



From East to West: Regional Disparities in Depressive and Anxious Symptoms Among Chinese Adolescents

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Background: To explore the prevalence and determinants of depressive and anxious symptoms among adolescents in China, focusing on regional disparities, cognitive function, psychological resilience, and family functioning.

Methods: A total of 39854 adolescents, aged 12–18 years, participated in this survey. Data were collected using SoJump software between January 8 and January 25, 2023. The Patient Health Questionnaire-9, Generalized Anxiety Disorder Questionnaire-7, Cognitive Deficits Questionnaire-5, Connor–Davidson Resilience Scale-10, and Family APGAR Questionnaire were completed. Statistical analyses, including descriptive statistics, correlation analysis, and multivariate linear regression, were conducted to explore the relationships between variables.

Results: Significant regional differences were observed in depression (6.16 ± 6.16 versus [vs] 5.18 ± 5.77 ; $P < 0.001$) and anxiety symptoms (4.15 ± 5.18 vs 3.34 ± 4.82 , $P < 0.001$), with adolescents in the western regions exhibiting higher scores. Depressive symptoms were positively correlated with cognitive function ($r = 0.577$, $P < 0.05$), as were anxious symptoms ($r = 0.533$, $P < 0.05$). Both depressive ($r = -0.339$, $P < 0.05$) and anxious symptoms ($r = -0.321$, $P < 0.05$) were negatively correlated with psychological resilience, as well as with family functioning ($r = -0.302$ and $r = -0.284$, respectively; $P < 0.05$). In addition, compared to adolescents who lived with their parents, those who lived with others had more severe depressive and anxious symptoms.

Conclusion: Our study revealed significant regional disparities in depressive and anxious symptoms among Chinese adolescents, with higher levels observed in Western China. Cognitive function showed a positive association, while psychological resilience and family functioning were negatively linked to these symptoms. By comprehending and targeting these factors through specific interventions and policies, we can ease the mental health burden on this vulnerable population.

Keywords: adolescent, depression, anxiety, resilience, region, China

Introduction

Compared to other stages of life, adolescence is a highly vulnerable period for mental health problems.¹ Recent tracking studies from birth to adulthood have shown that most adult mental disorders begin in early childhood and adolescence.^{2,3} Worldwide, it is estimated that 10–20% of children and adolescents have mental health problems.^{4–7} Adolescence is also considered a period of strong emotional reactions.^{8,9} Globally, the prevalence of depression and anxiety—the most common mental disorders—are increasing during adolescence,^{10–12} with the growth rate of these disorders among adolescents exceeding that among adults.¹³ According to a recent report, the global prevalence of depressive symptoms has increased from approximately 24% in the 2001–2010 period to 37% in the 2011–2020 period.¹⁴ In China, the prevalence of depressive symptoms ranges between 19.9–24.3% in children and adolescents.^{15,16} A meta-analysis

showed that in the past 20 years, depressive and anxious symptoms among Chinese adolescents significantly increased.^{17–19}

The factors that affect emotions are broad, and the most consistent risk factors for depression established in previous studies include cognition, stressors, and certain sociodemographic factors (such as sex, family history, and personality traits).²⁰ In addition, other factors that affect depressive moods have been reported. For example, living at high altitudes increases the risk of or exacerbates the symptoms of mental disorders, including anxiety, depression, and behavioral disorders.^{21,22} Extreme latitudes—defined here as regions located at high latitudes close to the Arctic and Antarctic Circles—also have a significant impact on mental health; people living at high latitudes have higher rates of mental health problems than those living closer to the equator.²³ Changes in lighting due to different latitudes are related to mental disorders such as depression.²⁴ In addition to the influence of the external environment, individual resilience, which varies according to environment, age, sex, and cultural origin, also affect the emotional stability of individuals exposed to different external environments.^{25,26}

Across various regions worldwide, there are notable variations in the occurrence of depressive symptoms among teenagers, with higher rates observed in the Middle East, Africa, and Asia compared to Europe, North America, and Oceania.¹⁴ Notably, across China's vast landscape, there are many regional differences in economic development,²⁷ education levels,²⁸ and family support systems.²⁹ Given these global patterns and China's internal socioeconomic inequalities, this study examined regional variations in depressive and anxious symptoms among adolescents, particularly between Eastern and Western China. Furthermore, we investigated the potential factors underlying these differences.

Methods

Participants and Procedure

This study employed a cross-sectional survey design. Using stratified convenience sampling, participants were recruited from three representative regions of China: Hebei Province and Shandong Province in Eastern China, and the Xinjiang Uygur Autonomous Region in Western China. These regions were selected to reflect geographic and socioeconomic diversity. Specifically, Xinjiang represents a vast and ethnically diverse area in Western China with relatively lower economic development, while Hebei and Shandong are located in Eastern China and represent more developed, urbanized regions with distinct cultural and educational environments. Data were collected between January 8 and January 25, 2023. The study initially enrolled 39,854 junior and senior high school students. Demographic characteristics including age, gender, grade level, family income, and parental education were collected using structured self-report questionnaires. To ensure data quality, participants who had a response time of less than 5 minutes, incomplete answers, or unreasonable responses were excluded. The final analytic sample included 35,455 students aged 12–18 years. Data were collected online using SoJump (<https://www.wjx.cn>), a widely used online survey platform in China.^{30,31} Invitations containing a unique link to the questionnaire were distributed through schools, with teachers assisting in administering the survey during designated class time.

Measures

General Information Questionnaire

Socio-demographic characteristics were assessed using a structured self-report questionnaire. The questionnaire collected information including participants' birth year, gender, current grade level, place of residence, and with whom they reside.

Patient Health Questionnaire-9 (PHQ-9)

PHQ-9 consists of 9 items for self-assessment to screen for the presence of depression and assess its symptom severity.^{32–34} The reliability and validity of the Chinese version of the scale has already been confirmed in previous studies.³⁵ Participants provided feedback on a 4-point Likert scale, with options ranging from 0 (never) to 3 (daily). Scores can range anywhere from 0 to 27. A score of 5 or higher indicates the presence of depressive symptoms, with higher scores indicating more pronounced depressive symptoms.^{30,36} In this study, the Cronbach's alpha was 0.92.

Generalized Anxiety Disorder Questionnaire-7 (GAD-7)

GAD-7 is a self-assessment questionnaire with 7 items used to evaluate anxiety symptoms.³⁷ Participants provided ratings on a 4-point Likert scale that ranged from 0 (not at all) to 3 (almost daily). Scores can range anywhere from 0 to 21. A score of 5 or higher indicates the presence of anxious symptoms, with higher scores indicating more pronounced anxiety symptoms.^{31,37} Based on previous studies, the Chinese version of the scale has shown satisfying reliability and validity.³⁸ For this sample, the Cronbach's alpha reached 0.94.

Perceived Deficits Questionnaire-Depression-5 (PDQ-D-5)

PDQ-D-5 is a self-assessment questionnaire with 5 items that assesses cognitive functions such as memory and attention based on the participants' actual responses over the past week.^{39,40} The reliability and validity of the Chinese version of the scale has been confirmed.⁴¹ Responses were rated on a 4-point Likert scale ranging from 0 (never) to 4 (always). Scores can vary between 0 and 20. Lower scores are indicative of better cognitive function.⁴² The internal consistency measured by Cronbach's alpha in this study was 0.86.

Connor–Davidson Resilience Scale-10 (CD-RISC-10)

CD-RISC-10 is a self-rating scale to evaluate how individuals cope with stress.²⁵ The Chinese version of the scale demonstrates good reliability and validity.⁴³ The new 10-item version saved the core dimensions of the original 25-item CD-RISC, and it has been extensively documented in terms of reliability and validity in Chinese population.^{44,45} The rating for each item ranges from 1 (rarely true) to 5 (almost always true). Higher total scores indicate greater respondent's resilience. This study found a Cronbach's alpha of 0.95.

Family APGAR Questionnaire (APGAR)

The APGAR assessment evaluates five aspects of family dynamics, such as adjustment, collaboration, development, love, and determination.⁴⁶ The options range from "Never" to "Always", corresponding to a scale of 0 to 2. Scores can range anywhere from 0 to 10. A family support system is considered better with higher scores, while scores below 7 may indicate dysfunction within the family.^{47,48} The Chinese version of the scale has excellent reliability and validity.⁴⁹ In our sample, the Cronbach's alpha was 0.93.

Data Analysis Strategy

Descriptive statistical analyses were performed on the general demographic data. Categorical data such as sex, place of residence, cohabitant living (living with a partner), and grade were expressed as numbers (n) and proportions. Due to the non-normal distribution of age, it has been expressed as a median and quartile. The chi-square test (χ^2) was used for categorical variables, and the Mann–Whitney *U*-test was used for non-normally distributed continuous variables.

For the clinical data, the prevalence of anxiety and depression was reported as relative percentages, and group differences were assessed using the chi-square test. The PHQ-9, GAD-7, CD-RISC-10, PDQ-D-5, and APGAR scores were presented as means \pm standard deviations, and differences between the two groups were assessed using the F-test. Age, sex, place of residence, cohabitant living, and grade were used as covariates, and questionnaire scores were used as dependent variables for the covariance analysis.

With PHQ-9 and GAD-7 as dependent variables and age, sex, place of residence, cohabitant living, grade, and scores of CD-RISC-10, PDQ-D-5, and APGAR as independent variables, a linear regression model was established to analyze the relationships between the independent and dependent variables. The regression coefficients (B), standardized coefficients (β), and their corresponding p-values were reported. Model fit was assessed using R^2 and F-statistics.

Analyses of the data were conducted using the IBM SPSS Statistics (version 26.0), and significance was set at $P < 0.05$.

Results

Study Population and Characteristics

This study included 39,854 students who completed the survey. To ensure data quality, we excluded 2,348 (5.89%) participants with invalid responses, such as those who took less than 5 minutes to complete the questionnaire or provided inconsistent or incomplete answers. We selected adolescents aged 12–18 years from the remaining pool (37,506 individuals), resulting in a final sample of 35,455 adolescent participants.

We divided the participants into two groups based on their province: Group 1 ($n = 19,618$) comprised individuals from Xinjiang, located in the western region of China, and Group 2 ($n = 15,837$) included participants from Hebei and Shandong, situated in the eastern region (Figure 1 and Table 1).

Comparison of Depressive and Anxious Symptoms, Cognitive Function, Resilience, and Family Function in Different Regions

Discrepancies were noted in the overall scores of PHQ-9 and GAD-7 among students from various areas. A pairwise comparison between groups showed that the score of depressive symptoms among participants in Group 1 (western region) was higher than that in Group 2 (eastern region) (6.16 ± 6.16 versus [vs] 5.18 ± 5.77 ; $P < 0.001$), as was the score of anxiety symptoms (4.15 ± 5.18 vs 3.34 ± 4.82 ; $P < 0.001$).

There were similar regional differences in cognitive function scores, with participants in Group 1 having higher cognitive function scores compared to Group 2 participants (7.29 ± 4.60 vs 6.81 ± 4.68 ; $P < 0.001$), indicating worse cognitive functions. Moreover, Group 1 adolescents exhibited lower scores in psychological resilience and family

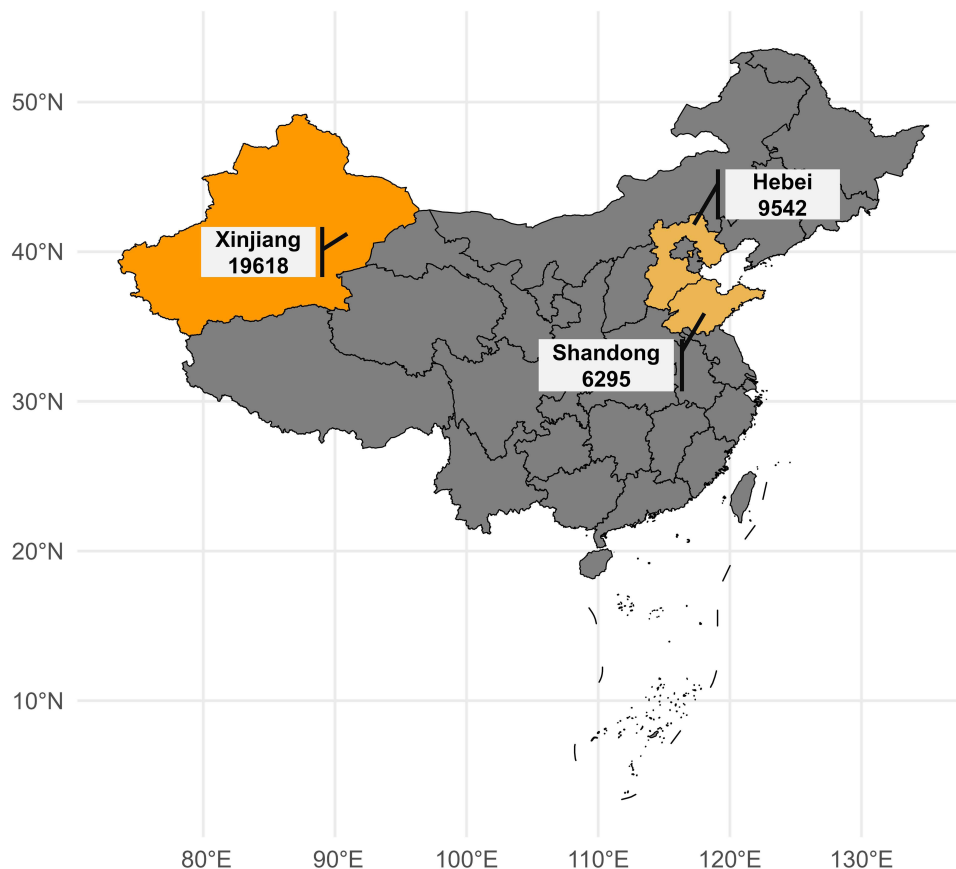


Figure 1 Geographical distribution of participants.

Table 1 Socio-Demographic Characteristics of Participants in the Eastern and Western Regions

Variables	Total	Group 1	Group 2	Z/ χ^2	P
N	35455	19618	15837		
Age (y)	16 (14, 17)	16 (14, 17)	16 (14, 17)	-1.949 [§]	0.051
Sex				5.697 [‡]	0.017
Male	16756 (47.3%)	9383 (47.8%)	7373 (46.6%)		
Female	18699 (52.7%)	10235 (52.2%)	8464 (53.4%)		
Residence				132.433 [‡]	< 0.001
City	23433 (66.1%)	12456 (63.5%)	10977 (69.3%)		
Rural area	12022 (33.9%)	7162 (36.5%)	4860 (30.7%)		
Live with				23.008 [‡]	< 0.001
Parents	33078 (93.3%)	18278 (93.2%)	14800 (93.5%)		
Grandparents	1788 (5.0%)	959 (4.9%)	829 (5.2%)		
Others	589 (1.7%)	381 (1.9%)	208 (1.3%)		
Grade				1370.716 [‡]	< 0.001
Junior grade one	7357 (20.8%)	4074 (20.8%)	3283 (20.7%)		
Junior grade two	6372 (18.0%)	3546 (18.1%)	2826 (17.8%)		
Junior grade three	4603 (13.0%)	2777 (14.2%)	1826 (11.5%)		
Senior grade one	8099 (22.8%)	4870 (24.8%)	3229 (20.4%)		
Senior grade two	7183 (20.3%)	4084 (20.8%)	3099 (19.6%)		
Senior grade three	1841 (5.2%)	267 (1.4%)	1574 (9.9%)		

Notes: Group 1 = Xinjiang; Group 2 = Hebei and Shandong. [§]Indicates statistical comparison using the Mann-Whitney U-test; [‡]Indicates statistical comparison using the chi-square (χ^2) test.

functioning compared to Group 2 participants (31.72 ± 10.74 vs 34.09 ± 11.04 , and 5.87 ± 3.06 vs 6.33 ± 3.12 , respectively; both $P < 0.001$) (Table 2).

Correlation Among Cognitive Function, Resilience, Family Function and Depressive and Anxious Symptoms

Positive correlations were found between depressive symptoms and cognitive function ($r = 0.577$, $P < 0.05$), while negative correlations were observed between depressive symptoms and psychological resilience ($r = -0.339$, $P < 0.05$) as well as family functioning ($r = -0.302$, $P < 0.05$). Likewise, cognitive function showed a positive correlation with anxiety symptoms ($r = 0.533$, $P < 0.05$), while psychological resilience ($r = -0.321$, $P < 0.05$) and family functioning ($r = -0.284$,

Table 2 Comparison of Depressive and Anxious Symptoms, Cognitive Function, Resilience, and Family Function in Different Regions

Variables	Group 1	Group 2	χ^2/F	P
PHQ-9 ≥ 5	10299 (52.5%)	7019 (44.3%)	234.518 [‡]	< 0.001
PHQ-9 score	6.16 ± 6.16	5.18 ± 5.77	317.086 [#]	< 0.001
GAD-7 ≥ 5	7316 (37.3%)	4635 (29.3%)	252.575 [‡]	< 0.001
GAD-7 score	4.15 ± 5.18	3.34 ± 4.82	297.187 [#]	< 0.001
PDQ-D-5 score	7.29 ± 4.60	6.81 ± 4.68	129.134 [#]	< 0.001
CD-RISC-10 score	31.72 ± 10.74	34.09 ± 11.04	382.049 [#]	< 0.001
APGAR score	5.87 ± 3.06	6.33 ± 3.12	168.503 [#]	< 0.001

Notes: Group 1 = Xinjiang; Group 2 = Hebei and Shandong. [‡]Indicates statistical comparison using the chi-square (χ^2) test; [#]Indicates statistical comparison using the F-test.

Abbreviations: PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder Questionnaire-7; PDQ-D-5, Perceived Deficits Questionnaire-Depression-5; CD-RISC-10, Connor-Davidson Resilience Scale-10; APGAR, Family APGAR Questionnaire.

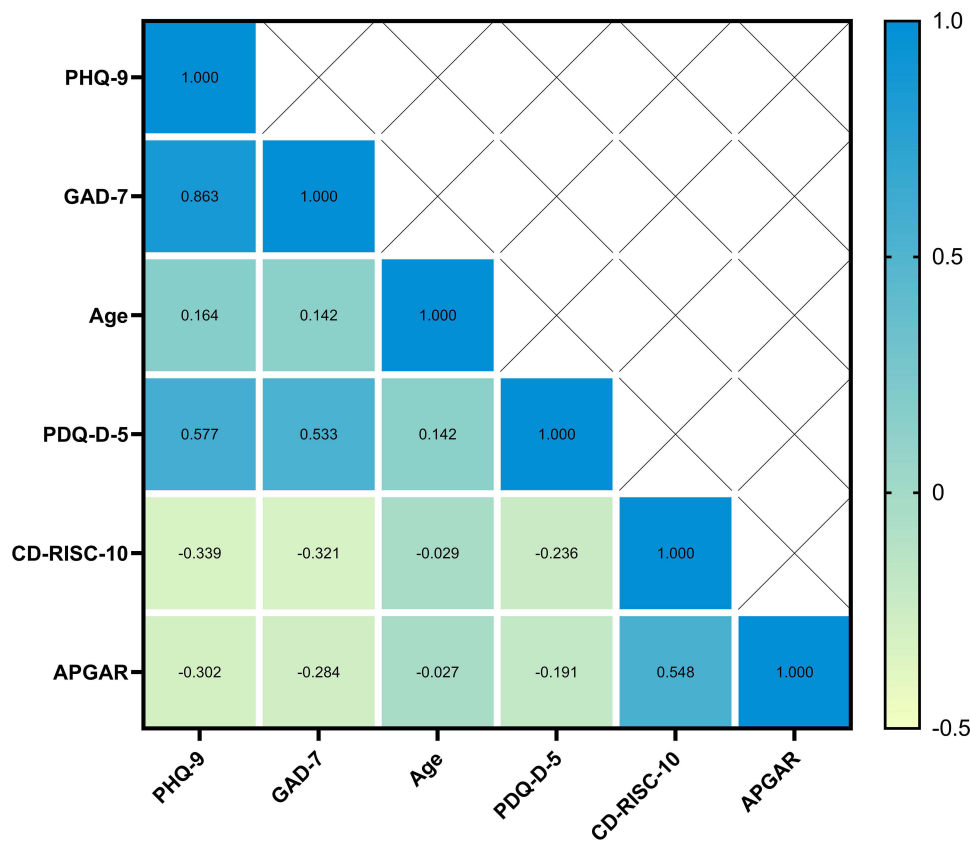


Figure 2 Correlation among cognitive function, resilience, family function and depressive and anxious symptoms.

Note: Values represent Pearson correlation coefficients (r).

Abbreviations: PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder Questionnaire-7; PDQ-D-5, Perceived Deficits Questionnaire-Depression-5; CD-RISC-10, Connor–Davidson Resilience Scale-10; APGAR, Family APGAR Questionnaire.

$P < 0.05$) were negatively correlated with anxiety symptoms. There was a negative correlation between cognitive ability and both psychological resilience ($r = -0.236$, $P < 0.05$) and family functioning ($r = -0.191$, $P < 0.05$). Positive correlation was found between family functioning and psychological resilience ($r = 0.548$, $P < 0.05$) as shown in Figure 2.

Depressive and Anxious Symptoms in Relation to Demographic Factors, Resilience, and Family Function

Age and cognitive function were correlated with depressive and anxious symptoms positively. Psychological resilience and family functioning were correlated with depressive and anxious symptoms negatively. Female participants had significantly higher PHQ-9 and GAD-7 scores than males, with adjusted mean differences of 0.753 points ($P < 0.001$) and 0.547 points ($P < 0.001$), respectively. Adolescents in urban areas had lower symptom scores compared to those in rural areas, with reductions of 0.534 points ($P < 0.001$) on the PHQ-9 and 0.446 points ($P < 0.001$) on the GAD-7. Students in the final grades of junior and senior high school showed elevated symptom levels, with increases of 0.446 points ($P < 0.001$) on the PHQ-9 and 0.533 points ($P < 0.001$) on the GAD-7. Living arrangements were also linked to mental health outcomes. Adolescents living with grandparents had slightly higher scores—0.291 points ($P = 0.010$) for depression and 0.195 points ($P = 0.049$) for anxiety—compared to those living with parents. The highest symptom levels were found among those residing with others, with increases of 0.972 points ($P < 0.001$) on the PHQ-9 and 0.760 points ($P < 0.001$) on the GAD-7 (Table 3).

Table 3 Depressive and Anxious Symptoms in Relation to Demographic Factors, Resilience, and Family Function

Variables	PHQ-9 Total Score			GAD-7 Total Score		
	B	β	P	B	β	P
Constant	0.013		0.963	0.173		0.472
Age	0.307	0.082	0.000	0.199	0.063	0.000
Sex						
Male	0			0		
Female	0.753	0.063	0.000	0.547	0.054	0.000
Residence						
Rural area	0			0		
City	−0.534	−0.042	0.000	−0.446	−0.042	0.000
Grade						
Others	0			0		
Junior & Senior grade three	0.446	0.029	0.000	0.533	0.041	0.000
Live with						
Parents	0					
Grandparents	0.291	0.011	0.010	0.195	0.008	0.049
Others	0.972	0.021	0.000	0.760	0.019	0.000
PDQ-D-5	0.644	0.498	0.000	0.499	0.461	0.000
CD-RISC-10	−0.083	−0.151	0.000	−0.068	−0.148	0.000
APGAR	−0.244	−0.126	0.000	−0.190	−0.117	0.000
R²	0.013			0.345		
F	2629.684			2075.884		

Abbreviations: PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder Questionnaire-7; PDQ-D-5, Perceived Deficits Questionnaire-Depression-5; CD-RISC-10, Connor–Davidson Resilience Scale-10; APGAR, Family APGAR Questionnaire.

Discussion

The vast territory of China provides a unique setting for this study, which aims to compare depression and anxiety symptoms among adolescents between eastern and western regions of China, focusing on demographic factors, cognitive function, psychological resilience, and family functioning. By surveying and analyzing 35,455 student participants, using self-reported measures, we uncovered a series of intriguing findings that offer new perspectives and insights into understanding adolescent mental health issues and their related influencing factors.

First, we found significant differences in the prevalence of depressive and anxious symptoms among children and adolescents in the eastern (Hebei and Shandong) and western (Xinjiang) regions of China. The self-rated questionnaires revealed that adolescents in the western region exhibited more depression and anxiety symptoms than those in the eastern region. This may be related to factors such as the lower level of economic development, educational resources, and academic pressure in the western region of China, which could have implications for adolescents' mental health.^{50–54} Previous meta-analyses have indicated that the detection rate of depressive symptoms among primary school students in economically underdeveloped areas of China is higher than that in economically developed areas at 21.7% and 12.4%, respectively.⁵⁵ Adolescents from economically disadvantaged families face greater pressure due to their parents' expectations, yet they have fewer opportunities to enhance their educational levels.⁵⁶ The time they spend on academics does not necessarily correlate with their academic performance, and they may face a relatively higher risk of depression.⁵⁶ Additionally, we observed differences in cognitive function, psychological resilience, and family functioning between adolescents in Eastern and Western China. Adolescents in the western region exhibit poorer cognitive function, psychological resilience, and family functioning, which may also have implications for their psychological well-being.

Further analysis indicated correlations between depressive and anxiety symptoms with cognitive function, psychological resilience, and family functioning. Specifically, we found that depressive and anxious symptoms were positively

correlated with PDQ-D-5 scores, indicating that more severe emotional symptoms were associated with greater perceived cognitive difficulties. This result may appear to contrast with previous findings in which depression and anxiety were negatively associated with performance-based cognitive test scores. However, this apparent discrepancy can be explained by the nature of the measurement tools used. In our study, cognitive function was assessed using the PDQ-D-5, a self-reported measure reflecting individuals' subjective perception of cognitive deficits rather than their objective cognitive performance. In contrast, many studies reporting negative associations employed objective neuropsychological assessments, such as the Montreal Cognitive Assessment.⁵⁷ Consistent with previous studies, our findings showed that the PDQ-D-5 scores of adolescents from rural backgrounds were significantly higher than those from urban areas, indicating poorer cognitive function among individuals in remote areas.⁴⁰ Educational disparities may be a primary factor contributing to cognitive differences among adolescents from the eastern and western regions, as studies have found a close relationship between education and cognitive function.⁵⁸ Additionally, adolescents in western regions exhibited relatively poorer psychological resilience. Numerous studies suggest that psychological resilience is a critical protective factor against negative mental status, such as anxiety and depressive symptoms.^{59–63} Family functioning is also crucial for adolescents. Prior research suggests that family dysfunction, as a significant social psychological factor, increases the risk of mental health issues.^{64,65} Adolescents with better family functioning may receive more family support, promoting positive adaptation to stressful events, and further reducing the occurrence of anxiety and depressive symptoms.

In addition, we identified several demographic factors that influence anxiety and depressive symptoms. For example, girls exhibited significantly more severe symptoms of depression and anxiety than boys, whereas adolescents living in rural areas showed significantly less symptoms of depression and anxiety than those living in urban areas. These findings are similar to previous research indicating that women are at a higher risk of depression and anxiety, potentially due to their greater susceptibility to certain social factors.^{66,67} Therefore, more attention should be given to girls in adolescence. Furthermore, the prominence of anxiety and depressive symptoms among rural adolescents aligns with factors such as lower economic status, limited educational resources, and lower rates of college enrollment in rural areas, as discussed earlier.^{55,56,68–70} We also observed significantly elevated scores of depression and anxiety symptoms among individuals experiencing academic pressure (junior and senior high school students) and adolescents who did not live with their parents. We are aware of the immense academic pressure faced by students in China,^{71–73} particularly in the under-developed western regions,⁶⁸ which may contribute to increased anxiety and depressive feelings. Living arrangements also play a significant role in adolescent emotions; a meta-analysis indicated a higher prevalence of depression symptoms (up to 30.7%) among “left-behind children” in China.⁷⁴ In addition, research on the impact of family structure on adolescent emotions has shown a significant correlation between adolescent depression and single-parent households.⁷⁵ These findings underscore the importance of demographic factors in adolescent mental health issues and provide a basis for developing targeted intervention strategies. This highlights how parental care and the provision of a safe and emotionally warm environment are crucial to the psychological health and growth of adolescents.

Limitations

The study has some limitations that must be acknowledged. First, the cross-sectional design precludes causal inferences, and longitudinal research is necessary to determine the temporal relationships between the variables. Second, the reliance on self-reported measures may introduce response bias, and future studies should include objective assessments and clinical evaluations. Finally, while efforts were made to ensure data quality through rigorous cleaning procedures, residual confounding factors may have influenced the results.

Conclusions

This study offers important insights into the various factors influencing depression and anxiety among adolescents. Large sample size is a key strength, improving the reliability of the findings, and the comprehensive evaluation of factors affecting mental health. Multivariate analyses revealed complex relationships between these variables. Our results show regional differences in depression and anxiety levels, as well as strong links between cognitive functions, psychological resilience and family functioning. These findings suggest that addressing these factors through targeted interventions and

policies, such as improving access to educational resources, enhancing family support systems, and promoting mental health awareness, could significantly help reduce the burden of depression and anxiety in this vulnerable population.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author (Zhou S-J) upon reasonable request.

Ethics Statement

The ethical standards from the 1964 Declaration of Helsinki and its later amendments were followed, and approval for this study was granted by the Ethics Committee of Beijing Huilongguan Hospital. All respondents and their guardians provided informed consent.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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