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Personality perspective on depression and anxiety symptoms among Chinese adolescents and young adults: a two-sample network analysis

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Abstract

Background The mental health burden among adolescents has been increasing, impacting individuals even before formal diagnosis of common mental disorders. Although personality traits, as key indicators of mental health conditions, play a crucial role in the development of mental disorders, there is a gap regarding the trait-to-symptom pathways and similarities and differences between adolescents and young adults.

Methods A total of 860 adolescents and 1751 young adults participated in this study. The Chinese Big Five Personality Inventory assessed the Big Five traits, while depression and anxiety symptoms were measured using the Patient Health Questionnaire-9 and the Generalized Anxiety Disorder-7, respectively. Network analysis computed the bridging centrality of Big Five traits and elucidated trait-to-symptom pathways. Furthermore, network comparison was applied to compare network structure between adolescents and young adults.

Results In both age groups, neuroticism exhibited a transdiagnostic activating effect on depression and anxiety. Conscientiousness demonstrated the strongest protective effect against depression, whereas agreeableness was most protective against anxiety. In both samples, neuroticism primarily influenced symptoms associated with negative emotions and thoughts. Comparatively, extraversion exhibited a significant increasing protective effect against depression throughout adolescence, while neuroticism increasingly activated anxiety symptoms.

Conclusions This study highlights the potential to utilize personality traits for early detection and precise intervention in adolescent populations, providing actionable insights. By identifying the level of neuroticism, we can effectively detect high-risk adolescent individuals prior to formal diagnosis. By delineating the neuroticism-to-symptom pathways, we can implement targeted intervention on their pathological interactions.

Keywords Big five traits, Depression, Anxiety, Network analysis

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Introduction

Depression and anxiety are among the most common mental disorders global wide [1, 2], constituting a major challenge to both society and medical service. The prevalence of depression and anxiety has continued to rise sharply among adolescents and young adults over the past decade, with global prevalence of 2.69% to 3.85% for depression and 4.34% to 4.58% for anxiety [3–5]. The onset of mental disorders first peaks around the age of 14 [6], during which individuals experience rapid neurodevelopment and transition in their emotional and cognitive functions [7] and become extremely vulnerable to social stressors or public crisis [8–10]. The early onset of common mental disorders in adolescents often indicates less desirable clinical outcomes and heavier disease burden [11, 12] and calls for early identification and intervention [13]. An expansion of adolescence to the early adulthood of 24 has highlighted the continuous effect of neurological and social development on mental well-being [14, 15]. During the short intervals of biological and social transition, the complexity of how depression and anxiety are influenced requires more empirical evidence.

Personality has been proved to be a common and stable indicator for mental illnesses [16]. The proposal of the Big Five has largely facilitated the personality-psychopathology research [17, 18]. The Big Five indicated a general level of personality traits, which were integrated by a number of specific facets in a hierarchical order. Based on this consensus, subsequent studies have made enormous effort to reveal the correlation between personality traits and mental disorders [19, 20]. For example, personality traits could predict the relapse or recurrence of psychiatric symptoms [21, 22], or moderated the association between stressors and mental disorders [23, 24]. However, much of the research regarded mental disorders as categorial diagnoses and ended up with homogenous conclusions [16]. In this way, it neglected the potential heterogeneity of distinct symptoms and the trait-to-symptom pathways remained ambiguous. Considering differential relationships between personality traits and distinct symptoms, a more fine-grained understanding of personality-psychopathology at the symptom level is needed.

The network theory has rapidly developed as an alternative way to conceptualize mental disorders [25, 26]. Unlike the latent variable theory which assumes a latent cause leads to the observed symptoms, the network theory posits that mental disorders arise from the constellation of heterogeneous symptoms and their interactions [25, 27]. In this way, symptoms are no longer passive representations of a common cause; they are active agents that can directly influence each other [28]. Additionally, external factors such as personality can activate or inhibit the symptom network through bridging connections to certain symptoms. With the network approach, we can visualize the symptom network and observe trait-to-symptom pathways [29–31]. The personality traits with strong activating effect serve as potential targets for early detection and prevention [25], while symptoms that are directly influenced by personality traits are central for further intervention [32]. More recent research has compared symptom networks between different groups to demonstrate their similarities and distinctions [33]. To summarize, the network analysis has become an important tool for studying mental disorders and how external factors influence them [34–36].

Previous research has established that adolescence and young adulthood are critical periods for the onset of depression and anxiety [4, 6]. Meanwhile, personality traits, which are gradually shaped during this time, can influence and predict the onset of depression and anxiety [37, 38]. As the mental health burden increases, it is pivotal to investigate the non-clinical populations prior to official diagnosis for prevention purposes. Additionally, following the peak incidence of adolescent depression and anxiety at age 14, the effect of personality traits continues to evolve and persisted into early adulthood [4]. Within both age intervals, significant biological and social changes take place, underscoring the necessity to compare their symptom networks.

This study attempted to demonstrate the network structure between the Big Five traits and two common mental disorders, depression and anxiety, among adolescents and young adults. We adopted the network analysis to reveal the trait-to-symptom pathways and compared the network characteristics between adolescents and young adults. The aim of this study is three-fold: 1) identify the bridging effect of five personality traits; 2) demonstrate important trait-to-symptom pathways; and 3) show the common and specific characteristics between networks among adolescents and young adults.

Method

Participants

Data for the adolescent sample were collected from middle school students in Shaanxi Province, utilizing traditional paper-and-pencil assessments. Out of the initial pool of responses, 25 were excluded from subsequent analysis due to non-response to demographic items or incorrect responses to designated attention check items. Finally, the adolescent sample consisted of 860 participants, with 48.37% identified as female and a mean age of 15.22 years (SD = 0.47, range = 14–17 years). The young adult sample comprised undergraduate students from five universities in Shaanxi Province, through online

survey platform Wenjuanxing, with survey links disseminated via WeChat. After screening, 274 responses were excluded due to participants being under the age of 18, failing attention check items, or providing incomplete demographic information. Eventually, the young adult sample consisted of 1751 participants, with 58.60% identified as female and an average age of 19.11 years (SD = 1.26, range = 18–23 years).

In accordance with the institutional review board (Ethics Application No: KY20234188–1), the current study, which is classified as low-risk research in school settings involving children aged 14 and above, received approval from the Ethics Committee of the First Affiliated Hospital of the Fourth Military Medical University. Specifically, for participants under the age of 16, approval from either the school director or the teacher is deemed adequate and serves as a substitute for parental consent. For this study, approval was obtained from the head psychological education teacher prior to the distribution of the questionnaires. In addition, informed consent was obtained from all participants before they engaged in the study, ensuring that they were fully aware of the study's purpose, procedures, and any potential risks. All participants were informed that their participation was voluntary and that they could withdraw at any time without any negative consequences.

Measures

The study utilized the Chinese Big Five Personality Inventory-15 to assess the participants' Big Five traits, including extraversion, agreeableness, conscientiousness, neuroticism, and openness, each containing three items [39]. The internal consistency of each dimension (neuroticism, conscientiousness, agreeableness, openness and extraversion) was 0.800, 0.611, 0.823, 0.853 and 0.843 respectively in adolescents; and 0.818, 0.673, 0.715, 0.831 and 0.796 in adults. Symptom severity of depression and anxiety were evaluated using the Patient Health Questionnaire-9 (PHQ-9) for depression [40] and the Generalized Anxiety Disorder-7 (GAD-7) scale for anxiety [41]. The reliability analysis indicated satisfactory internal consistency for both measures, with Cronbach's alpha coefficients of 0.86 in adolescents and 0.89 in young adults for the PHQ-9; and 0.91 in adolescents and 0.92 in young adults for the GAD-7.

The descriptive statistical analysis was conducted using the IBM SPSS software (version 27.0, IBM Corp., Armonk, N.Y., USA). Given that all item scores were found to be non-normally distributed (Shapiro–Wilk tests, $p < 0.05$), the Mann–Whitney U tests were employed to compare the adolescent and young adult samples in terms of PHQ-9 and GAD-7 scores and the Big Five traits.

Network estimation and visualization

Four regularized partial correlation Gaussian Graphical Models were estimated to analyze the Big Five-depression and Big Five-anxiety relationship in both adolescents and young adults. Each node represented a Big Five trait or a depression/anxiety symptom, with edges indicating regularized partial correlations between nodes. We used the graphical LASSO (Least Absolute Shrinkage and Selection Operator) method for regularization, setting the tuning parameter at 0.5 for balance between sensitivity and specificity [42]. The resulting sparse networks highlighted significant edges. To aid visual comparison, we utilized the average layout approach to present multiple networks, noting that node placement does not imply bridge centrality.

To analyze inter-community connections, we divided the network into two communities: Big Five traits and symptoms of depression or anxiety. We calculated the bridge expected influence (BEI) for each node, quantifying the aggregate weight of inter-community edges associated with it. Positive BEI values indicate the activating effects of personality trait nodes on depression or anxiety symptoms, while the negative BEI values indicate the protecting effects. These calculations were conducted using the R package "Networktools" [43].

Network stability and accuracy

For each network, bootstrap analyses were conducted to assess edge weight reliability and centrality index robustness [44]. Nonparametric bootstrap analysis with 1000 samples generated 95% confidence intervals for network edges, ensuring precise estimates. Subsequently, case-dropping bootstrap analysis, also with 1000 samples, computed the correlation stability (CS) coefficient of each network, with a value of 0.25 or higher considered acceptable and 0.5 or higher optimal. Bootstrap difference tests were then performed on bridge centrality indices and edge weights to detect significant differences.

Network comparison

The networks of adolescents and young adults were compared using the Network Comparison Test from the "NetworkComparisonTest" package in R [45]. This test employs permutation testing, with 1000 permutations in our study, to contrast the two networks. Specifically, we compared inter-community edge weights and BEI of the Big Five-depression and Big Five-anxiety networks in adolescents and young adults. Given the exploratory nature of our study and no prior hypotheses about edge differences, corrections for multiple comparisons were not applied during testing.

Results

Descriptive analysis

Descriptive statistics of both samples are displayed in Table 1. In the adolescent group, significantly higher scores were observed across all depression and anxiety symptoms. Specifically, 295 adolescents (34.30%) met the clinical cut-off score for depression (PHQ-9 total score ≥ 10), compared to 215 young adults (12.28%) above the cut-off score. Similarly, 237 adolescents (27.56%) met the clinical cut-off score for anxiety (GAD-7 total score ≥ 10), compared to 93 young adults (5.31%) above the cut-off score.

The Big Five-depression networks

The Big Five-depression networks of adolescents and young adults, as well as the BEI values, are shown in Fig. 1. Among all Big Five traits, neuroticism consistently exhibited strongest positive bridging effect on the onset of depression symptoms in both groups (adolescents = 0.60, young adults = 0.65), while conscientiousness exhibited the most negative bridging effect (adolescent = -0.18, young adult = -0.21). The CS coefficients were 0.67 (in adolescents) and 0.75 (in young adults), suggesting the adequate stability of the BEI estimation for the two Big Five-depression networks (Fig S1 and S2). Bootstrap difference tests are shown in Fig S1 and S2as well.

The Big Five-depression edge weights of adolescents and young adults are shown in Table S1 and S2 respectively. In general, neuroticism represented positive correlations with all nine depression symptoms in both adolescents and young adults. In both groups, the strongest linkage emerged between neuroticism and "feeling of worthlessness" (D6, adolescents = 0.13 and young adults = 0.14), "depressed mood" (D2, adolescents = 0.11 and young adults = 0.11), and "thoughts of death" (D9, adolescents = 0.10 and young adults = 0.10). On the other hand, conscientiousness showed negative correlations with depression symptoms, with the strongest connection with "concentration difficulties" (D7, adolescents = -0.09 and young adults = -0.14). Agreeableness also had negative correlations with certain depression symptoms, with the strongest with "thoughts of death" (D9, adolescents = -0.09 and young adults = -0.05). Openness and extraversion mainly showed negative correlations as well. Additionally, conscientiousness and openness were positively correlated with one depression symptom in young adults, respectively. Bootstrap 95% confidence intervals and difference tests for edge weights are illustrated in Fig S1 and S2.

Notably, the network comparison revealed three exclusive Big Five-depression edges among young adults: openness- "appetite changes" (D5, $p = 0.04$), extraversion- "anhedonia" (D1, $p = 0.02$), and extraversion- "thoughts of death" (D9, $p = 0.02$). Moreover, the absolute value of the BEI for extraversion was significantly higher in young adults ($p = 0.02$), suggesting its increasing deactivating effect on depression across adolescence.

Table 1 Descriptive statistics on the Big-Five traits and depression and anxiety symptoms

Variables	Adolescent		Young adult		*p*
	Mean	SD	Mean	SD	
Dimensions of Big Five personality					
Neuroticism (NEU)	11.11	3.71	8.74	3.43	< 0.001
Conscientiousness (CON)	11.64	2.94	12.37	2.63	< 0.001
Agreeableness (AGR)	12.71	3.52	13.35	2.85	< 0.001
Openness (OPE)	11.56	3.51	10.87	3.16	< 0.001
Extraversion (EXT)	11.03	3.93	11.03	3.51	0.652
Symptoms of depression					
Anhedonia (D1)	1.14	0.74	0.84	0.59	< 0.001
Depressed or sad mood (D2)	1.04	0.81	0.71	0.57	< 0.001
Sleep difficulties (D3)	0.90	0.94	0.72	0.73	< 0.001
Fatigue (D4)	1.24	0.90	0.86	0.64	< 0.001
Appetite changes (D5)	0.82	0.91	0.65	0.66	0.003
Feeling of worthlessness (D6)	1.08	0.98	0.69	0.67	< 0.001
Concentration difficulties (D7)	1.12	0.88	0.86	0.71	< 0.001
Psychomotor agitation/retardation (D8)	0.59	0.80	0.40	0.58	< 0.001
Thoughts of death (D9)	0.58	0.87	0.19	0.45	< 0.001
Total score	8.50	5.42	5.91	4.09	< 0.001
Symptoms of anxiety					
Nervousness or anxiety (A1)	1.33	0.82	0.61	0.63	< 0.001
Uncontrollable worry (A2)	1.15	0.92	0.54	0.65	< 0.001
Worry too much (A3)	1.13	0.93	0.66	0.70	< 0.001
Trouble relaxing (A4)	1.17	0.97	0.58	0.67	< 0.001
Restlessness (A5)	0.75	0.86	0.40	0.57	< 0.001
Irritable (A6)	1.03	0.93	0.59	0.66	< 0.001
Afraid something will happen (A7)	0.78	0.91	0.38	0.56	< 0.001
Total score	7.34	5.12	3.76	3.65	< 0.001

The Big Five-anxiety networks

The Big Five-anxiety networks of adolescents and young adults and their BEI values are demonstrated in Fig. 2. In both groups, neuroticism represented the most positive bridging effect on the onset of anxiety symptoms (adolescent = 0.54, young adult = 0.63), and agreeableness had the most negative bridging effect (adolescent = -0.11, young adult = -0.16). The CS coefficients were 0.75 (in adolescents) and 0.75 (in young adults), suggesting the sufficient stability of the BEI estimation (Fig S3 and S4). Bootstrap difference tests of the two networks are shown in Fig S3 and S4.

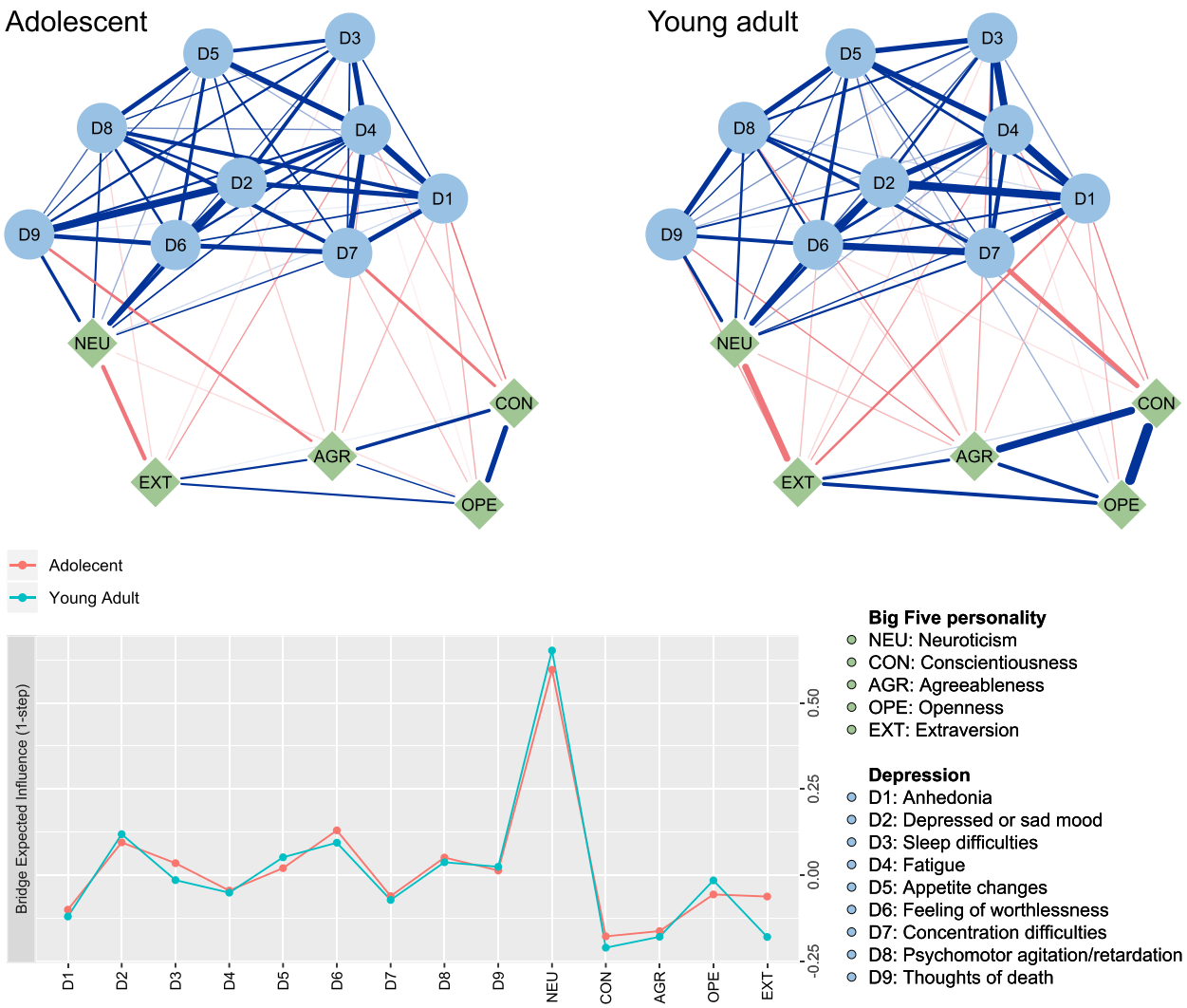

Fig. 1 The Big Five-depression networks in adolescents (upper left) and young adults (upper right), as well as the BEI values of each node (lower left). Bule edge represent positive partial correlations, while red edges represent negative partial correlations. The thicker the edge, the stronger the correlation

The Big Five-anxiety edge weights of adolescents and young adults are illustrated in Table S3 and S4 respectively. In both groups, neuroticism consistently showed negative correlations with anxiety symptoms, with the strongest with "worry too much" (A3, adolescent = 0.24 and young adult = 0.18) and "afraid something will happen" (A7, adolescent = 0.17 and young adult = 0.21). On the contrary, we found negative correlations between other Big Five traits and anxiety symptoms. Fig S3 and S4 demonstrate bootstrap 95% confidence intervals and difference tests for edge weights of the two networks.

It is worth noting that the network comparison test identified three novel Big Five-anxiety edges that were significantly different: neuroticism- "irritable" (A6, $p = 0.01$) and extraversion- "nervousness" (A1, $p = 0.02$) in young adults; and openness- "nervousness" (A1, $p = 0.01$) in adolescents. Furthermore, the BEI value of neuroticism was observed to be marginally higher in young adults ($p = 0.06$), indicating its climbing trend for activating anxiety symptoms.

Discussion

This study investigated the trait-to-symptom relationships between the Big Five traits and depression and anxiety symptoms among adolescents and young adults. We found that, in both groups, neuroticism represented as the transdiagnostic risk factor on depression and anxiety symptoms. Specifically, the neuroticism-to-symptom pathways mainly relied on emotion-related symptoms ("feeling of worthlessness" and "depressed mood" in

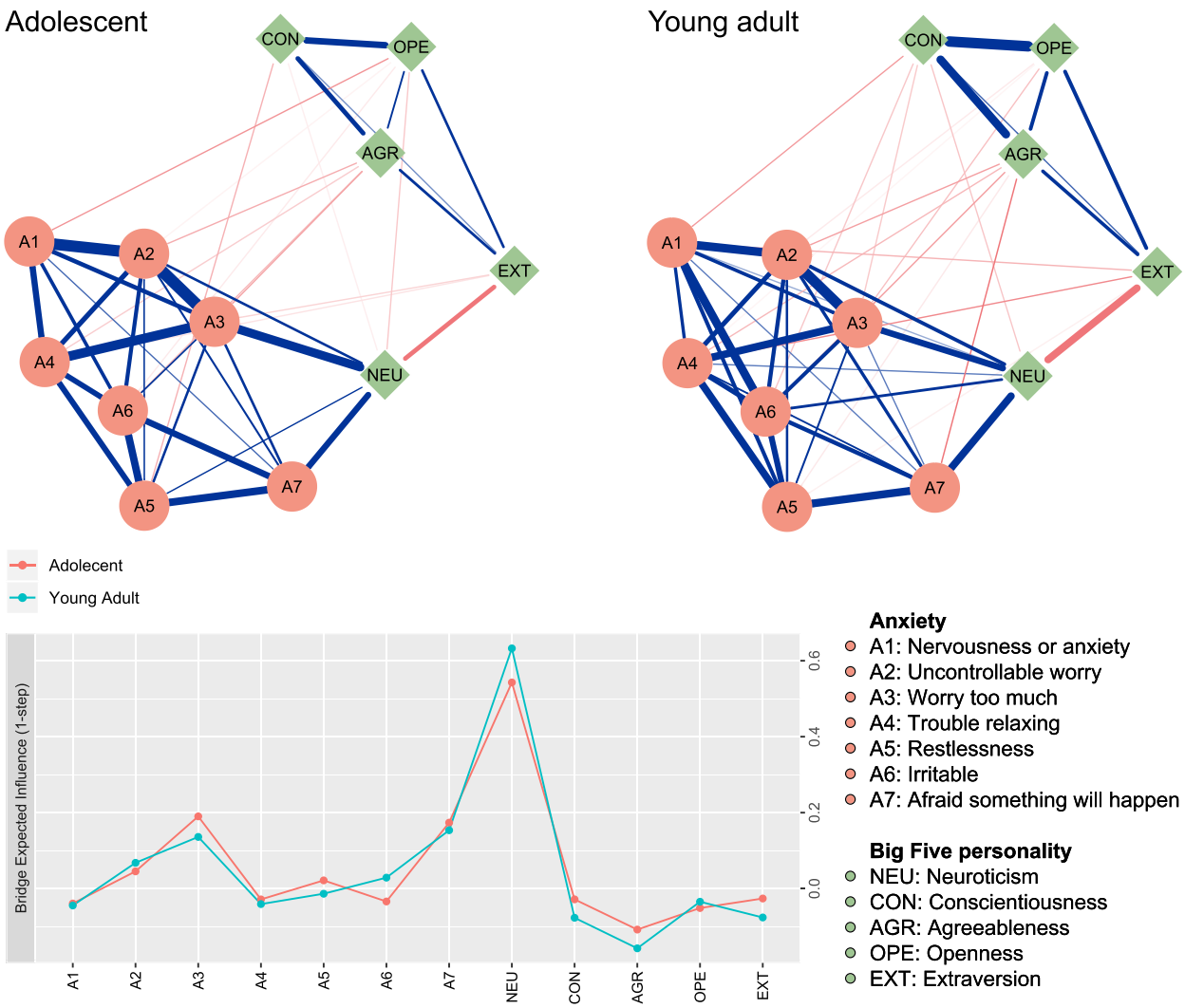

Fig. 2 The Big Five-anxiety networks in adolescents (upper left) and young adults (upper right), as well as the BEI values of each node (lower left). Bule edge represent positive partial correlations, while red edges represent negative partial correlations. The thicker the edge, the stronger the correlation

depression; and "worry too much" and "afraid something will happen" in anxiety). Conscientiousness and agreeableness were the most prominent protecting traits for depression and anxiety respectively. The network comparison revealed that extraversion had more significant protecting effect on depression for young adults, which may due to its exclusive correlations to "anhedonia" and "thoughts of death". While neuroticism had more pathogenic effect on anxiety in young adults, probably because of extra linkage with "irritable".

Neuroticism was indicated to be the general risk factor for common mental disorders [16], which was conformed in our study among adolescents and young adults. However, the gap of previous studies was the specific pathways of how neuroticism influenced mental disorders. In this study, we found that neuroticism activated depression and anxiety mainly through emotion-related symptoms, which stayed consistent across the two samples. As initially defined, neuroticism indicates the tendency to experience negative emotions and psychological distress [46]. People with high levels of neuroticism are sensitive to negative affect, have low self-esteem, and own irrational perfectionistic beliefs [47]. That coincided with the finding that the strongest pathways between neuroticism and depression and anxiety were based on negative emotions and thoughts. Recent study has demonstrated that biological process were also involved in the pathway between neuroticism and mental health outcomes [48].

Conscientiousness was thought to be the general protecting factor for most mental disorders as well [16].

In our study, conscientiousness exhibited the strongest negative bridging effect on depression symptoms, suggesting its prominent protecting effect on depression. People with high conscientiousness tend to have strong sense of purpose and aspiration [46] and are more likely to adopt problem-solving approach for emotion regulation [47]. Thus, conscientiousness are thought to be more effective in countering adversity and depressive emotions [49]. On the other hand, the prominent protection effect of agreeableness on anxiety was inconsistent with the previous review [16], which can be explained by its association with heightened social sensitivity during adolescence [50]. Adolescents experience physical, cognitive and social changes, which makes them particularly sensitive to social environment, especially peer evaluation. Peer rejection may trigger their feelings of unworthiness, while peer acceptance provides companionship and support. Those with higher levels of agreeableness are more likely to build harmonious relationships and cope effectively with social stressors. These mechanisms may explain why agreeableness demonstrates a more pronounced protective effect against anxiety in adolescents compared to other age groups [50].

The comparison of the network structure between the two samples across adolescence revealed novel findings, which extended our findings and highlighted their differences in personality-psychopathology relationship. The protecting effect of extraversion on depression was significantly higher in young adults, suggesting the plasticity of the extraversion-depression pathways across adolescence. The increasing protecting effect of extraversion might base on its novel correlations with "anhedonia" and "thoughts of death", which coincided with core symptoms of how neuroticism influenced depression. The differing mechanisms of extraversion's protective effect on depression between adolescents and adults may be better understood through a developmental psychology lens. As individuals transition into adulthood, they often experience significant changes in social roles, responsibilities, and expectations. Thus, the emerging exposure and requirement under social settings make them vulnerable to social withdrawal, especially for those who struggle or avoid social contexts, which was shown to be associated with the lack of academic motivation and emotional dysfunctions such as depression, suicidal ideation or self-harm [51, 52]. As for anxiety symptoms, we found an escalating reinforcement effect of neuroticism in young adults, with its extra correlation with "irritable". The above findings may suggest that the bridging connections of personality traits as well as their psychopathological pathways were evolving through adolescence and were potential intervention targets.

Our study had significant clinical implications for early detection and intervention of depression and anxiety among adolescent population. First, the identification of neuroticism as the transdiagnostic risk factor contributes to early warning of common mental disorders. Comparing with the measure of psychiatric symptoms, the evaluation on personality traits is more efficient and neutral in identifying at-risk individuals prior to the diagnosis of mental disorders [53, 54]. Specifically, we can evaluate the neuroticism with only three items; and the measure of personality trait induces less stigma for mental illnesses and less self-report bias. Thus, schools may consider adding personality tests into mental health screening. Second, regarding early intervention, the personality traits with activation or inhibition effect on psychiatric symptoms could be important targets of prevention [55, 56]. For example, regular training via a smartphone application could modify personality traits in the desired direction and thus decrease the risk of developing potential mental disorders, though evidence specific to adolescent populations remains limited [57]. Given the unique developmental characteristics of adolescents, the effectiveness and acceptability of these interventions among adolescent samples require further validation. Third, the specific pathways delineated between personality traits and psychiatric symptoms also provided insights of precise intervention on the personality-psychopathology interactions. For instance, by adopting positive emotion regulation strategies, we can reduce depressive symptoms through the inhibition of negative emotions and thoughts caused by neuroticism. Finally, by revealing the differences of the network structure between adolescents and young adults, we can implement interventions on highly plastic personality traits and associated pathways. For example, enhancing the extraversion level or inhibiting its correlation with negative emotions could be an effective way to suppress depression symptoms in adolescents as they turn into adults.

Several limitations need to be considered when interpreting the study results. First, due to our sampling method, we collected data during one specific period in one province, which limited to interpretate our results for other populations. While we acknowledge the limitations of our sample, it is important to consider how regional cultural and economic factors may influence our findings. For instance, participants from regions with highly competitive educational environments might experience amplified effects of neuroticism on anxiety due to increased stressors. Similarly, urban–rural differences and cross-cultural variations could play a significant role in shaping personality-depression or anxiety relationships [58]. These considerations highlight the need for future research to

explore such moderating effects systematically. Second, this study adopted a two-sample cross-sectional design rather than a longitudinal cohort design. It hinders our estimation of the evolving characteristics of the trait-to-symptom relationships across adolescence. Future research regarding the longitudinal observation of the personality-psychopathology networks would be worthwhile. Finally, the network estimation was limited to the measures applied. More validation with other measures of personality traits and symptoms of depression and anxiety is needed.

Conclusion

This study aimed to delineate the trait-to-symptom profile between the Big Five traits and depression and anxiety among adolescents and young adults, and identify their similarities and distinctions. We demonstrated that neuroticism was the transdiagnostic risky factor for depression and anxiety symptoms through negative emotions and thoughts, while conscientiousness and agreeableness were prominent protecting factors for depression and anxiety respectively. Additionally, extraversion exhibited significant increasing protecting effect on depression across adolescence, while neuroticism had increasing activating effect on anxiety. From a network perspective, our findings provide a fine-grained understanding of the personality-psychopathology relationship, and contributes to the early detection and precise intervention for individuals across adolescence.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12888-025-06675-w.

Supplementary Material 1.

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Clinical trial number
Not applicable.

Authors' contributions
Xianyang Wang: Conceptualization, Investigation, Formal analysis, Writing – original draft, Writing – review & editing. Ziwei Wang: Conceptualization, Investigation, Resources, Writing – review & editing. Donglei Jiang: Conceptualization, Investigation, Resources, Writing – review & editing. Chang Liu: Methodology, Resources, Writing – review & editing. Wanying Xing: Methodology, Writing – review & editing. Zhitao Yuan: Methodology, Writing – review & editing. Longbiao Cui: Conceptualization, Writing – review & editing. Shengjun Wu: Conceptualization, Project administration, Funding acquisition, Writing – review & editing. Lei Ren: Conceptualization, Methodology, Investigation, Formal analysis, Visualization, Writing – original draft, Writing – review & editing.

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Data availability
The data that support the findings of this study are available from the corresponding author on reasonable request.

Declarations

Ethical approval and consent to participate
In accordance with the institutional review board (Ethics Application No: KY20234188–1), the current study, classified as low-risk research in school settings involving children aged 14 and above, follows ethical guidelines that allow for approval from either the school director or the teacher as a substitute for parental consent for participants under the age of 16. Prior to distributing the questionnaires, approval was obtained from the head psychological education teacher. Informed consent was then obtained from all participants, ensuring they understood the purpose, procedures, and any potential risks of the study. Participants were also made aware that their involvement was voluntary and that they could withdraw at any time without any negative consequences.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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