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Original Paper

Exploring the Complex Relationship between Social Network Addiction and Mental Health in College Students: A Study Based on Multi-layer Network Analysis

Jiarui PAN[1*], Yuling ZHOU[2] & Shasha WANG[3]

[1] School of Psychology, Guizhou Normal University, Guiyang, China

[2] School of Psychology, Guizhou Normal University, Guiyang, China

[3] School of Psychology, Guizhou Normal University, Guiyang, China

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Abstract

With the development of science and technology, various types of online social media have developed rapidly, attracting a large number of users, but excessive use of social network addiction phenomenon, affecting the life and mental health. For college students, social network addiction is not uncommon and affects their mental health, so it is very important to understand the relationship between social network addiction and mental health and to intervene, so this study aims to explore the relationship between social network addiction and mental health. In this study, 1141 college students completed the Social Networking Addiction Scale and the College Mental Health Scale through an online survey. Social network addiction and mental health were then included as nodes and network analysis was performed using R software. It was found that, in the node network graph, there was a link between the well-being experience dimension of mental health and the mood change dimension of social network addiction, and there was a link between the courage to challenge dimension of mental health and the online social interaction preference dimension of social network addiction. In the total sample and the male sample, "I feel that my life is boring" in the mental health scale is the node with the highest intensity, while "I can't concentrate on my study" in the mental health scale has the highest node intensity in the female sample. From the above results, it is concluded that there is a relationship between some dimensions of social network addiction and some dimensions of mental health among college students. Individuals' boredom affects their mental health and social network addiction, and in the case of female college students, their commitment to study also affects their mental health and social network addiction.

Keyword

mental health, social network addiction, network analysis

1. Introduction

Currently, the mental health status of college students in China is still not optimistic. According to the "China National Mental Health Development Report (2021-2022)" (Fu & Zhang, 2023), a survey was conducted on the mental health status of nearly 80,000 college students aged 15-26 across 31 provinces (including autonomous regions and municipalities) such as Shandong and Hebei. The results showed that 21.48% of students were at risk of depression, and 45.28% were at risk of anxiety. Based on previous research findings, it is not difficult to see that improving the mental health level of college students is crucial for them.

With the emergence and evolution of social networks, traditional ways of interaction have also changed. The proper use of social networks can meet Maslow's hierarchical needs for relationships and promote interpersonal relationships. However, excessive use of social networks by individuals to establish and maintain relationships may lead to addiction tendencies, resulting in social network addiction, which can have negative impacts on physical and mental health (Zhang, 2021). Andreassen (Andreassen, Torsheim, & Pallesen, 2014) and others defined social network addiction as "an excessive focus on social networks, spending a lot of time and energy on social networks, thereby affecting other social activities, interpersonal relationships, mental health, and well-being." Research indicates that college students' mental health problems mainly stem from internet addiction (Liu, Li, & Cao, 2022). Therefore, it is necessary to study the relationship between social network addiction and mental health among college students to promote their mental health development through this research.

In the process of studying the complex relationships between research variables, traditional psychological statistical methods, such as regression analysis, exploratory factor analysis, and mediation and moderation effect analysis, often struggle to efficiently and conveniently map out the complex interactions between variables. This is especially true when it comes to the occurrence and development of psychological or behavioral processes, which general statistical methods cannot fully capture. In contrast, network analysis techniques effectively address these shortcomings. They can not only quickly process and analyze the interrelationships among multiple, even hundreds of variables but also clearly and intuitively present the relationships between variables (Zhang, 2021). Network analysis can understand the closeness of relationships between variables (Galderisi, Rucci, Kirkpatrick, Mucci, Gibertoni, Rocca, ... & Maj, 2018) and perform mathematical analysis and visualization of the relationships among complex variables without relying on a priori assumptions about the relationships between variables (Galderisi, Rucci, Kirkpatrick, Mucci, Gibertoni, Rocca, ... & Maj, 2018; Beard, Millner, Forgeard, Fried, Hsu, Treadway, ... & Björgvinsson, 2016; Costantini, Epskamp, Borsboom, Perugini, Mõttus, Waldorp, & Cramer, 2015). By exploring the fine-grained relationships among various variables in psychological constructs, network analysis helps researchers understand the

mechanisms of generation, maintenance, development, and change of various psychological variables. In network analysis, a network is composed of relevant nodes and the connections between them. Nodes usually represent the variables being studied, and the connections between nodes indicate the closeness of the relationships between the study variables (Liu & Ma, 2018; Cai, Dong, Yuan, & Hu, 2020). Network analysis typically uses three centrality indicators to quantitatively describe the relationships between variables and other variables. The common centrality indicators are: (1) Strength Centrality: measures the total correlation of a node with all other directly related nodes; (2) Betweenness Centrality: indicates the number of times a node is on the shortest path between two other nodes, measuring the degree to which a variable acts as a bridge or mediator connecting other variables; (3) Closeness Centrality: represents the reciprocal of the sum of the average shortest path lengths between a node and other variable nodes, measuring the closeness of a variable to other variables (Opsahl, Agneessens, & Skvoretz, 2010).

Most current studies exploring the relationship between social network addiction and mental health use traditional statistical methods, which have certain limitations in exploring the complex relationships between variables. Therefore, using network analysis methods to explore the relationship between social network addiction and mental health can more precisely examine the subtle relationships between variables and help understand the mechanisms of generation, maintenance, and development of these variables. Based on network analysis, this study treats items related to social network addiction and mental health as network nodes, constructing a network model based on the relationship between these two variables. The main purposes of the study include: (1) exploring the item-level relationship between social network addiction and mental health; (2) identifying key central nodes in the network. Based on these analyses, we aim to provide deeper insights to help understand the complex relationships between social network addiction and mental health and to provide specific targets for interventions addressing social network addiction and mental health issues among college students, thereby promoting their mental health. This method has significant theoretical and practical implications, providing effective strategies and means for improving college students' social network usage behavior and their mental health status.

2. Subjects and Methods

2.1 Subjects

This study used a convenience sampling method, selecting undergraduate students from freshman to senior year, as well as graduate students from first to third year, as research subjects. A total of 1,164 questionnaires were distributed, with some samples from certain grades subjectively excluded due to insufficient sample size. Ultimately, 1,141 valid questionnaires were obtained, with an effective rate of 98.02%. Among them, there were 794 males and 348 females; 741 freshmen, 187 sophomores, 184 juniors, 13 seniors, 6 first-year graduates, 9 second-year graduates, and 2 third-year graduates.

2.2 Tools

1. Chinese Social Media Addiction Scale (Liu & Ma, 2018)

2. This study used the Chinese Social Media Addiction Scale developed by Liu and Ma (Liu & Ma, 2018) to measure the degree of social network addiction among college students. The scale consists of six dimensions, using a 5-point Likert scale ranging from "completely disagree" to "completely agree," scored 1-5 points. The higher the score, the higher the degree of social network addiction. In this study, the Cronbach's α coefficient for the total scale was 0.93.

3. Mental Health Scale for College Students (MHS-CS)

This study used the Mental Health Scale for College Students (MHS-CS) developed by Cheng Ke and Huang Xiting (Cheng & Huang, 2009) to measure the mental health status of college students. The scale includes six dimensions and uses a 5-point Likert scale. Higher scores indicate better mental health status. In this study, the Cronbach's α coefficient for the scale was 0.94, indicating good internal consistency.

2.3 Statistical Methods

This study used SPSS and R 4.3.3 statistical software to organize and analyze the collected questionnaires. The R packages Bootnet, qgraph, and bruceR were used for network modeling, analysis, and visualization. The methods used to analyze the data mainly included descriptive analysis and network analysis. Through these analyses, the relationship between social network addiction and mental health was revealed.

3. Research Results

3.1 Descriptive Statistics

The descriptive statistics of the Mental Health Scale for College Students and Social Network Addiction scores are shown in Table 1.

Table 1. Descriptive Statistics of Mental Health Scale for College Students and Social Network Addiction Scores (N=1141)

Item	Mean ± SD	Median	Minimum	Maximum
Mental Health	90.09±16.44	89	41	135
Well-being	17.68±3.59	18	5	25
Interpersonal Harmony	17.12±3.63	17	5	25
Positive Learning Attitude	16.00±4.04	16	5	25
Emotional Regulation	13.03±3.25	13	4	20

Goal Pursuit	12.83±3.00	12	4	20
Challenge Willingness	13.44±2.55	13	5	20
Social Network Addiction	84.33±15.29	84	28	140
Social Preference	18.75±4.15	19	6	30
Emotional Changes	16.59±3.83	17	5	25
Negative Consequences	15.42±3.55	15	5	25
Compulsiveness	17.92±4.77	18	6	30
Salience	7.59±2.56	8	3	15
Relapse	8.06±2.66	9	3	15

3.2 Correlation Network Analysis

The results of the correlation network analysis are shown in Figure 1. Among the mental health items of college students, items 20 (I am afraid of interacting with strangers) and 21 (I can't concentrate on studying), and items 6 (I crave life's challenges) and 7 (My life is meaningful now) are the most closely connected nodes in the network. Additionally, the connections between item 1 (I like my current life) and item 2 (I feel shy and uncomfortable when with the opposite sex), and item 17 (I have no long-term plans for the future) and item 18 (Any challenge makes me feel uneasy) are also very close.

In the social network addiction items, items 54 (I try to control the time spent on social media, but I fail) and 55 (I try to reduce the number of times I log into social media, but I fail) are the most closely connected nodes in the network.

Item 19 (I find college life unbearable) and item 39 (Although social media has some negative effects on me, I will continue to use it), and item 26 (Any challenge makes me feel uneasy) and item 34 (Using social media makes me happier when I am unhappy), and item 19 (I often lose my temper, I want to control it but can't) and item 31 (I feel more comfortable communicating through social media) have a direct positive relationship. It can be inferred that there is a relationship between college students' mental health and social network addiction. Overall, in the network, some variables of college students' mental health and social network addiction can be linked, indicating that there are interactions among the various variables rather than them being independent of each other.

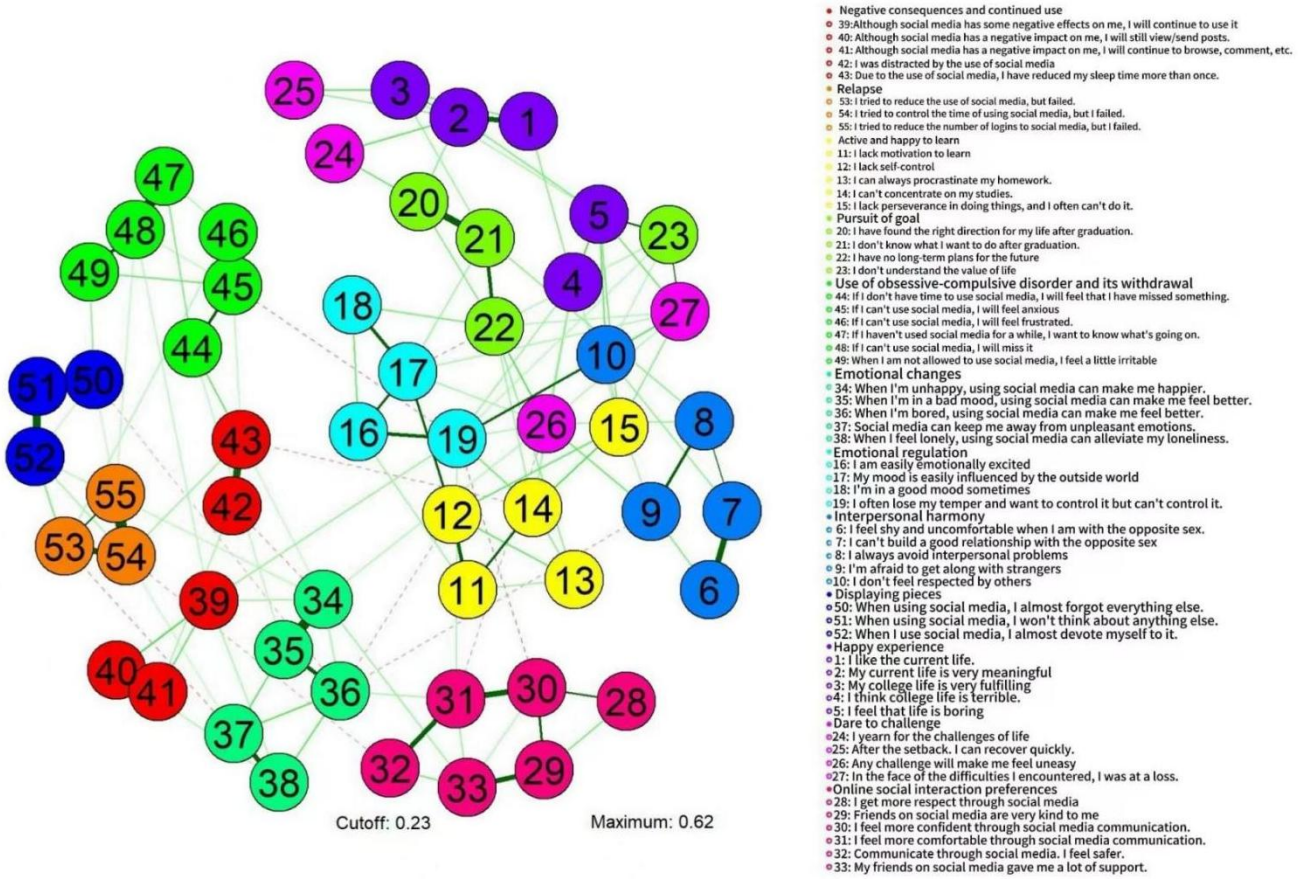

Figure 1. Network Estimation of Mental Health and Social Network Addiction in College Students

3.3 Centrality Metrics of Nodes

Figure 2 shows the Z-scores of closeness, betweenness, and strength centrality metrics for each item node in the network of college students' mental health and social network addiction. The results show that item 5 (I find life boring) has the highest strength, followed by item 14 (I can't concentrate on studying). Item 42 (I get distracted due to using social media) has the highest closeness, followed by item 12 (I lack self-control), item 11 (I lack motivation to study), and item 43 (Due to using social media, I have reduced sleep time more than once). Item 42 (I get distracted due to using social media) also has the highest betweenness, followed by item 41 (Although social media has a negative impact on me, I will continue to browse, comment, etc.).

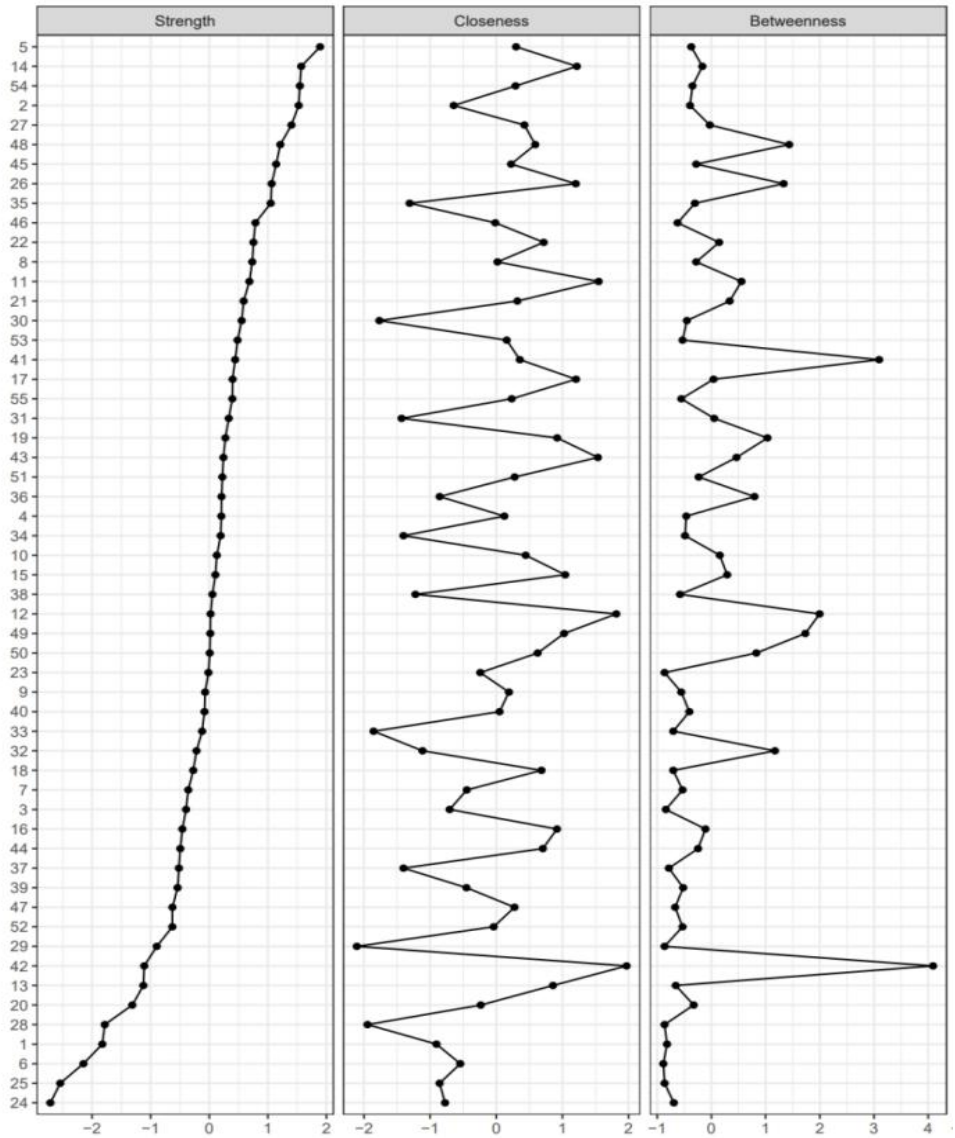

Figure 2. Z-scores of Centrality Metrics for Each Item Node

3.4 Network Analysis of Social Network Addiction and Mental Health by Different Age Groups

Age was divided into two groups: 18-20 years old and 21-23 years old. The centrality indices of each node in the network of social network addiction and mental health for different age groups are shown in Figure 3. In the 18-20 age group network, node 14 (I can't concentrate on studying) has the highest node strength, node 26 (Any challenge makes me feel uneasy) has the highest closeness, and node 49 (I feel irritated when I am not allowed to use social media) has the highest betweenness score. In the 21-23 age group network, node 5 (I find life boring) has the highest node strength, node 54 (I try to control the time I spend on social media, but I fail) has the highest closeness, and node 39 (Although social media has some negative effects on me, I will continue to use it) has the highest betweenness score. Node 5 (I find life boring) also has the highest expected influence.

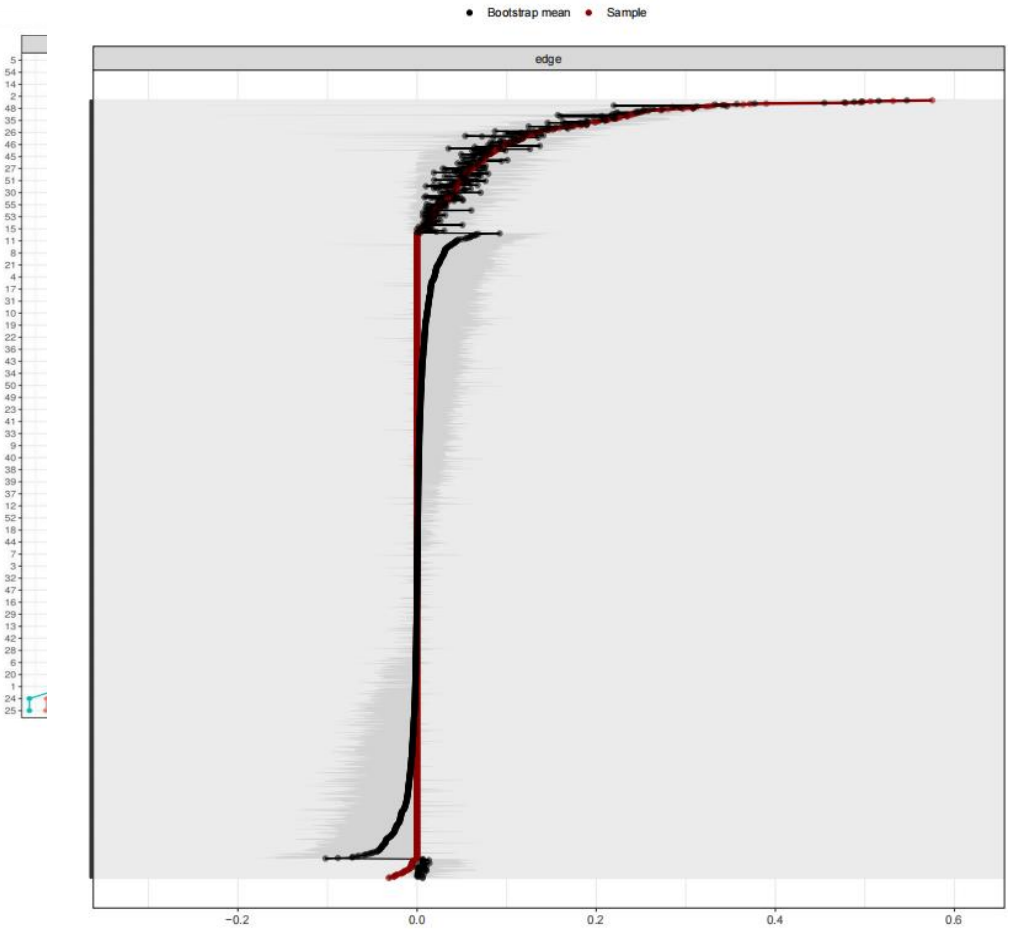

Figure 3. Centrality Indices (Strength, Closeness, Betweenness, Expected Influence) by Age Group

3.5 Accuracy Estimation of Edge Weights

This study used the Non-parametric Bootstrap method to estimate the accuracy of edge weights and test the differences in edge weights. The results are shown in Figure 4. The vertical axis represents all the edges in the network (vertical axis labels have been removed to avoid clutter), and the horizontal axis represents the confidence interval. The red line represents the mean estimated from the original sample, the black line represents the mean estimated by the bootstrap method, and the gray area represents the confidence intervals corresponding to the two methods. The results in Figure 4 show that in most networks, the 95% confidence intervals for edge weights using Bootstrap are relatively narrow, and the 95% confidence intervals for most edge weights overlap. This result indicates that the edge weights estimated in this study are reasonably accurate.

Figure 4. Accuracy Test of Edge Weights

3.6 Stability of Strength Centrality

This study used the Case-Dropping Subset Bootstrap method to test the stability of centrality indices.

As shown in the figure, the red line represents the average relationship between the strength centrality of the original sample and the subsets, while the red area represents the range from the 2.5th percentile to the 97.5th percentile. This stability can be quantified using the correlation stability coefficient (CS coefficient). The results in Figure 5 show that the stability coefficients for the strength centrality of each node in the network exceed the threshold of 0.5, indicating that the network has good stability.

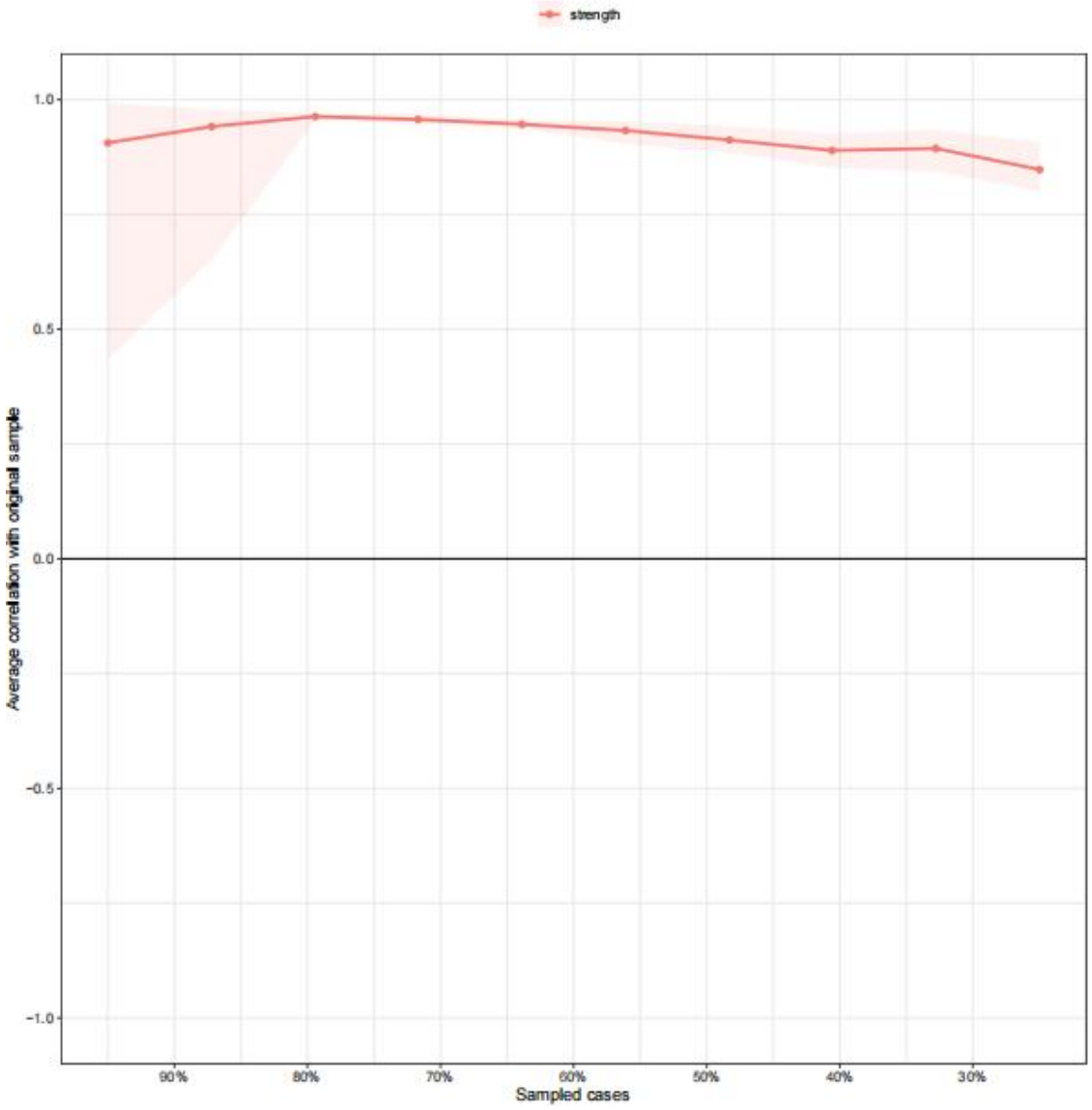

Figure 5. Stability Test of Centrality Indices

4. Discussion

This study used network analysis methods to explore the item-level relationship between mental health and social network addiction among college students. This exploration is significant for understanding

the mechanisms of the association between social network addiction and mental health and for developing effective strategies to intervene in social network addiction.

The results of this study found that in the network, most of the item nodes in the Mental Health Scale clustered into one group by dimension, forming two large clusters overall. The network results showed that almost all the closely linked nodes were from the same dimension. In the scale, "I lack self-control" belongs to the dimension of positive learning attitude, but in the network graph, it represents more of an individual's self-control. From this result, it can be inferred that an individual's self-control can affect their emotional regulation. In both scales, the node "I often lose my temper and want to control it but can't" in the mental health scale is correlated with the nodes "Although social media has some negative effects on me, I still continue to use it" and "I feel more comfortable communicating through social media" in the social network addiction scale. This result shows that an individual's level of emotional regulation can also affect their use of social media. This study suggests that individuals with poor emotional regulation are more likely to continue using social media despite its negative effects.

In the centrality index results, the node "I find life boring" in the mental health scale has the highest strength, indicating that this node has broader and closer connections with other nodes in the network. Research has found that bored individuals may experience negative emotions such as loneliness, anger, social anxiety, and depression, which can affect their mental health [5]. If individuals are immersed in loneliness, tension, and restrictive boredom, they may adopt a negative mood coping strategy of using social media to alleviate boredom. Bored individuals spend more time indulging in social media use [9].

In the strength centrality analysis grouped by age, the nodes "My college life is fulfilling" and "I find college life unbearable" show significant differences. The experience of college life has a greater impact on the mental health and social network addiction of the younger age group. Freshmen who have just entered college may find the new environment more influential. These results remind us to pay more attention to the adaptation issues of freshmen, helping them better adapt to college life and promote their mental health levels (Hong, Zhang, & Cheng, 2014; Meng, Yang, Xu et al., 2012).

The findings of this study are significant both theoretically and practically. Theoretically, we explored the item-level relationship between social network addiction and mental health among college students, providing a deeper understanding of their correlation. Practically, central nodes have a broad impact on other nodes and play an important role in the entire network (Liu & Ma, 2018; Robinaugh, Millner, & McNally, 2016), making them key targets for intervention.

5. Limitations and Prospects

This study used network analysis to discuss the relationship between college students' mental health and social network addiction, achieving some progress, but there are also certain limitations:

(1) Cross-sectional Study

This study employed a cross-sectional design to discover the relationship between college students'

mental health and social network addiction. However, to prove causality, future research needs to use longitudinal tracking methods to determine the causal relationship between the two.

(2) Measurement Overlap

Some nodes in this study may exhibit measurement overlap, such as item 51 (When using social media, I don't think about anything else) and item 52 (When using social media, I am almost fully engaged). This result may significantly increase edge weights and centrality, but currently, there is no standardized method in social network analysis to determine topological overlap and merge overlapping items (Zhang & Horvath, 2005).

6. Conclusion

This study is the first to use correlation network analysis to examine the parallel relationships between various items of college students' mental health and social network addiction. It revealed the internal mechanisms of the concepts of mental health and social network addiction, enhancing the understanding of the relationship between the two variables. Additionally, this study identified certain central nodes that may provide potential intervention targets and solutions for addressing social network addiction and improving mental health levels among college students.

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