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Family Environment, Health Risk Behaviors, and Adolescent Mental Health: A Cross-Sectional Network Analysis in a Chinese Vocational Student Population

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Abstract

Background

Adolescent mental health problems, particularly depression and anxiety, pose a global public health challenge. Family environment and health risk behaviors are key influencing factors, yet their complex interrelationships with psychological symptoms remain unclear. This study employed network analysis to investigate these associations, aiming to identify core symptoms and potential gender differences.

Methods

A total of 1,601 students were recruited from two higher vocational colleges in Nanning, Guangxi, using a cluster random sampling method. Adolescents' family environment, health risk behaviors, and mental health status were assessed using the Family Environment Scale, the Student Health Status and Influencing Factors Questionnaire, and the Mental Health Scale for Middle School Students, respectively. The EBICglasso method was used to estimate networks and derive centrality indices, followed by the Network Comparison Test to evaluate gender differences.

Results

"Depression" and "Anxiety" exhibited the highest strength centrality as core symptoms. Family "Cohesion" and "Conflict" served as key bridge nodes connecting health risk behaviors to mental health. The strongest association was observed between "Sleep deprivation" and "Depression." No significant gender differences were found in network structure.

Conclusion

Depression and anxiety are central to adolescent mental health problems, with family cohesion and sleep deprivation representing important intervention targets. Family-based emotional communication training and sleep health promotion may hold preventive value.

1. Introduction

Adolescent mental health has emerged as a significant global public health challenge. Recent years have witnessed a substantial rise in mental health problems among adolescents, including depression, anxiety, and suicidal behaviors(Keyes and Platt, 2024). According to the World Health Organization (WHO), approximately one in seven adolescents aged 10–19 suffers from a mental health disorder, with depression and anxiety being the leading causes of disability in this age group(WHO, 2024). The situation in China is equally concerning. China's National Mental Health Development Report (2021–2022) indicates that 14.8% of adolescents exhibit varying degrees of depression risk(Fu, 2023), with a

notably higher prevalence observed among those aged 15–17 compared to other age groups(Jiang and Zeng, 2024). These issues not only harm individual development but also impose a substantial societal burden, as reflected in the rising global disease burden related to adolescent depression over the past three decades, with an increase of 20.7%(Yang, 2024a).

Adolescence is a vulnerable period for psychological and behavioral problems(Bi, 2025). Developmental psychopathology theory emphasizes that risk and protective factors influence psychological adaptation through complex gene–environment interactions. (Boyce, 2021;Rutter, 2012). Given the multidimensional etiology of adolescent mental health issues(Xiong, 2023), health risk behaviors and the family environment emerge as significant contributing factors. Research indicates that lifestyle factors significantly impact psychological state and mental well-being(Camprodon-Boadas, 2025). Studies indicate that smoking or alcohol use positively correlates with depression and anxiety in adolescents(Halladay, 2024). Furthermore, a large-scale Chinese cross-sectional study demonstrated that physical inactivity, insufficient sleep, and poor diet independently increase the risk of adolescent depression(Zhang, 2024). Beyond lifestyle factors, the family environment profoundly shapes adolescent psychological resilience through mechanisms such as emotional support, parenting styles, and conflict resolution patterns. Prolonged exposure to adverse family conditions—including parental conflict, domestic violence, or an emotionally neglectful atmosphere—has been shown to significantly impair adolescents' emotional regulation and social adaptation(Jin, 2025). Correspondingly, adolescent depression is strongly linked to deficits in familial emotional support. Empirical evidence indicates that adolescents raised in families exhibiting low emotional responsiveness are more prone to negative self-perceptions, which further exacerbates their vulnerability to depression(Li, 2023).

In summary, family environmental factors and health risk behaviors are established risk factors for adolescent mental health symptoms. Previous studies have predominantly explored the association between these factors and adolescent mental health separately, employing traditional approaches such as mediation analyses, moderation analyses (Ren and Liang, 2023;Zhang, 2022), conventional regression, or structural equation modeling (SEM) (Yang, 2024b). However, the relationships are likely not simple unidirectional causal chains nor driven by a single latent variable; instead, they constitute a complex network of interactions. Borsboom and Cramer (Borsboom and Cramer, 2013)propose that mental disorders fundamentally represent complex dynamic network systems, formed by the causal interplay among specific psychological and behavioral symptoms. In this context, network analysis offers a distinct methodological advantage over conventional analyses. While regression and SEM typically focus on estimating global latent constructs or direct causal pathways, network analysis maps the structure of conditional dependencies among observed variables—visualized as edges in the network—after accounting for all other variables in the system. These edges do not represent direct causal effects but rather unique statistical associations that remain between two variables when controlling for the rest of the network(Borsboom, 2017), thereby revealing potential direct interactions or shared mechanisms that might otherwise remain obscured in broader latent models. The present study aims to leverage network analysis to: (1) elucidate the specific network structure and association strengths among adolescent family environment, health risk behaviors, and mental health symptoms; and (2)

identify potential differences in core mental health symptoms between male and female subgroups. This approach seeks to provide an empirical basis for developing targeted adolescent mental health prevention and intervention strategies.

2. Methods

2.1 Study subjects

A total of 2,221 senior college students were recruited from two higher vocational colleges in Nanning City, Guangxi Province, between December 2024 and January 2025, using a whole cluster random sampling method. Via lottery, two schools were selected—one each from Qingxiu District and Xixiangtang District of Nanning City. Within each selected school, 1–4 classes were randomly chosen from both the 2023 and 2024 grade cohorts. All students in the selected classes were invited to participate. Data were collected using an online questionnaire platform. Of the 2,221 questionnaires distributed, 1,601 valid questionnaires were retained, yielding a response rate of 72.1%. Inclusion criteria were: (1) enrollment in higher education at the participating institutions, and (2) age between 12 and 19 years. Exclusion criteria were: (1) questionnaire completion time less than 25% of the median completion time (i.e., < 639 seconds), and (2) incorrect answers to validity check questions. Consequently, 1,601 participants were included in the final analysis (see Fig. 1). The study was approved by the Ethics Committee of Nanning Fifth People's Hospital. Informed consent forms were signed by all participating students and their parents(SL2024-17-02).

2.2 Measures

Collect demographic information on all participants, including gender, age, ethnicity, place of residence, and family structure, among others, as detailed in Table 1.

Adolescent health risk behaviors were assessed using the Questionnaire on Students' Health Status and Influencing Factors (Secondary School Version), uniformly compiled by the National Student Common Diseases and Health Influencing Factors Surveillance Project Workgroup. In this study, the Cronbach's alpha coefficient for the scale was 0.740, and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.802. Health risk behaviors were defined according to classification criteria from the Comprehensive Report on the Survey of Health-Related/Risky Behaviors of Chinese Adolescents 2005(Chengye, 2007). Multi-categorical variables included High-fat diet, High-salt diet, High-fiber diet, High-protein diet, High-sugar diet, Fermented food, Carbonated beverage, and Salty snack consumption. Each of these was categorized into four levels: rarely or almost never (< 1 time/week), occasionally (1–2 times/week), regularly (3–5 times/week), and almost daily. Additionally binary variables included, for example, Smoking history: any history of cigarette smoking; Drinking history: consumption of at least one full glass of an alcoholic beverage; Sleep deprivation: <9 hours/day for junior high school students or < 8 hours/day for senior high school students ; Lack of exercise: failure to achieve ≥ 60 minutes of moderate-intensity physical activity on at least 3 days within the past 7 days.

Adolescent mental health was assessed using the Mental Health Scale for Chinese Middle School Students (MSSMHS) (Zhou, 2024), developed by Professor Wang Jisheng to reflect the cultural context and behavioral patterns of Chinese adolescents. This 60-item self-report scale measures ten common psychological problem dimensions: obsessive-compulsive symptoms, paranoia, hostility, interpersonal sensitivity, depression, anxiety, learning pressure,maladjustment, mood swings, and psychological imbalance. This study employed a five-point Likert scale comprising declarative statements. The scale demonstrated excellent internal consistency (Cronbach's α = 0.979) and sampling adequacy (KMO = 0.958). A total score > 2 points was defined as indicative of abnormal mental health, with the following severity gradations: 2–2.99 (mild), 3–3.99 (moderate), 4–4.99 (severe), and 5 (extreme).

The Chinese version of the Family Environment Scale (FES-CV) was revised and adapted by Prof.Phillips(Phillips, 1998)and colleagues in 1991 based on the original Family Environment Scale (FES) developed by American psychologist Moss R.H. The scale contains 10 subscales evaluating 10 different family social and environmental characteristics: Cohesion, Expressiveness, Conflict, Independence, Achievement Orientation, Intellectual-Cultural Orientation, Active-Recreational Orientation, Moral-Religious Emphasis, Organization, and Control. All 90 items are scored dichotomously: a 'yes' response is assigned '1' and a 'no' response is assigned '2'. The score for each item in the scale is further categorized into three levels—low, moderate, and high—represented by 1, 2, and 3, respectively. Specific scores are provided in Supplementary Table S1. The total score for each subscale is then calculated according to the scoring protocol. The Cronbach's alpha coefficient of the scale is 0.988, and the KMO measure of sampling adequacy is 0.990.

2.2 Statistical analysis

2.2.1 Demographic data analysis

Data were analyzed using SPSS 19.0. T-tests were used to compare age differences between gender groups, while Chi-square test were used to compare the differences in the distribution of categorical variables, including ethnicity, education level, place of residence, only-child status, and family structure.

2.2.2 Network estimation

The network model was estimated using the graphical LASSO method, with model selection guided by the Extended Bayesian Information Criterion (EBIC). All analyses were performed automatically via the estimateNetwork function with the default EBICglasso estimator, which computes partial correlation coefficients as edge weights. The resulting network comprised nodes representing 10 family environment items, 12 health risk behaviors, and 10 mental health symptoms. In the visualizations generated by the qgraph package, edge thickness corresponds to the strength of the association (weight), while blue and red colors denote positive and negative partial correlations, respectively. Node centrality indices, reflecting the relative importance of each variable within the network, were calculated using the centralityPlot function. The mgm package was employed to compute node predictability, visually encoded as the ring area around each node. Consistent with methodological

guidance(Bringmann, 2019), Betweenness and Closeness were omitted due to their instability in psychological networks. Centrality was therefore measured using Strength—the total weight of a node's connections—and bridge centrality, which captures a node's role in linking distinct communities(Burger, 2023). All centrality indices were reported as standardized z-scores. The accuracy and stability of the network model were assessed via bootstrapped Confidence Intervals (CIs) and the Correlation Stability Coefficient (CS-C). A CS-C value ≥ 0.5 is recommended, with values ≥ 0.25 considered acceptable(Wagenmakers, 2018).

2.2.3 Comparison of network characteristics.

Given evidence of gender differences in adolescent mental health(Ye, 2025), family environment, health risk behaviors, and mental health symptoms, networks models were constructed for males and females. Network structures were compared between genders using the NetworkComparisonTest(NCT) package, employing permutation testing(van Borkulo, 2023). with 1,000 permutations evaluating differences in global strength and network structure. Additionally, Holm-Bonferroni-corrected pairwise comparisons were applied to identify significant differences in specific edge weights between the two networks. All network analyses were conducted using R statistical software (version 3.6.0), with a significance level (α) set at 0.05 for hypothesis testing.

3. Result

3.1 Descriptive statistics

Among 1,601 participants, 313 (19.6%) were male and 1,288 (80.4%) female. The overall mean age was 16.7 ± 7.6 years. Compared to females, male participants had higher rates of obesity (36.5% vs 28.8%) and were more likely to have junior high school education or below (39.8% vs 31.0%), reside in urban areas (39.8% vs 31.0%), be one-child (19.2% vs 12.0%), and have left-behind experiences (14.7% vs 8.2%). No significant differences were observed in father's education (p = 0.749), mother's education (*P* = 0.829), family structure (*P* = 0.803), or parental marital status (*P* = 0.690) (Table 1).

Table 1
General demographic characteristics of adolescent participants.

Variables	**Male (n = 313)**	**Female (n = 1288)**	**Total (n = 1601)**	χ^2/t	***P***
Age (X ± SD)	17.4 ± 10.7	16.5 ± 6.6	16.7 ± 7.6	1.792	0.073
BMI (n%)					
Underweight	94(30.0)	417(32.4)	511(31.9)	20.024	< 0.001
Normal	90(28.8)	470(36.5)	560(35.0)		
Overweight	27(8.6)	48(3.7)	75(4.7)		
Obesity	102(32.6)	353(22.0)	455(28.4)		
Ethnicity (n%)					
Han	138(44.1)	577(44.8)	715(44.7)	0.051	0.821
None of the above	175(55.9)	711(55.2)	886(55.3)		
Educational level (n%)					
Junior high school and below	72(23.0)	221(17.2)	293(18.3)	5.753	0.016
High school/tertiary	241(77.0)	1067(82.8)	1308(81.7)		
Residential area (n%)					
Rural	97(31.0)	512(39.8)	609(38.0)	8.201	0.004
Urban	216(69.0)	776(60.2)	992(62.0)		
One-child (n%)					
No	253(80.8)	1134(88.0)	1387(86.6)	11.313	0.001
Yes	60(19.2)	154(12.0)	214(13.4)		
Left-behind (n%)					
No	267(85.3)	1183(91.8)	1405(90.6)	12.625	< 0.001
Yes	46(14.7)	105(8.2)	151(9.4)		
Family structure (n%)					
Nuclear family	232(74.1)	979(76.0)	1211(75.6)	0.995	0.803
Three-generation immediate family	60(19.2)	236(18.3)	296(18.5)		

Variables	Male (n = 313)	Female (n = 1288)	Total (n = 1601)	χ^2/t	*P*
Intergenerational family	11(3.5)	43(3.3)	54(3.4)		
Host family	10(3.2)	30(2.3)	40(2.5)		
Father's educational level (n%)					
Primary and below	50(16.0)	187(14.5)	237(14.8)	1.217	0.749
junior high school	166(53.0)	664(51.6)	830(51.8)		
High school/tertiary	78(24.9)	345(26.8)	423(26.4)		
College and above	19(6.1)	92(7.1)	111(6.9)		
Mother's educational level (n%)					
Primary and below	67(21.4)	254(19.7)	321(20.0)	0.887	0.829
Junior high school	158(50.5)	643(49.9)	801(50.0)		
High school/tertiary	68(21.7)	308(23.9)	376(23.5)		
College and above	20(6.4)	83(6.4)	103(6.4)		
Marital status of parents (n%)					
Stable marriage	256(81.8)	1014(78.7)	1270(79.3)	1.464	0.690
Reorganization of marriage	16(5.1)	74(5.7)	90(5.6)		
Bereaved of one's spouse	7(2.2)	34(2.6)	41(2.6)		
Divorcee	34(10.9)	166(12.9)	200(12.5)		

3.2 Network analysis result

Figure 2 visualizes the network of relationships among family environment factors, health risk behaviors, and adolescent mental health symptoms. The predictability of the nodes is displayed in the form of a circular pie chart, with the average predictability of this adolescent sample being 0.384. Within the family environment-mental health connections, the three strongest edge weights were observed between ‘Conflict’ and ‘Depression’ (weight = 0.057), ‘Achievement Orientation’ and ‘Obsessive-compulsive symptoms’ (weight = 0.040), and ‘Cohesion’ and ‘Depression’ (weight=-0.037). Among the health risk behavior-mental health connections, the three strongest edge weights were ‘Smoking history’ and ‘Hostility’ (weight = 0.062), ‘Sleep deprivation’ and ‘Depression’ (weight = 0.040), and ‘High salt diet’ and ‘Paranoia’ (weight = 0.018). (Supplementary Table S2)

In terms of strength, the 'closeness' node has the highest strength, while the 'depression,' 'anxiety,' and 'paranoia' nodes are also statistically stronger than most other symptoms in the network (Fig. 3). This pattern suggests that family environment may play a significant role, potentially acting as a key contributor or modulator, in the risk for these core mental health symptoms within this student population.

In terms of bridge strength, the nodes 'Conflict', 'Cohesion', 'Sleep deprivation', and 'Depression' became the four most prominent bridge strength values (Fig. 4 and Fig. 5). For the stability analysis of the network, strength showed an excellent level of stability (CS coefficient = 0.750), indicating that 75% of the sample could be dropped without significantly altering the network structure (Fig. 6). The 95% *CI* bootstrap of the estimated edge weights indicated that the estimates were reliable and stable (Supplementary Figure S1). Bootstrap difference tests showed that most comparisons between edge weights were statistically significant.

3.3 Network Comparison Tests

In the comparison of network models between male and female adolescents, there were no significant differences in overall network strength (male network strength = 11.340, female network strength = 11.137, S = 0.203, p = 0.990) or edge weights (M = 0.210, p = 0.052)(see Supplementary Figure S2-S4).

4. Discussion

This study used a network research model to explore family environment, health risk behaviors, and adolescent mental health symptom associations, identifying core adolescent mental health symptoms and multiple pathways of associations between different clusters, as well as exploring variability in the network model across gender.

We found that adolescent mental health problems exhibited strong interconnections, forming a distinct cluster. Within this cluster, depression and anxiety demonstrated the highest strength centrality in the network. Consistent associations were observed in subgroup comparisons across genders, aligning with prior research(Yang, et al., 2024a). Empirical studies indicate that children and adolescents encounter various stressors, including those stemming from academics, parents, and peers, which are associated with a range of serious mental health problems(Chen, 2024). Among these, depression and anxiety are particularly prominent. Globally, it is estimated that approximately 6.2% of adolescents suffer from depression and 6.5% from anxiety(Zhou, 2023). A recent national psychological report in China stated(Fu, et al., 2023)that between elementary and junior high school years, the detection rate of major depression among children and adolescents increased significantly from 3.3% to 8.2%, while the rate of mild depression rose from 9.8% to 16.5%. This growth rate represents the peak across all school stages. Furthermore, a meta-analysis encompassing 2,905,979 school and college students(Guoliang and Xiaoxiao, 2023)indicated that the three most prevalent mental health problems among students in China were depression (22.2%), self-injurious behaviors (20.1%), and anxiety (18.1%). These findings strongly align with the results of the present study.

The high prevalence of depression and anxiety in the adolescent population is a complex and multifactorial phenomenon. According to the theory of the biopsychosocial medical model, adolescents' mental health is influenced by biological, psychological, and social factors. Among these, the family functions as an important buffer system, with family conflict, parental separation, and emotional neglect, among others, all being important risk factors for adolescent depression and anxiety.

In this study, 'Cohesion' serves as the most intense node within the family environment, and its extensive connections highlight the central protective role of emotional support and cohesion in adolescent mental health networks. Meanwhile, 'Conflict' and 'Cohesion,' as bridge nodes, indicate that family environment factors are key hubs linking domains of health-risk behaviors and mental health symptoms. Aligned with our study findings, A cross-sectional survey of 507 adolescents(Nguyen, 2024)showed that a family environment characterized by poor parent-child relationships and significant conflict significantly increased adolescent depression risk. Therefore, how does the family environment affect adolescent mental health? Research consistently demonstrates that positive family and parent-child relationships are crucial for the development of children's emotion regulation skills and mental health(Ratliff, 2023). A meta-analysis showed that emotion regulation significantly mediates the association between unsupported emotional socialization and internalizing symptoms in children and adolescents(Lin, 2024), whereas poor family functioning, such as family conflict, undermines children and adolescents' ability to regulate their emotions, which in turn contributes to psychopathology, including depression and anxiety(Morris, 2007). This finding suggests that family-based therapeutic approaches aimed at improving communication patterns and emotional responsiveness may represent a crucial intervention strategy for preventing adolescent mental health problems.

In addition to the aforementioned family environment factors, adolescents' lifestyle behaviors are also important influences on mental health issues. This study found that 'lack of sleep,' as a key bridge among health risk behaviors, is directly linked to the core psychological symptom of 'Depression'. Consistent with our study, a Florida survey found that sleep-deprived adolescents had higher odds of depressive symptoms(Gunderson, 2023), and longitudinal studies further elucidate the temporal nature of this relationship, indicating that sleep deprivation increases the risk of depression in adolescents, with shorter sleep duration predicting increased depressive symptoms at follow-up(Liu, 2020). Psychologically, sleep deprivation not only reduces overall levels of positive emotions but also impairs emotional responses to rewarding experiences(Zhao, 2024). Notably, dysfunction in the brain's reward system is clinically associated with anhedonia(Corral-Frias, 2016), a core symptom of depression. Biologically, sleep deprivation adversely affects adolescent mental health by inducing hyperactivation of the hypothalamic-pituitary-adrenal (HPA) axis stress response. Cortisol, a key mediator of the HPA axis, is highly sensitive to acute stress in both adults and children(LaVoy, 2020). Furthermore, sleep deprivation leads to hyperactivation of the HPA axis, leading to an increase in circulating inflammatory cytokines, which have also been widely implicated in the pathogenesis of depression(Nettis, 2021;Nikkheslat, 2020). Regarding sleep deprivation, the mechanisms proposed in the literature provide a theoretical framework for future research; however, these remain hypotheses requiring further

validation, and the findings should be interpreted with caution given the cross-sectional nature of the current data.

A previous study on network analysis of parenting styles and adolescent depression and anxiety symptoms(Suo, 2025) identified gender differences in network structure but not global strength, whereas our study observed no significant gender differences in either global strength or network structure. This discrepancy may be attributed to two factors: 1) Uneven distribution of sample size: After gender stratification, the male subgroup comprised only 313 participants (19.5%), and the small sample size is likely to reduce statistical validity, making it difficult to detect the statistical significance of the differences. 2) Sample homogeneity: Our study subjects were recruited exclusively from two higher vocational colleges in Nanning City, and their socio-economic status, cultural backgrounds, and parenting practices likely resulted in reduced variability within the adolescent group. This homogeneity may account for the minimal differences observed in both network structure and strength. Therefore, this result of no significant gender differences should be interpreted with caution and needs to be validated in future independent samples with matched sample sizes.

There are several limitations of this study: (1) This study is a cross-sectional study, which cannot deduce the real causal relationship among the three, and can only provide a basis for the subsequent study of the longitudinal dynamic network structure. (2) The source of samples in this study is rather limited; participants were recruited exclusively from two higher vocational colleges in Nanning City, limiting the generalizability of the findings. A multi-center survey can be used in the follow-up study to improve the extrapolation of the results. (3) We used a web-based self-administered questionnaire in the study, and the sample size excluded in the subsequent analysis was large, accounting for 28%. In response to these two problems, we took corresponding measures, on the one hand, we collected data in order to ensure the quality of the questionnaire, and the following quality control was carried out in the data collection stage. First, the support of school leadership was sought to improve the response rate and compliance. Second, we excluded invalid samples with less than 10 minutes of response time to improve data quality. Finally, we included trap questions in the questionnaire to ensure that participants read and answered carefully. On the other hand, we compared the demographic and other characteristics between the included and excluded samples during the data analysis stage. No statistically significant differences in demographics were found (see Supplementary Table S3), suggesting the analyzed sample remains representative despite exclusions.

5. Conclusion

In summary, this study employed network analysis to examine the interrelationships among family environment, health risk behaviors, and adolescent mental health symptoms. Our findings highlight depression and anxiety as the most prominent core symptoms in this population. Key factors strongly associated with adolescent mental health problems include ‘Cohesion’ and ‘Conflict’ within the family environment, as well as health risk behaviors such as ‘Sleep deprivation’. Therefore, understanding and

addressing adolescent mental health risk necessitates a holistic and integrated approach that considers the complex interplay of these diverse factors.

Abbreviations

SEM
structural equation modeling
KMO
Kaiser-Meyer-Olkin
MSSMHS
Mental Health Scale for Chinese Middle School Students
FES-CV
The Chinese version of the Family Environment Scale
EBIC
Extended Bayesian Information Criterion
CS-C
Correlation Stability Coefficient
NCT
NetworkComparisonTest
HPA
hypothalamic-pituitary-adrenal

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Nanning Fifth People's Hospital(SL2024-17-02). Participation in the study was voluntary and anonymous. Informed consent was obtained from all participants and from the legal guardian(s) of any participation under the age of 16. Participants signed a consent form before completing the questionnaire.

Consent for publication

Not applicable.

Competing interests

All authors declare they have no conflicts of interest.

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Author Contribution

J L: conceptualization, methodology, software, formal analysis, writing - review and editing. H F and D Z: conceptualization, methodology, and funding acquisition. X F, Y L, and B B: conceptualization, data collection. X L: methodology, writing. G H, S H, J L, and Y W : conceptualization, formal analysis. All authors reviewed the manuscript.

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Data Availability

The data that support the findings of this study are available from the corresponding author (nnwyy0927@163.com) upon reasonable request.

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Figures

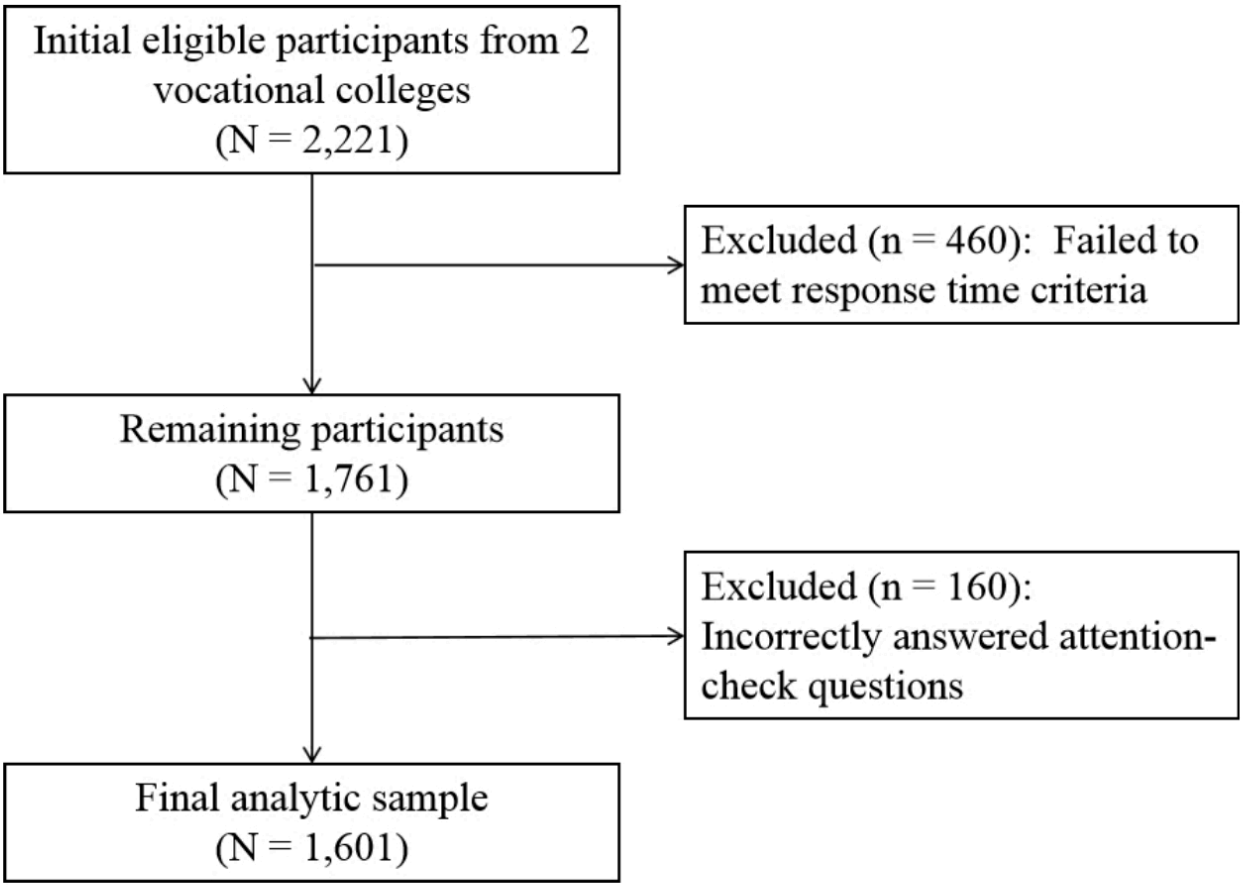


Figure 1

The flowchart of the participant enrolment procedure

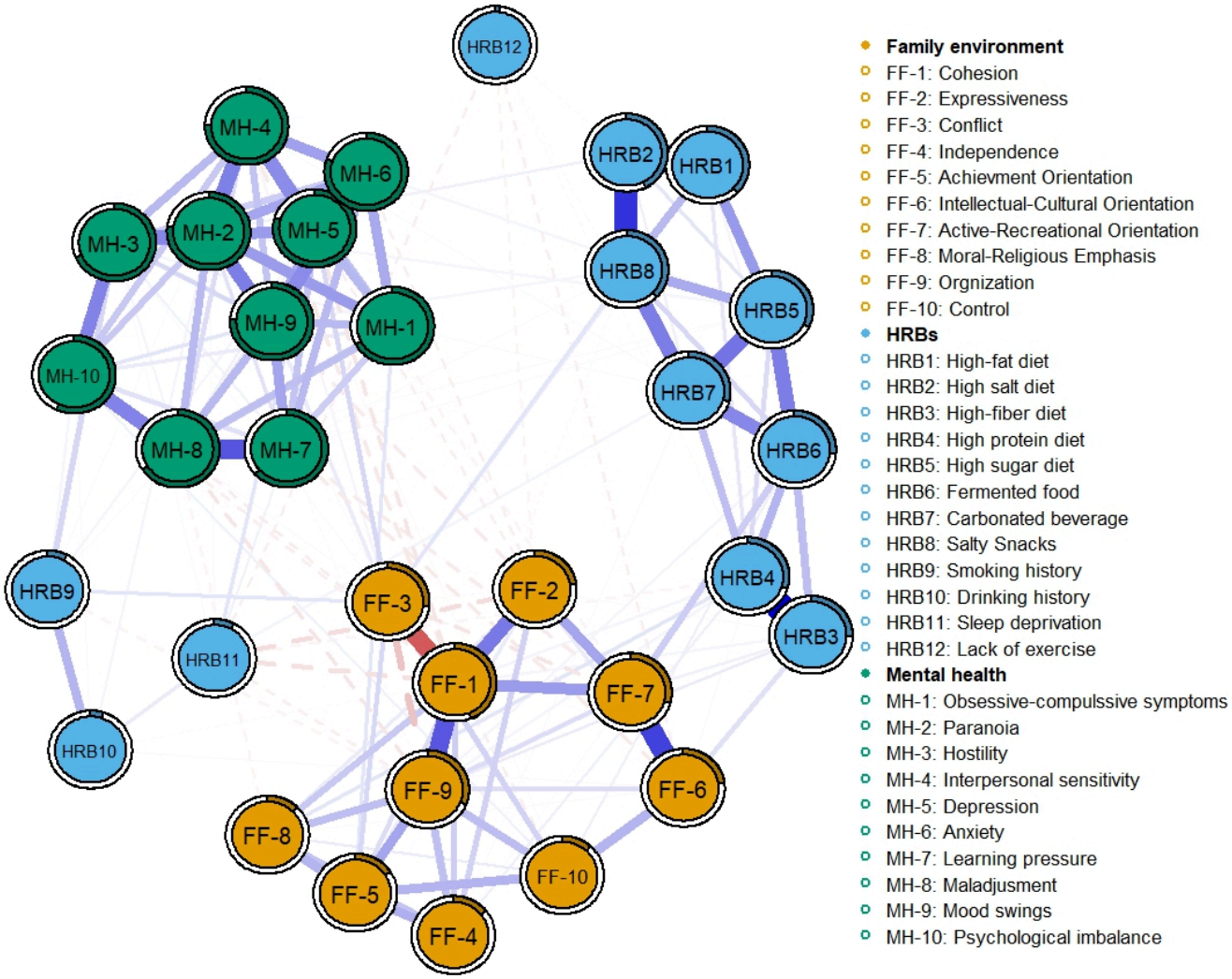


Figure 2

Network estimates of family environment, health risk behaviors, and adolescent mental health symptoms

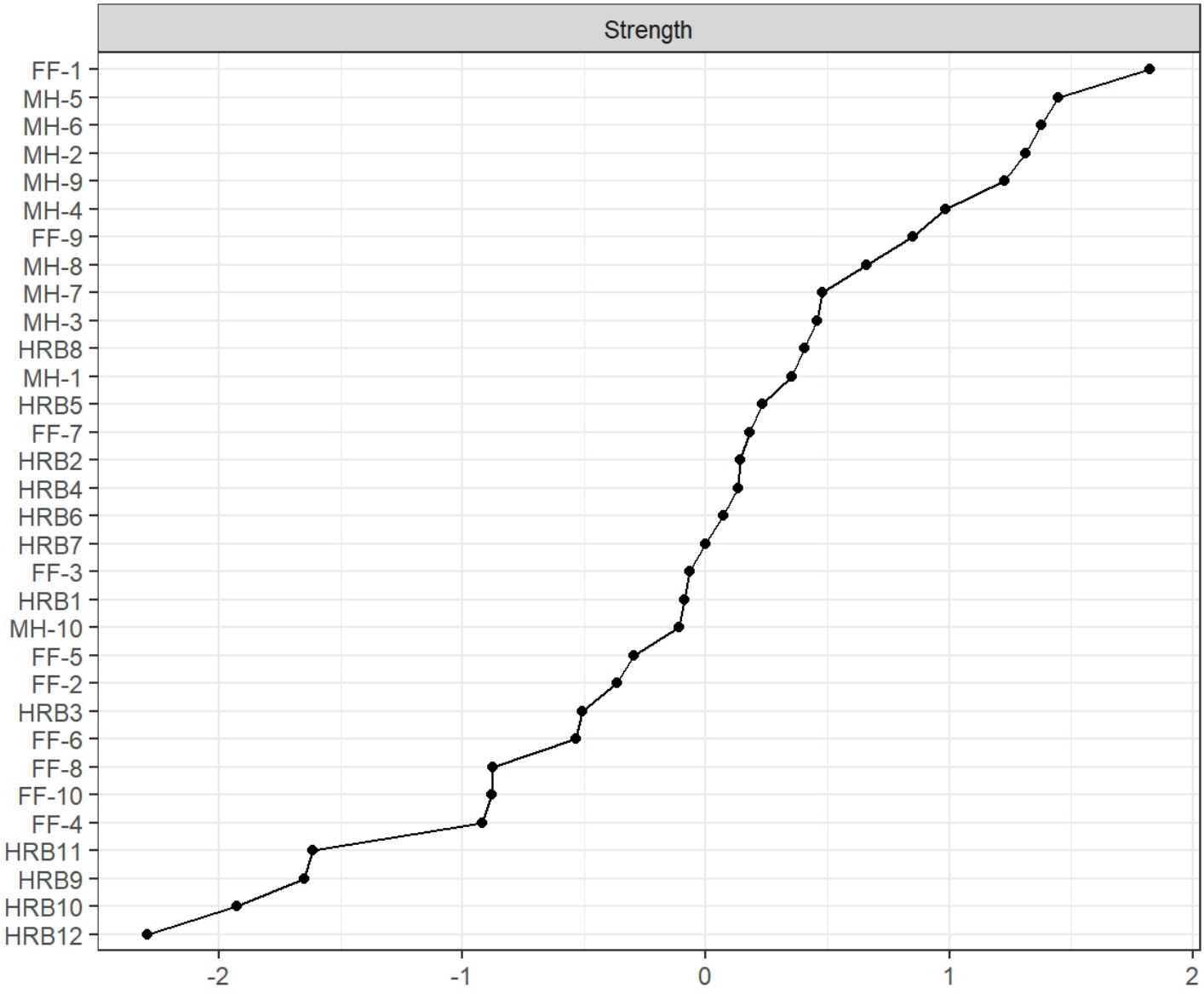


Figure 3

Centrality measurements of network nodes

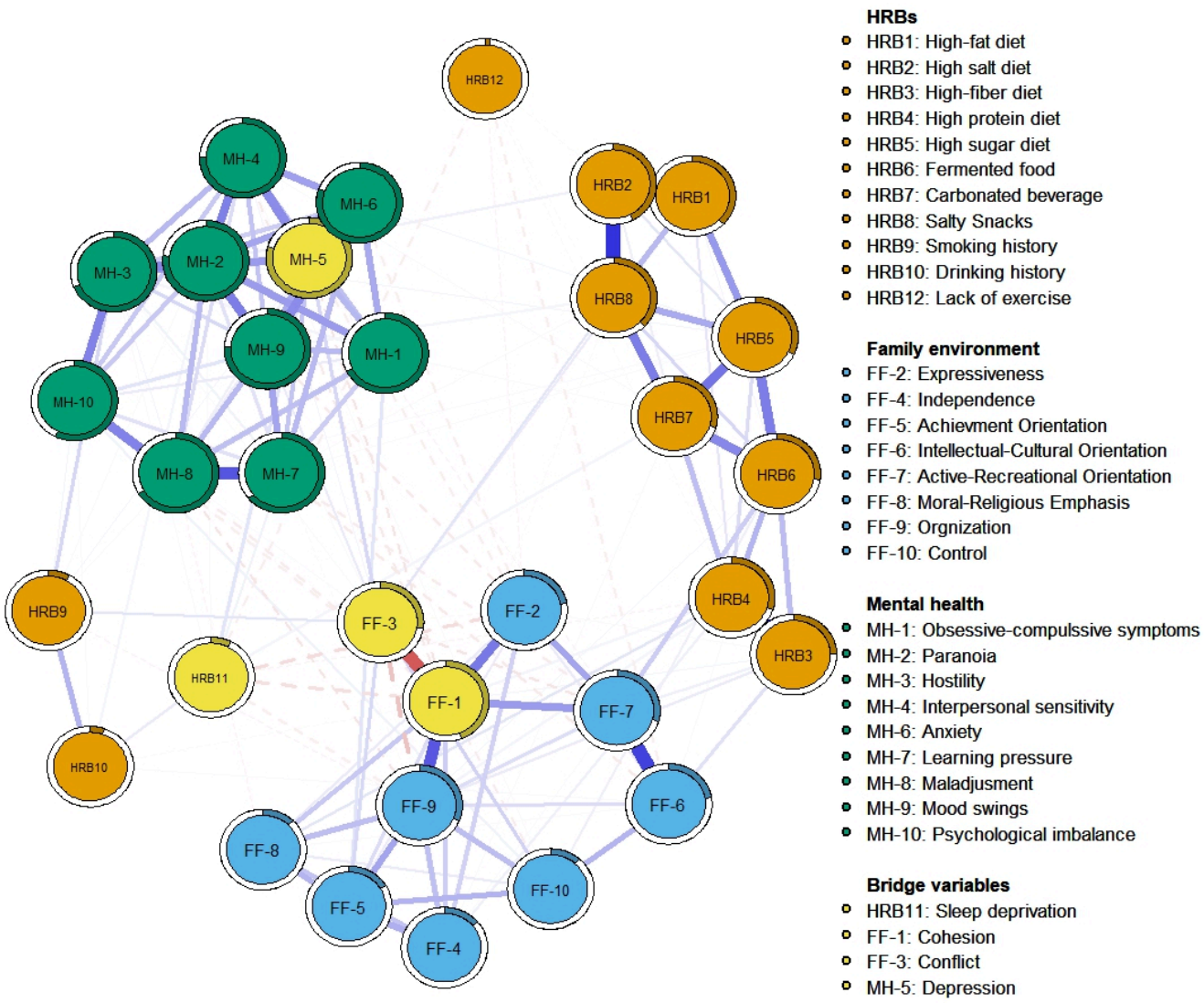


Figure 4

The bridge nodes in the network structure of family environment, health risk behaviors, and mental health among adolescents

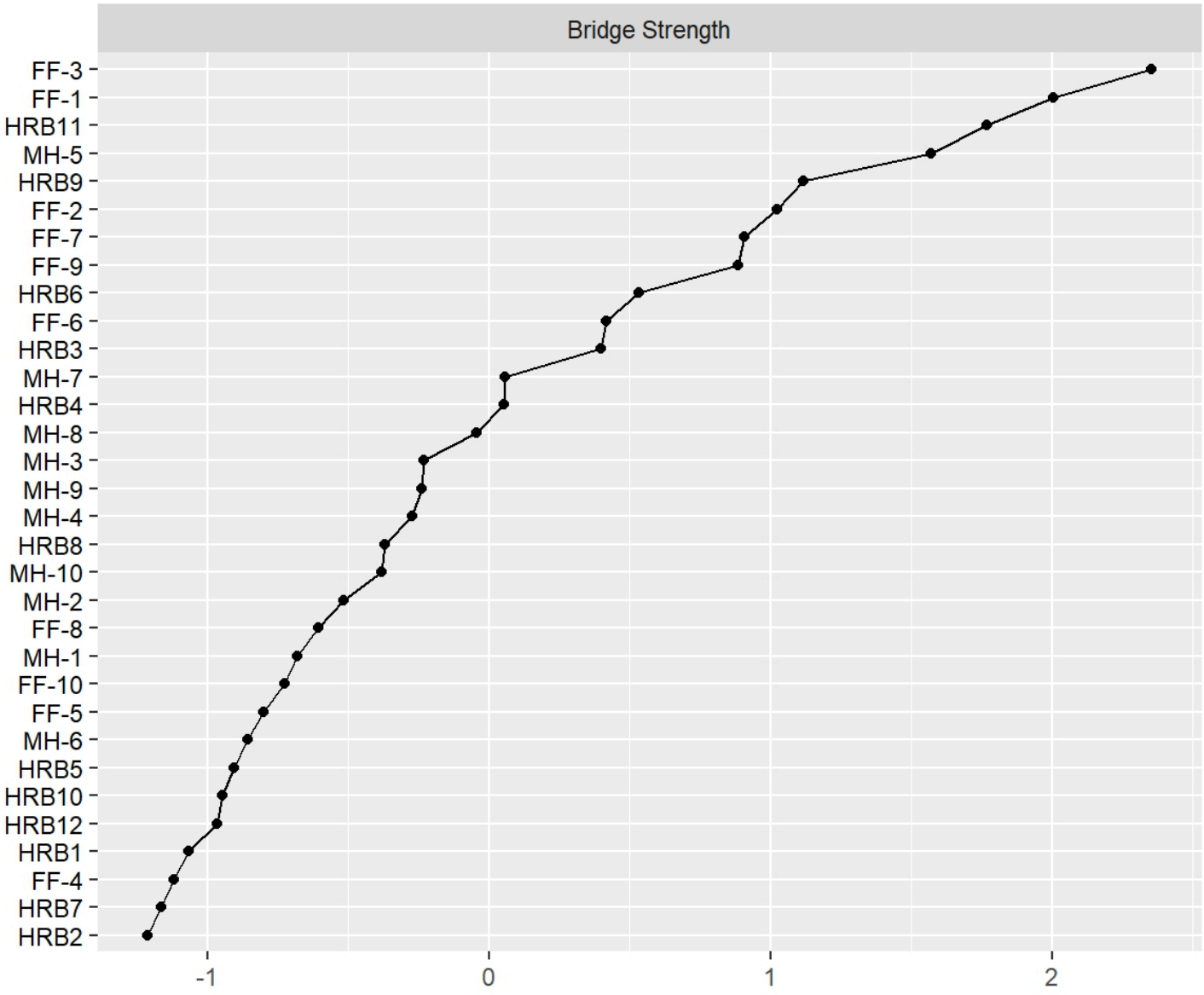


Figure 5

Bridge strength of nodes across family environment, health risk behavior, and mental health communities

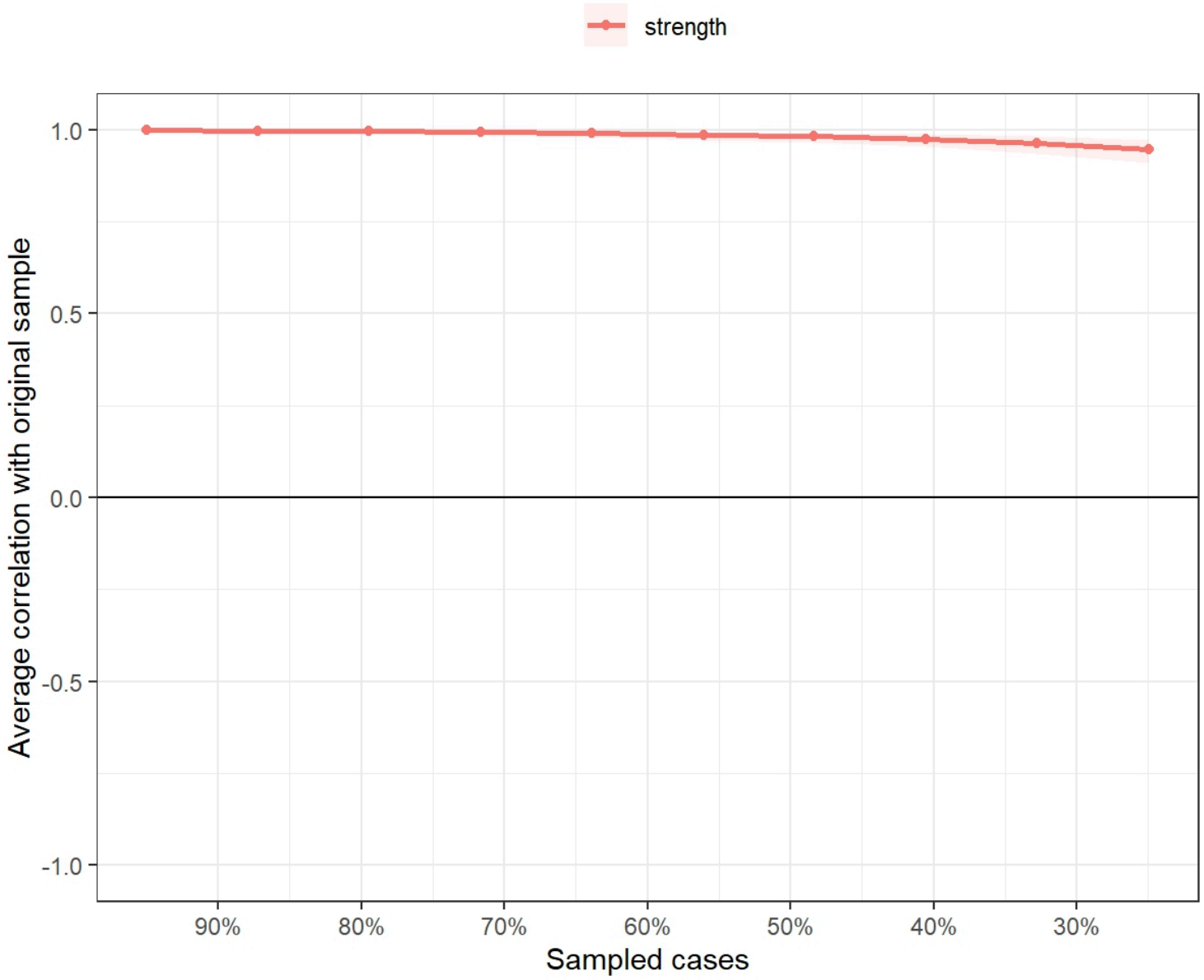


Figure 6

Robustness testing of network structures

Supplementary Files

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- SupplementaryMaterial.docx