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RESEARCH

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Unveiling the hidden connections: network analysis of depressive symptoms, internet addiction, and attachment in Chinese children and adolescents

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Abstract

Background Children and adolescents diagnosed with major depressive disorder (MDD) often grapple with significant non-suicidal self-injury (NSSI), linked to interpersonal challenges, insecure attachment, and internet addiction. This study explores these relationships in children and adolescents using network analysis, drawing data from seven hospitals in China.

Results The study included 162 youths with depressive disorder and 102 healthy controls from seven hospitals. The MDD + NSSI group exhibited severe internet addiction, heightened depressive symptoms, and insecure attachment. Network analysis identified central symptoms (compulsive use) and key bridge symptoms (tolerance symptoms) in the networks related to depressive symptoms, internet addiction, and attachments. These findings suggest potential targets for intervention among children and adolescents at risk for or suffering from depression.

Conclusions This study sheds light on the intricate relationship between NSSI, attachment issues, and internet addiction in Chinese adolescents with MDD. The network analysis pinpointed central and key bridge symptoms, offering valuable insights for targeted interventions in children and adolescents at risk for or experiencing depression and associated challenges.

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Background

Non-suicidal Self-injury (NSSI) denotes the act of purposefully causing harm to one's own body surface, without any intention of committing suicide [1–3]. The prevalence of this behavior problem in adolescents with depressive disorder has gradually increased in recent years [1, 3, 4]. Meanwhile, the occurrence of NSSI is often closely related to interpersonal difficulties and lack of social support [5–8]. Furthermore, NSSI can cause a series of addiction-related behavioral problems such as internet addiction [9–12] and substance abuse [13]. Some scholars [14, 15] believe that NSSI is addictive behavior in itself, but this is still controversial.

Attachment theory suggests that the ability to regulate emotions effectively develops in healthy relationships. When individuals suffer from various pressures, they are unable to properly regulate their emotions and often need to seek the help of "attachment figures" [16, 17]. During the growth from infancy to adolescence, the main "attachment figures" gradually changes from parents or caregivers to peers [17, 18]. However, in China, parents or caregivers are still closely related to individuals even in adolescence or even early adulthood [19]. Variations in attachment relationships or attachment patterns with parents and peers may significantly influence patients' depressive symptoms and NSSI.

The growing concern in society is centered around the rising issue of f dependence in young individuals [20]. This problematic addiction not only isolates adolescents socially, but also hampers their academic performance, resulting in negative effects such as reduced self-esteem, diminished confidence, and worsening of depression [21]. These consequences have a profound impact on the mental well-being and overall development of teenagers. Through extensive investigation, numerous studies have consistently shown a strong association between internet addiction and depression. More specifically, teenagers displaying symptoms of depression are more prone to develop internet addiction, and conversely, youths with internet addiction are more susceptible to experiencing depression. A significant study conducted on a large sample size of the Chinese population [9] further validated the direct correlation between internet addiction and NSSI.

Research on the association between parental and peer attachment styles and internet addiction is currently limited but there are some high-quality research findings available. For example, one study [22] have found a negative correlation between the quality of maternal companionship and internet addiction issues in adolescents, while no correlation was found with fathers. A study [23] conducted in Japan with 1413 community adolescents also suggested that developing secure attachment could help alleviate and/or prevent internet addiction. Additionally, a study [24] conducted in rural areas of China confirmed that high levels of anxious attachment and low levels of intimate attachment are partially responsible for the increased risk of internet addiction in adolescents.

Previous studies have highlighted the need for further research into the relationship between attachment, NSSI, and internet addiction in patients with depression. Currently, there is a significant gap in the literature in this area, and it is essential to explore these factors more comprehensively to better understand the complex interactions among them. This research gap highlights the need for further investigation in this area. Therefore, the aim of our research is to investigate and gain insights into the relationship between attachment styles, NSSI, and internet addiction in individuals suffering from depression. By addressing this gap in the literature, valuable insights can be gained, potentially leading to a better understanding and more effective interventions for this vulnerable population.

Methods

Data will be obtained from inpatients with depression in seven child mental health centers as well as health students in secondary schools in the city where each mental health center is located. The 7 centers were Beijing Children's Hospital, Shandong Mental Health Center, Shandong Daizhuang Hospital, Qingdao women and children's hospital, The Third Hospital of Weihai, Nantong Fourth People's Hospital, Ningbo Kangning Hospital.

For this study, we would collect 3 groups of children and adolescents, depressive group with NSSI, depressive group without NSSI and healthy control (HC). In the first two groups, hospitalized patients diagnosed with MDD according to Diagnostic and Statistical Manual of Mental Disorders (DSM-5), aged 6–17 years, were included. In addition, the first group had a DSM-5-based comorbid NSSI and the second group had no NSSI. Patients with concurrent psychiatric and neurological disorders (such as traumatic brain injury, epilepsy and so forth) would be excluded. HC group would include children and adolescents without neurological or mental diseases.

To conveniently and effectively assess the level of attachment to parents and peers, as well as the severity of internet addiction, NSSI, and depression, we used the Inventory of Parent and Peer Attachment (IPPA) [25], Revised Chen Internet Addiction Scale (CIAS-R) [26–28], Modified Adolescents Self-Harm Survey (MASHS) [29], and Patient Health Questionnaire-9 (PHQ-9) [30–32], respectively.

The IPPA is a scale that was developed in 1987. It consists of three sections: attachment to father, attachment to mother, and attachment to peers. Each section contains 25 items that measure attachment levels in three dimensions: trust, communication, and alienation. Healthy attachment patterns are characterized by higher levels of trust and communication, along with lower levels of alienation. In this study, the alienation dimension is scored in reverse. Therefore, a higher total score in each section indicates a stronger attachment relationship. Several recent studies have confirmed the good reliability and validity of IPPA [33–35].

The CIAS-R, a 26-item scale, was used to assess internet addiction in this study. It consists of five subscales: compulsive use, withdrawal symptoms, tolerance symptoms, interpersonal and health-related problems, and time management problem. Each subscale contains a specific number of items that capture different aspects of internet addiction. Participants rated their responses on a four-point Likert scale, ranging from 1 (do not apply to me at all) to 4 (apply to me very much). The total scores on the scale ranged from 26 to 104, with higher scores indicating higher levels of internet addiction. A threshold score of 63/64 has been found to have good diagnostic accuracy for identifying internet addiction among adolescents, with scores of 64 or above classified as indicating internet addiction [36]. The CIAS-R has demonstrated high split-half reliability, test–retest reliability, and convergent validity [28]. The Cronbach's α values for the five subscales were 0.81, 0.84, 0.79, 0.84, and 0.78, respectively.

The Modified Adolescents Self-Harm Scale (MASHS) assesses both the frequency and severity of 18 commonly observed self-harming behaviors in Chinese adolescents [29]. Response options for frequency and severity range from "never" (scored as 1) to "more than five times" (scored as 4) and from "non-perceptible injury" (scored as 1) to "extremely critical injury" (scored as 5). Permission to employ the questionnaire was obtained from the respective authors. The reliability and validity have confirmed by Chinese population [10, 29].

The Patient Health Questionnaire-9 (PHQ-9) is a questionnaire consisting of nine items that serves as a screening tool for depression in primary care and other medical settings. The questionnaire was specifically designed for this purpose. In the initial study of the PHQ-9, which involved a total of 580 participants with 41 diagnosed cases of major depression, a cut-off score of 10 or above was established as the standard to identify individuals who may be experiencing major depression. This cut-off score indicates the presence of symptoms commonly associated with major depression and helps healthcare professionals to identify those who may need further evaluation or treatment [32]. Numerous recent research endeavors have substantiated the commendable reliability and validity of PHQ-9 [31, 37, 38].

To commence, we conducted an analysis of group differences in various demographic factors (such as sex, age, duration of depression, first episode/relapse), as well as clinical and psychological variables (attachment, internet addiction, self-harming, depression) across three distinct groups (MDD + NSSI, Pure MDD, and healthy control). The data's normality was evaluated through the Kolmogorov–Smirnov test. Descriptive statistics, including the mean ± standard deviation, were employed for variables that exhibited a normal distribution, while those not adhering to normality were described using the median (interquartile range).

Given our sample size, all variables can be approximated as normal distributions, allowing for the use of ANOVA for inter-group comparisons.

Statistical analysis comprised one-way analysis of variance (ANOVA) with subsequent post hoc examination, specifically employing Bonferroni's post hoc test, conducted using the bruceR [39] package for R version 4.3.2.

The MDD + NSSI and Pure MDD groups were amalgamated into a unified MDD group. For the network analysis of internet addiction, attachment, and depression, we employed the R-package qgraph (version 1.9.2) [40] in R (version 4.3.2; R Core Team, 2023). This program utilizes a Gaussian graphical model (GGM) for data examination. The regularized causal correlation network is constructed using the GGM model algorithm, employing the glasso (graphical lasso or graph minimal absolute shrinkage and selection operator) process [41]. During this process, all edges precisely contract to zero to diminish pseudo-correlations, a phenomenon facilitated by LASSO regularization [42]. Meanwhile, the Extended Bayesian Information Criterion (EBIC) was employed to choose the most fitting model [43]. In this network representation, each object is illustrated as a node, and the connections between objects are denoted as edges. Graph edges can be categorized as either positive (depicted in blue) or negative (depicted in red). The thickness of the edge signifies the strength of the relationship among the nodes.

Leveraging centrality measures to characterize the connectivity of each node allowed for the identification of factors that are more central or influential in the network. In cases where the network incorporates negative correlations among nodes, the expected influence (EI) index is utilized, as research indicates its superior performance compared to the commonly used "Strength" index when negative correlations are present [44]. Alternatively,

the strength index would be employed. Additionally, the R-package networktools (version 1.5.0) was employed to compute the bridge centrality metrics. Bridge centrality indices, including bridge strength, bridge closeness, bridge betweenness, and bridge expected influence, were evaluated using the networktools "bridge" function. This analysis aimed to identify specific symptoms that act as pathways linking attachment, depression, and internet addiction symptoms. Bridge centrality assesses a node's role in connecting its network to other networks. Comparable to expected influence, the Bridge Expect Influence (BEI) is computed by summing a node's edge weights [45], with the consideration that only edges connecting nodes from one community to another are included in the calculation. The cumulative sum of edge weights connecting a specific node to every node in the opposing community represents the node's bridge-predicted influence. A node is more inclined to trigger the opposing community if it possesses a greater bridge-anticipated influence. The current network consisted of three node communities: attachment (3 scores of subscales of IPPA), depression (total score of PHQ-9) and internet addiction symptoms (5 scores of subscales of CIAS-R).

Utilizing centrality measures to depict the connectivity of each node enabled the identification of factors more central or influential within the network. In instances where the network encompassed negative correlations among nodes, the expected influence (EI) index was employed, as it has been demonstrated to outperform the frequently used "Strength" index when negative correlations are present [44]. Otherwise, the strength index was utilized. Additionally, the R-package networktools (version 1.5.0) was employed to compute bridge centrality metrics. Bridge centrality indices, including bridge strength, bridge closeness, bridge betweenness, and bridge expected influence, were assessed using the networktools "bridge" function. The objective of this analysis was to identify particular symptoms serving as pathways in the connections between attachment, depression, and internet addiction symptoms [45]. Bridge centrality assesses a node's role in connecting its network to other networks. Analogous to expected influence, the Bridge Expect Influence (BEI) is computed by summing the edge weights associated with a node [45]. However, it is important to note that only edges connecting nodes from one community to the other are considered in this calculation. The cumulative sum of edge weights connecting a specific node to every node in the opposing community defines the node's bridge-predicted influence. A node is more prone to activate the opposing community if it possesses a greater bridge-anticipated influence. The existing network was characterized by three node communities: attachment (comprising three scores of subscales of IPPA), depression (represented by the total score of PHQ-9), and internet addiction symptoms (comprising five scores of subscales of CIAS-R).

Applying the R-package bootnet (version 1.5), we utilized the bootstrapping technique to evaluate the precision and robustness of the network estimate [41]. Initially, bootstrapped confidence intervals (CIs) were employed to measure the accuracy surrounding each edge-weight (the weight assigned to each edge). The precision of the graphical representation, emphasizing distinctions between weights, diminishes with increasing overlap in edge-weight CIs. Following this, we employed bootstrap resampling on participant subsets to evaluate the stability of centrality indices. In particular, we investigated how centrality indices varied as the number of participant subgroups decreased, for example, comparing the entire sample (100%) to a subset of the sample (for example, 10%). The rate at which centrality changes with diminishing proportions reflects the stability of the centrality, with faster changes indicating lower stability. Finally, to identify significant variations between edges or nodes, we conducted bootstrapping on the paired differences of edge weights and the paired differences of node centrality.

Results

General participant characteristics

In the final analysis, our study encompassed a total of 264 participants recruited from 7 centers across China. This cohort comprised 81 individuals diagnosed with MDD exhibiting NSSI behavior, another 81 MDD patients without NSSI behavior, and 102 healthy control subjects.

The comparison of age among the MDD + NSSI and MDD groups did not reveal significant differences ($p = 0.178$). However, the MDD + NSSI group exhibited a statistically significant age difference compared to the healthy control (HC) group ($p = 0.000$), and similarly, the MDD group showed a significant age difference in comparison to the HC group ($p = 0.002$). In terms of gender, there were no significant differences between the MDD and HC groups ($p = 0.651$). Furthermore, the MDD + NSSI group displayed significant age differences when compared to both the MDD group ($p = 0.006$) and the HC group ($p = 0.010$). However, no significant differences were found in episode duration ($p = 0.769$) or the type of depressive episode ($p = 0.751$) between the MDD + NSSI and MDD groups. Detailed information, including the distribution of boys and girls in each group, disease duration, and the form of depressive episodes, can be found in Table 1 and Fig. 1.

Table 1 Comparison between 3 groups of demographic data and clinical characteristics (n = 264)

	NSSI + MDD	MDD	HC	*p*	*p′*	*p″*	*p‴*
Age	15 (3)	14 (4)	13 (9)	0.000	0.178	0.002	0.000
Sex							
Male	17 (20.99)	35 (43.21)	40 (39.22)	0.006	0.006	0.651	0.010
Female	64 (79.01)	46 (56.79)	62 (60.78)				
Type							
FE	48	48	–	0.751	–	–	–
RE	33	38					
During	14 (20)	15 (14)	–	0.7693	–	–	-
Father-Tr	28 (9)	7.5 (18)	32 (6)	0.000	0.000	0.000	0.000
Father-Co	22 (5)	25.28 ± 8.099	23 (4)	0.006	0.002	0.011	0.008
Father-Al	12 (5)	16 (8)	12 (4)	0.004	0.000	0.532	0.001
Mother-Tr	30.75 ± 6.470	35.81 ± 8.203	31.40 ± 4.065	0.001	0.001	0.751	0.002
Mother-Co	23 (5)	29.89 ± 7.961	23 (5)	0.000	0.000	0.103	0.013
Mother-Al	9 (5)	16 (9)	8 (4)	0.000	0.000	0.012	0.015
Peer-Tr	32 (10)	37 (11)	35.29 ± 5.494	0.008	0.085	0.108	0.003
Peer-Co	25 (7)	29.5 (11)	27.12 ± 4.159	0.062	0.005	0.283	0.098
Peer-Al	15 (4)	16.5 (6)	15 (2)	0.085	0.037	0.120	0.078
Depression	29 (7)	20.65 ± 5.373	0 (1)	0.000	0.000	0.000	0.000
IA	46.23 ± 14.95	42.49 ± 12.76	38.50 ± 10.64	0.008	0.336	0.109	0.001
IA-CU	9.23 ± 3.71	9 (6)	8 (6)	0.987	0.154	0.645	0.155
IA-WS	9 (6)	8.58 ± 3.30	7 (4)	0.824	0.136	0.014	0.003
IA-TS	8.94 ± 4.01	7.86 ± 3.36	6 (4)	0.085	0.013	0.000	0.000
IA-IHP	9 (4)	8 (3)	8 (2)	0.023	0.990	0.002	0.002
IA-TM	8 (8)	6 (6)	6 (4)	0.124	0.916	0.077	0.006
Self_harming	35.94 ± 13.222	–	–	–			

p′: group "NSSI + MDD" and "MDD"; *p″*: group "MDD" and "HC"; *p‴*: group "NSSI + D" and "HC"; IA: internet addiction; IA-CU: compulsive use subscale of CIAS-R; IA-WS: withdrawal symptoms of CIAS-R; IA-TS: tolerance symptoms of CIAS-R; IA-IHP: interpersonal and health-related problems of CIAS-R; IA-TM: time management problems of CIAS-R

Comparison of psychological and behavioral indicators between groups

MDD + NSSI, MDD, and healthy control groups

No significant differences were found in peer communication ($p = 0.062$), peer alienation ($p = 0.085$), compulsive use, withdrawal symptoms, tolerance symptoms, and time management (all $p > 0.05$).

Significant differences were observed in other variables ($p < 0.05$).

MDD + NSSI versus MDD

No statistical differences were found in peer's trust, total CIAS-R score, compulsive use, withdrawal symptoms, interpersonal and health-related problems, and time management (all $p > 0.05$).

Other variables showed statistical differences between MDD + NSSI and MDD ($p < 0.05$).

MDD versus healthy control groups

No significant differences were found in paternal alienation, maternal trust, maternal communication, peer trust, peer communication, peer alienation, total CIAS-R score, compulsive use, and time management (all $p > 0.05$).

Significant differences were observed in other variables between MDD and healthy control groups ($p < 0.05$).

MDD + NSSI versus healthy controls

No statistical difference in peer communication, peer alienation, and compulsive use (all $p > 0.05$).

Other variables showed statistical differences between MDD + NSSI and healthy controls ($p < 0.05$).

For more details, please refer to Table 1, Figs. 2 and 3.

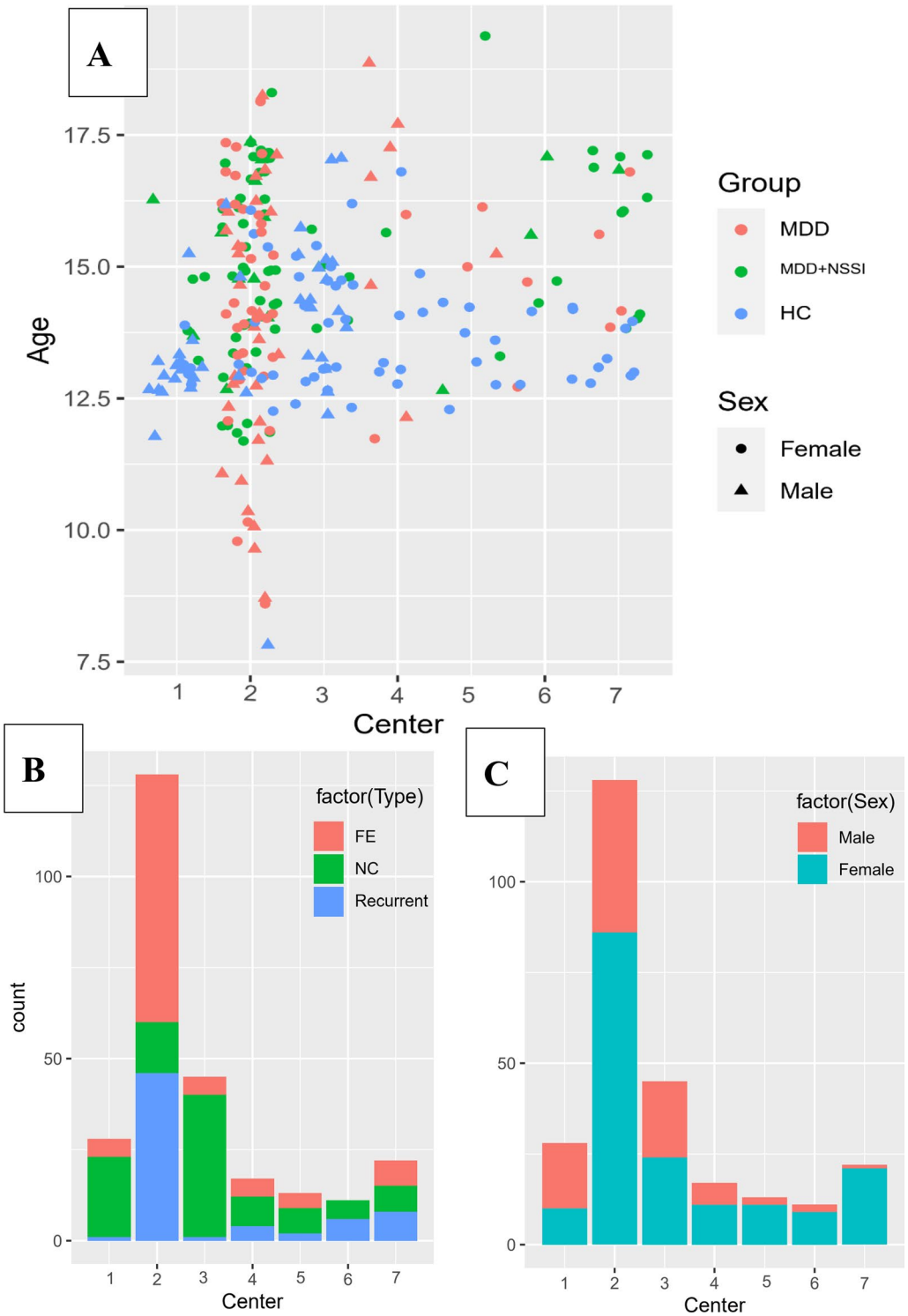

Fig. 1 General demographic results. Notes: MDD: the group of patients with MDD and without NSSI; MDD + NSSI: the group of patients with MDD and NSSI; HC: healthy control; FE: first episode; The Number of center: 1. Beijing Children's Hospital; 2. Shandong Mental Health Center; 3. Shandong Daizhuang Hospital; 4. Qingdao women and children's hospital; 5. The Third Hospital of Weihai; 6. Nantong Fourth People's Hospital; 7. Ningbo Kangning Hospital. **A** Scatter plot of age, type and sex distribution of the enrolled subjects in each sub-center; **B** The type distribution bar chart of subjects included in each sub-center; **C** Bar chart of sex distribution of subjects included in each subcenter

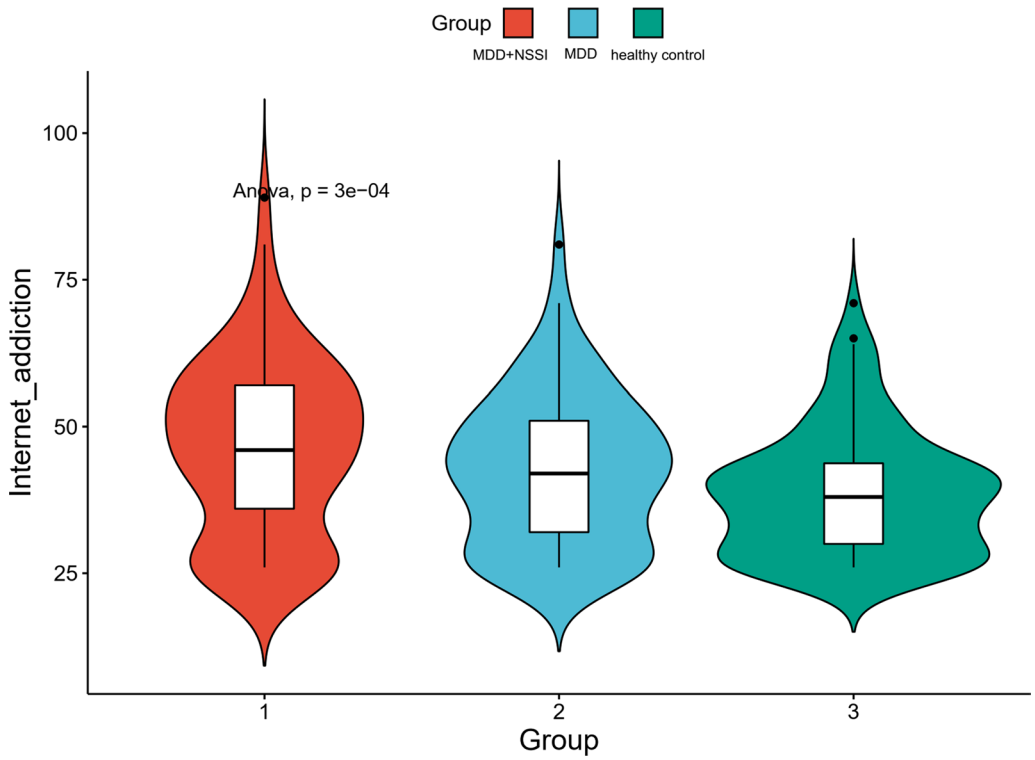

Fig. 2 Violin plot of internet addiction score (total score of CIAS-R) in 3 groups

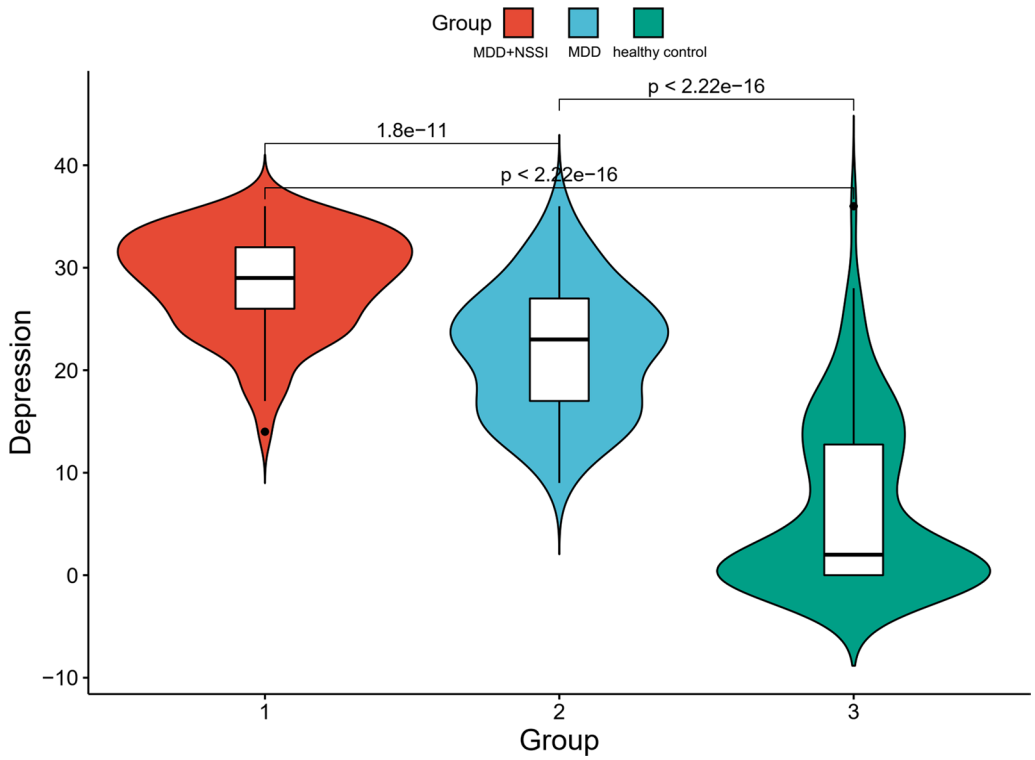

Fig. 3 Violin plot of depressive score (total score of PHQ-9) in 3 groups

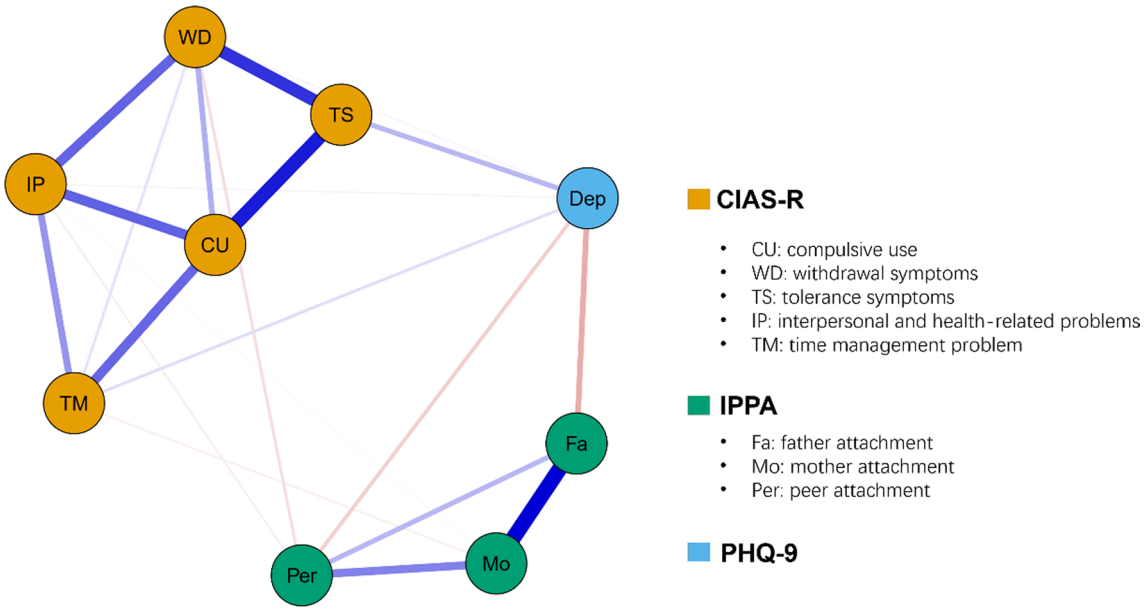

Fig. 4 Network structure of internet addiction, depression and attachments in our MDD sample. *Notes*: Green edges represent positive associations and red edges represent negative associations between nodes

Network analysis

The LASSO network of self-rating scales is shown in Fig. 4. The network density was high (0.611, 22/36), with an average weight of 0.072. 72.73% (16/22) of the edges were positively associated and 27.27% (6/22) were negatively correlated. The correlation matrices for the CIAS-R, IPPA subscales and PHQ-9 are shown in Table S3. Examining the network among CIAS-R subscales, we identified the strongest association between subscales compulsive use and tolerance symptoms (r = 0.390). Similarly, within the IPPA framework, the most robust pairwise correlation was observed between subscales father attachment and mother attachment (r = 0.433). Cross-scale associations were investigated, exploring the relationship between CIAS-R subscales and PHQ-9 scores, the analysis revealed that subscales within category tolerance symptoms exhibited the most robust association with PHQ-9 (r = 0.120). Conversely, among IPPA subscales, the highest association with PHQ-9 was observed a negative relation in subscale father attachment (r = −0.139). Notably, between CIAS-R and IPPA, among the rare three non-zero edges, the negative correlation between withdrawal symptoms and peer attachment is the most prominent (r = −0.053).

We have negative correlations in our network, so we use expected influence (EI) for the centrality estimation. The centrality plot (Fig. 5) reveals that compulsive use and tolerance symptoms were the highest obsessive traits with the highest central symptoms of EI. The Bridge EI (Fig. 6) illustrates that the tolerance symptoms was the strongest bridge factor in these factors. The centrality difference test (Figure S1) indicates that nodes highlighted in black are statistically more robust than the other nodes in the network. The bootstrapped difference test for node bridge strength is presented in Figure S2.

The network exhibited strong stability. The CS-C (correlation stability coefficient) of EI is 0.750, signifying that EI remains correlated with the original data even after discarding 75.0% of the data (Figure S3).

Discussion

In our sample, individuals with MDD and NSSI tended to show poorer attachment patterns (lower trust, communication, and alienation scores) than those with pure MDD and healthy controls. The trust, communication, and alienation scores were reversed-scored dimensions in the IPPA inventory [25], and a higher score for these dimensions indicates a more secure attachment pattern. This finding is consistent with previous research that has shown that individuals with MDD and NSSI may have poorer attachment patterns than those with pure MDD or healthy controls. This theory was similar with recent study [46] which indicated insecure attachment patterns can be one of the predictors of NSSI.

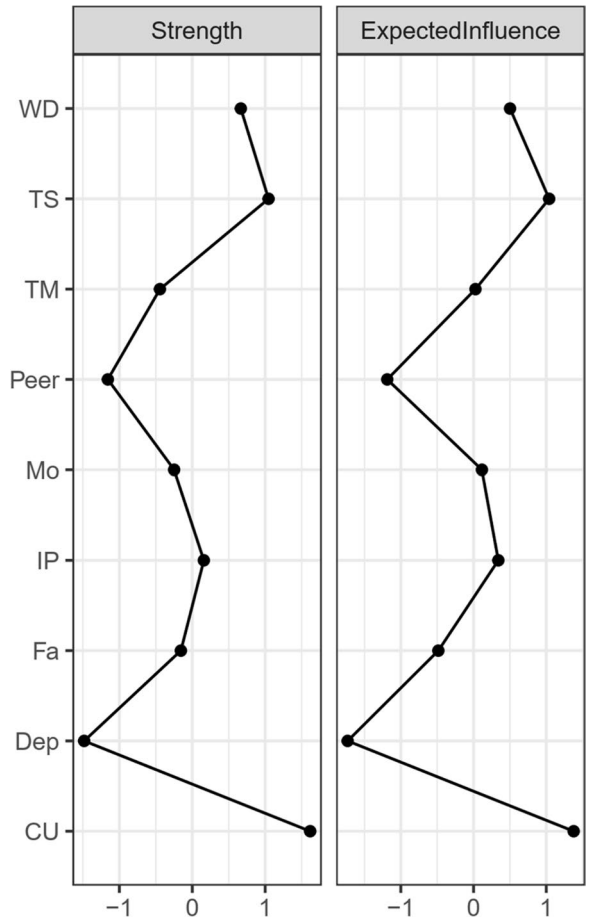

Fig. 5 Centrality plot depicted the strength and expected influence (z-score) of each variable chosen in the final network. *Notes*: WD, withdrawal symptoms; TS, tolerance symptoms; TM, time management problem; Peer, peer attachment; Mo, mother attachment; IP, interpersonal and health-related problems; Fa, father attachment; Dep, depressive symptoms; CU, compulsive use

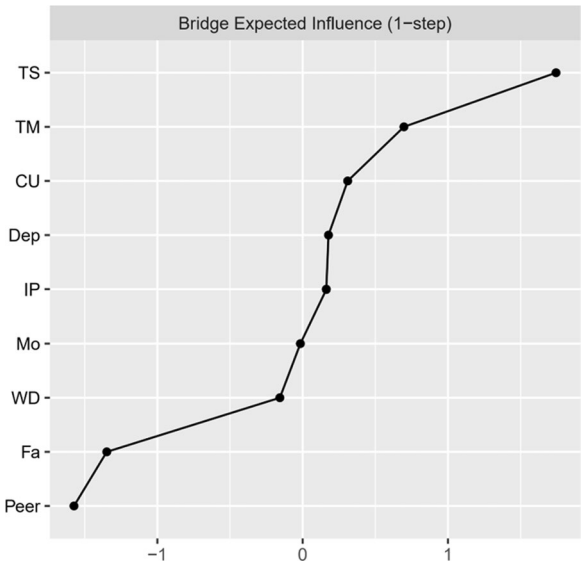

Fig. 6 Centrality plot depicted the bridge expected influence (z-score) of each variable chosen in the final network. *Notes*: WD, withdrawal symptoms; TS, tolerance symptoms; TM, time management problem; Peer, peer attachment; Mo, mother attachment; IP, interpersonal and health-related problems; Fa, father attachment; Dep, depressive symptoms; CU, compulsive use

For the relationship between NSSI and internet addiction, previous study [9] have shown that internet addiction appears to be associated with NSSI. In our study, the fact that group of MDD + NSSI emerged higher score of CIAS-R has proved above theory. But there are no studies to explain why. Whether NSSI and internet addiction are both behavioral addictions need further research to explore.

To our knowledge, this study represents the inaugural network analysis investigating the interrelationships among internet addiction, depressive symptoms, and attachments within a cohort of Chinese children and adolescents diagnosed with MDD. The primary symptoms evident in this network were compulsive use and tolerance. Notably, the network delineated a substantial connection between internet addiction and depressive symptoms, with tolerance symptoms being the predominant link. Moreover, the network highlighted a pronounced association between depressive symptoms and attachments, particularly emphasizing the significant role of father attachment in this linkage. Additionally, the interplay between internet addiction and attachments was prominently marked by the connection between withdrawal symptoms and peer attachment. These findings offer valuable insights into the intricate dynamics of these relationships within the context of MDD among Chinese children and adolescents.

Our findings revealed that compulsive use emerged as the most central symptom in the network, underscoring its pivotal role in activating and sustaining the psychopathology network involving internet addiction, depression, and attachments. Notably, this observation implies that addressing and improving compulsive use may exert the most significant impact on other variables within the entire network.

It is noteworthy that our study identified a unique insight not previously reported in existing network analysis literature. The distinctiveness lies in the understanding that enhancing compulsive use in the context of internet addiction could potentially yield the most substantial positive effects on other interconnected variables within the comprehensive network of psychopathology. This novel perspective contributes a valuable dimension to the existing knowledge on the intricate relationships among these variables.

The most influential bridge factor identified in our study was the tolerance symptoms of internet addiction, indicating that this specific index has the greatest contribution to overall network connectivity. Notably, the factor exhibiting the highest cross-scale correlation with this node was depressive symptoms. This suggests a noteworthy insight—by addressing and improving depressive symptoms, there exists a potential indirect pathway to enhance the overall network of addiction, specifically by positively influencing tolerance symptoms. In other words, improvements in depressive symptoms may have a beneficial cascading effect on tolerance symptoms and, consequently, the broader connectivity within the network.

Within the network correlations, a noteworthy observation is the significant negative correlation identified between peer attachment and the "withdrawal symptoms" and "interpersonal and health-related problems" associated with internet addiction. Importantly, this finding aligns with results from prior studies [47], although the cited study did not specifically break down the factors of internet addiction. The consistency in results across studies provides compelling evidence that a more secure attachment to peers predicts a lower degree of internet addiction. Consequently, to enhance the levels of internet addiction among children and adolescents, efforts should be directed towards improving their attachment levels to peers.

We also encountered some limitations in this study. On the one hand, for convenience, we used the PHQ-9 to assess depression, but this scale is generally used only to screen for depression and may not assess the severity of depression.

On the other hand, despite low sample size (162 patients for 9 nodes), we conducted a stability test (CS-C test). It's recognized that the ideal sample size for network analysis is suggested to be 15–20 times the number of nodes [48]. In addition, due to the limit of sample size, we can no longer group to build the network of each group. Because each group has a smaller sample size. Replicability needs validation through a larger sample study to enhance generalizability and reliability.

Despite the mentioned limitations, the present study possesses notable strengths. To the best of our knowledge, it is the initial network analysis and multicenter study investigating the interplay among attachment, nonsuicidal self-injury (NSSI), and internet addiction in children and adolescents with MDD.

Conclusions

We can draw a conclusion as follows: the existence of NSSI correlates with an insecure attachment style and increased severity of internet addiction in children and adolescents with MDD. Key symptoms, such as compulsive use, and bridge symptoms, like tolerance symptoms, in the network of depression, internet addiction, depressive symptoms, and attachments, could be targeted for intervention in at-risk or depressed children and adolescents. This offers a theoretical foundation for targeted interventions to improve the mental health of children and adolescents with depression in the future.

Abbreviations

MDD	Major depressive disorder
NSSI	Non-suicidal self-injury
HC	Healthy control
DSM-5	Diagnostic and Statistical Manual of Mental Disorders
IPPA	Inventory of Parent and Peer Attachment
CIAS-R	Revised Chen Internet Addiction Scale
MASHS	Modified Adolescents Self-Harm Survey
PHQ-9	Patient Health Questionnaire-9
EI	Expected influence

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s41983-024-00883-z.

Additional file 1.

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Author contributions

X.A. and S.W. completed the statistical analysis of the data and contributed to the writing of the paper. D.Q. and X. W provided guidance for the implementation of the survey and contributed to the writing of the paper. Other authors were involved in data collection.

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Availability of data and materials

The data presented in this study are available on request from the corresponding author, without undue reservation, to any qualified researcher.

Declarations

Ethics approval and consent to participate

We obtained the informed written consent of all patients (or their parent or legal guardian in the case of children under 16) prior to their inclusion in the study. This study was approved by the Ethics Committee of Shandong mental health center on Aug 6th, 2021, with the reference number 2021–44; Ethics Committee of Shandong Daizhuang Hospital on Oct 26th, 2022, with the reference number 202210HY-1. In cases where the need for ethics approval was waived, this information is provided in accordance with the ethical standards of The Egyptian Journal of Neurology, Psychiatry and Neurosurgery.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no conflict of Interest.

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