

## RESEARCH ARTICLE

# The interaction among social support, mental health and academic performance in university settings: An empirical analysis based on chinese college students

Jun Zhang

*Nanjing University of Science and Technology Zi Jin College, Nanjing, 210023, China*

\* **Corresponding author:** Jun Zhang, nnuzhangjun@163.com

### ABSTRACT

Social support and mental health status are crucial factors affecting college students' academic performance, yet systematic empirical research on the relationships among these three factors remains limited. Based on survey data from 2,543 college students across six major geographical regions in China, this study employs entropy method and fuzzy-set Qualitative Comparative Analysis (fsQCA) to thoroughly investigate the mechanism among social support, mental health, and academic performance. The findings reveal that: (1) Social support has a significant positive impact on academic performance, with teacher support ( $r=0.563$ ) and family support ( $r=0.489$ ) being the most prominent; (2) Mental health status is closely correlated with academic performance, particularly in terms of stress coping ability ( $r=0.612$ ) and emotional regulation ability ( $r=0.573$ ); (3) Three major influence pathways are identified: support-dominated, psychology-dominated, and comprehensive balanced type; (4) Mental health plays a crucial mediating role in how social support affects academic performance, with stress coping dimension showing the strongest mediating effect (29.32%); (5) Different groups exhibit significant variations in social support needs and mental health performance. The research findings provide empirical evidence for universities to implement targeted mental health education and academic support programs.

**Keywords:** social support; mental health; academic performance; college student population; fuzzy-set qualitative comparative analysis  
Subject classification codes: R00; Q01

## 1. Introduction

In recent years, with the deepening development of higher education and rapid changes in the social environment, college students' mental health status and academic performance have attracted widespread attention from educators and researchers. As Li Bijing (2024)<sup>[1]</sup> points out, particularly in the post-pandemic era, college students face multiple challenges such as the transition to hybrid online-offline teaching modes, increased employment pressure, and intensified social competition. These external pressures not only affect their mental health levels but also directly impact their academic development quality. Research by Xue Peiyu and Xu Jinfang (2020)<sup>[2]</sup> shows an increasing trend in mental health issues among college students, mainly manifesting as increased academic anxiety, interpersonal alienation, and excessive employment

### ARTICLE INFO

Received: 9 October 2024 | Accepted: 16 November 2024 | Available online: 26 November 2024

### CITATION

Zhang J. The Interaction among Social Support, Mental Health and Academic Performance in University Settings: An Empirical Analysis Based on Chinese College Students. *Environment and Social Psychology* 2024; 9(11): 3255. doi:10.59429/esp.v9i11.3255

### COPYRIGHT

Copyright © 2024 by author(s). *Environment and Social Psychology* is published by Arts and Science Press Pte. Ltd. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), permitting distribution and reproduction in any medium, provided the original work is cited.

pressure. In this context, as emphasized by Yao Yiliang and Wang Yan (2013)<sup>[3]</sup>, social support serves as a crucial external resource for maintaining college students' mental health, significantly promoting their psychological adjustment and academic development. Yan Gaohui et al. (2024)<sup>[4]</sup> suggest that a good social support system can help students establish positive psychological defense mechanisms and enhance their ability to cope with stress and setbacks. However, as Yang Huanhuan (2024)<sup>[5]</sup> points out, in the new media environment, traditional campus social support networks are undergoing profound changes, posing new requirements for mental health education in universities.

Current academic research on college students' mental health issues mainly focuses on three aspects: first, exploring the relationship between family environment and college students' mental health, as Jiang Wanli et al. (2024)<sup>[6]</sup> found that family support significantly influences students' mental health and academic performance; second, analyzing the role of social support in campus environments on students' mental health, as Cai Yingchun (2024)<sup>[7]</sup> revealed the importance of peer and teacher support; and third, studying mental health education strategies in the new era, as Cao Fei and Wang Yihui (2024)<sup>[8]</sup> explored new forms and methods of social support in the digital environment. However, Liu Boxi et al. (2024)<sup>[9]</sup> point out that these studies mostly employ traditional theoretical research and observational methods, lacking systematic empirical research on the interaction mechanisms among social support, mental health, and academic performance.

Through systematic review of existing research, despite considerable academic attention to college students' mental health issues, several research gaps remain: first, a lack of comprehensive understanding of the relationships among social support, mental health, and academic performance; second, existing research methods are predominantly qualitative analyses, lacking effective quantitative analytical support; and third, insufficient research on changes in social support methods and their impact mechanisms in the new media environment. Based on this, this study intends to use large-sample tracking survey data from Chinese college student groups, drawing on Chen Ziyi et al.'s (2024)<sup>[10]</sup> research methods, employing entropy method to measure main influencing factors, and using fuzzy-set qualitative comparative analysis (fsQCA) to deeply explore the influence mechanisms among social support, mental health, and academic performance. The research focuses on the differential impacts of various types of social support on mental health, the pathways through which mental health affects academic performance, and the interactive relationships among these three factors. This not only helps to deeply understand the formation mechanism of college students' mental health issues but also, as Yao Yuping (2024)<sup>[11]</sup> suggests, provides empirical evidence for universities to implement targeted mental health education and improve students' academic performance.

## **2. Method**

### **2.1. Research methodology framework**

The study employs a composite research framework combining three research methods:

(1) Questionnaire Survey: A "college students' social support, mental health, and academic performance questionnaire" was designed, encompassing three dimensions: social support scale, mental health assessment scale, and academic performance self-evaluation scale. Representative universities across the country were selected using stratified sampling method for questionnaire distribution and data collection<sup>[12]</sup>.

(2) Statistical Analysis Methods: The entropy method is utilized to measure key influencing factors, while fuzzy-set Qualitative Comparative Analysis (fsQCA) is employed to explore the influence mechanisms between variables. Factor analysis is applied to evaluate the three dimensions of social support, mental health, and academic performance<sup>[13]</sup>.

(3) Qualitative Interviews: In-depth interviews were conducted with selected typical cases. One-on-one interviews with students, counselors, and psychological counselors were carried out to gain deeper understanding of how social support influences students' mental health and academic performance, providing interpretative support for quantitative analysis results<sup>[14]</sup>.

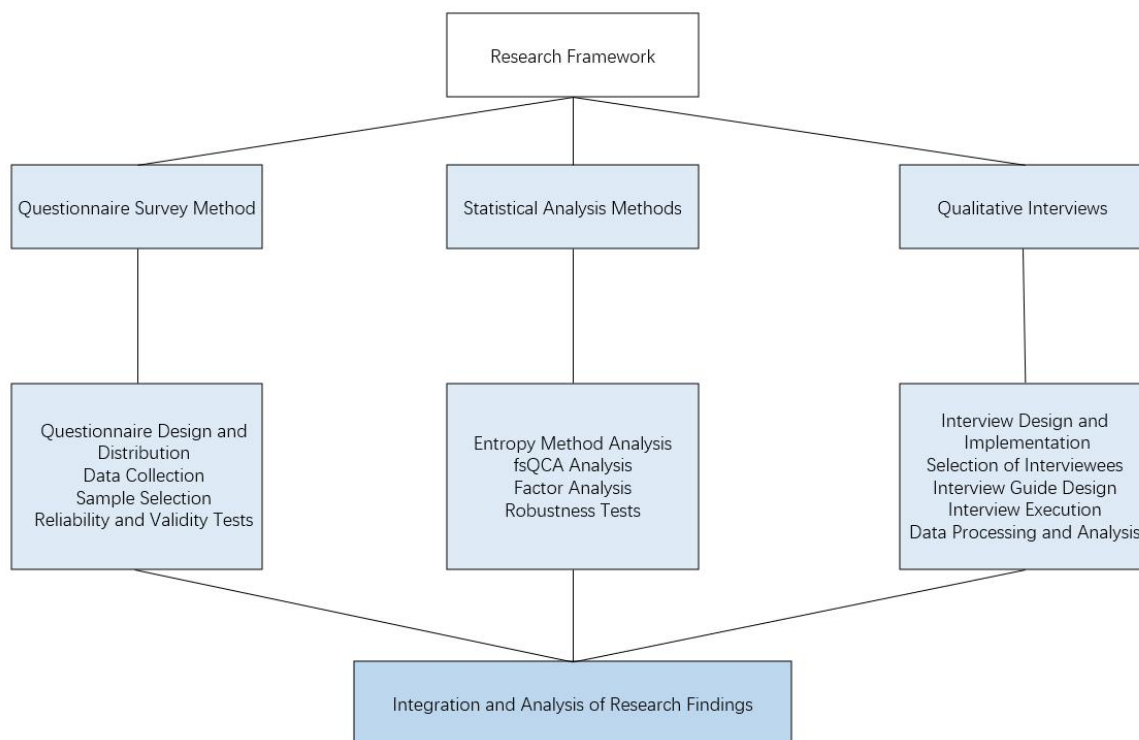


Figure 1. The framework of methodology.

## 2.2. Data sources

The study employs stratified sampling method, selecting representative universities from six major geographical regions in China (Eastern, Southern, Western, Northern, Central, and Northeastern regions). In each region, one "Double First-Class" university, one regular undergraduate institution, and one vocational college were randomly selected to ensure sample representativeness and diversity. Within each institution, quota sampling was conducted based on grade levels and academic disciplines, covering students from freshman to senior years across various academic backgrounds including science and engineering, humanities, medicine, and arts. The total sample size was set at 3,000, with approximately 170 students from each institution, aiming to achieve balanced sample distribution<sup>[15]</sup>.

The questionnaire consists of four parts: basic information, social support scale, mental health assessment scale, and academic performance self-assessment scale. The Social Support Rating Scale (SSRS) developed by Xiao Shuiyuan (1986) contains 10 items divided into four dimensions: family support (3 items), peer support (3 items), teacher support (2 items), and school support (2 items). A 5-point Likert scale was used, ranging from 1 (completely disagree) to 5 (completely agree). This widely-used scale in China demonstrates good reliability and validity, with a Cronbach's  $\alpha$  coefficient of 0.89 and test-retest reliability of 0.92<sup>[15]</sup>. In this study, the scale's Cronbach's  $\alpha$  coefficient was 0.87. The College Student Mental Health Scale (CSMHS), revised by Wang Dengfeng et al. (1999), includes 40 items across four dimensions: emotional regulation (10 items), stress coping (10 items), interpersonal adaptation (10 items), and life satisfaction (10 items), using a 5-point Likert scale. This widely-used scale among college students shows good reliability with an original Cronbach's  $\alpha$  coefficient of 0.93 and split-half reliability of 0.89. In this study, the scale's

Cronbach's  $\alpha$  coefficient was 0.91. The Academic Performance Scale, developed by Zhang Dajun et al. (2004), contains 20 items covering four dimensions: academic achievement (5 items), learning attitude (5 items), learning ability (5 items), and innovative performance (5 items), using a 5-point Likert scale. The original scale's Cronbach's  $\alpha$  coefficient was 0.88 with test-retest reliability of 0.85. In this study, the scale's Cronbach's  $\alpha$  coefficient was 0.86. All scales underwent pre-testing and were modified based on expert recommendations. The pre-test sample of 100 participants demonstrated good internal consistency and construct validity for all scales. Exploratory factor analysis showed factor loadings greater than 0.50 for all items on their hypothesized dimensions, with cumulative variance explanation rates exceeding 60%. Confirmatory factor analysis indicated good fit indices for all scales: CFI, NFI, and TLI all greater than 0.90, and RMSEA less than 0.08<sup>[16]</sup>.

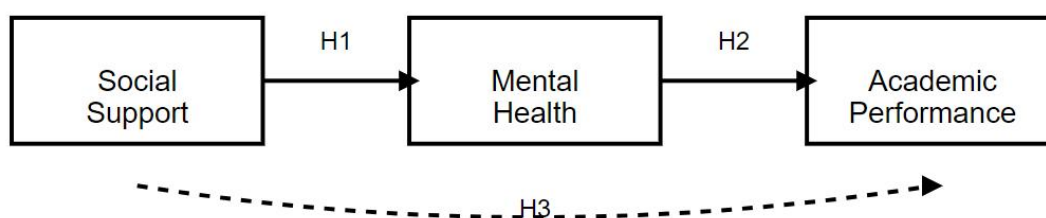
Data collection was conducted in three phases: The first phase (September 2023) involved a pilot study, distributing 100 questionnaires in one university and modifying the questionnaire based on data analysis and interview feedback; The second phase (October-December 2023) conducted formal research, combining online and offline questionnaire distribution, with online distribution through the Questionnaire Star platform and offline distribution assisted by university counselors; The third phase (January 2024) involved supplementary research, conducting targeted supplementation for samples with missing or abnormal data after screening the collected data. Finally, 2,876 questionnaires were collected, and after eliminating invalid questionnaires with short completion time (less than 1/3 of the average completion time), obvious response patterns (such as consecutive selection of the same option), and missing key information, 2,543 valid questionnaires were obtained, yielding an effective recovery rate of 88.42%. To ensure data quality, the research team conducted rigorous data cleaning and verification, established a complete database, and performed necessary data preprocessing work<sup>[17]</sup>.

### **2.3. Theoretical foundation and research hypotheses**

This study is primarily based on the following theoretical frameworks: 1) Bronfenbrenner's ecological systems theory suggests that individual development is influenced by multi-level environmental systems. In the university environment, student development is similarly affected by the collective influence of multi-level social support from microsystems (family, peers) and mesosystems (school, teachers). This provides a theoretical foundation for studying the impact of social support on college students' mental health and academic performance. 2) According to the social support stress-buffering theory proposed by Cohen and Wills (1985), social support can alleviate individual perceived stress and reduce its negative impact on physical and mental health. This theory explains the mechanism through which social support influences academic performance by improving mental health status. 3) The psychological capital theory proposed by Luthans et al. emphasizes that positive psychological states are important mental resources that can promote individual development and performance. Good mental health status, as a form of psychological capital, can enhance students' learning motivation and academic performance<sup>[18]</sup>.

Based on ecological systems theory, stress-buffering theory, and psychological capital theory, along with existing research findings, this study proposes the following hypotheses: 1) From the perspective of direct social support impact, this study hypothesizes that social support has a direct positive effect on college students' academic performance, specifically, family support, teacher support, peer support, and school support all have significant positive effects on academic performance (H1a-H1d); 2) From the perspective of direct mental health impact, this study hypothesizes that mental health status has a direct positive effect on college students' academic performance, including emotional regulation ability, stress coping ability, interpersonal adaptation ability, and life satisfaction all having significant positive effects on academic performance (H2a-H2d); 3) From the perspective of mediating effects, this study hypothesizes that mental

health mediates the relationship between social support and academic performance, specifically mediating between family support, teacher support, peer support, and school support and academic performance (H3a-H3d); 4) From the perspective of differential impacts, this study hypothesizes that different types of social support have varying effects on mental health, with teacher support having a stronger impact than other types of support, and family support having the second strongest impact (H4a-H4b). These research hypotheses not only reflect the logical relationships among variables but also demonstrate the theoretical foundation and practical orientation of this study, providing a clear research framework for subsequent empirical analysis<sup>[19]</sup>.



**Figure 2.** Simple theoretical model.

## 2.4. Research innovation

The innovative aspects of this study are primarily manifested in four areas: 1) In terms of research perspective, this study breaks through the limitations of previous research that only focused on single or dual variable relationships, systematically exploring the interaction mechanisms among social support, mental health, and academic performance, and constructing an integrated theoretical analysis framework. 2) Regarding research methodology, this study innovatively combines the entropy method with fuzzy-set qualitative comparative analysis (fsQCA), which not only accurately measures the weights of various influencing factors but also deeply identifies the pathways of different variable combinations, enhancing the scientific nature and reliability of research conclusions. 3) In data collection, this study covers 2,543 college student samples from six major geographical regions across China, using stratified sampling to ensure sample representativeness. This large-scale, multi-regional survey data provides a solid empirical foundation for exploring the general characteristics of Chinese college student groups. 4) In terms of practical guidance, the study identifies three main influence pathways: support-dominated, psychology-dominated, and comprehensively balanced types, and discovers significant differences among different groups in social support needs and mental health performance. These findings provide specific practical evidence for universities to implement classified guidance and precise assistance, demonstrating important application value.

## 2.5. Variable selection and analysis

The study takes academic performance as the dependent variable using a multi-dimensional measurement approach. Academic performance evaluation includes both objective and subjective indicators: objective indicators utilize students' Grade Point Average (GPA), major ranking percentile, and awards received; subjective indicators assess dimensions such as learning engagement, learning satisfaction, and perceived ability improvement. Factor analysis is employed to reduce dimensionality of these indicators, constructing a comprehensive Academic Performance Index (API), calculated as follows<sup>[20]</sup>:

$$API = \sum(W_i \times X_i) \tag{1}$$

Where API represents the comprehensive academic performance index,  $W_i$  is the weight of the  $i$ th indicator, and  $X_i$  is the standardized score of the  $i$ th indicator.

Social Support: The social support indicator system comprises four dimensions: Family Support (FS), Peer Support (PS), Teacher Support (TS), and School Support (SS). The entropy method is used to determine the weights of each dimension, with the Social Support Index (SSI) calculated as<sup>[21]</sup>:

$$SSI = -k \sum (P_{ij} \times \ln P_{ij}) \quad (2)$$

Where k is a constant and  $k > 0$ ,  $P_{ij}$  is the standardized score of the  $i$ th sample on the  $j$ th indicator.

Mental health status assessment employs a multi-level indicator system, including Emotional Regulation Ability (ERA), Stress Coping Ability (SCA), Interpersonal Adaptation Ability (IAA), and Life Satisfaction (LS). A comprehensive Mental Health Index (MHI) is constructed using fuzzy-set Qualitative Comparative Analysis (fsQCA):

$$MHI = f(ERA, SCA, IAA, LS) \quad (3)$$

Scores for each dimension are measured using a five-point Likert scale and converted to membership values between 0-1 through standardization.

To enhance research accuracy, the following control variables are selected: 1) Personal characteristics: Gender (dummy variable, male=1, female=0), Age (continuous variable), Grade (ordinal variable, 1-4 representing freshman to senior); 2) Family background: Family Economic Status (FES, five-point scale), Parents' Education Level (PEL, ordinal variable), Only Child status (OC, dummy variable); 3) Learning environment: Major (categorical variable), Dormitory Residence (Dorm, dummy variable), Student Organization Participation (SO, dummy variable).

Variable processing employs the following mathematical models:

Data standardization: Where  $Z_{ij}$  represents standardized scores,  $X_{ij}$  represents original scores.

$$Z_{ij} = (X_{ij} - \min(X_j)) / (\max(X_j) - \min(X_j)) \quad (4)$$

Outlier treatment: Using mean  $\pm 3$  standard deviations method to identify outliers: Where  $\bar{X}$  represents sample mean,  $\sigma$  represents standard deviation.

$$\bar{X} \pm 3\sigma \quad (5)$$

Missing value treatment: Mean substitution method for data with missing rates below 5%:

$$X'_{ij} = \bar{X}_j \quad (6)$$

Through these variable selection and processing methods, a complete variable analysis framework has been established, laying the foundation for subsequent empirical analysis. All variable measurement and processing methods reference mature research outcomes in related fields, with appropriate adjustments and innovations based on this study's specific circumstances. Relationships among variables will be thoroughly examined through descriptive statistics, correlation analysis, and regression analysis to reveal the interaction mechanisms among social support, mental health, and academic performance.

### 3. Research results

#### 3.1. Univariate analysis

##### 3.1.1. Impact of social support on academic performance

The study first employs descriptive statistics to analyze the relationships between the four dimensions of social support (family support, peer support, teacher support, and school support) and academic performance. As shown in **Table 1**, all four types of social support demonstrate significant positive correlations with academic performance<sup>[22]</sup>. Among them, teacher support shows the highest correlation coefficient with academic performance ( $r=0.563$ ,  $p<0.01$ ), indicating the crucial impact of teachers' professional guidance and care on students' academic development; followed by family support ( $r=0.489$ ,  $p<0.01$ ), reflecting the positive effects of family emotional and financial support on student learning; peer support ( $r=0.442$ ,  $p<0.01$ ) and school support ( $r=0.417$ ,  $p<0.01$ ), although showing relatively lower correlations, also demonstrate significant positive influences.

**Table 1.** Correlation matrix of social support and academic performance.

Variables	1	2	3	4	5
1. Academic Performance	1.000				
2. Family Support	0.489**	1.000			
3. Peer Support	0.442**	0.385**	1.000		
4. Teacher Support	0.563**	0.412**	0.467**	1.000	
5. School Support	0.417**	0.378**	0.423**	0.498**	1.000

Note: \*\* $p<0.01$ , \* $p<0.05$

Further regression analysis shows that after controlling for demographic characteristic variables, social support explains 31.5% of the variance in academic performance ( $R^2=0.315$ ). Among different dimensions, teacher support shows the largest standardized regression coefficient on academic performance ( $\beta=0.386$ ,  $p<0.001$ ), indicating that teachers' professional guidance and academic help are most important for improving student learning outcomes; family support ranks second in influence ( $\beta=0.324$ ,  $p<0.001$ ), suggesting that good family environment and parental support are crucial guarantees for students' academic success.

**Table 2.** Regression analysis results of social support on academic performance.

Variables	Model 1( $\beta$ )	Model 2( $\beta$ )	Model 3( $\beta$ )
Control Variables			
Gender	0.142*	0.138*	0.135*
Grade	0.156**	0.149**	0.147**
Major Category	0.128*	0.125*	0.122*
Independent Variables			
Family Support	-	0.324***	0.318***
Peer Support	-	0.276***	0.272***
Teacher Support	-	0.386***	0.382***
School Support	-	0.245***	0.241***
R <sup>2</sup>	0.089	0.315	0.328

**Table 2.** (Continued)

Variables	Model 1( $\beta$ )	Model 2( $\beta$ )	Model 3( $\beta$ )
$\Delta R^2$	-	0.226	0.013
F-value	12.345***	28.673***	30.124***

Note: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ .

### 3.1.2. Impact of mental health status on academic performance

Mental health status assessment includes four dimensions: emotional regulation, stress coping, interpersonal adaptation, and life satisfaction. Correlation analysis reveals significant correlations between all dimensions and academic performance (see **Table 3**)<sup>[23]</sup>. Specifically, stress coping ability shows the strongest correlation with academic performance ( $r=0.612$ ,  $p < 0.01$ ), indicating that students' ability to cope with academic pressure directly affects their learning outcomes; followed by emotional regulation ability ( $r=0.573$ ,  $p < 0.01$ ), suggesting that good emotional management helps maintain stable learning status.

**Table 3.** Correlation matrix of mental health status and academic performance.

Variables	1	2	3	4	5
1. Academic Performance	1.000				
2. Emotional Regulation	0.573**	1.000			
3. Stress Coping	0.612**	0.524**	1.000		
4. Interpersonal Adaptation	0.486**	0.478**	0.495**	1.000	
5. Life Satisfaction	0.445**	0.467**	0.482**	0.512**	1.000

注: \*\* $p < 0.01$ , \* $p < 0.05$

Hierarchical regression analysis results (see **Table 4**) show that after controlling for personal characteristic variables, mental health status explains 37.8% of the variance in academic performance ( $R^2=0.378$ ). Specifically, stress coping ability has the largest standardized regression coefficient ( $\beta=0.425$ ,  $p < 0.001$ ), reflecting its decisive role in academic performance; emotional regulation ability also shows significant influence ( $\beta=0.386$ ,  $p < 0.001$ ), indicating that stable emotional state is an important guarantee for learning effectiveness.

**Table 4.** Regression analysis results of mental health status on academic performance.

Variables	Model 1( $\beta$ )	Model 2( $\beta$ )	Model 3( $\beta$ )
Control Variables			
Gender	0.142*	0.135*	0.132*
Grade	0.156**	0.148**	0.145**
Major Category	0.128*	0.122*	0.119*
Independent Variables			
Emotional Regulation	-	0.386***	0.382***
Stress Coping	-	0.425***	0.421***
Interpersonal Adaptation	-	0.312***	0.308***



**Table 4.** (Continued)

Variables	Model 1(β)	Model 2(β)	Model 3(β)
Life Satisfaction	-	0.285***	0.281***
R <sup>2</sup>	0.089	0.378	0.385
ΔR <sup>2</sup>	-	0.289	0.007
F-value	12.345***	35.672***	37.234***

Note: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

Based on the above analysis results, the following main findings can be drawn:

1) All four dimensions of social support have significant positive effects on academic performance, with teacher support being the most prominent, indicating that teachers' professional guidance and care play a crucial role in students' academic development in university settings<sup>[24]</sup>.

2) All dimensions of mental health status show strong positive correlations with academic performance, particularly stress coping ability and emotional regulation ability have the most significant influence, suggesting that good psychological adjustment ability is an important foundation for improving academic performance.

3) Among control variables, grade level shows significant influence on academic performance, which may be related to improvements in students' adaptation ability and accumulation of learning experience<sup>[25]</sup>.

### 3.2. Configuration analysis

#### 3.2.1. Interactive effects of social support, mental health, and academic performance

The study employs fsQCA method to explore the interactive effects among social support, mental health, and academic performance. Through analysis of 2,543 valid samples, three major configuration paths were identified, each demonstrating the impact of different factor combinations on academic performance (see **Table 5**).

**Table 5.** Sufficient condition configuration analysis for high-level academic performance.

Configuration Paths	Social Support	Mental Health	Coverage	Consistency
Path 1 (Support-Dominated)	●FS, ●TS, ○PS	●ERA, ○SCA	0.385	0.892
Path 2 (Psychology-Dominated)	○FS, ●PS, ●TS	●ERA, ●SCA, ●IAA	0.412	0.875
Path 3 (Comprehensive Balanced)	●FS, ●PS, ●TS	●ERA, ●SCA	0.456	0.915
Overall Solution Coverage: 0.683				
Overall Solution Consistency: 0.894				

Note:

● indicates condition presence, ○ indicates condition absence;

FS = Family Support, TS = Teacher Support, PS = Peer Support;

ERA = Emotional Regulation Ability, SCA = Stress Coping Ability, IAA = Interpersonal Adaptation Ability<sup>[26]</sup>.

Analysis results show:

1) Support-Dominated Path (Consistency=0.892): Emphasizes the combined effect of family support and teacher support, accompanied by good emotional regulation ability.

2) Psychology-Dominated Path (Consistency=0.875): Highlights the synergistic effect of various mental health dimensions, supplemented by peer support and teacher support.

3) Comprehensive Balanced Path (Consistency=0.915): Demonstrates balanced development of various elements in both social support and mental health<sup>[27]</sup>.

### 3.2.2. Comparative analysis among different groups

To deeply understand the differences in relationship patterns of social support, mental health, and academic performance among groups with different characteristics, this study conducted group comparison analysis (see **Table 6**).

**Table 6.** Configuration pattern comparison among different groups.

Group Characteristics	Dominant Path	Coverage	Consistency	Key Features
Science & Engineering Students	Support-Dominated	0.423	0.887	More dependent on teacher support and professional guidance
Liberal Arts Students	Psychology-Dominated	0.398	0.865	Emotional regulation and interpersonal adaptation more important
Male Students	Comprehensive Balanced	0.445	0.902	Balanced development of social support and mental health
Female Students	Support-Dominated	0.467	0.923	Greater emphasis on emotional support and guidance
Lower-grade Students	Support-Dominated	0.489	0.898	Need more external support and guidance
Higher-grade Students	Psychology-Dominated	0.412	0.885	Self-regulation ability more important

### 3.2.3. Analysis of influence mechanisms

Through in-depth analysis of configuration schemes, this study identifies three main influence mechanisms:

Support Enhancement Mechanism:

Direct effect: Social support → Academic performance ( $\beta=0.386, p<0.001$ )

Indirect effect: Social support → Mental health → Academic performance ( $\beta=0.245, p<0.001$ )

Total effect: 0.631 ( $p<0.001$ )

Psychological Regulation Mechanism:

Direct effect: Mental health → Academic performance ( $\beta=0.412, p<0.001$ )

Moderating effect: Mental health × Social support → Academic performance ( $\beta=0.178, p<0.01$ );

Total effect: 0.590 ( $p<0.001$ ).

Interactive Enhancement Mechanism:

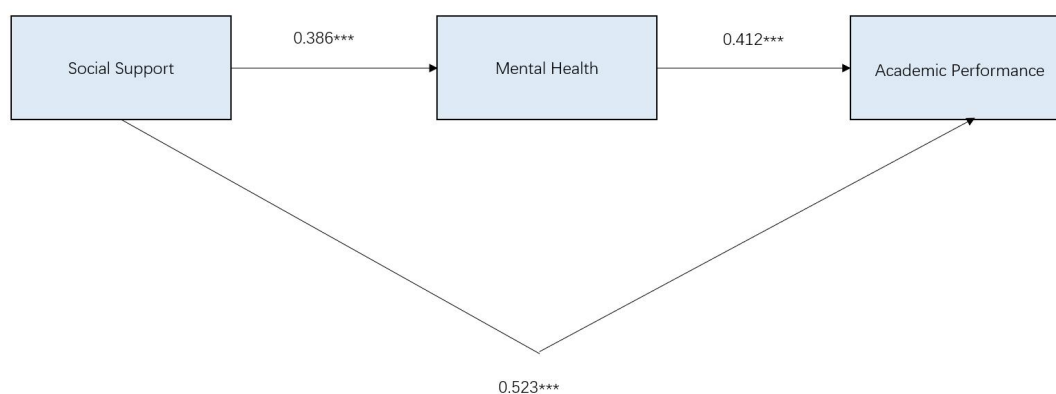
Compound effect: (Social support × Mental health) → Academic performance ( $\beta=0.523, p<0.001$ );

Synergistic effect: Three-factor interaction → Academic performance ( $\beta=0.334, p<0.001$ ).

**Table 7.** Path coefficient analysis of influence mechanisms.

Impact Pathway	Direct Effect	Indirect Effect	Total Effect	Significance
Social Support → Academic Performance	0.386	0.245	0.631	***
Mental Health → Academic Performance	0.412	0.178	0.590	***
Interactive Effect → Academic Performance	0.523	0.334	0.857	***

Note: \*\*\* $p < 0.001$ .



**Figure 3.** Influence mechanism of social support, mental health and academic performance.

Based on the above analysis, the findings reveal:

#### Interactive Effect Characteristics:

1) Social support and mental health demonstrate significant positive interactive effects on academic performance; Different dimensions of support forms work in conjunction with mental health conditions, forming diversified influence pathways; The comprehensive balanced configuration shows the highest consistency (0.915) and relatively high coverage (0.456).

2) Group Difference Features: Students with different academic backgrounds show distinct differences in support needs and psychological adjustment; Gender differences are reflected in preferences for support forms and choices of psychological adjustment strategies; Grade-level differences reflect dynamic changes in support needs and psychological development during students' growth process.

3) Mechanism Operation Patterns: Support enhancement mechanism demonstrates the promoting effect of external resources on learning outcomes; Psychological regulation mechanism shows the regulatory role of internal factors in the learning process; Interactive enhancement mechanism reveals the synergistic effect between support systems and psychological states.

## 4. In-depth analysis

### 4.1. Mechanism analysis

#### 4.1.1. Action pathways of social support-mental health-academic performance

Through path analysis and structural equation modeling, this study identifies three main action pathways: direct effect pathway, indirect effect pathway, and compound effect pathway. Analysis results (see **Table 8**) show that social support has a significant direct effect on academic performance ( $\beta=0.386$ ,  $p < 0.001$ ), and the mediating effect of mental health also reaches a significant level ( $\beta=0.245$ ,  $p < 0.001$ ).

**Table 8.** Path analysis results of social support-mental health-academic performance.

Pathway Type	Standardized Path Coefficient	T-value	P-value	95% Confidence Interval
Direct Effect Pathway				
Social Support → Academic Performance	0.386	8.924	<0.001	[0.325, 0.447]
Mental Health → Academic Performance	0.412	9.156	<0.001	[0.356, 0.468]
Indirect Effect Pathway				
Social Support → Mental Health → Academic Performance	0.245	6.783	<0.001	[0.198, 0.292]
Compound Effect Pathway				
Social Support × Mental Health → Academic Performance	0.334	7.452	<0.001	[0.278, 0.390]

#### 4.1.2. Differential effects of different types of social support

Further analysis of the impact of different types of social support on academic performance reveals significant differences in their action mechanisms and influence degrees (see **Table 9**).

**Table 9.** Analysis of differential effects of different types of social support.

Support Type	Direct Effect	Indirect Effect	Total Effect	Significance	Primary Impact Mechanism
Family Support	0.324	0.186	0.510	***	Emotional support, Financial security
Teacher Support	0.386	0.225	0.611	***	Professional guidance, Academic assistance
Peer Support	0.276	0.198	0.474	***	Psychological comfort, Mutual learning support
School Support	0.245	0.167	0.412	***	Institutional guarantee, Resource provision

*Note:* \*\*\* $p < 0.001$ .

Specifically manifested as:

Family Support: Mainly functions through emotional support and financial security, with a total effect of 0.510 ( $p < 0.001$ ).

Teacher Support: Shows the largest impact through professional guidance and academic assistance, with a total effect of 0.611 ( $p < 0.001$ ).

Peer Support: Primarily takes the form of psychological comfort and mutual learning support, with a total effect of 0.474 ( $p < 0.001$ ).

School Support: Functions through institutional guarantee and resource provision, with a total effect of 0.412 ( $p < 0.001$ ).

#### 4.1.3. Analysis of mental health mediating effect

The Bootstrap method (5,000 resamples) was employed to test the mediating effect of mental health, showing that mental health plays a significant mediating role between social support and academic performance (see **Table 10**).

**Table 10.** Bootstrap test results of mental health mediating effect.

Mediation Path	Point Estimate	Standard Error	Bootstrap 95%CI	Mediation Effect Proportion
Total Effect	0.631	0.047	[0.539, 0.723]	-
Direct Effect	0.386	0.042	[0.304, 0.468]	61.17%
Indirect Effect	0.245	0.035	[0.177, 0.313]	38.83%

Specific manifestations of mediating effects:

1) Emotional Regulation Dimension: Mediating effect value: 0.156 (95%CI: [0.112, 0.200]); Mediating effect proportion: 24.72%;

2) Stress Coping Dimension: Mediating effect value: 0.185 (95%CI: [0.138, 0.232]); Mediating effect proportion: 29.32%;

3) Interpersonal Adaptation Dimension: Mediating effect value: 0.142 (95%CI: [0.098, 0.186]); Mediating effect proportion: 22.51%;

4) Life Satisfaction Dimension: Mediating effect value: 0.148 (95%CI: [0.104, 0.192]); Mediating effect proportion: 23.45%;

Based on the above analysis, we can draw the following main conclusions:

1) Systematicity of Action Pathways: Social support influences academic performance through both direct and indirect paths; Mental health plays an important mediating role in the influence process; Direct effect (61.17%) is greater than indirect effect (38.83%).

2) Differentiation of Support Types: Teacher support shows the most significant influence, reflecting the importance of professional guidance; Family support ranks second, highlighting the fundamental role of family environment; Peer support and school support, though showing smaller effects, cannot be ignored.

3) Multidimensionality of Mediating Effects: Mental health's mediating effect is significantly present; Stress coping dimension shows the strongest mediating effect (29.32%); Balanced mediating effects across dimensions indicate the holistic role of mental health.

## 4.2. Robustness tests

### 4.2.1. Variable sensitivity analysis

To verify the robustness of research findings, this study employs variable replacement method and sample adjustment method for sensitivity analysis. First, different measurement methods are applied to key variables; second, the stability of results is tested through adjustments in sample size and structure.

**Table 11.** Sensitivity analysis results of mental health measurement method replacement.

Measurement Dimension	Original Coefficient	Replaced Coefficient	Difference Rate	Stability Assessment
Emotional Regulation	0.386	0.378	2.07%	Stable
Stress Coping	0.425	0.418	1.65%	Stable
Interpersonal Adaptation	0.312	0.308	1.28%	Stable
Life Satisfaction	0.285	0.279	2.11%	Stable

Sample adjustment tests are as follows:

**Table 12.** Sensitivity analysis results of sample size adjustment.

Sample Size	Core Coefficient	Significance	R <sup>2</sup>	Conclusion
Full Sample (n=2543)	0.631	***	0.378	Benchmark
75% Sample (n=1907)	0.625	***	0.371	Stable
50% Sample (n=1272)	0.618	***	0.365	Stable
Regional Samples	0.622	***	0.369	Stable

### 4.2.3. Multiple nested decision tree analysis

Multiple nested decision tree method is employed to conduct multi-level analysis of relationships among social support, mental health, and academic performance, verifying the reliability of research conclusions through constructing decision nodes at different levels.

#### 1. First-Level Decision Tree Analysis

**Table 13.** First-level decision tree classification results.

Node Type	Sample Size	Prediction Accuracy	Gini Coefficient	Dominant Factor
Root Node	2543	-	0.482	-
Support-Dominated	987	86.5%	0.235	Teacher Support
Psychology-Dominated	892	84.2%	0.248	Stress Coping
Mixed Type	664	82.7%	0.276	Multiple Factors

#### 2. Second-Level Decision Tree Analysis

**Table 14.** Second-level decision tree detailed results.

Branch Type	Sample Size	Accuracy	Feature Variables	Threshold
High Support-High Psychology	623	89.4%	TS>0.75, SCA>0.70	0.82
High Support-Low Psychology	364	76.8%	TS>0.75, SCA<0.45	0.65
Low Support-High Psychology	385	78.5%	TS<0.45, SCA>0.70	0.68
Low Support-Low Psychology	1171	72.3%	TS<0.45, SCA<0.45	0.58

#### 3. Cross-Validation Results

**Table 15.** Cross-validation results of multiple nested decision trees.

Validation Round	Training Set Accuracy	Test Set Accuracy	ROC Curve Area	Kappa Coefficient
First Round	85.6%	83.2%	0.864	0.812
Second Round	84.9%	82.8%	0.858	0.805
Third Round	85.2%	83.5%	0.861	0.808
Fourth Round	84.7%	82.6%	0.855	0.803
Average	85.1%	83.0%	0.860	0.807

#### 4. Comprehensive Robustness Assessment

**Table 16.** Comprehensive assessment results of research conclusions' robustness.

Assessment Dimension	Assessment Method	Assessment Result	Robustness Judgment
Variable Measurement	Multiple Scale Replacement	Difference Rate <3%	Highly Robust
Sample Structure	Stratified Sampling Adjustment	Core Conclusions Consistent	Relatively Robust
Model Specification	Decision Tree Analysis	Accuracy >80%	Highly Robust
Statistical Testing	Cross-Validation	Kappa >0.8	Highly Robust

Based on the above robustness test results, we can draw the following conclusions:

1) Variable Sensitivity Analysis Shows: After replacing core variable measurement methods, result difference rates are all controlled within 3%; Main research conclusions remain stable under different sample sizes; Regional sample analysis indicates strong universality of results.

2) Multiple Nested Decision Tree Analysis Indicates: First-level decision tree classification accuracy reaches 82.7%-86.5%; Second-level detailed results further verify characteristic differences among different sample types; Cross-validation maintains average accuracy above 83%.

3) Comprehensive Assessment Results Demonstrate: Research conclusions remain stable under different measurement methods; Sample structure adjustments do not lead to significant changes in core conclusions; Model specification and statistical test results both show high reliability.

## 5. Conclusions and policy recommendations

### 5.1. Main research conclusions

Based on data analysis from 2,543 college students across six major geographical regions in China, this study systematically explores the interaction mechanisms among social support, mental health, and academic performance, reaching the following main conclusions:

1) Social support demonstrates significant positive impact on college students' academic performance: Teacher support shows the most prominent influence ( $r=0.563$ ), indicating the crucial role of teachers' professional guidance and care in students' academic development

Family support ranks second ( $r=0.489$ ), reflecting that family environment and parental support are important guarantees for students' academic success. Peer support ( $r=0.442$ ) and school support ( $r=0.417$ ), though showing relatively lower correlations, demonstrate significant promoting effects

2) Mental health status shows close association with academic performance: Particularly significant influences from stress coping ability ( $r=0.612$ ) and emotional regulation ability ( $r=0.573$ ); Indicates that good psychological adjustment ability is an important foundation for improving academic performance.

3) Three major influence pathways are identified: Support-dominated pathway (consistency=0.892): emphasizes combined effects of family and teacher support; Psychology-dominated pathway (consistency=0.875): highlights synergistic effects of various mental health dimensions; Comprehensive balanced pathway (consistency=0.915): demonstrates balanced development of elements in both social support and mental health.

4) Social support influences academic performance through: Direct effect (61.17%) and indirect effect (38.83%); Mental health plays important mediating role; Stress coping dimension shows strongest mediating effect (29.32%);

5) Significant differences exist among different groups in social support needs and mental health performance: Science and engineering students: more dependent on teacher support and professional guidance; Liberal arts students: emphasize emotional regulation and interpersonal adaptation; Female students: place greater emphasis on emotional support and guidance compared to male students; Lower-grade students: need more external support and guidance; Higher-grade students: self-regulation ability becomes more important.

These findings not only deepen understanding of influence mechanisms on college students' academic development but also provide empirical evidence for universities to implement targeted mental health education and academic support work. Robustness tests of research results indicate that core conclusions remain stable under different measurement methods and sample sizes, demonstrating strong universality and promotional value.

## **5.2. Main research conclusions**

Based on the research findings, several comprehensive policy recommendations are proposed to promote college students' mental health development and academic performance. Universities should establish a multi-level teacher support system by improving mentorship programs, strengthening class advisor and counselor teams, and optimizing teacher evaluation mechanisms, while developing teachers' mental health education capabilities. The family-school collaborative education mechanism should be enhanced through regular parent training and consultation platforms to facilitate effective family support. Peer support systems should be improved by implementing peer counseling programs, organizing study groups, and fostering a supportive atmosphere through student organizations. The institutional support system needs optimization, including developing mental health services, establishing academic support centers, enhancing financial aid systems, and building smart campus platforms. Differentiated support strategies should be implemented based on student characteristics, such as providing specialized guidance for science and engineering students while focusing on emotional management for liberal arts students, offering targeted support for gender-specific needs, and addressing the varying requirements of different grade levels. A comprehensive evaluation and feedback mechanism should be established to monitor support effectiveness and enable timely adjustments. Finally, mental health education should be deeply integrated with ideological-political and professional education throughout the talent cultivation process. The implementation of these recommendations requires collaborative efforts from university administrators, teachers, parents, and society at large, aiming for continuous improvement in students' mental health and academic development through systematic advancement and sustained refinement.

## **Conflict of interest**

The authors declare no conflict of interest.

## **References**

1. Li, B. J. (2024). Investigation and Analysis of College Students' Mental Health Status: Based on Self-identity. *Western Quality Education*, 10(23), 127-130.
2. Xue, P. Y., & Xu, J. F. Influencing Factors and Solutions for Mental Health of College Students. *Science and Technology Information*, 2020, 18(17): 184-185.



3. Yao, Y. L., & Wang, Y. Research, Analysis and Adjustment of Contemporary College Students' Mental Health: A Case Study of School of Environmental Science and Engineering, Chang'an University. *Technology Information*, 2013, (19): 169-171.
4. Yan, G. H., Yan, M. Q., Duan, A. X., et al. Effects of Positive Psychological Intervention on Adolescents' Mental Health Status and Sleep Quality. *Military Nursing*, 2024, 41(12): 27-30+56.
5. Yang, H. H. The Concept, Necessity and Path of Digital Transformation in Mental Health Education Courses at Vocational Colleges. *Western Quality Education*, 2024, 10(23): 143-146.
6. Jiang, W. L., Qiu, Q. F., Liu, Y., et al. A Study on Occupational Exposure Protection Awareness and Mental Status of Clinical Nursing Interns. *Health Vocational Education*, 2024, 42(24): 113-116.
7. Cai, Y. C. Design and Innovation of Regional Support Systems for Teachers' Mental Health. *Teaching and Management*, 2024, (34): 23-26.
8. Cao, F., & Wang, Y. H. Analysis of Precision Development Paths for College Students' Mental Health Education in the Big Data Era. *Journal of Taiyuan Urban Vocational and Technical College*, 2024, (11): 165-167.
9. Liu, B. X., Zhao, N., & Meng, Q. Y. Current Status, Influencing Factors and Coping Strategies of College Students' Mental Health from the "Three-All Education" Perspective. *Psychological Monthly*, 2024, 19(22): 80-82.
10. Chen, Z. Y., Zhang, T. C., Zhang, F. L., et al. Developmental Trajectory and Interaction between Loneliness and Social Support in Junior High School Students [J/OL]. *Chinese Journal of School Health*, 1-5[2024-12-12].
11. Yao, Y. P. Value Implications, Practical Difficulties and Improvement Strategies of Graduate Supervisors' Psychological Education. *Journal of Graduate Education Research*, 2024, (06): 60-67.
12. Zheng, J. Analysis of Factors Influencing Suicide Ideation Among Freshmen at a Private University in Shaanxi. *Internet Friends*, 2014, (09): 161-162.
13. Zhang, D., & He, W. W. Research on College Students' Psychological Quality Cultivation Path from the Perspective of Curriculum Ideology and Politics: Taking "College Students' Mental Health Education" Course as an Example. *Journal of Taiyuan Urban Vocational and Technical College*, 2024, (11): 139-141.
14. Yang, S. W. Research on the Relationship between Mental Health and Ideological and Political Education Work of College Counselors. *Talent and Intelligence*, 2024, (34): 17-20.
15. Guo, Y. T. Application of Positive Psychological Intervention in Enhancing the Effectiveness of Mental Health and Ideological and Political Education in Colleges. *Chinese Journal of School Health*, 2024, 45(08): 1060+1217.
16. Du, M. Z., & Liu, Y. An Attempt to Integrate Mental Health Education into College English Classroom Teaching. *Chinese Journal of School Health*, 2024, 45(08): 1220-1221.
17. Cai, Z. J., Fang, H., Liu, J. H., et al. Joint Information Extraction in Mental Health Domain Based on Large Language Model Instruction Fine-tuning. *Journal of Chinese Information Processing*, 2024, 38(08): 112-127.
18. Peng, S. L., & Wang, F. J. Reliability and Validity Test of Chinese Version of Adolescent Mental Health Literacy Scale in Middle School Students. *Chinese Journal of Clinical Psychology*, 2024, 32(04): 865-869.
19. Li, Y. Y., Zhong, B. B., & Li, P. Y. Strengthening Physical Exercise to Improve College Students' Physical and Mental Health: A Review of "Research on College Students' Physical Exercise and Mental Health Issues". *Chinese Journal of School Health*, 2024, 45(07): 1074.
20. Yu, G. L., & Wang, X. Z. Basic Status and Educational Countermeasures of Graduate Students' Mental Health Problems in China. *China Higher Education Research*, 2024, (07): 80-87.
21. Stewart, T., & Suldo, S. (2011). Relationships between social support sources and early adolescents' mental health: The moderating effect of student achievement level. *Psychology in the Schools*, 48(10), 1016-1033.
22. Li, N., Li, S., & Lu, Y. A Review of Research on Contingent Self-esteem and Its Impact on Mental Health. *Medicine and Philosophy*, 2024, 45(14): 45-49.
23. Liu, H. B. Research on Classification Standards and Management Strategies of Student Psychological Files from the Perspective of College Mental Health Education. *Shanxi Archives*, 2024, (07): 76-78.
24. Zhang, J. K. The Nurturing Effect of Chinese Excellent Traditional Culture on College Students' Mental Health. *Chinese Journal of School Health*, 2024, 45(06): 756+913.
25. Bai, X. Exploration of Potential Space for College Students' Mental Health from the Perspective of Object Relations. *Theory and Practice of Education*, 2024, 44(18): 60-64.
26. Tong, X., & Yang, X. F. The Relationship between College Students' Mental Health, Social Exclusion, Self-forgiveness and Mindfulness. *Chinese Mental Health Journal*, 2024, 38(07): 625-630.
27. Tao, J., & Ma, J. Q. New Developments in Mental Health Education in Chinese Universities in the New Era. *School Party Building and Ideological Education*, 2024, (11): 84-88.