A latent class analysis of depressive symptoms among rural Chinese adolescents and their association with psychological resilience

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ABSTRACT

Numerous studies have demonstrated the heterogeneity of depressive symptoms, but few studies have focused on the heterogeneity of depressive symptoms among rural Chinese adolescents. In November to December 2022, multistage sampling was employed to administer questionnaires to 1,816 rural adolescents aged 11–19 years from six schools in Henan Province, China. Depressive symptoms were measured using the Chinese version of the Children's Depression Inventory Scale. Latent class analysis (LCA) was utilized to identify subgroups of depressive symptoms. The investigation of subgroup characteristics and associated factors was conducted through χ^2 tests, ANOVA, and multinomial logistic regression analyses. The findings revealed a 24.24 % detection rate of depressive symptoms among Chinese rural adolescents. LCA analysis of responses to the 27 items in the Depressive Symptoms Scale led to the classification of depressive symptoms into four subgroups based on severity: "no depressive symptoms group" (22.5 %), a "low depressive symptoms group" (35.7 %), a "transition group" (31.6 %), and a "high depressive symptoms group" (10.2 %). Gender, grade level, academic performance, academic stress, family environment, and level of psychological resilience are associated factors for subgroups of depressive symptoms among rural adolescents. There should be increased training of rural educators to enable early recognition of depressive characteristics and risk factors, facilitating targeted prevention and intervention strategies.

1. Introduction

Adolescence is an important period in developing and changing individual physiological, emotional, and social functions (Ren et al., 2019). Adolescent depression has become a severe and challenging public health problem (Weersing et al., 2017). Unlike adults, adolescents are more susceptible to external environmental stressors, exhibiting a heightened vulnerability to mood disorders and depressive symptoms (Su et al., 2011). A 2022 systematic review highlighted the alarming global prevalence of depressive symptoms among adolescents aged 10–19, reaching as high as 34 % (Shorey et al., 2022).

In consonance with international trends, Chinese children and adolescents face an elevated risk of experiencing depressive symptoms (Rao et al., 2019). Previous researches have indicated that rural adolescents, when compared to their urban counterparts, exhibit higher rates of depressive symptomatology (Liu et al., 2020; Zhang et al., 2001). This disparity can be attributed to the relatively lower economic development in rural areas and the paucity of accessible quality healthcare and psychoeducational resources (Yan et al., 2021), resulting in an augmented risk for depressive symptoms among rural youth (Feng et al., 2022). Past investigations on depressive symptoms in rural adolescent populations have been region-specific (e.g., China, Australia, India) (Black et al., 2012; Das et al., 2021; Li et al., 2019a), gender-specific (Lai et al., 2012; Wang et al., 2011), and have explored the relationships between depressive symptoms and various factors such as self-harm (Lai et al., 2021), internet addiction (Shang et al., 2023), and academic performance (Feng et al., 2022). A majority of these studies have relied on depression scale score thresholds to classify individuals into discrete levels of depression, often overlooking individual distinctions and group heterogeneity in depression occurrence, which are pivotal for tailored

prevention and intervention strategies (Zhang et al., 2016).

Latent class analysis (LCA) is a person-centered research approach grounded in probabilistic model classification. It involves categorizing individuals based on their responses to externally measured items, thereby revealing latent traits. The aim is to maximize differences between these categorized groups while minimizing variations within them (Lanza, 2016; Mori et al., 2020). LCA relies on statistical criteria to identify the best-fitting model, with a particular emphasis on capturing the heterogeneity within the groups. Consequently, LCA can be used to identify subgroups and diverse characteristics of depressive symptoms in adolescents (Mezulis et al., 2011; Ling et al., 2021).

In studies encompassing diverse adolescent populations, depressive symptoms have been found to be classified into different potential categories through the use of LCA. For example, Rice conducted semi-structured diagnostic interviews with 335 adolescents using the Child and Adolescent Psychiatric Assessment (CAPA) and identified three potential categories: the low depression group (87 %), the vegetative depression group (7 %), and the cognitive group (6 %) (Rice et al., 2019). Mezulis surveyed 2,187 sixth graders employing the Mood and Feelings Questionnaire (MFQ) and uncovered six potential categories based on severity (Mezulis et al., 2011). Prior research in China has applied LCA to scientifically categorize depressive symptoms in Chinese adolescents. For instance, a study involving 7,862 adolescents from Hangzhou, China, used a 9-item Patient Health Questionnaire (PHQ-9) and identified three potential categories: the "low depression group," the "depressed mood group," and the "depression group" (Cui, 2020). Ling (Ling et al., 2021) employed the Center for Epidemiologic Studies Depression Scale (CES-D) to classify depressive symptoms into four categories, namely, "probable clinical depression" (8.2 %), "subthreshold depression" (19.2 %), "mild depression" (41.8 %), and "low depression" (30.8 %). However, it is noteworthy that no prior study appears to have delved into the structural patterns of depressive symptoms among rural adolescents in China, a demographic recognized for its heightened susceptibility to mental health challenges.

Psychological resilience plays a pivotal role in the wholesome development of adolescents (Fu and Wei, 2013) and is recognized as a significant contributor to the emergence of depressive symptoms in this age group. Psychological resilience refers to the dynamic process through which individuals effectively adapt to adversity, trauma, or substantial stressors (Southwick et al., 2014). In line with the Model of Three Mental Resilience System mechanisms (Davydov et al., 2010), psychological resilience establishes a protective mechanism that can shield individuals from adverse events, including adversity and trauma, such as depression and anxiety. Numerous studies have underscored the inverse relationship between psychological resilience and the risk of depression, with individuals exhibiting high psychological resilience displaying a lower susceptibility to depressive symptoms, while those with lower psychological resilience tend to experience heightened negative emotions, including depression (Terrill et al., 2016; Wu et al., 2017). However, there remains a need to further investigate and analyze the connection between psychological resilience and the various subgroups of depressive symptoms among rural adolescents.

This study aimed to further understand the characteristics of rural Chinese adolescents associated with depressive symptoms. To achieve this, LCA was employed to identify subtypes of depressive symptoms in rural Chinese adolescents. Additionally, the study sought to elucidate whether these subgroups of depressive symptoms were linked to psychological resilience and demographic characteristics. By considering the factors associated with different subtypes, this research endeavors to provide essential preliminary insights for tailored preventive and interventional strategies addressing depressive symptoms among rural Chinese adolescents.

2. Materials and methods

2.1. Research design and participant selection

For this study, a multi-stage sampling approach was employed to select research sites within Henan Province, China during the period between November and December 2022. Initially, Xuchang, Kaifeng, and Luohe were chosen from a total of 18 cities in Henan Province using the random number table method. Subsequently, convenience sampling was utilized to pick one junior high school and one senior high school in the rural regions of each of the three selected cities, resulting in a total of six schools being included in the study. These six middle schools were further categorized by grade level, with two classes randomly chosen from each grade level. A comprehensive survey of all students within the selected classes was conducted.

Upon securing consent and cooperation from the participating schools, two types of questionnaires were administered: paper-based and online surveys. The online survey was facilitated through the "Questionnaire Star" online platform. Respondents received the survey link through either a WeChat group or email. We established response options and a specified deadline for questionnaire completion. To maintain the questionnaire's quality and prevent duplicate responses, we stipulated that each device could only submit responses once. The on-site survey, on the other hand, was conducted by researchers who collected questionnaires in person with the assistance of school facilitators during regular class time.

In total, 1,965 questionnaires were distributed, and 1,955 questionnaires were collected, with 1,329 completed online and 626 offline. Questionnaires exhibiting confusing logic, incomplete information, repetitive responses, or extremely short online response times (less than 200 s) were manually excluded. Ultimately, 92.4 % of submitted questionnaires were valid and included in the final analysis. The study received approval from the Ethics Committee of Zhengzhou University (No. 2022–105), and informed consent was obtained from the study participants, the students' parents, and the school authorities.

2.2. Measures

2.2.1. Sociodemographic profile

The survey gathered data on various sociodemographic attributes, encompassing age, gender, grade level, academic performance, whether the respondents were single children, family composition, family atmosphere, and the educational background of the respondents' parents.

2.2.2. Assessment of depression

Depressive symptoms were assessed using the Children's Depression Inventory (CDI), originally developed by Kovacs in 1977 and based on the Beck Depression Inventory (Kovacs, 1992). The CDI is suitable for individuals aged 7–20 and comprises 27 items, encompassing common depressive symptoms such as changes in appetite, sleep disturbances, and suicidal ideation. The scale is organized into five dimensions: lack of pleasure, negative emotions, ineffectiveness, interpersonal difficulties, and negative self-esteem. Each entry has three options for describing the degree of depression items, scored on a 0–2 point scale, where higher scores indicate more pronounced depressive symptoms (Liu et al., 2019). Based on the original norm for the scale, a score of 19 was used as the threshold to indicate the presence of depressive symptoms (Timbremont et al., 2004). In 2000, Yu Dawei translated the scale into a Chinese version and demonstrated that the Chinese adaptation of the CDI exhibited high reliability and validity (Yu and Li, 2000). In the present study, the Cronbach's α coefficient for the scale was 0.882, which indicates good reliability.

2.2.3. Evaluation of resilience

The resilience scale employed in this study was developed by Yueqin Hu (Hu and Gan, 2008) and comprises 27 items. It encompasses five

factors: goal orientation, emotional regulation, and positive cognitive outlook, family support and interpersonal assistance. The scale was scored on a 5-point Likert scale (from "1 = not at all consistent" to "5 = fully consistent with the scale"). Additionally, some items were reverse-scored. Higher cumulative scores on the scale reflect higher levels of resilience. In this study, Cronbach's α coefficient of the total scale was 0.891, indicating robust reliability.

2.3. Data analysis

In this study, we utilized Mplus version 7.4 to conduct LCA for the purpose of empirically categorizing Chinese rural adolescents based on their depressive symptoms. Prior to LCA, scores for items on the CDI scale were recoded as follows: raw scores of 0 remained as 0, while raw scores of 1 and 2 were transformed into 1 to represent the presence (1) or absence (0) of each symptom. To determine the best fitting model, we assessed various fit indicators, including the Akaike information criteria (AIC) (Akaike, 1987), Bayesian information criteria (BIC) (Schwarz, 1978), and adjusted BIC (aBIC). Smaller values across these indicators reflect better model fit (Shi et al., 2018). To validate the optimal model and ascertain the number of groups, we employed the Lo-Mendell-Rubin corrected likelihood ratio (LMR) and Bootstrap-based likelihood ratio test (BLRT). A significance level of $p < 0.05$ indicated that the model with K categories was superior to the one with K-1 categories (Lo, 2001; Nylund et al., 2007). Classification accuracy was evaluated using Entropy, which ranges from 0 to 1. A higher Entropy value signifies more accurate classification, with an Entropy of 0.8 indicating over 90 % accuracy (Wang et al., 2017). The optimal model is selected by combining the above indicators and considering conceptual interpretability and simplicity of the model (Wang and Bi, 2018). After determining the optimal model, each participant was assigned to a specific category based on the posterior probability (Wang and Chen, 2019).

Statistical analysis of the data was carried out using IBM SPSS Statistics 25.0. Descriptive statistics, including mean ± standard deviations (SDs) for normally distributed measurement data and medians for non-normally distributed data, were used to describe the data. Frequency and percentages were employed for count data. The differences in sociodemographic characteristics among the identified categories were assessed using the χ2 test or Fisher's exact probability method. Analysis of variance (ANOVA) was utilized to explore variations in resilience scale scores among the identified categories. Furthermore, multinomial logistic regression analysis was conducted to investigate the factors associated with depressive symptoms based on the identified categories. In all statistical analyses, significance was defined as $p < 0.05$.

3. Results

3.1. Participant characteristics

A total of 1,226 individuals completed the online survey, with a mean score of 13.61 ± 7.81 on the depression symptoms scale, while 590 individuals participated in the written survey, with a mean score of 13.55 ± 7.26 on the same scale. Notably, there was no significant difference in depressive symptom scores between the two survey modes ($p = 0.87$). The average age of the respondents was 15.11 ± 1.89 years,

with 48.46 % being female and 52.20 % enrolled in high school. Further comprehensive descriptive statistics for the sample are available in Appendix A.

3.2. Latent class analysis of depressive symptoms

We conducted an evaluation of the fit for five LCA models, and the statistical fit metrics are summarized in Table 1. The optimal model, determined based on a combination of latent category metrics, was a four-category model. As the number of categories increased, the AIC, BIC, and aBIC values exhibited a decreasing trend, with Model 5 having the smallest value (Fig. 1). However, Model 5's LMR value did not attain statistical significance ($p = 0.605$), suggesting that the 4-class model was a better fit than the 5-class model. Moreover, the 4-class model exhibited Entropy values exceeding 0.8, and its LMR and BLRT values were statistically significant ($p < 0.05$). When comparing the 3-class model to the 4-class model, the latter had a lower BIC value, reinforcing the selection of the 4 potential classes as the optimal model. With four classes, the average probability of rural adolescents belonging to a specific potential class ranged from 86.4 % to 91.0 %, indicating the model's reliability. Different response probability graphs were generated for the four potential categories across the 27 items (Fig. 2).

These four latent classes were named as follows based on their conditional probabilities on each CDI entry. No depressive symptoms group (C1) displayed a lower probability of scoring on each CDI entry, with conditional probabilities of less than 10.0 % on all 17 entries and a prevalence of less than 5 % on more than half of the entries. The conditional probability for entry 7 (self-hatred) was 0, and the conditional probabilities for "sadness," "suicidal perceptions," "crying," and "loneliness" were close to 0. C1 was named the "No Depressive Symptoms Group" and consisted of 408 cases, accounting for 22.5 % of the sample. High depressive symptoms group (C4) exhibited high conditional probabilities for appearing on all entries. Twenty-two entries had
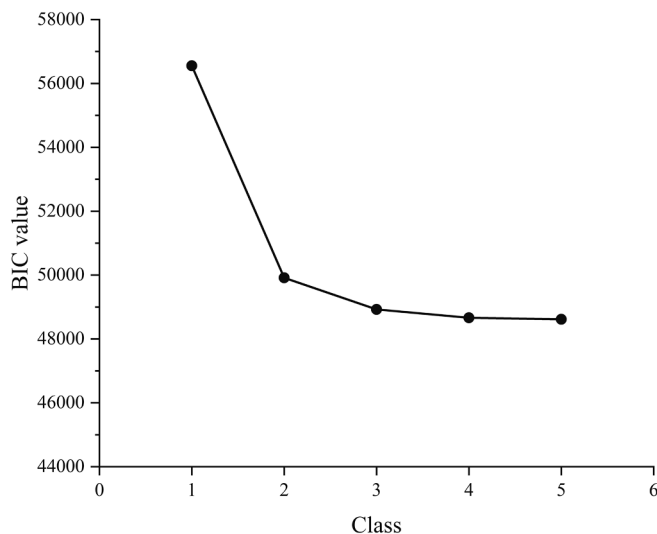

Fig. 1. BIC Values in each latent class of rural adolescents in China, 2022.

Table 1
Model fit indices of the latent class analysis solutions in a sample of Chinese rural adolescents (N = 1816).

Model (K-Class)	K	Log (L)	AIC	BIC	aBIC	Entropy	LMR	BLRT	Category Probability
1- Class	27	−28176.116	56406.232	56554.85	56469.073	–	–	–	1
2- Class	55	−24751.469	49612.938	49915.679	49740.947	0.891	<0.001	<0.001	0.452/0.548
3- Class	83	−24150.565	48467.129	48923.994	48660.307	0.825	<0.001	<0.001	0.232/0.420/0.348
4- Class	**111**	**−23914.103**	**48050.206**	**48661.193**	**48308.551**	**0.808**	**0.006**	**<0.001**	**0.102/ 0.357/0.316/0.225**
5- Class	139	−23786.852	47851.704	48616.814	48175.218	0.791	0.605	<0.001	0.106/0.251/0.075/0.35/0.214

K is the number of parameters freely estimated; Log(L): likelihood ratio Likelihood test. The items in bold are the models we chose.
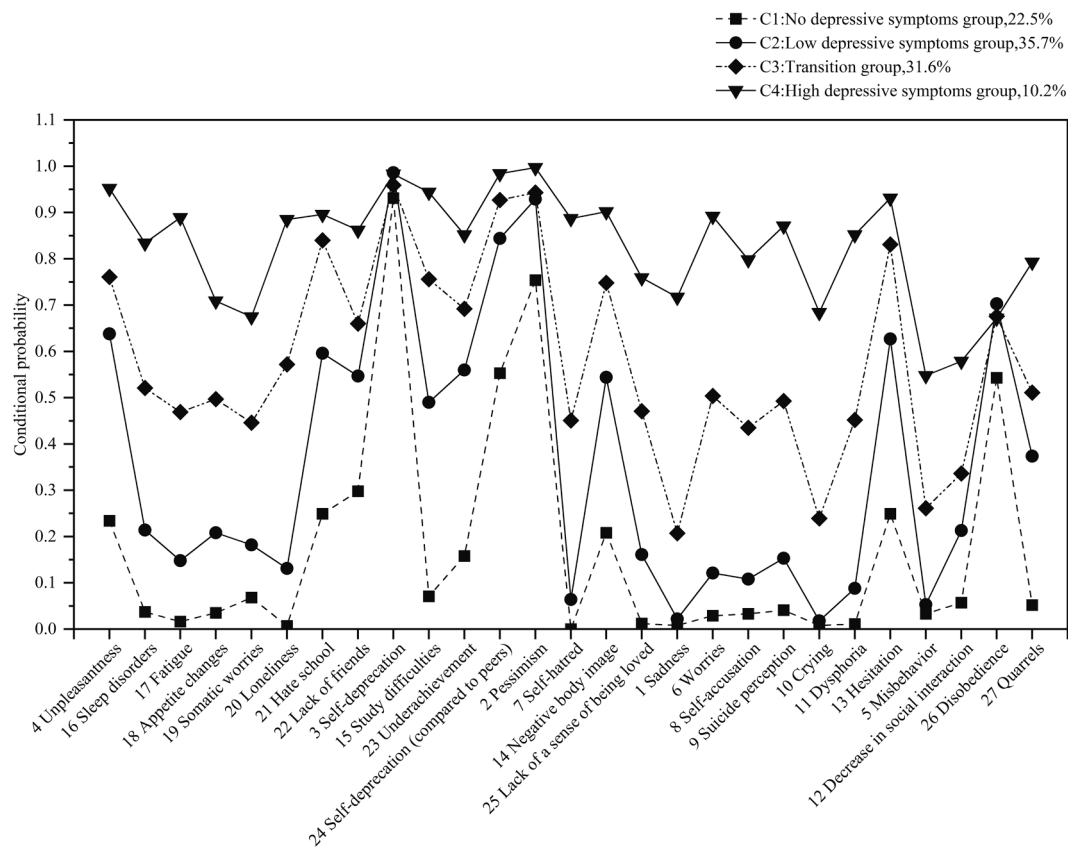
Fig. 2. Subgroups of depressive symptoms in Chinese rural adolescents by latent class analysis, 2022.

conditional probabilities exceeding 70 %, and all entries had conditional probabilities higher than 54 %. The conditional probability for "suicidal perception" was particularly high at 87.1 %. C4 was named the "High Depressive Symptoms Group" and comprised 186 cases, representing 10.2 % of the total group. Transition group (C3) had a conditional probability level higher than low depressive symptoms group (C2) but not as high as C4. The conditional probability of 15 measurement items exceeded 50 %, and the conditional probability for suicidal perception was relatively high at 49.3 %. This category included 574 cases, making up 31.6 % of the total group, and was named the "Transition Group." Low depressive symptoms group (C2) overall conditional probability level fell between C1 and C3, being higher than C1. Its trend was similar to C1, but the probability of scoring was higher for entries such as "unpleasantness," "hesitation," "negative body image," "study difficulties," "underachievement," and "suicidal perception." C2 was named the "Low Depressive Symptoms Group" and consisted of 648 cases, representing 35.7 % of the total group.

3.3. Comparisons between subgroups

Statistically significant differences among the resulting classes were assessed by comparing sociodemographic variables and resilience scores, as detailed in Table 2. Notably, significant differences were observed between the classes. The categories exhibiting depressive symptoms were more likely to experience poorer academic performance, increased academic stress, lower parental education levels, and a less favorable family atmosphere compared to the group without depressive symptoms. Furthermore, there was a significant variance in resilience scores across these groups. The high depressive symptoms group had a significantly lower resilience score (76.24 ± 11.38) compared to the no depressive symptoms group (106.17 ± 16.44) (F = 278.223, $p < 0.001$).

3.4. Associations of psychological resilience and demographic characteristics with depressive symptoms classes

The multinomial regression analyses results, summarized in Table 3, shed light on the factors associated with each subgroup of depressive symptoms, employing C1 as the reference group. Gender, grade, age, academic performance, parental education level, family atmosphere, and resilience scores were evaluated as independent variables. When compared to C1, academic performance emerged as a significant factor influencing C2 (OR = 0.422, 95 % CI = 0.240, 0.742, $p = 0.003$). Family atmosphere was identified as the factor impacting C3 (OR = 0.163, 95 % CI = 0.039, 0.676, $p = 0.012$) and C4 (OR = 0.102, 95 % CI = 0.022, 0.476, $p = 0.004$) when contrasted with C1. Psychological resilience is an associated factor in subgroups of depressive symptoms. Resilience scores were notably lower in C2 (OR = 0.945, 95 % CI = 0.936, 0.955), C3 (OR = 0.893, 95 % CI = 0.881, 0.904), and C4 (OR = 0.824, 95 % CI = 0.805, 0.844) in comparison to C1.

4. Discussion

This study stands as the inaugural endeavor to delve into the underlying characteristics of depressive symptoms in rural Chinese adolescents and to elucidate the factors associated with distinct subgroups among this demographic. It unveiled a notable prevalence of depression among rural adolescents, registering at 24.24 %. While this figure is higher than the 15.3 % reported by Zhou (Zhou and Wang, 2011), it is lower than the 36.6 % documented by Tu (Tu et al., 2023). These discrepancies may be attributed to variations in the selected study subjects and the depression assessment scales utilized. Nonetheless, the findings of our study, coupled with the aforementioned reports, collectively underscore the elevated risk of depressive symptoms within the rural adolescent population, underscoring the urgency of implementing

Table 2
Subgroup characteristics of rural adolescents in China, 2022 (N = 1816).

Variables	No depressive symptoms group (%)	low depressive symptoms group (%)	Transition group (%)	High depressive symptoms group (%)	χ2 /F	P
Gender					11.185[a]	0.011
Boy	223 (54.66)	312 (48.15)	269 (46.86)	76 (40.86)		
Girl	185 (45.34)	336 (51.85)	305 (53.14)	110 (59.14)		
Age					31.527 [a]	< 0.001
≤15 years old	256 (62.75)	360 (55.56)	263 (45.82)	88 (47.31)		
≥16 years old	152 (37.25)	288 (44.44)	311 (54.18)	98 (52.69)		
Grade					38.762 [a]	< 0.001
Junior high school	237 (58.09)	328 (50.62)	226 (39.37)	77 (41.40)		
Senior high school	171 (41.91)	320 (49.38)	348 (60.63)	109 (58.60)		
Ethnicity					3.303 [a]	0.347
The Han nationality	399 (97.79)	642 (99.07)	564 (98.26)	184 (98.92)		
Other	9 (2.21)	6 (0.93)	10 (1.74)	2 (1.08)		
Academic Performance					52.979 [a]	< 0.001
Top 25 % of the grade	128 (31.37)	133 (20.52)	112 (19.51)	24 (12.90)		
Moderate	254 (62.26)	441 (68.06)	378 (65.85)	123 (66.13)		
Bottom 25 % of the grade	26 (6.37)	74 (11.42)	84 (14.64)	39 (20.97)		
Academic stress					155.161 [a]	< 0.001
Lighter	27 (6.62)	21 (3.24)	15 (2.61)	4 (2.15)		
General	336 (82.35)	487 (75.15)	370 (64.46)	80 (43.01)		
Heavier	45 (11.03)	140 (21.61)	189 (32.93)	102 (54.84)		
Only child or not					4.990 [a]	0.173
Yes	41 (10.05)	41 (6.33)	49 (8.56)	15 (8.06)		
No	367 (89.95)	607 (93.67)	525 (91.46)	171 (91.94)		
Family Composition					2.815 [a]	0.832
Both parents	387 (94.85)	607 (93.67)	533 (92.86)	172 (92.47)		
Single parent	15 (3.68)	25 (3.86)	26 (4.53)	8 (4.30)		
Other	6 (1.47)	16 (2.47)	15 (2.61)	6 (3.23)		
Father's education level					35.833 [a]	< 0.001
Junior high school and below	238 (58.33)	469 (72.38)	424 (73.87)	136 (73.12)		
High school or technical secondary school	104 (25.49)	122 (18.83)	99 (17.25)	35 (18.82)		
College and above	66 (16.18)	57 (8.79)	51 (8.88)	15 (8.06)		
Mother's education level					30.564 [a]	< 0.001
Junior high school and below	246 (60.29)	474 (73.15)	416 (72.48)	140 (75.27)		
High school or technical secondary school	86 (21.08)	105 (16.20)	98 (17.07)	31 (16.67)		
College and above	76 (18.63)	69 (10.65)	60 (10.45)	15 (8.06)		
Family atmosphere					156.956 [a]	< 0.001
Relatively harmonious	369 (90.44)	514 (79.32)	373 (64.98)	95 (51.08)		
General	36 (8.82)	127 (19.60)	173 (30.14)	74 (39.78)		
Comparatively bad	3 (0.74)	7 (1.08)	28 (4.88)	17 (9.14)		
psychological resilience (Score, x ± s)	106.17 ± 16.44	93.67 ± 12.52	85.27 ± 10.56	76.24 ± 11.38	278.223[b]	< 0.001

a:χ2 test ; b:Welch's ANOVA test.

preventive measures and targeted interventions.

Adopting a person-centered perspective, this study substantiated the evident clustering characteristics of depressive symptoms in rural adolescents. The results of this study, where latent classes were delineated by severity, were generally congruent with prior investigations but also featured some distinctions (Ling et al., 2021; Cui, 2020). Ling's study employed the CES-D to scrutinize the categorical attributes of depression in Chinese adolescents and highlighted the prevalence of the depressed and subthreshold depressed groups, characterized by symptoms of sadness, loneliness, concentration difficulties, and low self-esteem (Ling et al., 2021). Additionally, Cui's research unveiled that the more severely depressed group and the second-most severely depressed mood group exhibited prominent symptoms related to the loss of pleasure, low mood, sleep disturbances, and low self-esteem (Cui, 2020). Nonetheless, due to differences in sample population selection and assessment tools, the subgroup of rural adolescents with depressive symptoms in this study often had symptoms of self-depreciation, negative body image, and hesitation, in addition to a more prominent absence of pleasantness and pessimistic symptoms. These findings underscore the significance of heightened attention from clinical practitioners, educators, and parents to rural adolescents who exhibit symptoms of depression, low self-evaluation, learning difficulties, negative body image, and a lack of pleasurable experiences.

The study showed that gender was a factor associated with subgroups of depressive symptoms among rural adolescents. Boys exhibited a higher likelihood of belonging to the "no depressive symptoms group," while girls were more frequently represented in the "high depressive symptoms group." This is consistent with previous research (Ling et al., 2021; Cui, 2020). Studies have consistently shown that girls have higher rates of depression (Black et al., 2012; Li et al., 2019b). This discrepancy could potentially be attributed to the pronounced physiological changes that girls undergo during adolescence. In comparison to boys, girls are more emotionally sensitive and prone to depressive symptoms (Hyde et al., 2008). This study underscores the significance of addressing the mental health of girls within rural adolescent populations, emphasizing the importance of tailored attention and guidance to mitigate depressive symptoms.

Furthermore, the results elucidate that grade level, academic performance, and academic stress are associated with subgroups of depressive symptoms among rural adolescents. Compared with junior high school students, high school students were notably more likely to fall into the "transition group" and "high depressive symptom group," signifying that high school students are more likely to have higher levels of depressive symptoms, which is consistent with the findings of Liu (Liu et al., 2020). This may be attributed to the amplified learning challenges and academic pressures experienced by high school adolescents (Sun

Table 3

Multiple logistic regression analysis of the variables related to the subgroup of depressive symptoms in Chinese rural adolescents, using category C1 as reference, 2022.

Dependent variable	Independent variable	b	SE	Wald χ2	OR	p	CI (95 %)
Low depressive symptoms group	Academic Performance (Bottom 25 % of the grade)						
	Top 25 % of the grade	-0.863	0.288	8.971	0.422	0.003	0.240 ~ 0.742
	Academic stress (Heavier)						
	Lighter	-1.071	0.389	7.589	0.343	0.006	0.160 ~ 0.734
	General	-0.679	0.201	11.359	0.507	0.001	0.342 ~ 0.753
	Psychological resilience score	-0.056	0.005	125.836	0.945	0.000	0.936 ~ 0.955
Transition group	Grade (Senior high school)						
	Junior high school	-0.951	0.311	9.363	0.386	0.002	0.210 ~ 0.710
	Academic Performance (Bottom 25 % of the grade)						
	Top 25 % of the grade	-1.133	0.316	12.868	0.322	0.000	0.173 ~ 0.598
	Academic stress (Heavier)						
	Lighter	-1.769	0.473	14.013	0.171	0.000	0.068 ~ 0.431
	General	-1.154	0.214	29.042	0.315	0.000	0.207 ~ 0.480
	Family atmosphere (Comparatively bad)						
	Relatively harmonious	-1.815	0.726	6.252	0.163	0.012	0.039–0.676
	Psychological resilience score	-0.114	0.007	286.895	0.893	0.000	0.881 ~ 0.904
High depressive symptoms group	Gender (Girl)						
	Boy	-0.581	0.227	6.526	0.559	0.011	0.358 ~ 0.874
	Grade (Senior high school)						
	Junior high school	-1.226	0.432	8.045	0.294	0.005	0.126 ~ 0.685
	Academic Performance (Bottom 25 % of the grade)						
	Top 25 % of the grade	-1.770	0.417	18.051	0.170	0.000	0.075 ~ 0.385
	Moderate	-0.714	0.351	4.131	0.490	0.042	0.246 ~ 0.975
	Academic stress (Heavier)						
	Lighter	-2.516	0.698	13.006	0.081	0.000	0.021 ~ 0.317
	General	-2.015	0.264	58.195	0.133	0.000	0.079 ~ 0.224
	Family atmosphere (Comparatively bad)						
	Relatively harmonious	-2.280	0.785	8.443	0.102	0.004	0.022 ~ 0.476
	Psychological resilience score	-0.193	0.012	266.204	0.824	0.000	0.805 ~ 0.844

The reference group is within the () ; OR: Odd-Ratio; CI: Confidence interval.

et al., 2021). Rural adolescents with top 25 % grades and moderate academic stress were more likely to belong to the "no depressive symptoms group." Conversely, those with lower academic performance and high academic stress levels were more inclined to be part of the "low depressive symptoms group," "transition group," or "high depressive symptoms group." This indicates that those with lower academic performance and elevated academic stress may be more susceptible to depression, in line with the findings of Zhou (Zhou et al., 2021). While multiple studies have established an association between academic performance, academic stress, and depression (Khesht-Masjedi et al., 2019; Verboom et al., 2014; Zhou et al., 2021), the causal relationship between them is not fully established. Future longitudinal studies should strive to elucidate the extent of their influence on subgroups of depressive symptoms. As per the implications drawn from this study, schools and families can institute targeted psychological counseling for students grappling with academic challenges to mitigate their risk of developing high levels of depressive symptoms.

The study reveals that family atmosphere was associated with subgroups of depressive symptoms in rural adolescents. Adolescents raised in a positive home atmosphere were more likely to belong to the "no depressive symptoms group" as opposed to the "transition group" or "high depressive symptoms group." This finding emphasizes that a harmonious family environment serves as a protective factor against depression, consistent with prior research by Zhang (Zhang et al., 2017). Abramson's theory of depressive hopelessness (Abramson et al., 1978) posits that depression arises when individuals perceive an inability to control events, leading to feelings of powerlessness. A supportive and harmonious family atmosphere instills a sense of security, belonging, and support, fostering open communication among family members and contributing to adolescents' psychological well-being (Zhang et al., 2017; Lai and Zhang, 2020). Conversely, a less supportive family atmosphere generates feelings of insecurity and threat, resulting in self-condemnation and diminished self-worth, heightening the risk of depression. The study's implications suggest that school community workers should remain attuned to issues pertaining to the family atmosphere of rural adolescents and provide appropriate interventions.

Furthermore, the research underscores the role of psychological resilience as a factor associated with subgroups of depressive symptoms in rural Chinese adolescents. Individuals possessing higher levels of psychological resilience exhibit lower levels of depressive symptoms, suggesting the potential for psychological resilience to protect against depression among rural adolescents, although causation cannot be inferred in the current study. These findings align with the results of Huang (Huang, 2019) and highlight the critical role of psychological resilience as a protective mechanism for individuals (Masten, 2001). Interventions targeting psychological resilience have demonstrated effectiveness in elevating resilience levels and preventing and reducing depression (Dray et al., 2017). Gillham's utilization of the Pennsylvania Resilience Program (PRP) for enhancing children's psychological resilience resulted in fewer depressive symptoms and the prevention of depressive symptom escalation in the intervention group compared to the control group even two and a half years after the PRP intervention concluded (Gillham et al., 2007). Consequently, the findings underscore the need for schools and families to prioritize the cultivation of psychological resilience among rural adolescents, bolstering their resilience levels and safeguarding their mental well-being.

5. Limitations and future directions

Several limitations in this study warrant acknowledgment. Firstly, the reliance on cross-sectional survey data restricts our ability to establish causality or delineate the direction of associations. Moreover, the enduring stability of these potential categories over time necessitates further investigation. Secondly, this study exclusively employed questionnaires to gauge subjects' depressive symptoms, offering only an initial assessment that warrants validation in the future through the integration of more scientifically rigorous diagnostic methods, such as interviews and observations. Lastly, the study's participants were exclusively drawn from rural adolescents aged 11–19 in six schools across three cities in Henan Province, China. Consequently, the generalizability of our findings may be somewhat constrained. Subsequent studies could broaden the scope of subjects and augment sample sizes to

enhance the representativeness of the results.

6. Conclusion

This study delineated the classification of depressive symptoms among rural adolescents into four distinct categories through LCA: the "C1 No Depressive Symptoms Group" (22.5 %), the "C2 Low Depressive Symptoms Group" (35.7 %), the "C3 Transition Group" (31.6 %), and the "C4 High Depressive Symptoms Group" (10.2 %). It is imperative for families, schools, and society to be vigilant regarding depressive symptoms in rural adolescents, with specific emphasis on girls, high school students, and adolescents with lower academic performance, heightened academic stress, suboptimal family atmospheres, and diminished psychological resilience. To foster the healthy development of rural adolescents, the establishment of an integrated social-school-family environment is recommended. Governments should disseminate knowledge related to depression, allocate increased mental health resources, and provide supportive services tailored to rural youth. Schools should undertake routine psychological assessments and implement diverse forms of mental health education. Moreover, schools and community workers can offer depression education to rural adolescent families, fostering parental awareness of their adolescents' emotional well-being and the significance of fostering a positive family atmosphere and communication. Educators play a pivotal role in identifying depressive symptoms among rural adolescents. Therefore, governments and schools should provide comprehensive training to rural teachers, enabling them to promptly recognize depressive indications and risk factors, thereby facilitating the early identification of students at heightened depression risk and the implementation of effective interventions, including counseling or referrals to healthcare facilities.

Ethical approval

The procedures used in this study followed the principles of the Declaration of Helsinki of 1949. This study was approved by the Ethics Committee of Zhengzhou University (No. 2022–105). Informed consent was obtained from all subjects participating in the study.

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CRediT authorship contribution statement

Zhenxiang Cui: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Huijuan Xue:** Writing – review & editing, Formal analysis, Data curation. **Haoran Liu:** Formal analysis, Data curation. **Fan Liu:** Investigation, Formal analysis. **Siyuan Feng:** Investigation, Formal analysis. **Hui Chen:** Visualization, Supervision. **Caihui Huang:** Visualization, Supervision. **Jingjing Wang:** Visualization, Supervision. **Dongling Liu:** Funding acquisition, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2024.102625.

References

Abramson, L.Y., Seligman, M.E., Teasdale, J.D., 1978. Learned helplessness in humans: critique and reformulation. J. Abnorm. Psychol. 87, 49–74.

Akaike, H., 1987. Factor analysis and AIC. Psychometrika 52, 317–332. https://doi.org/10.1007/BF02294359.

Black, G., Roberts, R.M., Li-Leng, T., 2012. Depression in rural adolescents: relationships with gender and availability of mental health services. Rural Remote Health 12, 2092.

Cui, J., 2020. The Characteristics of and Prediction on Adolescent Depression Based on Machine Learning. Zhejiang University.

Das, S.C., Mallicka, S., Priyadarshini, P., Manasa, R.V., 2021. Prevalence of severe depression among adolescents in rural area of Odisha, India. Indian J. Community Med. 46, 438–441. https://doi.org/10.4103/ijcm.IJCM_570_20.

Davydov, D.M., Stewart, R., Ritchie, K., Chaudieu, I., 2010. Resilience and mental health. Clin. Psychol. Rev. 30, 479–495. https://doi.org/10.1016/j.cpr.2010.03.003.

Dray, J., Bowman, J., Campbell, E., Freund, M., Wolfenden, L., Hodder, R.K., McElwaine, K., Tremain, D., Bartlem, K., Bailey, J., Small, T., Palazzi, K., Oldmeadow, C., Wiggers, J., 2017. systematic review of universal resilience-focused interventions targeting child and adolescent mental health in the school setting. J. Am. Acad. Child Adolesc. Psychiatry 56, 813–824. https://doi.org/10.1016/j.jaac.2017.07.780.

Feng, T., Jia, X., Pappas, L., Zheng, X., Shao, T., Sun, L., Weisberg, C., Li, M.L., Rozelle, S., Ma, Y., 2022. Academic performance and the link with depressive symptoms among rural Han and minority Chinese adolescents. Int. J. Environ. Res. Public Health 19. https://doi.org/10.3390/ijerph19106026.

Fu, Y., Wei, X., 2013. Relationship between Resilience, stress cognitive appraisal, coping and mental health of teenage students. Chin. J. Health Psychol. 21 https://doi.org/10.13342/j.cnki.cjhp.2013.05.025.

Gillham, J.E., Reivich, K.J., Freres, D.R., Chaplin, T.M., Shatté, A.J., Samuels, B., Elkon, A.G.L., Litzinger, S., Lascher, M., Gallop, R., Seligman, M.E.P., 2007. School-based prevention of depressive symptoms: A randomized controlled study of the effectiveness and specificity of the penn resiliency program. J. Consult. Clin. Psychol. 75, 9–19. https://doi.org/10.1037/0022-006X.75.1.9.

Hu, Y., Gan, Y., 2008. Development and Psychometric Validity of the Resilience Scale for Chinese Adolescents. Acta Psychol. Sin. 902–912.

Huang, J., 2019. The Mediating Role Of Subjective Social Status Of Middle School Students In Their Psychological Resilience And Depression. Guizhou Normal University.

Hyde, J.S., Mezulis, A.H., Abramson, L.Y., 2008. The ABCs of depression: integrating affective, biological, and cognitive models to explain the emergence of the gender difference in depression. Psychol. Rev. 115, 291–313. https://doi.org/10.1037/0033-295X.115.2.291.

Khesht-Masjedi, M.F., Shokrgozar, S., Abdollahi, E., Habibi, B., Asghari, T., Ofoghi, R.S., Pazhooman, S., 2019. The relationship between gender, age, anxiety, depression, and academic achievement among teenagers. J. Family Med. Prim. Care 8, 799–804. https://doi.org/10.4103/jfmpc.jfmpc_103_18.

Kovacs, M., 1992. The Children's depression inventory. Psychopharmacol. Bull. 21, 995–1124.

Lai, S., Su, C., Song, S., Yan, M., Tang, C., Zhang, Q., Yin, F., Liu, Q., 2021. Depression and deliberate self-harm among rural adolescents of Sichuan Province in Western China: A 2-Year longitudinal study. Front. Psych. 12, 605785 https://doi.org/10.3389/fpsyt.2021.605785.

Lai, Y., Zhang, Q., Liu, S., Zhang, M., Yang, F., 2012. Study on anxiety and depression of middle school students in Rural Beijing. Chin. J. Health Psychol. 20, 1204–1207. https://doi.org/10.13342/j.cnki.cjhp.2012.08.015.

Lai, F., Zhang, B., 2020. The impact of family atmosphere and parental education on depression of minors in Quanzhou. China Preventive Medicine 21, 934–936.

Lanza, S.T., 2016. Latent class analysis for developmental research. Child Dev. Perspect. 10, 59–64.

Li, J.-Y., Li, J., Liang, J.-H., Qian, S., Jia, R.-X., Wang, Y.-Q., Xu, Y., 2019b. Depressive Symptoms Among Children and Adolescents in China: A Systematic Review and Meta-Analysis. Med. Sci. Monit. 25, 7459–7470. https://doi.org/10.12659/MSM.916774.

Li, G., Mei, J., You, J., Miao, J., Song, X., Sun, W., Lan, Y., Qiu, X., Zhu, Z., 2019a. Sociodemographic characteristics associated with adolescent depression in urban and rural areas of Hubei province: a cross-sectional analysis. BMC Psychiatry 19, 386. https://doi.org/10.1186/s12888-019-2380-4.

Ling, Y., Liu, C., Scott Huebner, E., Zeng, Y., Zhao, N., Li, Z., 2021. A study on classification features of depressive symptoms in adolescents. J. Ment. Health 30, 208–215. https://doi.org/10.1080/09638237.2019.1677865.

Liu, Z., Li, J., Wang, Y., Miao, M., Zhong, J., 2019. Structural Verification and Measurement Invariance of Chinese Version of Children's Depression Inventory. Chin. J. Clin. Psych. 27, 1172–1176. https://doi.org/10.16128/j.cnki.1005-3611.2019.06.019.

Liu, F., Song, X., Shang, X., Wu, M., Sui, M., Dong, Y., Liu, X., 2020. A meta-analysis of detection rate of depression symptoms among middle school students. Chin. Ment. Health J. 34, 123–128.

Lo, Y., 2001. Testing the number of components in a normal mixture. Biometrika 88, 767–778. https://doi.org/10.1093/biomet/88.3.767.

Masten, A.S., 2001. Ordinary magic: Resilience processes in development. Am. Psychol. 56, 227–238. https://doi.org/10.1037/0003-066X.56.3.227.

Mezulis, A., Vander Stoep, A., Stone, A.L., McCauley, E., 2011. A latent class analysis of depressive and externalizing symptoms in nonreferred adolescents. J. Emot. Behav. Disord. 19, 247–256. https://doi.org/10.1177/1063426610377763.

Mori, M., Krumholz, H.M., Allore, H.G., 2020. Using latent class analysis to identify hidden clinical phenotypes. J. Am. Med. Assoc. 324, 700–701.

Nylund, K.L., Asparouhov, T., Muthén, B.O., 2007. Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. Struct. Equ. Model. Multidiscip. J. 14, 535–569. https://doi.org/10.1080/10705510701575396.

Rao, W.-W., Xu, D.-D., Cao, X.-L., Wen, S.-Y., Che, W.-I., Ng, C.H., Ungvari, G.S., He, F., Xiang, Y.-T., 2019. Prevalence of depressive symptoms in children and adolescents in China: A meta-analysis of observational studies. Psychiatry Res. 272, 790–796. https://doi.org/10.1016/j.psychres.2018.12.133.

Ren, Z., Zhou, G., Wang, Q., Xiong, W., Ma, J., He, M., Shen, Y., Fan, X., Guo, X., Gong, P., Liu, M., Yang, X., Liu, H., Zhang, X., 2019. Associations of family relationships and negative life events with depressive symptoms among Chinese adolescents: A cross-sectional study. PLoS One 14, e0219939.

Rice, F., Riglin, L., Lomax, T., Souter, E., Potter, R., Smith, D.J., Thapar, A.K., Thapar, A., 2019. Adolescent and adult differences in major depression symptom profiles. J. Affect. Disord. 243, 175–181. https://doi.org/10.1016/j.jad.2018.09.015.

Schwarz, G., 1978. Estimating the Dimension of a Model. The Annals of Statistics 6. https://doi.org/10.1214/aos/1176344136.

Shang, R., Pang, H., Jiang, J., Ji, Y., Liu, Q., Zhang, M., Yang, R., Li, S., Li, Y., Liu, Q., 2023. Internet addiction and depressive and anxious symptoms among Chinese rural left-behind adolescents: Mediating roles of resilience and friendship quality. Child Care Health Dev. https://doi.org/10.1111/cch.13160.

Shi, D., Li, Z., Yang, J., Liu, B., Xia, H., 2018. Symptom characteristics of stroke patients latent class analysis. Chin. Nurs. Res. 32, 3184–3189.

Shorey, S., Ng, E.D., Wong, C.H.J., 2022. Global prevalence of depression and elevated depressive symptoms among adolescents: A systematic review and meta-analysis. Br. J. Clin. Psychol. 61, 287–305. https://doi.org/10.1111/bjc.12333.

Southwick, S.M., Bonanno, G.A., Masten, A.S., Panter-Brick, C., Yehuda, R., 2014. Resilience definitions, theory, and challenges: interdisciplinary perspectives. Eur. J. Psychotraumatol. 5 https://doi.org/10.3402/ejpt.v5.25338.

Su, C, K, Y., L, J., 2011. Study on Adolescent Depression and the Relevant Risk Factors. China J. Health Psychol. 19, 629–631.

Sun, Y., Pan, W., Zhang, Y., Xu, G., Xi, J., Bao, Q., Bian, X., 2021. The relationship between stress, resilience, and quality of life in Chinese high school students. Ann. Palliat. Med. 10, 5483–5493. https://doi.org/10.21037/apm-21-929.

Terrill, A.L., Molton, I.R., Ehde, D.M., Amtmann, D., Bombardier, C.H., Smith, A.E., Jensen, M.P., 2016. Resilience, age, and perceived symptoms in persons with long-term physical disabilities. J. Health Psychol. 21, 640–649. https://doi.org/10.1177/1359105314532973.

Timbremont, B., Braet, C., Dreessen, L., 2004. Assessing depression in youth: relation between the Children's Depression Inventory and a structured interview. J. Clin. Child Adol. Psychol. 53 (33), 149–157.

Tu, W., Li, Y., Zhang, R., 2023. Negative Life events and depression of rural adolescents: mediating role of self-compassion. J. Chang. Univ. 37, 57–64+71.

Verboom, C.E., Sijtsema, J.J., Verhulst, F.C., Penninx, B.W.J.H., Ormel, J., 2014. Longitudinal associations between depressive problems, academic performance, and social functioning in adolescent boys and girls. Dev. Psychol. 50, 247–257. https://doi.org/10.1037/a0032547.

Wang, M., Bi, X., 2018. Latent variable modeling with Mplus applications – advanced part. Chongqing University Press 3–33.

Wang, T., Chen, M., Sun, Y., Yang, L., Sun, Y., Cao, Q., Gu, C., Han, T., 2011. Research on children's depression and the influence of left-behind status in rural area. Chin. J. School Health 32, 1445–1447. https://doi.org/10.16835/j.cnki.1000-9817.2011.12.016.

Wang, M., Deng, Q., Bi, X., Ye, H., Yang, W., 2017. Performance of the entropy as an index of classification accuracy in latent profile analysis: A Monte Carlo simulation study. Acta Psychol. Sin. 49, 1473–1482.

Wang, C, J., 2019. Application of latent category analysis to disease classification. Guangdong Medical Journal. 40, 223-226+229. .

Weersing, V.R., Jeffreys, M., Do, M.-C.-T., Schwartz, K.T.G., Bolano, C., 2017. Evidence base update of psychosocial treatments for child and adolescent depression. J. Clin. Child Adolesc. Psychol. 46, 11–43. https://doi.org/10.1080/15374416.2016.1220310.

Wu, Y.-L., Zhao, X., Ding, X.-X., Yang, H.-Y., Qian, Z.-Z., Feng, F., Lu, S.-S., Hu, C.-Y., Gong, F.-F., Sun, Y.-H., 2017. A prospective study of psychological resilience and depression among left-behind children in China. J. Health Psychol. 22, 627–636. https://doi.org/10.1177/1359105315610811.

Yan, Y., Xian, H., Wang, J., Sun, X., Wang, H., Gu, Y., Du, Z., Sun, X., 2021. Survey Research on the Setting and Utilization of the Fever Clinic at Primary Healthcare Institutions. Chinese General Practice 24, 4312–4318.

Yu, D., Li, X., 2000. Preliminary use of the children's depression inventory in China. Chin. Ment. Health J. 225–227.

Zhang, H., Tao, F., Zeng, G., Cao, X., Xu, S., Yu, X., 2001. Depression and Its Correlates among Middle School Students in Anhui Province. Chin. J. School Health 497–498. https://doi.org/10.3969/j.issn.1000-9817.2001.06.033.

Zhang, H., Wang, J., Li, X., Wang, Y., 2017. Influence of parental marital status and family atmosphere on the adolescent depressive symptoms and the moderating function of character strengths. Guangdong Medical Journal 38, 598–603. https://doi.org/10.13820/j.cnki.gdyx.20170309.007.

Zhang, J., Zhang, J., Wang, A., Su, P., 2016. Latent class analysis on resilience characteristics of empty-nest elderly in community. Chin. J. Behav. Med. Brain Sci. 25, 358–362. https://doi.org/10.3760/cma.j.issn.1674-6554.2016.04.016.

Zhou, T., Cheng, G., Wu, X., Li, R., Li, C., Tian, G., He, S., Yan, Y., 2021. The Associations between Sleep Duration, Academic Pressure, and Depressive Symptoms among Chinese Adolescents: Results from China Family Panel Studies. Int. J. Environ. Res. Public Health 18, 6134. https://doi.org/10.3390/ijerph18116134.

Zhou, Z., Wang, J., 2011. Analysis of depressive symptoms and their associated factors in rural primary and secondary school students. Acta Univ. Med. Anhui 46, 976–978. https://doi.org/10.19405/j.cnki.issn1000-1492.2011.09.038.