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**The Relationship Between Self-Control and Nicotine Dependence Among
Chinese College Student Smokers: A Cross-Sectional Statistical Mediation
Analysis of Sleep Quality Problems**

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Abstract

Objective: College student smokers are in a transitional developmental stage from late adolescence to early adulthood, during which smoking behavior may be associated with self-regulation difficulties, sleep quality problems, and nicotine dependence. Although previous studies have examined the relationships between smoking and sleep, self-control and health behavior, and sleep quality problems and addictive behavior, relatively limited research has incorporated self-control, sleep quality problems, and nicotine dependence into the same cross-sectional statistical mediation model among Chinese college student smokers. This study examined the associations among self-control, sleep quality problems, and nicotine dependence, and tested whether sleep quality problems played a cross-sectional statistical mediating role between self-control and nicotine dependence.

Methods: A cross-sectional questionnaire survey was conducted, and 945 Chinese college student smokers with at least one year of smoking history were included in the final analysis. The Self-Control Scale was used to assess self-control, the Pittsburgh Sleep Quality Index was used to assess sleep quality problems, and the Fagerström Test for Nicotine Dependence was used to assess nicotine dependence. SPSS 26.0 was used for descriptive statistics, correlation analysis, and regression analysis, and PROCESS macro Model 4 was used to test the cross-sectional statistical mediation effect. The indirect effect was estimated using 5,000 bootstrap samples to obtain 95% confidence intervals. Sex, age, only-child status, and long-term residence were controlled in the model.

Results: Self-control was significantly negatively correlated with both sleep quality problems and nicotine dependence, whereas sleep quality problems were significantly positively correlated with nicotine dependence. After controlling for demographic variables, the reported path

coefficients were standardized regression coefficients: self-control significantly negatively predicted sleep quality problems ($\beta = -0.330$, $p < 0.001$), sleep quality problems significantly positively predicted nicotine dependence ($\beta = 0.103$, $p = 0.002$), and the direct path from self-control to nicotine dependence remained significant ($\beta = -0.119$, $p < 0.001$). Bootstrap analysis indicated that the completely standardized indirect effect of sleep quality problems between self-control and nicotine dependence was significant (effect = -0.0341 , BootSE = 0.0118 , 95% bootstrap CI $[-0.0579, -0.0116]$).

Conclusion: Among Chinese college student smokers, lower self-control was associated with higher nicotine dependence both directly and indirectly through more severe sleep quality problems. These findings suggest that sleep quality problems may represent a meaningful behavioral link between self-control and nicotine dependence in a cross-sectional statistical mediation model. Campus tobacco-control and student health interventions may benefit from integrating self-control training, sleep health education, routine management, and nicotine dependence risk screening.

Keywords: college student smokers; self-control; sleep quality problems; nicotine dependence; cross-sectional mediation analysis

1 Introduction

Smoking is an important public health issue affecting the physical and mental health of college students. College students are in a critical transitional period from adolescence to early adulthood, during which academic arrangements, social relationships, daily routines, and health behaviors gradually shift from external regulation by family and school to individual self-management. At this stage, smoking behavior is easily influenced by peer interaction, emotion regulation,

immediate reward, life stress, and self-control. For college student smokers, smoking is not merely a single behavioral choice; it may also be part of a complex chain of health behaviors involving insufficient sleep, irregular routines, negative affect, and addiction risk. Previous research has shown that tobacco use among college students is associated with psychological distress, sleep quality problems, and negative emotions (Boehm et al., 2016; Fluharty et al., 2017). Therefore, examining the mechanisms related to nicotine dependence among college student smokers is helpful not only for understanding the psychological and behavioral basis through which smoking develops into dependence, but also for providing more targeted evidence for campus tobacco control, sleep health education, and mental health services.

Nicotine dependence is one of the most important outcomes in smoking-related problems. Compared with occasional or social smoking, nicotine dependence means that individuals have developed relatively stable physiological and psychological needs for nicotine, reflected in morning smoking, increased cigarette consumption, difficulty controlling smoking, withdrawal discomfort, and continued use. Nicotine exerts reinforcing effects through the brain reward system, and long-term use may increase the risk of tolerance, withdrawal, and relapse (Benowitz, 2009). For college students, the formation of nicotine dependence has developmental specificity. On the one hand, college life involves relatively high behavioral autonomy, making students more likely to encounter tobacco in social, recreational, or stressful situations. On the other hand, the self-regulation system of young people is still developing and stabilizing. Once smoking becomes combined with immediate relief, social integration, or coping with fatigue, smoking behavior may gradually shift from experimentation to dependence. Studies of adolescent and young adult smoking suggest that early symptoms of nicotine dependence may appear at

relatively low smoking frequency, and daily heavy smoking should not be regarded as the only criterion for identifying dependence risk (DiFranza et al., 2002).

From a measurement perspective, nicotine dependence differs from general smoking frequency. Smoking frequency or daily cigarette consumption mainly reflects how often the behavior occurs, whereas nicotine dependence emphasizes difficulty controlling nicotine use, physiological need, and withdrawal-related manifestations. Although the FTND contains relatively few items, it can quickly identify dependence severity based on morning smoking, daily cigarette consumption, difficulty refraining from smoking in restricted places, and smoking while ill (Heatherton et al., 1991). In addition, nicotine dependence can be understood as a multidimensional construct involving automatic use, craving, tolerance, withdrawal, and situational smoking motives (Etter et al., 2003; Piper et al., 2004; Shiffman et al., 2004). Therefore, examining nicotine dependence among college student smokers should go beyond whether a student smokes and should further attend to whether smoking has developed into a relatively stable physiological and psychological dependence.

Previous studies of college student smokers have often started from stress, anxiety, depression, and negative emotions, emphasizing that smoking may be used as an emotion-regulation strategy. The negative reinforcement model suggests that individuals may smoke to temporarily relieve tension, anxiety, irritability, or discomfort, and this temporary relief can reinforce subsequent smoking behavior (Baker et al., 2004). Relevant reviews have also indicated stable associations between smoking, anxiety, depression, and negative affect, suggesting that smokers may use smoking as a way to cope with negative emotions (Akbari et al., 2020; Leventhal & Zvolensky, 2015). However, explaining nicotine dependence among college student smokers only from the perspective of emotional problems may still fail to reveal the everyday behavioral mechanisms

behind it. Common problems among college students, such as staying up late, bedtime smartphone use, irregular routines, academic procrastination, and daytime fatigue, may play an important role between insufficient self-control and nicotine dependence. In other words, nicotine dependence may arise not only from wanting to smoke or feeling bad, but also from failure in managing daily rhythms and impaired sleep health.

Self-control is an important psychological capacity that enables individuals to inhibit impulses, delay gratification, maintain long-term goals, and regulate daily behavior. Individuals with high self-control are usually better able to resist immediate temptations and maintain stable academic, daily-life, and health behaviors; individuals with low self-control are more likely to show impulsive behavior, procrastination, addictive behavior, and health behavior dysregulation. Tangney et al. (2004) showed that self-control is associated with better adjustment, fewer psychological problems, and better behavioral performance. The longitudinal study by Moffitt et al. (2011) further showed that childhood self-control predicts health, economic, and public safety outcomes in adulthood. The meta-analysis by Ridder et al. (2012) also indicated that trait self-control is broadly related to multiple behavioral outcomes, especially habitual health behaviors and automatic behavioral regulation. For college student smokers, insufficient self-control may be reflected not only in difficulty controlling smoking impulses, but also in difficulty maintaining regular routines, stopping recreational activities in time, reducing bedtime smartphone use, and choosing immediate relief when fatigued or stressed.

From a self-regulation perspective, smoking and sleep are not independent daily behaviors. Both involve management of immediate reward, bodily sensations, and daily rhythms. Students with lower self-control may be more likely to pursue immediate gratification and neglect long-term health goals when facing tobacco, smartphones, games, social media, or nighttime entertainment.

Such self-regulation failure may increase smoking frequency and nicotine exposure on the one hand and reduce sleep quality on the other. Among student smokers, sleep quality problems may also interact with the physiological effects of nicotine. Nicotine has stimulant effects and may influence sleep onset and sleep structure; declining nicotine levels at night may also lead to awakening or discomfort, thereby disrupting sleep continuity (Jaehne et al., 2009; Wetter & Young, 1994). Therefore, self-control, sleep quality problems, and nicotine dependence may form a psychological and behavioral risk chain worthy of attention.

Sleep quality problems may constitute an important pathway linking self-control and nicotine dependence. The Pittsburgh Sleep Quality Index evaluates sleep problems in terms of subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction (Buysse et al., 1989). Sleep problems are common among college students and are closely related to mental health, learning status, and daytime functioning (Becker et al., 2018; Lund et al., 2010). Sleep is not only a physiological recovery process, but is also associated with emotion regulation, reward processing, and cognitive control (Goldstein & Walker, 2014; Palmer & Alfano, 2016). When individuals experience long-term insufficient sleep or reduced sleep quality, their impulse control, stress tolerance, and capacity for delayed gratification may be further impaired, increasing dependence on immediate rewards such as nicotine. In other words, sleep quality problems may be a concrete manifestation of low self-control in daily life, and may also further weaken individuals' ability to control smoking behavior.

Research on bedtime procrastination provides important insight into this mechanism. Kroese et al. (2014) conceptualized bedtime procrastination as a form of self-regulation failure, in which individuals delay going to bed even when they are not prevented from doing so by external circumstances and know that they may feel tired the next day. Kühnel et al. (2018) further

examined the relationships among chronotype, self-control resources, and bedtime procrastination using a diary design. Studies of Chinese college students also suggest that self-regulation and bedtime procrastination play important roles in the relationship between problematic smartphone use and sleep quality (Zhang & Wu, 2020), and that bedtime procrastination and self-control are related to smartphone addiction, depression, and anxiety (Geng et al., 2021). Although these studies do not all focus directly on smokers, they collectively indicate that sleep behavior is strongly influenced by self-control and lifestyle. Among college student smokers, if low self-control is associated with irregular routines and reduced sleep quality, individuals may be more likely to obtain short-term stimulation or relief through smoking when they are tired, sleepy, inattentive, or emotionally unstable, thereby showing higher nicotine dependence risk.

Although previous studies have separately explored the relationships between self-control and addictive behavior, sleep quality and mental health, and smoking and sleep quality problems, relatively limited research has incorporated self-control, sleep quality problems, and nicotine dependence into the same cross-sectional statistical mediation model among Chinese college student smokers. Compared with directly examining the bivariate relationship between self-control and nicotine dependence, testing the mediating role of sleep quality problems can more specifically reveal how self-control is related to nicotine dependence through daily rhythms and sleep health. Based on the above theory and empirical research, this study proposed the following hypotheses: first, self-control would be significantly negatively correlated with nicotine dependence; second, self-control would be significantly negatively correlated with sleep quality problems, while sleep quality problems would be significantly positively correlated with

nicotine dependence; third, sleep quality problems would play a significant cross-sectional statistical mediating role between self-control and nicotine dependence.

2 Methods

2.1 Participants

This study used a cross-sectional questionnaire survey design. Participants were recruited from several universities in China through online questionnaire links, campus publicity, and class notifications. Eligible participants were required to meet the following criteria: (1) aged 18 years or older; (2) currently enrolled in an institution of higher education; (3) having a history of cigarette smoking for at least one year; (4) continuing to smoke and not currently undergoing smoking cessation or receiving smoking-cessation treatment at the time of the survey; and (5) understanding the purpose of the study and voluntarily providing informed consent. Participants were subsequently screened using the 11 DSM-5 symptom criteria for tobacco use disorder, which assess symptoms occurring during the previous 12 months across four domains: impaired control, social impairment, risky use, and pharmacological features, including tolerance and withdrawal. Each criterion was coded as present or absent, and participants who endorsed two or more criteria were considered to have met the DSM-5 screening threshold for tobacco use disorder. Questionnaires were excluded if participants did not meet the eligibility or DSM-5 screening criteria or if the responses showed obvious invalid patterns, including an abnormally short completion time, an unusually high proportion of consecutive identical responses, almost all items answered using the same response option, or other clearly invalid response patterns.

A total of 1,962 questionnaires were initially collected. Following eligibility screening, Following eligibility screening, DSM-5 screening, and predefined data-quality-control procedures, 1,017 questionnaires were excluded, leaving 945 Chinese college student smokers with at least one year of smoking history in the final analytic sample. No additional outlier-based exclusions were applied beyond these predefined screening and data-quality-control procedures. Because the online survey required completion of all core items before submission, no item-level missing data were present for the main study variables in the final analytic dataset. This study was approved by the Human Research Ethics Committee of Zunyi Medical University (Approval No. ZMU[2025]3-009) and was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. All participants provided informed consent before participating in the study. Participants ranged in age from 18 to 30 years, with a mean age of 20.44 years ($SD = 1.49$). The sample included 706 males (74.7%) and 239 females (25.3%). Among the participants, 722 were enrolled in general undergraduate institutions (76.4%), whereas 223 were enrolled in higher vocational colleges (23.6%). A total of 143 participants were only children (15.1%), and 802 were not only children (84.9%). Regarding long-term residence before college, 550 participants were from rural areas (58.2%) and 395 were from urban areas (41.8%). Based on FTND scores, 496 participants were classified as having mild nicotine dependence (52.5%), 354 as having moderate nicotine dependence (37.5%), and 95 as having severe nicotine dependence (10.0%).

Table 1 Sample Characteristics

Category	Subcategory	n / M $\pm$ SD	%
Age (years)	M $\pm$ SD	20.44 $\pm$ 1.49	

Sex	Male	706	74.7
	Female	239	25.3
Institution type	General undergraduate institution	722	76.4
	Higher vocational college	223	23.6
Only-child status	Yes	143	15.1
	No	802	84.9
Long-term residence	Urban	395	41.8
	Rural	550	58.2
Nicotine dependence severity	Mild	496	52.5
	Moderate	354	37.5
	Severe	95	10.0

Note. Age is presented as mean $\pm$ standard deviation; categorical variables are presented as frequency and percentage. Nicotine dependence severity was classified according to FTND scores: 0-3 = mild, 4-6 = moderate, and ≥ 7 = severe.

2.2 Measures

Demographic information. A self-designed demographic questionnaire was used to collect participants' basic information, including sex, age, type of institution, major category, only-child status, and long-term residence. In this study, sex, age, only-child status, and long-term residence were included as control variables in the statistical model. Sex was coded as male = 1 and female = 2; only-child status was coded as only child = 1 and non-only child = 2; long-term residence was coded as urban = 1 and rural = 2.

Self-control. The Chinese version of the Self-Control Scale (SCS) was used to assess participants' level of self-control. The scale contains 19 items scored on a 5-point Likert scale, with total scores ranging from 19 to 95. After reverse scoring relevant items, higher total scores indicate higher self-control. The scale measures individuals' ability to inhibit impulses, control behavior, delay gratification, and maintain goal-directed behavior. In the present sample, Cronbach's alpha for the SCS was 0.845, indicating good internal consistency.

Sleep quality problems. The Chinese version of the Pittsburgh Sleep Quality Index (PSQI) was used to assess participants' sleep quality problems. The PSQI consists of 19 self-rated items that are aggregated into seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. The global score was calculated according to the standard PSQI scoring method, with higher total scores indicating more severe sleep quality problems (Buysse et al., 1989). In the present sample, Cronbach's alpha for the PSQI was 0.724, indicating acceptable internal consistency. Throughout this manuscript, the PSQI global score is consistently referred to as sleep quality problems. The term sleep disturbances is retained only when denoting the specific PSQI component.

Nicotine dependence. The Chinese version of the Fagerström Test for Nicotine Dependence (FTND) was used to assess participants' nicotine dependence. The FTND consists of six items and was scored according to the original FTND scoring method. It assesses physiological dependence characteristics such as morning smoking, daily cigarette consumption, and difficulty refraining from smoking. Total scores range from 0 to 10, with higher scores indicating more severe nicotine dependence (Heatherton et al., 1991). The FTND is a commonly used brief assessment tool in smoking and nicotine dependence research and is often used to distinguish

mild, moderate, and severe levels of nicotine dependence (Fagerström, 2012). According to established criteria, scores of 0–3 indicate mild dependence, scores of 4–6 indicate moderate dependence, and scores of 7 or above indicate severe dependence. In the present sample, Cronbach's alpha for the FTND was 0.625. Because the FTND contains few items and different items reflect different aspects such as smoking timing, smoking quantity, and control over withdrawal-related smoking, its internal consistency is relatively limited, and the results should be interpreted cautiously in light of the scale characteristics.

2.3 Data Processing and Statistical Analysis

SPSS 26.0 was used for statistical analysis. First, descriptive statistics were conducted for demographic variables and main study variables. Categorical variables were presented as frequencies and percentages, and continuous variables were presented as means and standard deviations. Pearson correlation analysis was then used to examine the preliminary relationships among self-control, sleep quality problems, and nicotine dependence. Finally, PROCESS macro Model 4 was used to test the statistical mediating role of sleep quality problems between self-control and nicotine dependence (Hayes, 2022).

In the mediation model, self-control was specified as the independent variable, sleep quality problems as the mediator, and nicotine dependence as the dependent variable. Sex, age, only-child status, and long-term residence were included as control variables. The indirect effect and its 95% confidence interval were estimated using 5,000 bootstrap samples. If the 95% Bootstrap confidence interval did not include 0, the indirect effect was considered statistically significant (Preacher & Hayes, 2008). Because all variables were measured at the same time point through self-report questionnaires, the results of this study should only be interpreted as cross-sectional statistical mediation and not as causal relationships or temporal ordering. For cross-sectional

mediation analysis, methodological research has noted that without longitudinal data, researchers should not directly interpret statistical pathways as true causal processes (Maxwell & Cole, 2007).

3 Results

3.1 Descriptive Statistics and Correlation Analysis

Descriptive statistics showed that the self-control score was 55.50 ± 10.21 , the sleep quality problems score was 8.59 ± 4.00 , and the nicotine dependence score was 3.30 ± 2.29 . Self-control scores ranged from 24.00 to 90.00, sleep quality problems scores ranged from 0.00 to 23.00, and nicotine dependence scores ranged from 0.00 to 10.00. Correlation analysis showed significant correlations among self-control, sleep quality problems, and nicotine dependence. Specifically, self-control was significantly negatively correlated with sleep quality problems, $r = -0.333$, $p < 0.001$; self-control was significantly negatively correlated with nicotine dependence, $r = -0.099$, $p = 0.002$; and sleep quality problems were significantly positively correlated with nicotine dependence, $r = 0.122$, $p < 0.001$. These results indicate that lower self-control was associated with more severe sleep quality problems and higher nicotine dependence among college student smokers, and that more severe sleep quality problems were associated with higher nicotine dependence. It should be noted that the correlations between self-control and nicotine dependence and between sleep quality problems and nicotine dependence were small, indicating that nicotine dependence is influenced by multiple factors and that this study focuses on one statistically meaningful but limited psychological and behavioral pathway.

Table 2 Descriptive Statistics and Correlations Among Main Variables

Variable	M	SD	1	2	3
1. Self-control	55.50	10.21	1		
2. Sleep quality problems	8.59	4.00	-0.333***	1	
3. Nicotine dependence	3.30	2.29	-0.099**	0.122***	1

Note. N = 945. M = mean; SD = standard deviation. ** $p < 0.01$, *** $p < 0.001$.

3.2 Testing the Mediating Effect of Sleep Quality Problems

After controlling for sex, age, only-child status, and long-term residence, PROCESS macro Model 4 was used to test the mediating role of sleep quality problems between self-control and nicotine dependence. The β values reported in the following regression results are standardized regression coefficients; the corresponding unstandardized coefficients (B), SEs, and 95% CIs are provided in Tables 3a and 3b. The results showed that, in the model with sleep quality problems as the dependent variable, self-control significantly negatively predicted sleep quality problems, $\beta = -0.330$, $t = -10.465$, $p < 0.001$. The overall model was significant, $R^2 = 0.119$, $F(5, 939) = 25.403$, $p < 0.001$. Among the control variables, age significantly positively predicted sleep quality problems, $\beta = 0.084$, $p = 0.007$, indicating that older participants in this sample reported slightly more sleep quality problems; sex, only-child status, and long-term residence were not significant predictors.

In the model with nicotine dependence as the dependent variable, both self-control and sleep quality problems were significant predictors. Specifically, self-control significantly negatively predicted nicotine dependence, $\beta = -0.119$, $t = -3.494$, $p < 0.001$; sleep quality problems significantly positively predicted nicotine dependence, $\beta = 0.103$, $t = 3.100$, $p = 0.002$. The overall model was significant, $R^2 = 0.082$, $F(6, 938) = 13.948$, $p < 0.001$. Among the control

variables, sex significantly negatively predicted nicotine dependence, $\beta = -0.242$, $p < 0.001$. Because sex was coded as male = 1 and female = 2, the result indicates that male college student smokers had higher nicotine dependence scores than female smokers. Only-child status also significantly negatively predicted nicotine dependence, $\beta = -0.066$, $p = 0.041$. Because only-child status was coded as only child = 1 and non-only child = 2, the result suggests that only children had higher nicotine dependence scores than non-only children. Age and long-term residence did not reach statistical significance in predicting nicotine dependence.

Bootstrap mediation analysis showed that the completely standardized indirect effect of sleep quality problems between self-control and nicotine dependence was significant (effect = -0.0341, BootSE = 0.0118, 95% bootstrap CI [-0.0579, -0.0116]). Because the confidence interval did not include 0, this indicates that the indirect effect of sleep quality problems between self-control and nicotine dependence was significant. Meanwhile, the standardized regression coefficient for the direct path from self-control to nicotine dependence remained significant ($\beta = -0.119$), indicating that sleep quality problems served as a partial statistical mediator. Given the cross-sectional design of this study, no causal direction among the variables can be inferred, and the mediation result should be understood as a statistical mediation relationship.

Table 3a Regression Results With Sleep Quality Problems as the Dependent Variable

Predictor	B	SE	β	t	p	95% CI
Self-control	-0.129	0.012	-0.330	-10.465	<0.001	[-0.153, -0.105]
Sex	0.118	0.289	0.013	0.409	0.683	[-0.450, 0.686]

Age	0.226	0.084	0.084	2.710	0.007	[0.062, 0.390]
Only-child status	-0.035	0.354	-0.003	-0.099	0.921	[-0.729, 0.659]
Long-term residence	-0.335	0.260	-0.041	-1.286	0.199	[-0.845, 0.176]

Note. N = 945. B = unstandardized regression coefficient; SE = standard error; β = standardized regression coefficient; CI = confidence interval. The overall model was significant, $R^2 = 0.119$, $F(5, 939) = 25.403$, $p < 0.001$.

Table 3b Regression Results With Nicotine Dependence as the Dependent Variable

Predictor	B	SE	β	t	p	95% CI
Self-control	-0.027	0.008	-0.119	-3.494	0.0005	[-0.042, - 0.012]
Sleep quality problems	0.059	0.019	0.103	3.100	0.002	[0.022, 0.097]
Sex	-1.274	0.169	-0.242	-7.518	<0.001	[-1.606, - 0.941]
Age	-0.001	0.049	-0.001	-0.015	0.988	[-0.097, 0.096]
Only-child status	-0.423	0.207	-0.066	-2.045	0.041	[-0.829, - 0.017]
Long-term residence	0.277	0.153	0.060	1.818	0.069	[-0.022, 0.576]

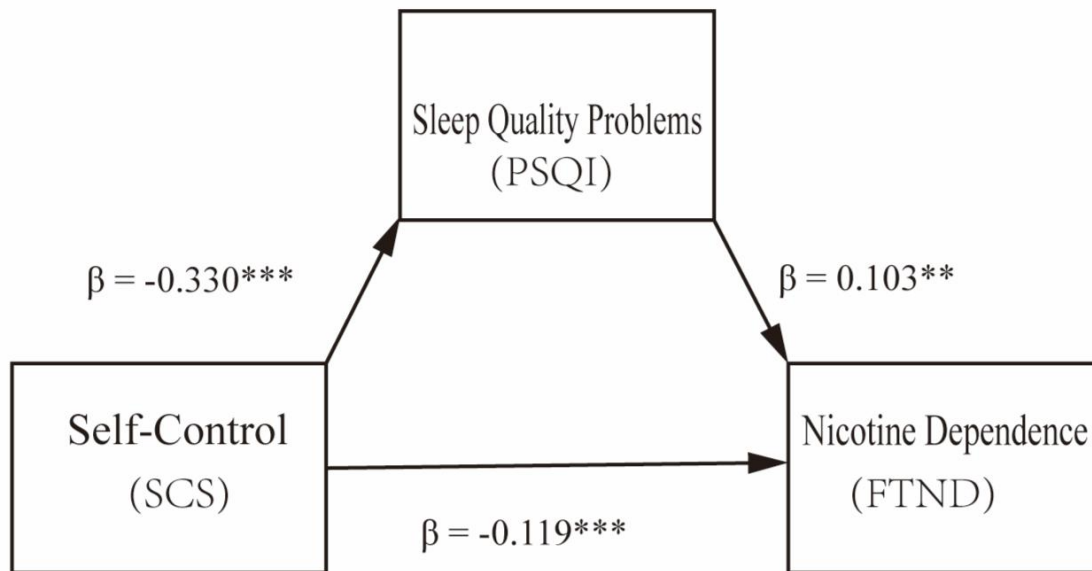
Note. N = 945. B = unstandardized regression coefficient; SE = standard error; β = standardized regression coefficient; CI = confidence interval. The overall model was significant, $R^2 = 0.082$, $F(6, 938) = 13.948$, $p < 0.001$.

Table 4 Direct and Indirect Effects of Sleep Quality Problems Between Self-Control and Nicotine Dependence

Effect type	Path	Estimate type	Estimate	SE/ BootSE	95% CI
Direct effect	Self-control → Nicotine dependence	Unstandardized direct effect (B)	-0.0267	0.0076	[-0.0416, -0.0117]
	Self-control → Sleep quality problems → Nicotine dependence	Unstandardized indirect effect (ab)	-0.0076	0.0026	[-0.0130, -0.0026]
Indirect effect	Self-control → Sleep quality problems → Nicotine dependence	Completely standardized indirect effect	-0.0341	0.0118	[-0.0579, -0.0116]

Note. The model controlled for sex, age, only-child status, and long-term residence. The direct effect is reported as an unstandardized regression coefficient (B). The indirect effect is reported both as an unstandardized indirect effect (ab) and as a completely standardized indirect effect. For the direct effect, SE and the conventional 95% CI are reported; for the indirect effects, BootSE and 95% bootstrap CIs based on 5,000 bootstrap samples are reported. An indirect effect was considered statistically significant when its 95% bootstrap CI did not include zero.

Figure 1 Mediation Model of Self-Control, Sleep Quality Problems, and Nicotine Dependence



Note. The model controlled for sex, age, only-child status, and long-term residence. Path coefficients are standardized regression coefficients (β); β is not used to label the indirect effect. ** $p < 0.01$, *** $p < 0.001$. This model is a cross-sectional statistical mediation model; arrows represent statistical regression paths and should not be interpreted as causal effects.

4 Discussion

This study examined cross-sectional associations among self-control, sleep quality problems, and nicotine dependence in 945 Chinese college student smokers, and further tested whether sleep quality problems played a statistical mediating role between self-control and nicotine dependence. The results showed that self-control was significantly negatively correlated with both sleep quality problems and nicotine dependence, whereas sleep quality problems were significantly positively correlated with nicotine dependence. Mediation analysis further indicated that, after controlling for sex, age, only-child status, and long-term residence, self-control was directly associated with nicotine dependence and indirectly associated with nicotine dependence

through sleep quality problems. Overall, sleep quality problems partially statistically explained the relationship between self-control and nicotine dependence.

This study found that lower self-control was associated with higher nicotine dependence among college student smokers. This result is consistent with self-control theory and previous research showing that higher self-control is associated with better behavioral adjustment, fewer maladaptive behaviors, and better health-related outcomes (Ridder et al., 2012; Tangney et al., 2004) . It also accords with prior evidence suggesting that individual differences in self-control are related to dimensions of nicotine dependence among smokers (Wilson & Maclean, 2013). Self-control is an important psychological regulatory resource that helps individuals inhibit impulses, manage behavior, delay gratification, and maintain long-term goals. Smoking has an obvious immediate reward component, and nicotine intake can provide subjective experiences of stimulation, relaxation, craving reduction, or discomfort relief within a short period; such immediate reinforcement and habit-related motives have also been observed among college student smokers (Piasecki et al., 2007). In cross-sectional terms, lower self-control may reflect greater difficulty resisting immediate smoking impulses and maintaining stable choices between long-term health goals and short-term rewards. In college life, students encounter peer smoking, social settings, academic pressure, nighttime entertainment, and flexible daily schedules, all of which require stronger self-control to maintain healthy behavior. Therefore, lower self-control may be associated with higher nicotine dependence, although the present design cannot establish a developmental causal process.

The effect size of the association between self-control and nicotine dependence should be interpreted cautiously. The zero-order correlation between self-control and nicotine dependence was small, $r = -0.099$, and the standardized regression coefficient for the direct path from self-

control to nicotine dependence was also relatively limited, $\beta = -0.119$. Nicotine dependence, as an addiction-related outcome, is influenced by multiple factors, including smoking duration, daily cigarette consumption, age at first smoking, peer smoking, family smoking, e-cigarette use, quit attempts, social environment, and individual biological sensitivity. Therefore, this study does not claim that self-control is the sole or primary determinant of nicotine dependence. Rather, it suggests that self-control may constitute one upstream psychological and behavioral factor worthy of attention. In a large college population, even small associations may warrant further evaluation as potential markers for risk stratification, but their predictive and preventive utility requires prospective validation.

This study also found that lower self-control was associated with more severe sleep quality problems. Sleep behavior is not determined entirely by physiological need; it is also influenced by daily choices, time management, and environmental cues. Many college students know the harms of insufficient sleep and have basic conditions for sleep, yet they still find it difficult to stop current activities in time when facing smartphones, games, social media, short videos, or nighttime socializing. This pattern reflects self-regulation difficulty in sleep behavior. Consistent with this interpretation, problematic smartphone use has been linked to poorer sleep quality in systematic review evidence and in studies of Chinese college students (Huang et al., 2020; Yang et al., 2020). For college student smokers, insufficient self-control may be reflected not only in difficulty controlling smoking impulses, but also in difficulty maintaining regular routines, reducing bedtime stimulation, and avoiding smoking-related coping when fatigued or stressed.

Sleep quality problems were also positively associated with nicotine dependence and remained a significant predictor in the regression model. Multiple links may exist between sleep quality problems and nicotine dependence. First, nicotine has stimulant effects and may delay sleep

onset, reduce sleep continuity, or alter sleep structure. Prior research has shown that smokers report poorer sleep quality and shorter sleep duration than non-smokers, and that higher nicotine dependence and smoking intensity are associated with shorter sleep duration (Cohrs et al., 2014). Systematic review evidence also suggests that smoking increases risk of sleep quality problems (Amiri & Behnezhad, 2020). Second, insufficient sleep may be accompanied by daytime fatigue, reduced attention, and lower learning efficiency, making individuals more likely to use smoking for brief stimulation or fatigue relief. Third, reduced sleep quality may weaken emotion regulation and impulse control, making individuals more likely to choose smoking as an immediate coping strategy under stress or discomfort. In cigarette smokers, poorer sleep quality has also been associated with stronger withdrawal, craving, and smoking urges (Purani et al., 2019). These processes may jointly form a cycle of sleep quality problems, increased fatigue or discomfort, smoking as coping, and worsened nicotine dependence, but such a cycle requires longitudinal verification.

The mediating result further suggests that sleep quality problems may serve as a concrete lifestyle-related link between self-control and nicotine dependence. Lower self-control was associated with more sleep quality problems, and sleep quality problems were further associated with higher nicotine dependence. This indirect association does not mean that sleep quality problems are the only pathway connecting self-control and nicotine dependence. Rather, it indicates that the abstract construct of self-control can be partly reflected in observable daily routines such as delayed sleep onset, bedtime smartphone use, nighttime smoking, and daytime fatigue. In this sense, sleep quality problems are not merely an ancillary variable in nicotine dependence research, but a behavioral indicator that helps situate nicotine dependence within broader lifestyle dysregulation.

Because sleep quality problems only partially explained the association between self-control and nicotine dependence, other pathways should also be considered. Individuals with lower self-control may be more susceptible to peer smoking influence and may find it harder to refuse cigarettes in social situations. They may also be more likely to experience academic procrastination, internet addiction, impulsive consumption, or emotional coping, all of which may further increase smoking frequency. In addition, self-control may be associated with persistence in quitting goals, the ability to avoid smoking cues, and tolerance of withdrawal discomfort. Future research can build on this model by including daily cigarette consumption, smoking duration, age at first smoking, peer smoking, willingness to quit, e-cigarette use, internet addiction, and emotion-regulation strategies to construct more complete multiple mediation or chain mediation models.

Regarding control variables, male college student smokers had significantly higher nicotine dependence scores than female smokers. This result is broadly consistent with tobacco epidemiological evidence from China showing that smoking prevalence among college students is substantially higher among males than females (Mingxin et al., 2026). Only-child status also significantly predicted nicotine dependence; under the coding scheme used in this study, only children had higher nicotine dependence than non-only children. This finding should be interpreted cautiously, because only-child status may be intertwined with family structure, parental monitoring, social support, economic conditions, and individual lifestyle. Long-term residence was close to but did not reach statistical significance in predicting nicotine dependence, indicating that urban-rural background may show a certain trend but has limited explanatory power after controlling for other variables.

Finally, this study used a cross-sectional statistical mediation model; therefore, all pathways should be interpreted as statistical associations rather than causal mechanisms. Although it is theoretically possible to propose that insufficient self-control may be associated with sleep quality problems, which are then associated with nicotine dependence, cross-sectional data cannot establish the temporal order among variables, and cross-sectional mediation models may produce biased estimates of longitudinal mediation processes (Maxwell & Cole, 2007). Reverse pathways may also exist: students with higher nicotine dependence may experience reduced sleep quality due to nighttime smoking, withdrawal discomfort, or changes in sleep structure, and sleep quality problems may in turn weaken self-control. Third variables, such as stress, depression, peer smoking, or internet addiction, may also simultaneously affect self-control, sleep quality problems, and nicotine dependence. Therefore, the more accurate interpretation of this study is that sleep quality problems play a cross-sectional statistical mediating role between self-control and nicotine dependence, rather than serving as a causal psychological mechanism.

5 Practical Implications

Given the cross-sectional design and the small completely standardized indirect effect, the practical implications of this study should be regarded as preliminary and hypothesis-generating. The observed association between sleep quality problems and nicotine dependence suggests that sleep quality assessment could be considered in future campus tobacco-control and student health programs. However, the present data do not show that screening or addressing sleep quality problems will reduce nicotine dependence.

Self-control and sleep-related behaviors may be considered candidate targets for the development of future interventions rather than established treatment components. Potential

strategies, including goal management, smoking-cue identification, bedtime behavior management, reduced bedtime smartphone use, avoidance of smoking before sleep, exercise, relaxation, and peer support, require prospective and experimental evaluation before conclusions can be drawn about their effectiveness.

A tiered support model could also be evaluated in future studies. Students with different levels of nicotine dependence and sleep quality problems may require different levels of assessment, health education, psychological support, smoking-cessation counseling, or medical referral. Nevertheless, this cross-sectional study cannot determine which components are effective, whether any component is sufficient, or how services should be sequenced.

6 Limitations and Future Directions

This study has several limitations. First, the cross-sectional design limits the ability to determine the temporal order and causal relationships among self-control, sleep quality problems, and nicotine dependence. Future studies should employ longitudinal designs, ecological momentary assessment, or intervention approaches to further examine the dynamic relationships among these variables. Cross-lagged models may also help clarify whether sleep quality problems predict subsequent changes in nicotine dependence or whether nicotine dependence contributes to later sleep deterioration.

Second, this study primarily relied on self-report questionnaires, which may introduce common method bias and social desirability effects (Podsakoff et al., 2003). Moreover, although self-control and sleep quality problems were identified as important correlates of nicotine dependence, other relevant factors, such as smoking behaviors, emotional symptoms, social influences, and biological indicators, were not included in the current model. Future research should combine

objective measures (e.g., wearable sleep monitoring and biochemical indicators), behavioral records, and more comprehensive models to better capture the multifactorial nature of nicotine dependence. In addition, the relatively low internal consistency of the FTND in this sample (Cronbach's $\alpha = 0.625$) may have affected the stability of observed associations. Future studies should consider using multiple measures of nicotine dependence to improve assessment reliability.

Third, the sample was limited to college student smokers, which restricts the generalizability of the findings to other populations, including non-smokers, older adults, and individuals with different smoking patterns. Future research should include more diverse samples and comparison groups to examine whether the relationships among self-control, sleep quality problems, and nicotine dependence vary across different populations. Furthermore, although the indirect effect through sleep quality problems was statistically significant, the completely standardized indirect effect was relatively small (effect = -0.0341), suggesting that sleep represents only one component of a broader risk pathway. Therefore, sleep-related interventions should be integrated with comprehensive smoking cessation strategies rather than considered as a standalone approach.

7 Conclusion

Based on a sample of 945 Chinese college student smokers, this study identified cross-sectional associations among self-control, sleep quality problems, and nicotine dependence. Lower self-control was associated with more severe sleep quality problems and higher nicotine dependence, and the indirect association through sleep quality problems was statistically significant but small. These findings support further investigation of self-control, sleep health, and nicotine

dependence within longitudinal and experimental designs. They should not be interpreted as establishing temporal ordering, a causal mechanism, or the effectiveness of self-control training, sleep-focused education, or other intervention components.

Declarations

Ethics Approval and Consent to Participate

This study was approved by the Human Research Ethics Committee of Zunyi Medical University (Approval No. ZMU[2025]3-009) and was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. All participants provided informed consent prior to participation.

Competing Interests

The authors declare that they have no competing interests.

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Data Availability

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

Author Contributions

B.H., W.Q., and T.B. contributed to the conception and development of the study. B.H. and W.Q. contributed to data collection, data processing, and statistical analysis. B.H. drafted the initial manuscript. T.B. supervised the study and critically revised the manuscript for important intellectual content. All authors reviewed and approved the final version of the manuscript.

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