.

Prior to network estimation, descriptive analyses were performed. Group differences between adolescents with and without NSSI were tested using χ^2 tests for categorical variables and t-tests or Mann-Whitney U tests for continuous variables depending on normality (assessed via the Shapiro-Wilk test). Cramer's V, Hedges' g, and Pearson's r were reported as effect sizes.

The network model was estimated using the Mixed Graphical Models (the "mgm" package), which accommodates both continuous and binary data [39]. To ensure model sparsity and interpretability, LASSO regularization was applied using the bootnet package, with model selection guided by the Extended Bayesian Information Criterion (EBIC) [40, 41].

Networks were visualized using "qgraph", where nodes represent variables and edges indicate partial correlations. Edge thickness reflects connection strength (e.g., green or blue for positive and red for negative associations) [42]. Although some edge weights appear numerically small, they reflect regularized partial correlations retained after LASSO penalization. In this context, even modest edge values indicate statistically robust and theoretically meaningful associations, as weaker and unstable connections are typically shrunk to zero.

Centrality was assessed using multiple indices, including node strength, closeness, betweenness, and expected influence. Node strength reflects the overall connectivity of each node and is the most commonly used indicator of centrality, defined as the sum of all edge weights connected to the node [43]. Closeness represents the proximity of a node to others, betweenness indicates the node's role in connecting other nodes, and expected influence accounts for both positive and negative edge weights [43, 44]. Additionally, the "mgm" package estimated node predictability, defined as the proportion of variance in a node explained by directly connected nodes [39]. The overall network, along with node strength and predictability, was visualized using the "qgraph" package [44].

In addition to centrality indices, bridge centrality was also calculated to identify nodes that serve as connectors between different symptom communities (i.e., NSSI behaviors, emotion regulation, interpersonal sensitivity, and cognitive insight) [45]. Bridge centrality was computed using the "networktools" R package.

Finally, the accuracy and stability of edge weights and centrality metrics were assessed using nonparametric bootstrapping with 1,000 resamples. The stability of the node strength was quantified using the correlation stability coefficient (CS-C), with values above 0.25 indicating acceptable stability for interpretation. In addition, the 95% confidence interval (CI) of edge weights were estimated to evaluate the precision of the connections. Wider CI reflect lower estimation accuracy, while narrower CI suggest more reliable edge estimates [46, 47].

Importantly, the sample sizes in both the full sample and the NSSI subgroup provided sufficient statistical power to support reliable estimation of network parameters and robust bootstrapping procedures. Prior methodological work has demonstrated through empirical simulation that network models estimated with sample sizes above 1,000 typically achieve stable edge-weight accuracy and acceptable centrality stability [47].

Results

General characteristics of the sample

A total of 5572 adolescents participated in the study. Among them, 2017 (36.2%) reported engaging in at least one NSSI behavior during the past year. The sample included 53.9% males, 56.0% high school students, and 64.6% from ethnic minority backgrounds. Full demographic details and group comparisons are provided in Table 1.

Compared to adolescents without NSSI, those who reported NSSI were significantly younger and more likely to be female ($p < 0.001$). Significant differences were also observed in grade level but not in residence and ethnicity.

Regarding psychological variables, adolescents with NSSI reported significantly lower cognitive reappraisal ($p < 0.001$) and higher expressive suppression ($p < 0.001$). They also demonstrated higher scores on all dimensions of interpersonal sensitivity (interpersonal awareness, need for approval, separation anxiety, friendliness, fragile inner-self) and cognitive insight (self-certainty and self-reflection) compared to the non-NSSI group ($p < 0.001$).

Binary-level network of NSSI

The binary-level network model is presented in Fig. 1a, where NSSI was operationalized as a binary variable indicating the presence or absence of any NSSI behavior in the past year. This network was estimated using the full sample.

Within this network, the NSSI node exhibited notable associations with several psychological variables, including cognitive reappraisal (ERQ1, edge weight = −0.12), expressive suppression (ERQ2, edge weight = 0.15), fragile inner-self (IPSM5, edge weight = 0.09) and self-reflection (BCIS2, edge weight = 0.09). A complete list of edge weights is provided in Additional File 1.

Centrality indices are displayed in Fig. 1b. In terms of strength centrality, the most influential nodes were fragile inner-self (IPSM5, strength = 1.5) and need for approval (IPSM2, strength = 1.5), followed by friendliness and cognitive reappraisal. Pairwise comparisons of centrality metrics are reported in Additional File 2 (Figs. 1, 2 and 3).

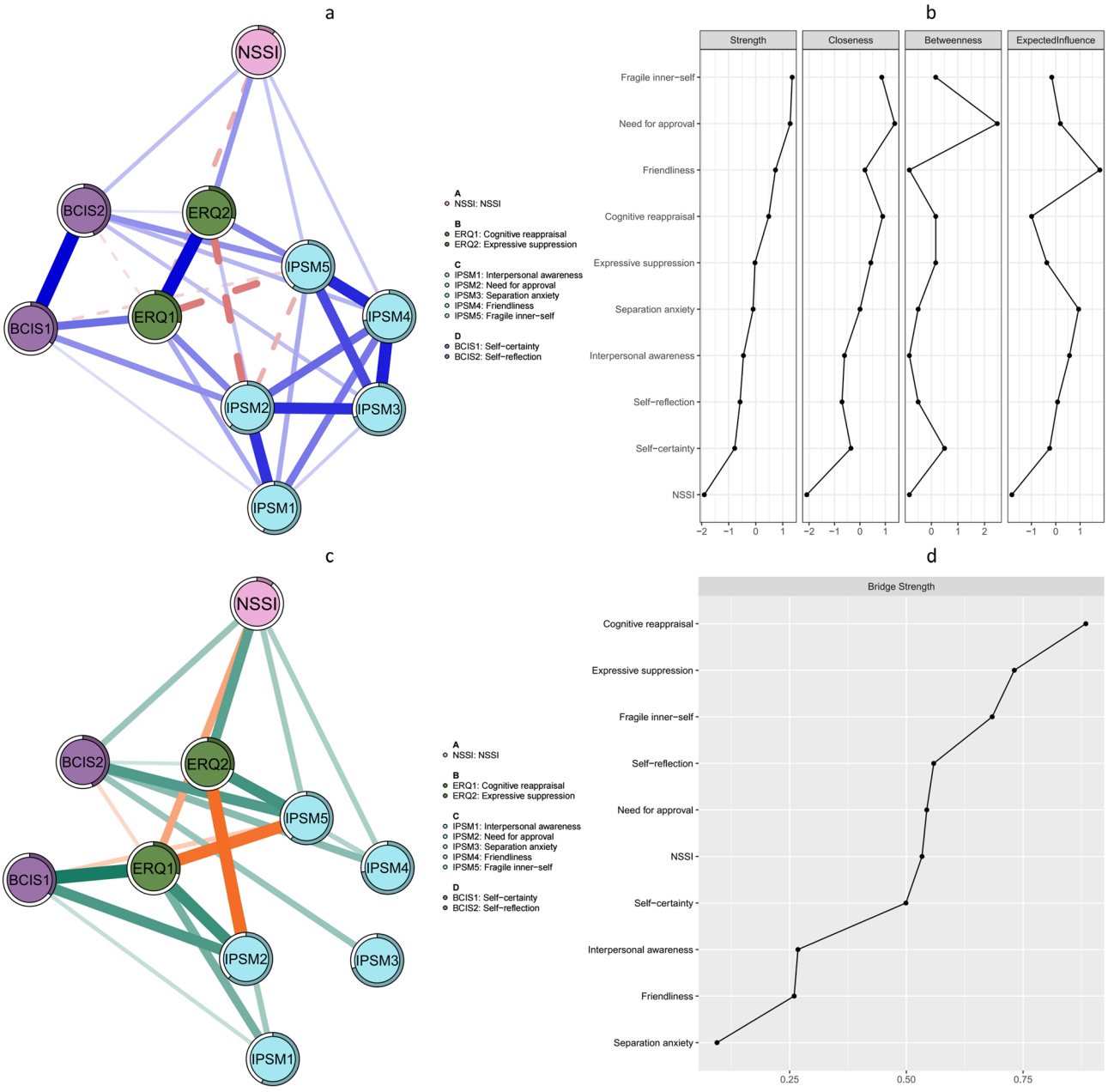

Fig. 1 Binary-Level Network of NSSI and Psychological Factors: **a** The Binary-Level Network of NSSI structure displaying the associations among overall NSSI (treated as a binary variable: presence vs. absence of NSSI), emotion regulation (cognitive reappraisal, expressive suppression), interpersonal sensitivity (including fragile inner-self, need for approval, interpersonal awareness, separation anxiety, and friendliness), and cognitive insight (self-reflection, self-certainty). Node colors represent different domains: pink nodes indicate NSSI, green nodes represent emotion regulation, blue nodes correspond to interpersonal sensitivity, and purple nodes denote cognitive insight. Thicker edges indicate stronger regularized partial correlations. **b** Centrality indices (strength, closeness, betweenness, expected influence) for each node in the Binary-Level Network of NSSI. Higher centrality values indicate greater influence of a node within the network structure. **c** The bridge network structure in the Binary-Level Network of NSSI, highlighting connections between different domains (emotion regulation, interpersonal sensitivity, cognitive insight, and NSSI). Stronger bridge connections are shown with thicker edges. **d** Bridge strength values for each node, identifying key bridging variables that connect different symptom communities across the network

The mean predictability across the entire network was 0.31, ranging from 0.11(NSSI) to 0.64 (interpersonal sensitivity). Detailed predictability values are provided in Additional file 2 (Table 2).

Symptom-level network of 18 specific NSSI behaviors

To further examine the internal structure of NSSI, a symptom-level network was constructed using the subsample of adolescents who reported engaging in NSSI

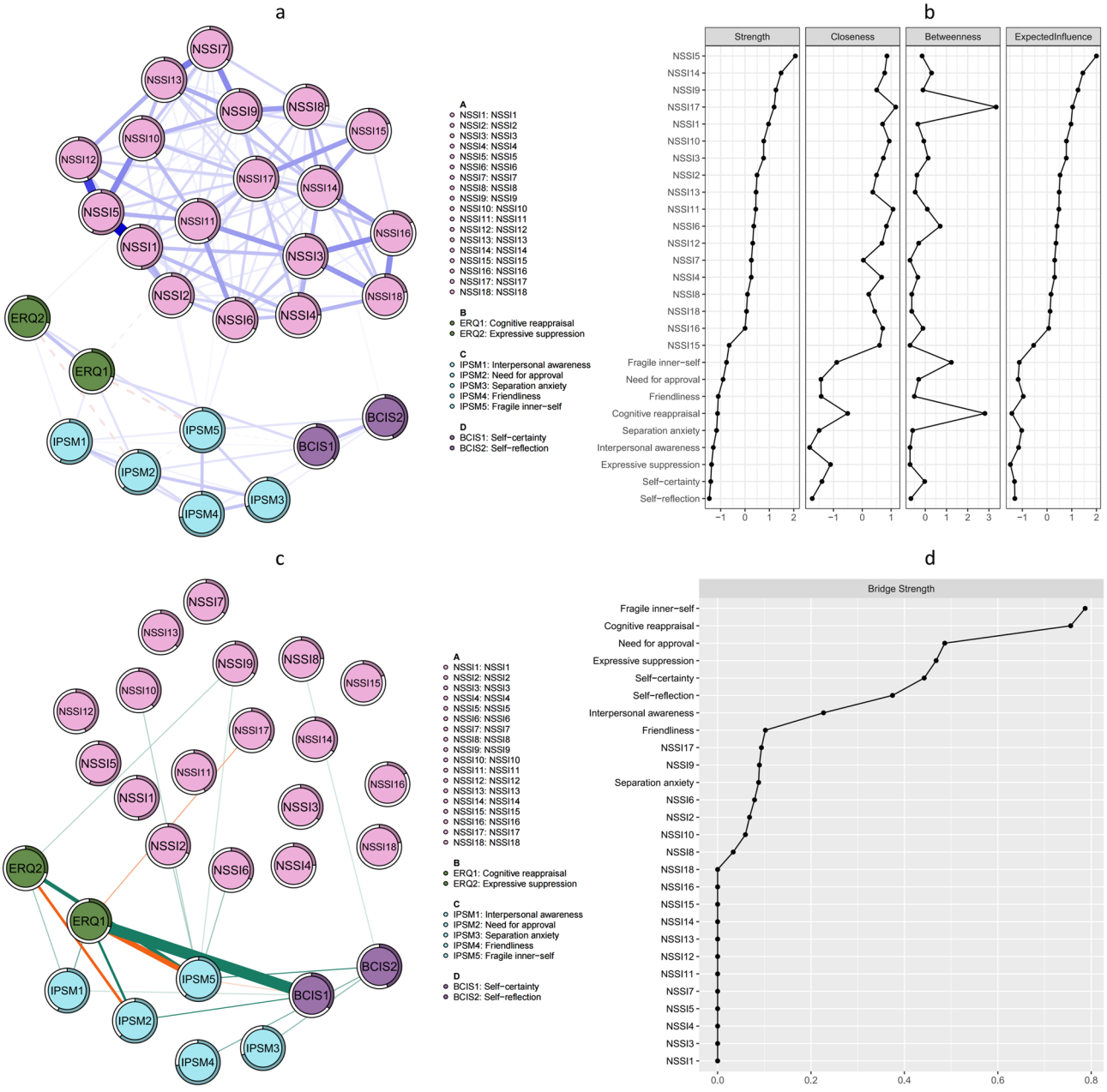

Fig. 2 Symptom-Level Network Model of 18 Specific NSSI Behaviors and Psychological Factors: **a** The symptom-level network structure displaying associations among 18 specific NSSI behaviors (e.g., cutting, scratching, burning), emotion regulation, interpersonal sensitivity, and cognitive insight. This model captures the more fine-grained structure of specific NSSI symptoms in relation to psychological risk factors. Node colors represent different domains: pink nodes indicate NSSI behaviors, green nodes represent emotion regulation, blue nodes correspond to interpersonal sensitivity, and purple nodes denote cognitive insight. Thicker edges indicate stronger regularized partial correlations. **b** Centrality indices (strength, closeness, betweenness, expected influence) for each node in the symptom-level network, identifying the most central NSSI behaviors and psychological factors. **c** The bridging network structure for the symptom-level model, illustrating how emotion regulation, interpersonal sensitivity, and cognitive insight variables link to specific NSSI behaviors. **d** Bridge strength values for each node in the symptom-level network, highlighting variables that act as key connectors between domains and symptom clusters

behaviors. In this model, NSSI was disaggregated into 18 specific behavioral forms.

Some nodes of interpersonal sensitivity, emotion regulation, and cognitive insight were directly connected to some specific NSSI behaviors, For example, ERQ1 (with NSSI17: Deliberately biting until the skin is broken, edge weight = −0.09), ERQ2 (with NSSI9: Deliberately punching hard objects such as walls or glass with the hand, edge weight = 0.05), IPSM5 (with NSSI6: Deliberately inserting objects into the skin or under nails, edge

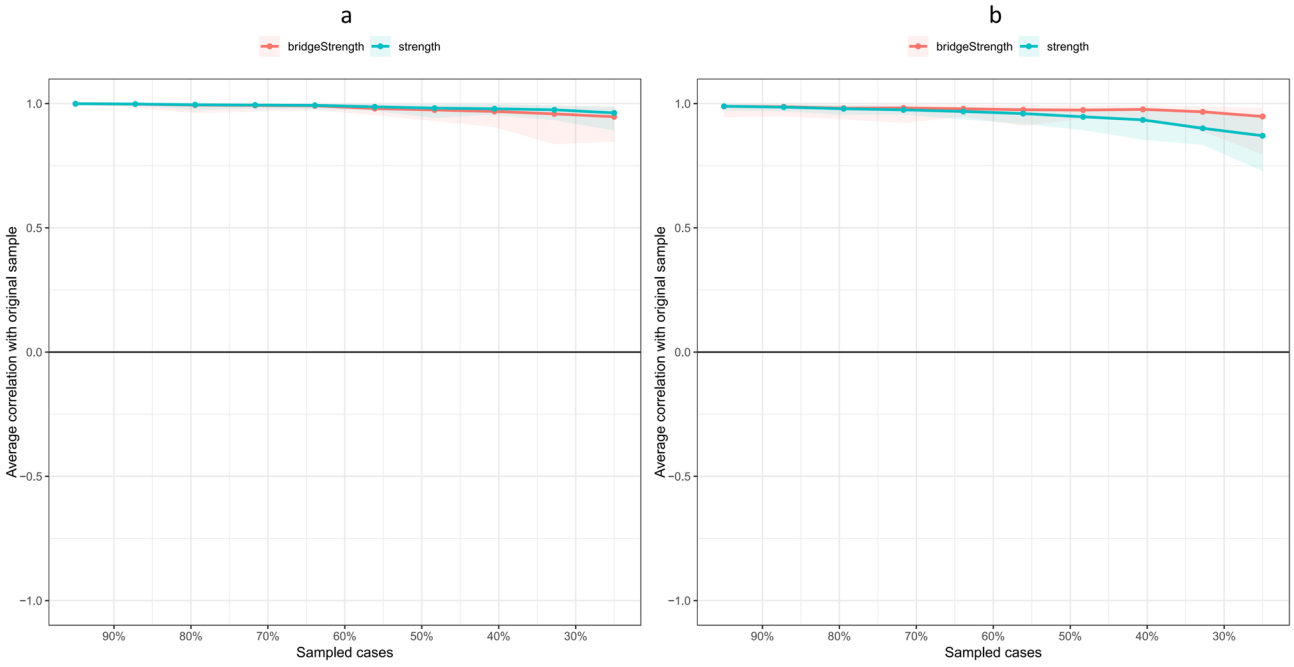

Fig. 3 Stability of Network Centrality Estimates: **a** Correlation stability coefficients for node strength and bridge strength in the overall NSSI network. **b** Correlation stability coefficients for node strength and bridge strength in the symptom-level network of 18 specific NSSI behaviors

weight = 0.08), and BCIS2 (with NSSI8: Deliberately pulling out hair, edge weight = 0.03). Other nodes were indirectly connected to the various NSSI behaviors through the aforementioned nodes. Detailed NSSI corresponding node labels used in the network analysis is provided in Additional File Additional file 2 (Table 1). Detailed edge weights are presented in Additional file 3.

Centrality indicators for the network were presented in Fig. 2b. The following nodes exhibited higher strength in the network: Deliberately scraping skin to cause bleeding (NSSI5, strength = 4.9), Deliberately tying ropes or other objects around wrists or body parts (NSSI14, strength = 4.2), Deliberately punching hard objects such as walls or glass with the hand (NSSI9, strength = 3.9), Deliberately biting until the skin is broken (NSSI17, strength = 3.8), Deliberately cutting skin with glass, a knife, or similar objects (NSSI1, strength = 3.6). Among the variables of interpersonal sensitivity, emotion regulation, and cognitive insight, the highest centrality was observed in fragile inner-self (IPSM5, strength = 1.5). Detailed edge weights are presented in Additional file 2 (Figs. 4, 5 and 6).

The mean predictability across the entire network was 0.31, ranging from 0.21 (NSSI behaviors) to 0.64 (interpersonal sensitivity). Detailed predictability values are presented in Additional file 2 (Table 3).

Bridging network structure and Bridge strength

In network analysis, bridge nodes are variables that connect distinct psychological domains. Bridge strength reflects their involvement in cross-community links. These bridge nodes may represent points of convergence where emotional regulation, interpersonal sensitivity and cognitive insight relate to NSSI behaviors.

The bridge network structure for the binary-level network of NSSI is shown in Fig. 1c, with corresponding bridge strength values in Fig. 1d. In this network, the most prominent bridging nodes were cognitive reappraisal (ERQ1, bridge strength = 0.88), expressive suppression (ERQ2, bridge strength = 0.73) and fragile inner-self (IPSM5, bridge strength = 0.68), which serve as key connectors linking emotion regulation, interpersonal sensitivity, cognitive insight, and NSSI.

Similarly, in the symptom-level NSSI network (Fig. 2c and d), fragile inner-self (IPSM5, bridge strength = 0.79), cognitive reappraisal (ERQ1, bridge strength = 0.76), and need for approval (IPSM2, bridge strength = 0.49) exhibited the highest bridge strength. Their consistent prominence across both models reinforces their role in linking psychological domains with specific NSSI behaviors.

Network stability and accuracy

The stability tests demonstrated that both the binary-level network of NSSI (Fig. 3a) and the symptom-level network of 18 specific NSSI behaviors (Fig. 3b) exhibited excellent robustness, with CS-C of 0.75 for both node strength and bridge strength.

Bootstrapped 95% confidence intervals for edge weights were generally narrow, indicating satisfactory estimation accuracy. The bootstrap difference test

revealed that most pairwise edge comparisons were statistically significant. Detailed results are provided in Additional File 4 (Figs. 7, 8, 9 and 10).

However, some edges between specific NSSI behaviors exhibited relatively wider confidence intervals, reflecting greater uncertainty in those associations. This may be partly due to reduced statistical power resulting from smaller subsample sizes for certain NSSI behaviors after disaggregation. Therefore, weaker connections should be interpreted with caution.

Discussion

To our knowledge, this study is the first to employ network analysis with dual network models to examine the complex associations among emotion regulation, interpersonal sensitivity, cognitive insight, and NSSI behaviors in a school based adolescent sample from China. The binary-level network emphasized the central roles of emotion regulation, interpersonal sensitivity, and cognitive insight in the occurrence of NSSI, while the symptom-level network revealed differentiated associations between specific traits and individual NSSI behaviors. Notably, we also introduced cognitive insight into NSSI research, offering novel insight into its relevance in youth populations. By identifying central and bridge nodes, our findings suggest that emotion regulation, interpersonal sensitivity and cognitive insight are closely interconnected with NSSI behaviors. Furthermore, the symptom-level model indicates that different forms of NSSI may be driven by distinct psychological mechanisms, underscoring the need for specific behavior assessment and intervention approaches.

The prevalence of NSSI behaviors in this study was relatively high, with 36.2% of adolescents reporting engagement in at least one form of NSSI during the past year. This rate exceeds the average prevalence reported in previous studies among general adolescent populations [48–50]. Several factors may account for this elevated prevalence. First, the data were collected in the Guangxi Zhuang Autonomous Region, where ethnic minority groups account for a large portion of the population, where overall socioeconomic development is comparatively limited, and shortage of mental health service resources, may contribute to a higher occurrence of NSSI. Second, compared with some earlier studies, this study used a detailed self-report instrument that assessed 18 specific NSSI behaviors. This approach may have increased sensitivity in detecting self-injury, especially for less overt or socially normalized forms.

Symptom-level network analysis revealed that certain behaviors—including "deliberately scraping skin to cause bleeding", "deliberately tying ropes or other objects around wrists or body parts", "deliberately punching hard objects such as walls or glass with the hand", "deliberately banging head against hard surfaces, causing bruises" and "deliberately cutting skin with glass, a knife, or similar objects"—exhibited the highest centrality within the network. These behaviors may be considered particularly representative forms of NSSI among adolescents in this study. This finding is consistent with prior research highlighting their high frequency and clinical severity in adolescent populations [51]. Given their central network position and functional significance, these behaviors could serve as priority targets for early identification and tailored intervention efforts.

The network analysis further revealed that cognitive reappraisal was negatively associated with NSSI behaviors, whereas expressive suppression was positively associated, which is consistent with previous findings [52]. Specifically, cognitive reappraisal, as an adaptive emotion regulation strategy, helps individuals reinterpret and reconstruct the meaning of emotional events at the cognitive level, thereby alleviating negative emotional experiences and reducing the likelihood of engaging in NSSI behaviors [34].

In contrast, adolescents with limited regulatory resources may rely more heavily on expressive suppression, an avoidant strategy that inhibits outward emotional expression without addressing internal distress [53]. This accumulation of unresolved emotional tension may heighten distress, prompting NSSI as a maladaptive outlet for short-term relief and arousal modulation, ultimately reinforcing NSSI via negative reinforcement [54–56].

Importantly, the symptom-level NSSI network allowed for a more granular understanding of these associations. Specifically, adolescents with a higher tendency toward expressive suppression were more likely to engage in externally expressive self-injurious behaviors, for example, deliberately punching hard objects such as walls or glass with the hand (NSSI9, edge weight = 0.05), whereas those with lower levels of cognitive reappraisal were more inclined to adopt more covert forms of self-injury such as deliberately biting until the skin is broken (NSSI17, edge weight = −0.09).These findings suggest that specific NSSI behaviors may reflect distinct emotion regulation profiles. Thus, by identifying the emotion regulation strategy associated with each NSSI pattern, interventions can be tailored more precisely. For instance, adolescents relying heavily on expressive suppression may benefit from training in expressive skills and emotional awareness, whereas those low in cognitive reappraisal may require support in cognitive reframing techniques. These targeted interventions may reduce the likelihood of continued NSSI engagement.

Furthermore, in this study, the fragile inner-self emerged as a core upstream vulnerability within the NSSI network, exhibiting high centrality and bridge centrality

across the binary-level and symptom-level models. Fragile inner-self reflects a negative self-perception of one's core identity, such as 'I am unlovable' or 'I must hide my true self', in which one's self-worth is overly reliant on external validation and feedback [36]. From the perspective of attachment theory, this internal vulnerability often originates from early adverse experiences, such as emotional neglect or unstable caregiving, which can foster insecure attachment styles and maladaptive self-schemas [57]. These schemas heighten adolescents' sensitivity to perceived interpersonal rejection, amplifying emotional responses and undermining adaptive regulation strategies [58]. Consistent with this, our findings showed that fragile inner-self was negatively associated with cognitive reappraisal and positively associated with expressive suppression. This suggests that adolescents with fragile self-concepts may be less able to reframe emotional experiences and more prone to suppress emotional expression [59]. This is particularly concerning during adolescence, a developmental period characterized by rapid self-concept formation. Discrepancies between the actual and ideal self may heighten shame and self-criticism, potentially leading to interpersonal difficulties and reinforcing self-punitive behaviors such as NSSI as maladaptive coping mechanisms for emotional and relational distress [12, 56, 60–62].

The symptom-level network further revealed that fragile inner-self was directly associated with several specific NSSI behaviors, including deliberately picking at wounds or preventing healing (NSSI2, edge weight = 0.07), deliberately inserting objects into the skin or under nails (NSSI6, edge weight = 0.08), deliberately punching hard objects such as walls or glass with the hand (NSSI9, edge weight = 0.04), and deliberately scratching severely enough to leave marks or cause bleeding (NSSI10, edge weight = 0.06). While these associations were relatively modest, this may be due to the lower statistical power in disaggregated symptom-level models where base rates are reduced, leading to smaller effect sizes and wider confidence intervals [58]. Nevertheless, these findings underscore the importance of targeting fragile self-concepts in prevention and intervention efforts. Interventions such as schema therapy, cognitive behavioral therapy, or acceptance and commitment therapy may help adolescents identify and restructure negative self-beliefs, thereby enhancing internal security and reducing reliance on NSSI as a maladaptive coping strategy [63].

It is noteworthy that the two dimensions of cognitive insight exhibited relatively low centrality and bridge centrality across the two network models. This suggests that cognitive insight may play a limited role in the direct pathways leading to NSSI behaviors in this adolescent sample. Previous research has focused on clinical populations with severe psychopathology, where entrenched cognitive distortions are more common and strongly linked to symptom expression. In contrast, adolescents in school-based settings may present less rigid cognitive patterns. More proximal factors, such as emotional dysregulation and interpersonal sensitivity, may exert a stronger immediate influence on NSSI in this group.

Nevertheless, the potential role of cognitive insight should not be entirely discounted. Notably, the self-reflection dimension was positively associated with NSSI, while also showing negative correlations with cognitive reappraisal and fragile inner-self. This may reflect a maladaptive form of self-focus, where adolescents recognize problematic thoughts but lack the regulatory capacity to manage them effectively [23, 64]. In contrast, self-certainty, reflecting confidence in one's own judgments, was not directly linked to NSSI behaviors but was significantly associated with emotion regulation and interpersonal sensitivity. This suggests that self-certainty may influence the use of regulation strategies such as expressive suppression, and shape one's interpretation of social feedback. While cognitive insight may not be a central driver of NSSI in general adolescent populations, its interaction with other psychological factors could still inform early identification and intervention strategies.

Finally, this study demonstrates that emotion regulation strategies, interpersonal sensitivity traits, and cognitive insight levels are closely associated with adolescent NSSI behaviors. In particular, fragile inner-self emerged as the most central node. Notably, expressive suppression was related to externally expressive NSSI behaviors like punching hard objects, whereas low cognitive reappraisal was associated with more covert behaviors such as biting until the skin is broken. cutting, biting and hitting were the most central NSSI behaviors, reflecting their clinical importance. These findings highlight the relevance of adaptive regulation strategies, interpersonal sensitivity and cognitive insight patterns in the prevention and intervention of NSSI.

Several limitations should be noted. First, although participants were drawn from urban school settings using convenience sampling, we did not assess psychiatric status, and the sample may not fully represent broader or more diverse adolescent populations. Future studies should incorporate basic mental health screening and more representative sampling strategies to enhance diagnostic clarity and generalizability. Second, the cross-sectional design and undirected network analysis preclude conclusions about causal or temporal relationships. Longitudinal approaches are needed to better understand the developmental pathways of NSSI. Third, the use of self-report measures may have introduced recall or social desirability biases. Fourth, cultural variables specific to Chinese adolescents were not explored but may shape NSSI expression and regulation patterns.

Lastly, the present study focused on selected psychological variables; other relevant factors such as impulsivity, aggression, and trauma history were not included. Future research should integrate these elements to provide a more comprehensive understanding of the mechanisms underlying adolescent NSSI.

Conclusions

This study utilized network analysis to examine the interplay between emotion regulation, interpersonal sensitivity, cognitive insight, and NSSI behaviors in adolescents. At the binary network level, fragile inner-self emerged as a central bridging node, showing strong associations with emotion regulation, interpersonal traits, and cognitive factors, as well as with the presence of NSSI behaviors. Cognitive reappraisal was negatively associated with NSSI, while expressive suppression showed a positive association, highlighting their contrasting roles in emotional coping. In contrast, both dimensions of cognitive insight demonstrated relatively weak connections within the network, suggesting a less prominent role in this adolescent sample. At the symptom level, behaviors such as cutting, biting, and head-banging showed higher centrality, indicating their representativeness within this sample. These findings underscore the importance of addressing key emotional and interpersonal vulnerabilities in the early prevention and targeted intervention of adolescent NSSI.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Not applicable.

Author contributions
Shuhan He.conducted the data analysis, organized tables, created figures, and wrote the manuscript. Chunyou Li, Shibei Zhang.assisted in data processing and statistical analysis. Yaxin Hu, Jian Wen, Lingjiang Liu, Jie Gao. were responsible for data collection and participant recruitment. Junlin Wu, provided critical feedback and manuscript revisions. Guoping Huang. supervised the study design, ensured methodological rigor, and provided final approval of the manuscript.

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Data availability
Data are available from the corresponding author upon reasonable request.

Declarations

Ethical approval and consent to participate
This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Informed consent was obtained from both the adolescents and their parents and/or legal guardians, with electronic informed consent forms duly signed. The Ethics Committee of The Third Hospital of Mianyang led the ethical oversight of this study, and ethical approval was granted by the institution (2023–123).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Yu L, Zhao J, Zhao T, Xiao Y, Ou Q, He J, Luo J, Zhong Y, Cen Y, Luo W, et al. Multicenter analysis on the non-suicidal self-injury behaviors and related influencing factors-A case study of left-behind children in Northeastern Sichuan. J Affect Disord. 2023;320:161–8.
2. Turecki G, Brent DA, Gunnell D, O'Connor RC, Oquendo MA, Pirkis J, Stanley BH. Suicide and suicide risk. Nat Reviews Disease Primers. 2019;5(1):74.
3. Lang J, Yao Y. Prevalence of nonsuicidal self-injury in Chinese middle school and high school students: A meta-analysis. Medicine. 2018;97(42):e12916.
4. Lei H, Yang Y, Zhu T, Zhang X, Dang J. Network analysis of the relationship between non-suicidal self-injury, depression, and childhood trauma in adolescents. BMC Psychol. 2024;12(1):234.
5. Gillies D, Christou MA, Dixon AC, Featherston OJ, Rapti I, Garcia-Anguita A, Villasis-Keever M, Reebye P, Christou E, Al Kabir N, et al. Prevalence and characteristics of Self-Harm in adolescents: Meta-Analyses of Community-Based studies 1990–2015. J Am Acad Child Adolesc Psychiatry. 2018;57(10):733–41.
6. Li X, Chen F, Lin Y, Jia Z, Tucker W, He J, Cui L, Yuan Z. Research on the relationships between psychological problems and school bullying and Non-Suicidal Self-Injury among rural primary and middle school students in developing areas of China. Int J Environ Res Public Health. 2020;17(10):3371.
7. Brañas M, Croci MS, Ravagnani Salto AB, Doretto VF, Martinho E Jr., Macedo M, Miguel EC, Roever L, Pan PM. Neuroimaging studies of nonsuicidal Self-Injury in youth: A systematic review. Life (Basel Switzerland). 2021;11(8):729.
8. Gratz K, Roemer L. Multidimensional assessment of emotion regulation and dysregulation: development, factor structure, and initial validation of the difficulties in emotion regulation scale. J Psychopathol Behav Assess. 2004;26:41–54.
9. Nock MK. Why do people hurt themselves?? New insights into the nature and functions of Self-Injury. Curr Dir Psychol Sci. 2009;18(2):78–83.
10. Nock MK, Prinstein MJ, Sterba SK. Revealing the form and function of self-injurious thoughts and behaviors: A real-time ecological assessment study among adolescents and young adults. J Abnorm Psychol. 2009;118(4):816–27.
11. Hamza CA, Willoughby T. Nonsuicidal self-injury and affect regulation: recent findings from experimental and ecological momentary assessment studies and future directions. J Clin Psychol. 2015;71(6):561–74.
12. Brereton A, McGlinchey E. Self-harm, emotion regulation, and experiential avoidance: A systematic review. Archives Suicide Research: Official J Int Acad Suicide Res. 2020;24(sup1):1–24.
13. Taylor PJ, Jomar K, Dhingra K, Forrester R, Shahmalak U, Dickson JM. A meta-analysis of the prevalence of different functions of non-suicidal self-injury. J Affect Disord. 2018;227:759–69.

14. Ochsner KN, Gross JJ. The cognitive control of emotion. Trends Cogn Sci. 2005;9(5):242–9.
15. Zhang Q, Liu P, Zhang Y, Yan M. The psychological experiences of adolescents who engage in Non-Suicidal Self-Injury: A Meta-Aggregative synthesis of qualitative studies. Issues Ment Health Nurs. 2024;45(8):857–67.
16. Xu H, Pei Y, Yong Z, Liu X, Wang W. Pathway from interpersonal sensitivity to depression among Chinese college students during the COVID-19 campus lockdown. Environ Health Prev Med. 2023;28:34.
17. Miller AB, Lenzenweger MF. Schizotypy, social cognition, and interpersonal sensitivity. Personality Disorders. 2012;3(4):379–92.
18. Eisenberger NI. The pain of social disconnection: examining the shared neural underpinnings of physical and social pain. Nat Rev Neurosci. 2012;13(6):421–34.
19. Hasking P, Rose A. A preliminary application of social cognitive theory to nonsuicidal Self-Injury. J Youth Adolesc. 2016;45(8):1560–74.
20. Hasking P, Whitlock J, Voon D, Rose A. A cognitive-emotional model of NSSI: using emotion regulation and cognitive processes to explain why people self-injure. Cognition Emot. 2017;31(8):1543–56.
21. Beck AT, Baruch E, Balter JM, Steer RA, Warman DM. A new instrument for measuring insight: the Beck Cognitive Insight Scale. Schizophr Res. 2004;68(2–3):319–29.
22. Ekinci O, Ugurlu GK, Albayrak Y, Arslan M, Caykoylu A. The relationship between cognitive insight, clinical insight, and depression in patients with schizophrenia. Compr Psychiatr. 2012;53(2):195–200.
23. Palmer EC, Gilleen J, David AS. The relationship between cognitive insight and depression in psychosis and schizophrenia: a review and meta-analysis. Schizophr Res. 2015;166(1–3):261–8.
24. Anestis MD, Khazem LR, Law KC. How many times and how many ways: the impact of number of nonsuicidal self-injury methods on the relationship between nonsuicidal self-injury frequency and suicidal behavior. Suicide Life-Threat Behav. 2015;45(2):164–77.
25. Baer MM, Tull MT, Forbes CN, Richmond JR, Gratz KL. Methods matter: non-suicidal Self-Injury in the form of cutting is uniquely associated with suicide attempt severity in patients with substance use disorders. Suicide Life-Threat Behav. 2020;50(2):397–407.
26. Lloyd-Richardson EE, Perrine N, Dierker L, Kelley ML. Characteristics and functions of non-suicidal self-injury in a community sample of adolescents. Psychol Med. 2007;37(8):1183–92.
27. Tang J, Yu Y, Wu Y, Du Y, Ma Y, Zhu H, Zhang P, Liu Z. Association between non-suicidal self-injuries and suicide attempts in Chinese adolescents and college students: a cross-section study. PLoS ONE. 2011;6(4):e17977.
28. Hevey D. Network analysis: a brief overview and tutorial. Health Psychol Behav Med. 2018;6(1):301–28.
29. Borsboom D. A network theory of mental disorders. World Psychiatry: Official J World Psychiatric Association (WPA). 2017;16(1):5–13.
30. De Beurs D. Network analysis: A novel approach to understand suicidal behaviour. Int J Environ Res Public Health. 2017;14(3):219.
31. Borsboom D, Cramer AOJ, Kalis A. Brain disorders? Not really: why network structures block reductionism in psychopathology research. Behav Brain Sci. 2018;42:e2.
32. Zheng Y. Epidemiologic investigation of self-mutilation behavior among adolescents in Wuhan and its functional model. Central China Normal University; 2006.
33. Feng Y. The relation of adolescents? self-harm behaviors, individual emotion characteristics and family environment factors. Central China Normal University; 2008.
34. Gross JJ, John OP. Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. J Personal Soc Psychol. 2003;85(2):348–62.
35. Wang L, Liu H, Li Z, Du WJCJHP. Reliability and validity of emotion regulation questionnaire Chinese revised version. China J Health Psychol. 2007;15(6):503–5.
36. Boyce P, Parker G. Development of a scale to measure interpersonal sensitivity. Aust N Z J Psychiatry. 1989;23(3):341–51.
37. Li Q, Wang HJJPS. The effects of social pressure and decision maker'role on helping decision-making among persons with different interpersonal sensitivity. J Psychol Sci. 2019;42(3):626–32.
38. Hao M, Li Z, Weng Y, Gao J, Tang Y, Huang G. Validity and reliability of the simplified Chinese version of the Beck Cognitive Insight Scale. Chin Mental Health J. 2025;39(04):315–20.
39. Haslbeck JMB, Waldorp LJ. Mgm: estimating Time-Varying mixed graphical models in High-Dimensional data. J Stat Softw. 2020;93(8):1–46.
40. Foygel R, Drton, MJAinips. Extended Bayesian information criteria for Gaussian graphical models. 2010;23.
41. Chen J, Chen ZJB. Extended bayesian information criteria for model selection with large model spaces. BMC Bioinformatics. 2008;95(3):759–71.
42. Mohsen P. Covariance estimation: the GLM and regularization perspectives. Stat Sci. 2011;26(3):369–87.
43. Robinaugh DJ, Millner AJ, McNally RJ. Identifying highly influential nodes in the complicated grief network. J Abnorm Psychol. 2016;125(6):747–57.
44. Epskamp S, Cramer AOJ, Waldorp LJ, Schmittmann VD, Borsboom D. Qgraph: network visualizations of relationships in psychometric data. J Stat Softw. 2012;48(4):1–18.
45. Jones PJ, Ma R, McNally RJ. Bridge centrality: A network approach to Understanding comorbidity. Multivar Behav Res. 2021;56(2):353–67.
46. Tio P, Epskamp S, Noordhof A, Borsboom D. Mapping the manuals of madness: comparing the ICD-10 and DSM-IV-TR using a network approach. Int J Methods Psychiatr Res. 2016;25(4):267–76.
47. Epskamp S, Borsboom D, Fried EI. Estimating psychological networks and their accuracy: A tutorial paper. Behav Res Methods. 2018;50(1):195–212.
48. Brown RC, Plener PL. Non-suicidal Self-Injury in adolescence. Curr Psychiatry Rep. 2017;19(3):20.
49. Brunner R, Kaess M, Parzer P, Fischer G, Carli V, Hoven CW, Wasserman C, Sarchiapone M, Resch F, Apter A, et al. Life-time prevalence and psychosocial correlates of adolescent direct self-injurious behavior: a comparative study of findings in 11 European countries. J Child Psychol Psychiatry Allied Discip. 2014;55(4):337–48.
50. Zhang P, Ouyang L, Liang M, Wu Y, Bao C, Yang K, Liu Y, Long J, Wang X, Liu G, et al. A cross-sectional epidemiological study of non-suicidal self-injury prevalence in Chinese psychiatric patients. Nat Mental Health. 2023;1(4):266–72.
51. Zetterqvist M, Lundh LG, Dahlström O, Svedin CG. Prevalence and function of non-suicidal self-injury (NSSI) in a community sample of adolescents, using suggested DSM-5 criteria for a potential NSSI disorder. J Abnorm Child Psychol. 2013;41(5):759–73.
52. Ewing L, Hamza CA, Willoughby T, Stressful, Experiences. Emotion dysregulation, and nonsuicidal Self-Injury among university students. J Youth Adolesc. 2019;48(7):1379–89.
53. Slee N, Garnefski N, Spinhoven P, Arensman E. The influence of cognitive emotion regulation strategies and depression severity on deliberate self-harm. Suicide Life-Threat Behav. 2008;38(3):274–86.
54. Richmond S, Hasking P, Meaney R. Psychological distress and Non-Suicidal Self-Injury: the mediating roles of rumination, cognitive reappraisal, and expressive suppression. Archives Suicide Research: Official J Int Acad Suicide Res. 2017;21(1):62–72.
55. Goldbach RE, Neukel C, Panizza A, Reinken A, Krause-Utz A. Differentiating between intrapsychic symptoms and behavioral expressions of borderline personality disorder in relation to childhood emotional maltreatment and emotion dysregulation: an exploratory investigation. Eur J Psychotraumatology. 2023;14(2):2263317.
56. Chapman AL, Gratz KL, Brown MZ. Solving the puzzle of deliberate self-harm: the experiential avoidance model. Behav Res Ther. 2006;44(3):371–94.
57. Beck AT, Haigh EA. Advances in cognitive theory and therapy: the generic cognitive model. Ann Rev Clin Psychol. 2014;10:1–24.
58. Madjar N, Ben Shabat S, Elia R, Fellner N, Rehavi M, Rubin SE, Segal N, Shoval G. Non-suicidal self-injury within the school context: multilevel analysis of teachers' support and peer climate. Eur Psychiatry: J Association Eur Psychiatrists. 2017;41:95–101.
59. Hankin BL, Abela JR. Nonsuicidal self-injury in adolescence: prospective rates and risk factors in a 2½ year longitudinal study. Psychiatry Res. 2011;186(1):65–70.
60. Hsieh M, Stright A. Adolescents' emotion regulation strategies, Self-Concept, and internalizing problems. J Early Adolescence. 2012;32:876–901.
61. Nagy LM, Muehlenkamp JJ. Negative self-perceptions and severity of NSSI: testing the benefits and barriers model. J Clin Psychol. 2024;80(6):1365–76.
62. Kiekens G, Bruffaerts R, Nock MK, Van de Ven M, Witteman C, Mortier P, Demyttenaere K, Claes L. Non-suicidal self-injury among Dutch and Belgian adolescents: personality, stress and coping. Eur Psychiatry: J Association Eur Psychiatrists. 2015;30(6):743–9.
63. Andover MS, Schatten HT, Morris BW, Miller IW. Development of an intervention for nonsuicidal Self-Injury in young adults: an open pilot trial. Cogn Behav Pract. 2015;22(4):491–503.
64. Ji R, Zhou M, Ou N, Chen H, Li Y, Zhuo L, Huang X, Huang G. Large-scale networks underlie cognitive insight differs between untreated adolescents

ongoing their first schizophrenic episode and their reference non-schizophrenic mates. Heliyon. 2022;8(10):e10818.

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