

The Effects of Social Media Addiction, Academic Stress, and Sleep Quality on Anxiety Symptoms: A Cross-Sectional Study of Chinese Vocational Students

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Purpose: While prior research has predominantly examined the direct effects of social media addiction, academic stress, and sleep quality on anxiety symptoms, the role of underlying mechanisms remains insufficiently explored. This study seeks to systematically investigate how social media addiction, academic stress, and sleep quality influence anxiety symptoms through the mediating mechanism of self-efficacy.

Methods: This study employed a cross-sectional survey design, using stratified random sampling to recruit 469 Chinese adolescents aged 12–18. Various tools were used for measurement, including the Social Media Addiction Scale, the Academic Stress Scale, the Pittsburgh Sleep Quality Index, the Generalized Anxiety Disorder-7 Scale, and the General Self-Efficacy Scale. Correlation analysis and mediation effect analysis were conducted using SPSS 26.0.

Results: After controlling for covariates such as gender, the results indicated significant correlations between social media addiction, academic stress, sleep quality, and anxiety symptoms in adolescents. Self-efficacy played a crucial mediating role in this process.

Conclusion: These findings provide new insights into the causes of anxiety symptoms among Chinese adolescents and offer a theoretical basis for future psychological health intervention strategies.

Keywords: social media addiction, academic stress, sleep quality, self-efficacy, anxiety symptoms

Introduction

Anxiety symptoms (ASy) are a common psychological condition characterized primarily by excessive worry, tension, and fear.¹ These symptoms manifest as uncertainty about the future, excessive tension, and worry, often accompanied by a sense of fear and unease, leading to a range of emotional, cognitive, physical, and behavioral responses.² ASy are widespread among adolescents.^{3,4} Assessments indicate a global prevalence of ASy in adolescents at approximately 5%.⁵ Additionally, a cross-sectional study on ASy among Chinese adolescents revealed that 26.9% of the participants exhibited ASy.⁶ Relevant studies show that ASy rank among the leading mental health issues in adolescents. Manifestations of adolescent ASy vary, including irritability, fatigue, and sleep disturbances.⁷ If these symptoms are not addressed promptly and effectively, they can impact not only adolescents' mental health but also their academic, social, and family lives.^{3,8,9} The current study suggests that the development of anxiety symptoms in adolescents is influenced by various factors, including psychological traits, physiological states, and environmental stressors.^{10–12} Among these, self-efficacy (SE) is considered an important psychological resource that moderates emotions. Higher self-efficacy can help adolescents adopt positive coping strategies, thereby effectively alleviating anxiety experiences.^{8,13} Additionally, sleep quality (SQ), as a key physiological factor, directly influences brain function and emotional regulation capacity, with poor SQ exacerbating ASy in adolescents.^{8,14} Furthermore, environmental factors such as social media addiction (SMA), academic stress (AS), family environment, and school climate have also been



shown to be closely related to adolescents' anxiety levels.^{15,16} SMA may reduce real-life social support for adolescents and increase their psychological burden, thereby heightening the risk of ASy.^{16–18}

Social Media Addiction and Anxiety Symptoms

SMA, also referred to as online social dependency, refers to an individual's frequent engagement with social media platforms to the extent that it substantially influences multiple areas of life, including daily routines, professional responsibilities, academic pursuits, and interpersonal relationships.¹⁹ This dependency is influenced by multiple psychological and societal elements, such as the desire for immediate satisfaction and approval, and the preference for online interactions over in-person communication due to social anxiety.^{20,21} As social media usage rises among adolescents, its possible effects on mental health are becoming more apparent. While social media platforms can provide convenience for social interaction and information exchange among adolescents, excessive use may lead to mental health issues, particularly ASy.²² Firstly, adolescents have a strong need for peer group recognition and acceptance. Interactions and feedback on social media are often seen as an important measure of self-worth and social status, which can contribute to the development of SMA in adolescents. The virtual and comparative nature of such social interactions can also increase ASy in adolescents.^{23,24} For instance, Yue, Yue, Zhang, Liu and Bao²⁴ found that SMA may lead adolescents to rely excessively on online interactions, potentially resulting in decreased self-worth and increased insecurity, thereby elevating ASy. Additionally, the immediate feedback mechanisms on social media, such as likes and comments, can heighten adolescents' sensitivity and increase their frequency of use, intensifying their SMA and further exacerbating ASy.^{25,26} Furthermore, negative interactions on social media, such as cyberbullying or conflicts, may increase adolescents' feelings of loneliness and helplessness, which are also significant contributors to heightened ASy.^{18,26,27} Overall, SMA presents multifaceted challenges to adolescents' mental health, affecting their social skills and interaction with the real world, and through various mechanisms, it increases the likelihood of ASy.

Academic Stress and Anxiety Symptoms

In the current educational environment, AS is a significant issue commonly faced by adolescents.²⁸ AS can be attributed to two key factors: high expectations of academic performance and a constant academic workload.²⁹ Adolescents feel intense pressure to meet the high expectations of teachers, parents, and peers, which impacts not only their mental health but also their physical well-being, social behavior, and future development.^{30,31} First of all, from a mental health perspective, AS can lead to negative emotions and physical responses in adolescents.^{32–34} For instance, Zuo, Zhao, Li et al³⁴ found that adolescents under prolonged stress are more likely to experience fatigue and helplessness, which not only affects their daily lives and social interactions but also reduces their learning efficiency and academic performance. Moreover, Avila-Carrasco, Díaz-Avila, Reyes-López et al³³ reported that adolescents experiencing ASy due to AS often exhibit physical symptoms such as insomnia. Additionally, AS influences adolescents' learning behaviors.^{30,35,36} For example, Liu, Chen, Liu et al³⁶ observed that under sustained AS, adolescents' motivation to learn may gradually decline, causing them to lose interest in their studies, which results in poorer learning outcomes and a perception of learning as a burden rather than an enjoyment, thereby increasing the risk of ASy. Furthermore, AS may prompt adolescents to withdraw from social interactions and activities, which can diminish their social support network and intensify feelings of loneliness. Consequently, this might raise the chances of experiencing ASy.³⁷ In summary, AS affects the psychological and behavioral development of adolescents, increasing their risk of developing ASy.

Sleep Quality and Anxiety Symptoms

SQ includes quantitative aspects of sleep, such as sleep duration, sleep latency, or number of awakenings, as well as more purely subjective aspects, such as the "depth" or "restfulness" of sleep.³⁸ Good SQ is typically characterized by sufficient sleep duration, minimal sleep interruptions, a quick onset of sleep, and a high degree of restfulness. Research indicates that adolescents benefit most physically and psychologically from a suggested nightly sleep duration of 8 to 10 hours.³⁹ Studies suggest that poor SQ affects about 20.65% of teenagers, with the percentage climbing to 25.34% for the 14–16 age group.^{40,41} Research shows that SQ affects ASy in adolescents.^{41,42} On one hand, poor SQ directly impacts brain function, especially in areas related to emotional regulation and cognitive processing.^{10,14,43} For example, Rodríguez-De Avila, Munera-Luque and Rodríguez-de França¹⁰ found that when SQ is poor, adolescents' nervous systems lack adequate rest and recovery, making it difficult to effectively manage and regulate emotions, which may increase ASy. On the other hand, reduced SQ diminishes

adolescents' ability to cope with everyday stress, amplifying the pressure they feel when facing academic tasks, social interactions, or daily challenges.^{16,44,45} For instance, Kim, Kim, Jang and Park⁴⁵ noted that adolescents have inherently more vulnerable psychological and emotional regulation abilities compared to adults, making them more susceptible to SQ issues that increasing the risk of ASy. Moreover, inadequate sleep routines and external factors, including the frequent use of digital devices, can result in a decline in adolescents' SQ, thereby intensifying ASy.^{45,46} Thus, there is a clear connection between SQ and ASy in adolescents; poor SQ not only impacts their emotional and cognitive functions but also heightens their daily stress, causing an increase in ASy.

The Mediating Role of Self-Efficacy

According to Self-efficacy Theory,⁴⁷ SE refers to an individual's subjective assessment of their ability to achieve goals and cope with challenges. As an essential psychological variable, SE plays a critical role in adolescent mental health. Studies show that adolescents who possess high levels of SE tend to choose more effective coping mechanisms when faced with stress, which helps in reducing the likelihood of experiencing ASy.⁴⁸ The level of SE largely determines whether adolescents can effectively manage ASy, with those lacking SE more prone to negative emotions, thereby increasing the risk of ASy.⁴⁹⁻⁵¹ For instance, Cherewick, Hipp, Njau and Dahl⁵⁰ confirmed that SE plays a crucial role in the mental well-being of adolescents, and its absence can heighten the likelihood of ASy. Moreover, there is a close link between SMA and SE. Studies show that SMA is accompanied by emotional fluctuations, attentional difficulties, and diminished self-control, all of which are detrimental to adolescents' SE.⁵² SMA is related to adolescents becoming engrossed in the virtual online world, which weakens their SE.^{20,48,53,54} For example, Aslan and Polat⁵⁴ found that SMA can reduce study time and academic performance, thereby diminishing adolescents' confidence in their abilities, a key indicator of reduced SE. Additionally, SMA may intensify social comparison among adolescents, causing them to question and doubt their abilities, which negatively impacts their SE.^{11,55,56} For instance, Al-Samarraie, Bello, Alzahrani, Smith and Emele¹¹ found that individuals with SMA often report lower satisfaction in interpersonal relationships and social skills, significantly reducing their SE.

Adolescents are exposed to AS as they navigate potential future challenges such as pursuing further education. Moderate AS can motivate adolescents to learn and help them build SE by overcoming academic challenges.⁵⁷ However, when AS becomes excessive, it can impair students' goal-setting and task assessment, affecting their SE as adolescents are more likely to lack confidence and fall into self-doubt.⁵⁸ Particularly when adolescents frequently encounter failure or fail to meet expected goals, they may gradually believe they are incapable of completing academic tasks, which diminishes their confidence and negatively impacts SE.^{56,57,59} For example, the study conducted by Zheng, Zhang and Ran⁵⁹ revealed that adolescents engage in a degree of self-assessment when confronted with academic pressures. In the event that adolescents perceive themselves to be experiencing difficulty in coping with these academic challenges, they may withdraw, which may ultimately result in a weakening of their SE. As SE weakens, adolescents may respond to AS more negatively, feeling incapable of achieving academic success, which may result in ASy related to academic tasks.^{60,61} For instance, Yang⁶¹ found that prolonged AS hinders students from taking appropriate actions to address their issues, resulting in tension, self-doubt, and decreased SE in emotional regulation, thus making them more prone to ASy.

SQ plays an important role in the overall development of both the physical and mental health of adolescents. The quality of sleep influences adolescents' SE both physiologically and psychologically.⁶² Specifically, better SQ aids in restoring cognitive function, enhancing emotional regulation, and improving focus, thereby instilling confidence in adolescents when facing academic tasks, which strengthens their SE.⁶³⁻⁶⁵ For example, a study by Aydin and Aydin⁶⁴ revealed the relationship between SQ and SE. Their findings suggest that good SQ promotes emotional stability and helps adolescents better manage stress and emotional challenges, which is an important way to enhance SE. Furthermore, adolescents with consistently high SQ report higher life satisfaction, stronger self-esteem, and better adaptability, all of which contribute to strengthening SE.^{64,66} On the other hand, when adolescents have stable SE, their perception of their abilities can mitigate the intensification of ASy, as they view SQ issues as temporary difficulties rather than insurmountable obstacles, reducing the likelihood of these issues translating into ASy.⁶⁷⁻⁶⁹ For instance, Yang, Sun, Zhao et al⁶⁹ found that strong SE fosters positivity toward new or challenging tasks, equipping individuals to cope effectively and lowering the risk of ASy.

Although research on ASy in adolescents is increasing, there remain gaps in the existing literature. Most studies primarily focus on single factors, such as the direct impact of SMA, AS, or SQ on ASy, while overlooking the complex interplay among multiple dimensions, including physiological, psychological, and social environmental factors. Specifically, factors such as SQ (a physiological factor), SE (a psychological factor), and SMA and AS (social environmental factors) may interact in complex indirect pathways affecting adolescents' ASy. SE, as a critical psychological resource in adolescent psychological development, may play a key mediating role in the interaction of these factors. Therefore, this study examines SE from the dimensions of physiological, psychological, and social environmental factors, systematically analyzing its mediating role in the effects of SMA, AS, and SQ on ASy. This approach addresses current research gaps and provides a theoretical foundation for intervention strategies targeting adolescent ASy. Building on this, we developed a research hypothesis framework, which is illustrated in Figure 1, and tested the hypotheses listed below:

H1: SMA is positively correlated with ASy

H2: AS is positively correlated with ASy

H3: SQ is positively correlated with ASy

H4: SE influences the association between SMA and ASy as a mediator

H5: SE acts as an intermediary in the link between AS and ASy

H6: SE plays a mediating role in the relationship between SQ and ASy The research model for this study is shown in Figure 1.

Methods

Participants and Procedure

This study was conducted from May to July 2024, aiming to explore the impact mechanisms of SMA, academic stress, and SQ on adolescents' ASy, and to examine the mediating role of SE. The research employed a cross-sectional design and collected data through a questionnaire survey. All research procedures strictly adhered to the ethical principles outlined in the Declaration of Helsinki regarding research involving human participants, and were reviewed and approved by the Ethics Committee of the Guangdong Mechanical & Electrical Polytechnic, with the ethics approval number No. 2024009. Informed consent was obtained from all participants prior to data collection. Written informed consent was obtained from their parents or legal guardians, in accordance with ethical guidelines and institutional requirements.

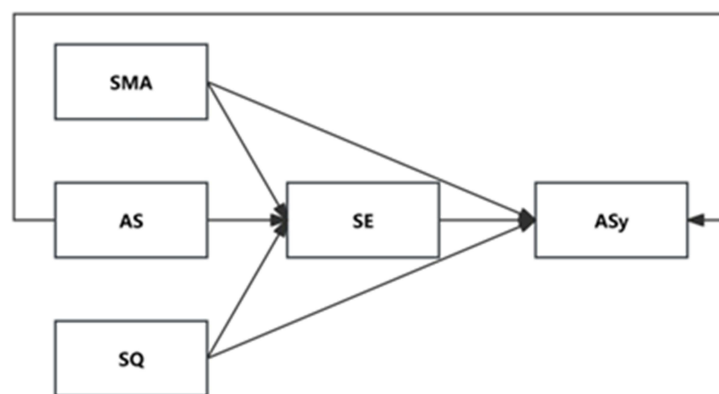


Figure 1 Research model.

To ensure the representativeness of the sample and the generalizability of the research conclusions, a stratified random sampling method was used to select samples from two representative higher vocational colleges in Guangdong Province: Guangdong Mechanical and Electrical Vocational Technical College and Guangzhou College of Science and Technology and Trade. The primary reason for selecting this group is that they are at the transitional stage from late adolescence to early adulthood, facing multiple challenges in academics, social life, and self-identity, which makes them highly susceptible to anxiety-related psychological issues, thus aligning well with the theme of this study. Additionally, selecting institutions with regional representativeness helps control the potential impact of cultural and geographical factors on the research results, thereby enhancing external validity.

During the data collection phase, 500 questionnaires were distributed, and 469 valid responses were returned, resulting in a response rate of 93.8%. All participants received detailed information about the study's purpose, content, and data usage prior to completing the questionnaire and signed a written informed consent form. For participants under 18 years of age, their participation was based on written informed consent from their legal guardians, ensuring that the study complied with ethical and legal regulations.

The questionnaires were administered during extracurricular time and were completed in classrooms under the supervision of two trained research assistants. All participants completed the questionnaires in an independent, quiet environment without external interference, and the entire process was anonymous and voluntary. The scales were completed sequentially in a single session, taking approximately 5 to 15 minutes. Participants were allowed to take short breaks based on their individual needs to avoid fatigue and ensure the quality and completeness of the data. Research assistants were present on-site to provide clarification and emphasized that there were no right or wrong answers, encouraging honest responses.

All measurement tools used in this study are well-established and internationally recognized scales, with the Chinese versions undergoing a standardized translation and back-translation process, ensuring good reliability and validity. Detailed information on the scales is provided in Section 2.2. The demographic characteristics of the sample are shown in Table 1.

Measures

This study's survey consisted of two sections. The first section focused on gathering demographic details from those participating, including gender, age, only-child status, and parents' educational level. The second part of the study employed a range of established scales, including the Social Media Addiction Scale (SMAS), the Adolescent Academic Stress Scale, the Pittsburgh Sleep Quality Inventory (PSQI), the Generalized Anxiety Disorder-7 Scale (GAD-7), and the General Self-Efficacy Scale (GSES), to assess the five dimensions, with a total of 52 items.

Table 1 Demographic Characteristics

Demographic Characteristics	Categories	Quantities	Percentage
Sex	Male	265	56.50%
	Female	204	43.50%
Age	12-13	51	10.87%
	14-16	243	51.81%
	16-18	175	37.31%
Only child	Yes	263	56.08%
	No	206	43.92%
Parents' Educational level	Primary school	31	6.61%
	Middle school	155	33.05%
	High school	169	36.03%
	University	114	24.31%

Social Media Addiction

This study employed the Yue,Zhang,Cheng,Liu and Bao⁷⁰ iteration of the Social Media Addiction Scale (SMAS) to assess adolescent SMA and to gain insight into adolescents' social media usage over the past year. The SMAS comprises six items. The items were rated using a 5-point Likert scale, where the responses varied from 1 (indicating a very low frequency or infrequency) to 5 (indicating a very high frequency or often). The scale yields a total score ranging from 6 to 30, with higher scores indicating a greater severity of social addiction problems. Previous studies have confirmed the reliability and validity of the SMAS.²⁰ The Cronbach's alpha coefficient for this study was 0.797, which is indicative of good reliability.

Academic Stress

The Ho,Nguyen and Nguyen⁷¹ version of the Academic Stress Scale for Adolescents was employed to evaluate students' perceived AS, which was divided into five categories: academic pressure, worry about grades, stress from self-expectations, workload, and academic despondency. The scale encompasses a total of 16 items. The items were scored on a five-point Likert scale, with responses ranging from 1 (strongly disagree) to 5 (strongly agree). The total scores ranged from 16 to 80, with higher scores indicating a greater degree of AS. The Academic Stress Scale for Adolescents has been confirmed to be reliable and valid.⁷² In this study, the Cronbach's alpha coefficient was 0.897, indicating good reliability.

Sleep Quality

The Pittsburgh Sleep Quality Index (PSQI) was used to measure SQ.⁷³ This scale is designed to provide a comprehensive subjective assessment of SQ, encompassing 19 self-rated questions and 5 observer-rated items. The 19 self-rated items are divided into seven dimensions: subjective sleep quality, sleep latency, total sleep duration, regular sleep efficiency, disturbances during sleep, use of sleeping medication, and daytime dysfunction. Each item is rated on a scale from 0 (very good) to 3 (very bad), with the cumulative score ranging from 0 to 21, providing an overall measure of SQ. The PSQI has demonstrated good reliability and validity in prior studies.⁷⁴ In this research, the Chinese adaptation of the PSQI was employed, which has demonstrated adequate reliability, with a Cronbach's alpha value of 0.712.

Anxiety Symptoms

Adolescents were evaluated for the presence of ASy using Huang and Liu⁷⁵ revised Generalized Anxiety Disorder-7 Scale (GAD-7), which consists of seven items and employs a four-point Likert scale (0=none, 1=few days, 2=most of the time, 3=almost every day). The total scores ranged from 0 to 27. A higher score corresponds to a more severe manifestation of ASy. The GAD-7 has been proven to be excellent, reliable, and valid.⁷⁶ The Cronbach's alpha coefficient for this scale in the present study was 0.852, which is indicative of good reliability.

Self-Efficacy

Adolescents' SE was assessed using Li,Yang,Zhao and Li⁷⁷ version of the General Self-Efficacy Scale (GSES), which consists of 10 items. The scale is based on a four-point Likert scale, with scores of 1–4 representing completely incorrect, slightly correct, mostly correct, and completely correct. The total score of the scale is calculated by summing the scores of all individual components and then dividing the result by 10. A higher total score reflects a higher overall SE. The GSES has been proven to be valid and reliable.⁷⁸ The Cronbach' α of this study is 0.718, which is a good reliability. The initial translation of all scales was carried out by two separate researchers: one, an expert in adolescent mental health with proficiency in both English and Chinese, and the other, a linguist with greater expertise in Chinese. Afterward, two new researchers, a subject matter specialist and a linguist, performed a back-translation from English to Chinese. The two resulting versions were carefully reviewed and compared for notable discrepancies, leading to the creation of a unified version. This harmonized version underwent a pilot test with a group of 20 Chinese university students. Any differences, unusual phrasing, and inconsistencies with the original English text were corrected, producing the final Chinese version.

Data Analysis

This study used SPSS26.0 to analyze the collected data. SPSS26.0 offers robust data processing and statistical analysis capabilities, which are particularly helpful for understanding and examining the effects of SMA, AS, and SQ on adolescents' ASy. Through regression analysis and mediation effect testing in SPSS26.0, this study effectively identifies the mediating role of SE among these variables and determines which factors have a significant impact on adolescents' ASy.

Results

Descriptive Statistics of the Questionnaires

This study used SPSS26.0 to conduct statistical analysis on data collected from 469 adolescents, examining whether there were significant differences in ASy across gender, age, only-child status, and parental education level. The findings indicated a gender difference in ASy among adolescents ($p < 0.05$), and that only-child status and parental education level also had significant effects on ASy ($p < 0.01$). However, factors such as age did not have a statistically significant impact on ASy ($p > 0.05$). Additionally, this study conducted correlation analysis on SMA, AS, SQ, and ASy. As shown in Table 2, Pearson correlation analysis indicated significant correlations between ASy and SMA ($r = 0.415$, $p < 0.01$), AS ($r = 0.505$, $p < 0.01$), and SQ ($r = 0.816$, $p < 0.01$). SE was also significantly correlated with SMA ($r = -0.400$, $p < 0.01$), AS ($r = -0.460$, $p < 0.01$), and SQ ($r = -0.692$, $p < 0.01$). Similarly, there was a significant correlation between SE and ASy ($r = -0.716$, $p < 0.01$).

Common Method Bias (CMB)

Common method bias (CMB) was evaluated using Harman's single-factor analysis. The results showed that no single factor dominated the variance.⁷⁹ The first factor accounted for around 21.60% of the variance, which was well below the 40% threshold. As a result, the study concludes that significant common method bias does not exist.

Intermediation Effectiveness Analysis

The correlation analysis outcomes satisfied the statistical criteria necessary for further examination of the mediating role of coping style and negative emotions.⁸⁰ This study conducted mediation analysis using Model 4 of the PROCESS macro in SPSS on data from 469 participants. The correlation and mediation analysis of the study variables are presented in Tables 2, 3, and Figure 2.

Table 2 Means, Standard Deviations and Correlation Analysis of Variables

Variables	M	SD	SMA	AS	SQ	ASy	SE
SMA	18.54	4.70	I				
AS	52.22	11.21	0.653**	I			
SQ	20.04	6.25	0.341**	0.449**	I		
ASy	20.64	5.95	0.415**	0.505**	0.816**	I	
SE	30.92	5.86	-0.400**	-0.460**	-0.692**	-0.716**	I

Note: ** $p < 0.01$.

Table 3 Regression Analysis of Variables

Outcome Variable	Predictor Variable	β	SE	T	CI (95%)		R^2	F
					LLCL	ULCI		
SE	SMA	-0.400***	0.042	9.440	0.317	0.484	0.160	89.120
	AS	-0.460***	0.041	11.197	0.379	0.541	0.212	125.363
	SQ	-0.692***	0.033	20.713	0.626	0.758	0.479	429.045
ASy	SE	-0.654***	0.035	18.912	0.586	0.722	0.532	264.487
	SMA	0.153***	0.035	4.416	0.085	0.221		
	AS	0.223***	0.035	6.377	0.154	0.292	0.551	286.180
	SQ	0.615***	0.035	17.761	0.547	0.683	0.709	567.763

Note: *** $p < 0.001$.

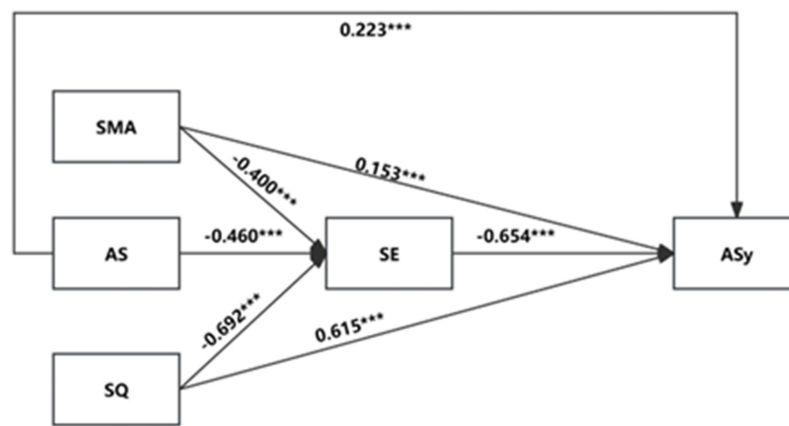


Figure 2 Intermediary model results.

Note: *** $p < 0.001$.

According to the regression analysis results in Table 3, SMA ($r = -0.400$, $p < 0.001$), AS ($r = -0.460$, $p < 0.001$), and SQ ($r = -0.692$, $p < 0.001$) were negatively correlated with SE. Additionally, SE was negatively correlated with ASy ($r = -0.654$, $p < 0.001$), while SMA ($r = 0.153$, $p < 0.001$), AS ($r = 0.223$, $p < 0.001$), and SQ ($r = 0.615$, $p < 0.001$) were positively correlated with ASy. Therefore, H1, H2, and H3 have been validated.

Table 4 presents the results of the mediation analysis. The total effect of SMA on ASy was 0.415, with a direct effect of 0.153. For AS, the total effect on ASy was 0.505, with a direct effect of 0.223. SQ had a total effect of 0.816 on ASy, with a direct effect of 0.615. When SE served as the mediator, the indirect effects were 0.262 (SMA), 0.2829 (AS), and 0.201 (SQ). The proportion of indirect effects was 63.13% for SMA, 55.84% for AS, and 24.63% for SQ. Therefore, H4, H5, and H6 have been validated.

Discussion

This study utilized SPSS26.0 analysis to investigate the effects of SMA, AS, and SQ on ASy among Chinese adolescents, focusing on the complex interrelations between these variables. It also explored SE's mediating role in these effects. The study hypothesized positive correlations between SMA, AS, SQ, and ASy, with SE acting as a mediator. Survey data were collected, organized, and analyzed to test these hypotheses. The subsequent section delves into the research findings, linking them to the study's initial questions and hypotheses.

SMA is positively correlated with ASy, thereby validating H1, consistent with the findings of Cancer,Efe and Basdas²⁶ found that excessive social media use among adolescents is associated with not only SMA but also a tendency to compare oneself with one's peers, which in turn is linked to increased psychological distress and a heightened risk of developing ASy.

Table 4 Analysis of Intermediation Effects

Effect Type	Path	Effect Value	SE	CI (95%)	
				LLCI	ULCI
Total Effect	SMA→ ASy	0.415	0.042	0.332	0.415
Direct Effect	SMA→ ASy	0.153	0.035	0.085	0.221
Indirect Effect	SMA→ SE→ ASy	0.262	0.033	0.198	0.330
Total Effect	AS→ ASy	0.505	0.040	0.426	0.505
Direct Effect	AS→ ASy	0.223	0.035	0.154	0.292
Indirect Effect	AS→ SE→ ASy	0.282	0.032	0.217	0.351
Total Effect	SQ→ ASy	0.816	0.027	0.763	0.868
Direct Effect	SQ→ ASy	0.615	0.035	0.545	0.683
Indirect Effect	SQ→ SE→ ASy	0.201	0.035	0.123	0.261

The increasing role of social media in the lives of today's youth has led to greater reliance and more frequent use, which may result in feelings of insecurity and diminished confidence in real-world situations, thus raising the risk of ASy.⁸¹ Additionally, the culture of comparison on social media may drive adolescents to constantly compare themselves with others, resulting in feelings of inferiority and ASy.⁸² Moreover, information overload on social media platforms is a significant contributor to ASy in adolescents. These platforms are saturated with extensive information and social updates, requiring adolescents to invest considerable time and mental energy in processing this information. This ongoing mental pressure can gradually transform into ASy.⁸³ Furthermore, chronic SMA hinders adolescents from allocating sufficient time to the maintenance and management of interpersonal relationships, thereby increasing their isolation in the offline world and exacerbating their ASy.¹⁸

There is a positive correlation between AS and ASy, thereby validating H2. This aligns with the findings of Avila-Carrasco, Díaz-Avila, Reyes-López et al.³³ examined the interconnection between AS and ASy in depth. The study revealed that academically stressed students often manifest significant somatization symptoms, which frequently co-occur with ASy. For the adolescent population, future problems such as further education result in certain pressures being borne by the individuals themselves. These include concerns about test scores, test anxiety and perceived learning burdens, among others. These factors work together to affect the psychological state of adolescents. If they do not handle these academic pressures well, they are highly likely to experience ASy.⁸⁴ Additionally, long-term AS affects adolescents' self-perceptions, particularly when they fail to meet their own or others' expectations regarding their academic performance. This can result in a sense of failure and powerlessness, which further lowers their self-esteem and increases their inner turmoil and tension, thus triggering ASy.⁸⁵

There is a positive correlation between SQ and the presence of ASy, thereby validating H3. In other words, individuals with more pronounced SQ issues exhibited elevated levels of ASy. This finding is consistent with the results of Kim, Kim, Jang and Park⁴⁵ examined a representative sample of adolescents and reported a significant correlation between SQ and ASy. These results reinforce the notion that SQ plays a pivotal role in influencing ASy in adolescents. On the one hand, SQ issues, such as insomnia and sleep interruptions, not only impede the restoration of physical and mental performance but may also exacerbate adolescent anxiety by fostering worry about sleep problems.⁸⁶ Conversely, SQ may directly impact the neurobiological functioning of the brain, particularly those regions associated with emotion regulation, such as the prefrontal cortex. Impairment in the functionality of these areas may render individuals more challenging to manage and regulate negative emotions, thereby increasing adolescent ASy.¹⁰

SE plays a mediating role in the impact of SMA on ASy, thereby validating H4. This finding is consistent with the study by Aslan and Polat⁵⁴ revealed that SMA affects adolescents' SE, potentially influencing their academic performance and subsequently leading to psychological issues, such as ASy. On one hand, SMA affects adolescents' SE by weakening their sense of personal confidence and capability.⁸⁷ On the other hand, when adolescents' SE is compromised, they may begin to doubt their confidence in handling challenges, and this lack of SE exacerbates their ASy.⁵⁴ This finding is also supported by the research of Yildirim, Koçak and Parlakyildiz,⁴⁹ whose study confirmed the significant role of SE in adolescent mental health, particularly in how it influences their perception and coping with ASy.

SE mediates the impact of AS on ASy, thereby validating H5. This is consistent with the study by Zheng, Zhang and Ran⁵⁹ suggests that prolonged AS leads students into a persistent state of psychological tension, weakening their SE. In this state, the excessive accumulation of negative emotions becomes difficult to regulate, further triggering or exacerbating their ASy. AS not only directly affects ASy but also influences them by modulating SE.⁸⁸ On one hand, excessive AS often overwhelms students, resulting in feelings of helplessness and frustration. Adolescents may begin to doubt their abilities, feeling incapable of meeting expected standards, which in turn reduces their SE.^{48,89} Furthermore, being in a high-stress academic environment for an extended period intensifies the negative impact on adolescents' SE, causing them to gradually lose interest and motivation in academic activities, leading to academic burnout and a higher susceptibility to ASy.⁹⁰ Additionally, adolescents with poor coping strategies or low SE may be more vulnerable to the adverse effects of AS, making them more likely to experience ASy.⁹¹

SE mediates the impact of SQ on ASy, thereby validating H6. This aligns with the findings of Aydin and Aydin⁶⁴ confirmed that SQ affects individuals' SE, which in turn influences their positive psychological state, leading to more frequent occurrences of ASy. In other words, prolonged issues with SQ result in sustained physiological and psychological stress, which can impact individuals' overall state, weakening their confidence in their abilities and consequently

affecting their level of SE.^{63,64} Additionally, SE is a crucial predictor of mental health.⁶² A reduction in SE makes it challenging for individuals to cope effectively with daily stress and challenges; the inability to cope effectively may result in a buildup of difficult-to-control negative emotions, ultimately triggering or exacerbating ASy.⁶⁸ For adolescents in particular, poor SQ may lead to reduced SE, which in turn can result in accumulated fatigue, emotional fluctuations, and declines in attention and memory—factors that contribute to the intensification of ASy.⁶²

Influence

This research offers a comprehensive examination of how SMA, AS, and SQ influence ASy in adolescents, incorporating SE as a mediator in the process. By exploring these relationships, it enhances understanding of adolescent mental health and clarifies SE's role, contributing to theoretical development and practical applications.

In terms of theoretical implications, this study introduces three novel theoretical innovations. Firstly, it constructs an integrative framework that addresses the complex interplay of physiological, psychological, and social factors influencing ASy, offering a comprehensive perspective. Secondly, by incorporating SE as a mediating variable, it deepens understanding of how external factors interact to impact ASy and enriches existing research on SE's role in mental health. In conclusion, the research expands the theoretical model linking SQ and mental health, unveiling how SQ indirectly influences ASy through SE and providing new insights into the interplay between physical and mental health.

In terms of practical significance, this study reveals the multiple factors influencing adolescents' social anxiety, which is crucial for developing effective mental health interventions for adolescents. Firstly, the study found a positive correlation between social media use and social anxiety, indicating that excessive use of social media may exacerbate adolescents' social anxiety. Therefore, schools and parents should collaborate to reduce the negative impact of social media use through the following innovative strategies: On one hand, schools can offer courses on the healthy use of social media to help adolescents recognize the potential psychological risks of online social interactions; on the other hand, parents can guide their children to engage in face-to-face social activities during family time, enhancing their real-life interaction skills. Additionally, an app could be developed that uses smart reminders and data analysis to help adolescents manage their social media usage time, offering timed breaks and reminders. Secondly, the significant relationship between adolescent stress and social anxiety suggests that schools should strengthen interventions in stress management and emotional regulation, particularly in areas such as time management and coping strategies. Schools can incorporate modules on emotional regulation and stress management into the curriculum, teaching students how to stay calm in high-pressure environments. Group activities can simulate stress coping scenarios, enhancing students' practical skills. Mental health education teachers can also regularly hold small seminars and workshops to teach effective methods for dealing with academic and social stress, helping adolescents build positive coping mechanisms. Finally, this study emphasizes the mediating role of SE, indicating that improving adolescents' SE is crucial for coping with life's challenges. To achieve this, schools should implement innovative measures, such as setting clear and achievable goals, motivating students to gradually reach them and providing timely positive feedback to help them build confidence. Additionally, schools can introduce resilience training courses to teach students how to recover from setbacks and establish a positive self-concept. To further enhance SE, students can be encouraged to participate in public service activities or team projects, which not only improve their social skills but also strengthen their adaptability when facing challenges.

Limitations

The study investigates the influence of SMA, AS, and SQ on ASy among adolescents, with a focus on the mediating effect of SE. It also provides an in-depth discussion of the findings. While the research provides valuable insights, it is not free from constraints. Firstly, the questionnaire employed to assess SQ in this study utilized a self-report methodology, which may have resulted in a high degree of subjectivity and susceptibility to individual memory bias and self-perception, particularly with regard to issues such as wake-up time, sleep duration and the presence of sleep disorders. Furthermore, the lack of objective physiological testing and reliance on subjective feelings may introduce a degree of bias. Secondly, this research adopts a cross-sectional design, with the questionnaire primarily focused on evaluating the adolescents' current situation, specifically within the past month. This approach is susceptible to chance events and may not fully capture the effects over time. Accordingly, future research could consider controlling for a greater number of potential influencing factors and paying closer attention to the accuracy and generalizability of the study in order to

obtain a more comprehensive and in-depth analysis. Furthermore, the diversity of the sample could be expanded to include adolescents of varying age levels, lifestyles, and cultural backgrounds, thus enhancing the broad applicability of the findings.

Conclusions

The purpose of the research was to explore the effects of SMA, AS, and SQ on ASy among Chinese adolescents from three perspectives: physical factors, psychological factors, and social environment. Additionally, the study aimed to assess the mediating role of SE in these relationships. The results of the data analysis conducted using SPSS26.0 indicated that SMA, AS, and SQ were all positively correlated with ASy. Additionally, SE was identified as a pivotal mediator in the influence of these variables on ASy, thereby establishing an indirect pathway of influence from these three variables to ASy. These findings deepen our understanding of the causes of ASy in adolescents, highlighting the role of psychological and social factors in the development of ASy. Based on these results, it is recommended that future interventions focus on enhancing adolescents' SE and improving SQ, while also addressing SMA and AS. These approaches will provide more comprehensive strategies for managing and preventing adolescent ASy.

Data Sharing Statement

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

Ethics Approval and Consent to Participate

The researchers confirm that all research was performed in accordance with relevant guidelines/regulations applicable when human participants are involved (eg, Declaration of Helsinki or similar). This study was approved by the Ethics Committee of Guangdong Mechanical & Electrical Polytechnic, with the ethics approval number No. 2024009.

Informed Consent

Informed consent was obtained from all participants prior to data collection. Written informed consent was obtained from their parents or legal guardians, in accordance with ethical guidelines and institutional requirements.

Disclosure

The authors report no competing interests in this work.

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