

Path of Physical Exercise's Impact on Deviant Behavior Among Chinese Adolescents

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Purpose: Physical exercise is an important predictor of deviant behavior in adolescents; however, the paths and mechanisms underlying this relationship remain understudied.

Patients and Methods: This cross-sectional study used education tracking data of 8725 Chinese adolescents (4453 males, 4240 females, average age 14 ± 0.73) to construct a chain mediation model to explore whether sleep quality and mental health mediated the relationship between physical exercise and adolescent deviant behavior.

Results: The results show that physical exercise cannot directly predict adolescent deviant behavior; however, it can indirectly affect deviant behavior through the mediating effect of sleep quality and mental health as well as the chain mediating benefit of "sleep quality–mental health".

Conclusion: Sleep quality and mental health are important internal factors of physical exercise that inhibit deviant adolescent behavior. The lack of physical activity and poor sleep quality should be prioritized in interventions regarding deviant behavior among Chinese adolescents.

Keywords: quality of sleep, mental health, deviant behavior, teenagers, mediation

Introduction

Deviant behavior refers to behavior that violates public moral and social norms and discipline, or behavior that is not recognized by the majority of a society and has a negative social impact.^{1,2} Deviant behaviors include 1) harmful behavior, which refers to behaviors that cause harm to others or to self, such as assault, school violence, verbal abuse, self-harm, or suicide;³ 2) academic adaptation problems, usually caused by non-intellectual factors, such as truancy, cheating, partial subjects, classroom disturbance, and inability to concentrate;⁴ and 3) partial malformations, which refer to bad habits caused by unhealthy psychological development, specifically manifested as smoking, alcoholism, drug abuse, and internet obsession.⁵

Adolescence is a critical and special period of individual growth. Adolescents are not yet physically and mentally mature; moreover, thinking patterns, values, and behavioral habits are still in the process of stereotyping, have limited integration ability, and are easily affected by the social environment, resulting in role confusion and deviant breeding behavior.¹ Deviant behavior may affect their physical and mental state, personality, family and social relationship networks, as well as the development of social adaptation, and could evolve into criminal behavior. First, the deviant behavior shown in adolescence can easily develop into behavioral habits, which will have different degrees of impact on survival levels and academic studies. Deviant behaviors prevent adolescents from focusing their time and energy on their studies, leading to low academic performance, which ultimately affects their future development. Second, deviant behavior can cause family tension and easily lead to family conflict. When adolescents show deviant behavior, parents' accusations and criticism will cause teenagers to rebel, resulting in the inability of both parties to communicate reasonably once the family is caught in a tense and conflicted environment. Adolescents are prone to choose an attitude of avoidance and alienation, resulting in a loose connection between them and their families. Finally, adolescent deviant behavior is likely to evolve into criminal behavior without scientific guidance or correction by external

forces. However, adolescents are in a decisive period of cognitive and behavioral development, which has obvious plasticity. In this period, interventions to correct deviant behaviors can effectively block their evolution into illegal behaviors. Therefore, preventing and correcting these problems has become a popular research topic for educators.

Existing studies have focused on family structure,⁶ parental attachment, parental supervision,⁷ peer relationships,⁸ campus environment,⁹ individual attitudes,¹⁰ and physical exercise¹¹ to discuss the prevention, correction, and intervention of deviant adolescent behavior. Relevant studies have shown that physical activity is an important means of preventing and reducing deviant behavior in adolescents.^{11,12} Specifically, physical activity can reduce adolescent smoking rates,¹³ aggression, and violence,¹⁴ and prevent suicide.¹⁵ Therefore, the first hypothesis of this study is:

Hypothesis 1: Physical exercise can directly affect deviant behavior in adolescents.

The path and mechanism of physical exercise prevention and reduction of deviant adolescent behaviors still need to be clarified. Physical exercise was associated with sleep quality, mental health, and deviant behavior in adolescents, whereas sleep quality and mental health were associated with deviant behavior. Adequate sleep volume and good sleep quality can eliminate fatigue and promote the recovery of an individual's mental state; conversely, a decrease in sleep quality leads to associated physiological dysfunction, which in turn leads to pathological changes.¹⁶ By surveying 1200 youths aged 14–16 years in sports clubs, the results showed that adolescents who participated in physical activity slept significantly better than those who did not participate.¹⁷ Adolescents who lack physical exercise generally have poor sleep quality, while those with high levels of physical activity enjoy longer deep sleep periods, fewer insomnia symptoms, and higher sleep quality.¹⁸ While both males and females showed a trend of a smaller proportion of sleep disorders in those engaged in physical exercise, this trend was more pronounced in girls.¹⁹ Physical exercise can effectively improve adolescents' sleep quality, which impacts deviant behavior. Related research suggests that poor or inadequate sleep quality is associated with a higher risk of suicide^{20,21} and strongly associated with deviant behaviors such as violence, regular alcohol consumption, illicit drug use, and truancy.^{22,23} Therefore, the second hypothesis of this study is:

Hypothesis 2: Physical exercise can influence the behavioral bias of adolescents through the mediating effect of sleep quality.

The relationship between physical exercise and adolescent mental health has received extensive scholarly attention. Developmental and social psychology posit that adolescent individuals are in a critical period of physical and psychological development, experience sexual germination to maturity, and are at a turning point in their lives.²⁴ They experience various psychological contradictions and conflicts, such as between ideals and reality, independence and dependence, communication desire and psychological closure. As their social adaptation function and ability to cope with setbacks are not yet mature, these contradictions and conflicts easily constitute psychological disorders, which in turn lead to various mental disorders.²⁴ Empirical studies have shown that nearly 20% of adolescents report mental health problems, whose frequency among adolescents in developed countries is increasing.²⁵ Physical activity is an essential part of adolescent life and a major predictor of mental health.²⁶ Physical exercise regulates psych emotions and improves individual mental health; for example, it can relieve adolescent tension in interpersonal relationships and negative emotions such as hostility, and dissatisfaction,²⁷ prevent depression,²⁸ regulate psychological resilience,²⁹ and educate students about learning anxiety, loneliness, and self-blame. Furthermore, mental health was found to be a predictor of deviant behavior in adolescents. For example, depression increases violent behavior and suicidal ideation,³⁰ while high levels of emotional, cognitive, and mental health buffer bullying, suicidal ideation, and behavior.³¹ A survey of Chinese adolescents showed that those with poorer mental health had higher suicidal attitudes, which in turn promoted greater suicidal ideation;^{32,33} those with major depressive and anxiety disorders had a higher smoking intensity; and those with poorer mental health had higher rates of truancy and being prone to alcohol abuse.³⁴ A survey on the participation of ethnic minority students in risky behaviors in Malaysia showed that mental health conditions played an important role in predicting deviant behaviors such as smoking, alcohol consumption, and illegal drug use among adolescents.³⁵ Physical exercise can affect mental health, which in turn can further affect deviant behavior. Therefore, the third hypothesis of this study is:

Hypothesis 3: Physical exercise can influence adolescent behavioral bias through the mediating effect of mental health.

There is a strong relationship between sleep quality and mental health. Lack of sleep is detrimental to an individual's physical and mental health, directly or indirectly leading to depression,^{36,37} and even major depression.³⁸ In addition, sleep deprivation has been linked to mental health problems such as anxiety, worry, and difficulty in concentrating.³⁹ Based on the theoretical views of the second and third hypotheses, combined with the fact that sleep quality can predict mental health, the fourth hypothesis of this study is:

Hypothesis 4: Sleep quality and mental health have a chain-mediating effect between physical exercise and deviant behavior.

Judging from the existing research results, there are few empirical studies on the influence of physical exercise on deviant behavior among Chinese adolescents. Owing to vast differences in cultural and social backgrounds, we cannot be sure whether the development of deviant behavior and the intervention mechanism of physical exercise in Chinese adolescents are consistent with the results of foreign studies. The solution to this problem depends on empirical research in China; therefore, based on a large sample of data from China, this study explored the role of sleep quality and mental health in the process of physical exercise on the deviant behavior of adolescents. Its aim was to find an effective mechanism for physical exercise to influence the deviant behavior of Chinese adolescents, to provide a theoretical basis for the formulation of strategies for deviant behavior prevention and correction in Chinese adolescents, and to provide a reference for deviant behavior intervention and correction in other countries. The path of physical exercise affecting the deviant behavior of Chinese adolescents is mainly verified by the above four hypotheses, and the hypothetical model, shown in Figure 1, is obtained as a result. This study identified the underlying mechanisms of physical exercise and deviant adolescent behavior, which have important implications for both theory and practice.

Materials and Methods

Data Description

The data for the study were derived from the 2014–2015 China Education Panel Survey, provided by the China Survey and Data Center of Chinese People's University. This data is completely open to academia (<http://ceps.ruc.edu.cn/English/Home.htm>), and the specific investigation methods can be found on the official website (<http://ceps.ruc.edu.cn>). Research approval was granted by the ethics committee of the Renmin University of China. The database uses a random and stratified approach to sample 112 classes from 438 schools nationwide, with all randomly selected classes included in the observation sample involving approximately twenty thousand students. In the 2014–2015 follow-up survey, all 10,279 students in the first grade of junior high school at the time of the baseline survey (who had then been promoted to the second grade of junior high school) were selected. This is one of the few large-scale educational tracking survey projects in China on a sustained and nationwide scale that comprehensively reflects the educational information of junior high school students. To improve the quality of the data, the author deleted cases containing any missing variables, unreasonable answers according to the method of logical reasoning, or case in which samples were not successfully followed up for various reasons. The final sample for this study was 8693 students (4453 boys, 4240 girls, mean age 14 ± 0.73).

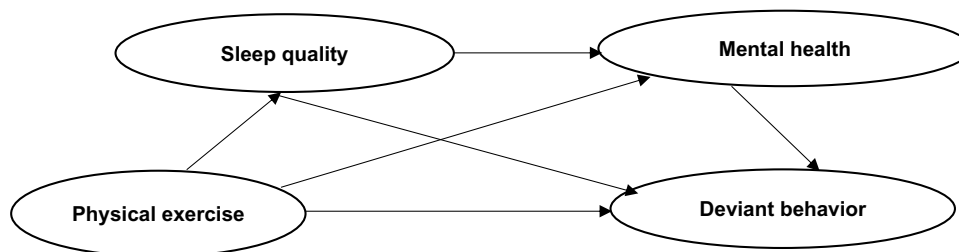


Figure 1 Hypothesized model.

Variable Measurement

Dependent Variable

The dependent variable in this study was school deviant behavior among adolescent students. This variable was measured by the China Education Panel Survey student questionnaire on whether they showed, for the past year, behaviors such as swearing, arguing, fighting, bullying weak classmates, grumpiness, inattentiveness, truancy, plagiarism, cheating on homework exams, smoking and drinking, attending internet cafes and arcades, as well as ten other indicators. Each indicator was measured on a 5-point Likert scale, with scores ranging from 1 to 5; higher scores indicated more frequent deviant behavior. Finally, these indicators were summed, the total score was calculated, and then divided by their number (10) to obtain an average score. The alpha reliability coefficient was 0.817, which is acceptable Table 1 lists the distribution of adolescents' deviant behaviors.

From the distribution of adolescents' deviant behavior (Table 1), among the ten deviant behaviors, inattention had the highest score, followed by swearing, grumpiness, and quarrels. On average, some of the remaining bad behaviors scored below 1.5 points on average. The lowest scoring behavior was truancy, with an average score of 1.08. In terms of the severity of these behaviors, their order was skipping class, smoking, drinking, bullying weak classmates, and similar disruptive attitudes, followed by inattentiveness, swearing, and quarrelling. The frequency of deviant behaviors that subtly break school rules, lack discipline, and are harder to spot is relatively high.

Explanatory Variables

The main explanatory variables were extracurricular physical activity, sleep quality, and mental health. The extracurricular physical activity was measured through the question "How many days a week do you typically exercise and how many minutes do you average each day?" The amount of extracurricular physical activity was multiplied by the number of days of exercise per week and the number of minutes of exercise per day divided by seven to obtain the average amount of exercise per day. The alpha reliability coefficient of the students' extracurricular exercise time was 0.847, which was acceptable. The quality of students sleep was measured by nine questions, including "Do you have difficulty falling asleep?" "When sleeping, do you easily wake up?" "When waking up, do you feel rested?" The answers were "no" and "yes", scoring 0 and 1 points, respectively. The score for sleep quality was given by the sum of the scores of the nine measurement questions; the higher the score, the worse the student's sleep quality. Cronbach's alpha coefficient for sleep quality measurements was 0.836, which was acceptable. The measurement of students' mental health consisted of seven questions, including "Have you felt depressed, unhappy, nervous, or overly worried in the past 10 days?" Answers used a 5-point Likert scale consisting of never, rarely, sometimes, often, and always, of 1, 2, 3, 4, and 5 points, respectively. The final mental health score was averaged using the scores of the 10 questions. Cronbach's alpha coefficient of the mental health test was 0.853, which was acceptable.

Table 1 The Distribution of Adolescent Deviant Behavior

Question Items	M	SD	Minimum Value	Maximum Value
Inattentiveness	2.23	1.031	1	5
Swearing	2.21	0.972	1	5
Grumpiness	1.86	0.975	1	5
Arguing	1.83	0.869	1	5
Plagiarism, cheating on homework exams	1.48	0.774	1	5
Fighting	1.34	0.688	1	5
Internet cafes and arcades	1.20	0.637	1	5
Bullying weak classmates	1.14	0.487	1	5
Smoking and drinking	1.10	0.468	1	5
Truancy	1.08	0.42	1	5

Models and Statistical Analysis Methods

Descriptive statistics and correlation analyses among the variables were conducted through SPSS 24.0. The mediating effect of sleep quality and mental health in the relationship between physical exercise and deviant behavior⁴⁰ was analyzed using Model 6 in the SPSS macro program. The Bootstrap method was used to test for significance of the regression coefficient, and the confidence interval corrected for robust standard error and 95% bias was obtained; if the confidence interval did not contain zero, the significance test $p \leq 0.05$ indicated that the effect was statistically significant.⁴¹

Results

Descriptive Statistics and Related Variable Analysis

Table 2 provides the descriptive statistics and related analyses of the means of each study variable. Results showed that physical exercise, sleep quality, mental health, and deviant behavior are significantly correlated, indicating that the data from this study were suitable for subsequent analyses.

Mediation Effect Analysis

A multivariate hierarchical regression analysis was performed using Model 6 of the SPSS PROCESS microprogram compiled by Hayes. The daily physical exercise duration was used as the independent variable, sleep quality and mental health were used as mediating variables, and deviant behavior was used as the dependent variable for the regression analysis. Table 3 shows that physical activity can not only significantly predict sleep quality ($\beta = 0.025$, $p < 0.001$), but also mental health ($\beta = 0.053$, $p < 0.001$); however, it did not significantly predict deviant behavior ($\beta = 0.010$, $p > 0.05$). Furthermore, sleep quality significantly predicted mental health ($\beta = 0.315$, $p < 0.001$) and deviant behavior ($\beta = 0.077$, $p < 0.001$), while mental health can significantly predict deviance ($\beta = 0.372$, $p < 0.001$).

Table 4 shows that the direct effect of physical exercise on deviant behavior is -0.0023 , and the 95% confidence interval is $[-0.0069, 0.0022]$, containing the value 0, indicating that the direct effect was not significant. The mediating effect of sleep quality between physical activity and deviance was -0.0005 , and the 95% confidence interval was $[-0.0009, -0.0001]$, which does not contain a 0 value, thus indicating that the mediation effect is significant. The mediating effect of mental health between physical exercise and deviance was -0.0047 , with a 95% confidence interval

Table 2 Descriptive Statistics and Related Analysis of Each Variable

Variable	M \pm SD	Physical Exercise	Sleep Quality	Mental Health	Deviant Behavior
Physical exercise	20.47 \pm 9.311	I			
Sleep quality	0.82 \pm 0.164	0.25*	I		
Mental health	2.17 \pm 0.807	0.61**	0.316**	I	
Deviant behavior	1.48 \pm 0.456	0.34**	0.195**	0.397**	I

Notes: **At level 0.01 (double-tailed), the correlation is significant. *At level 0.05 (double-tailed), the correlation is significant.

Table 3 Regression Analysis Between Study Variables

Variable	Sleep Quality			Mental Health			Deviant Behavior		
	B	SE	t	B	SE	t	B	SE	t
Physical exercise	0.025*	0.018	2.345	0.053**	0.013	5.222	0.010	0.001	0.999
Sleep quality				0.315**	0.007	30.979	0.077**	0.004	7.489
Mental health							0.372**	0.006	35.917
R ²	0.001			0.103			0.163		
F	5.500			497.865			565.161		

Notes: **At level 0.01 (double-tailed), the correlation is significant. *At level 0.05 (double-tailed), the correlation is significant.

Table 4 Mediation Effect Analysis

Variable	Effect Size	Boot Standard Error	Boot CI Lower Bound	Boot CI Upper Limit
Direct effects	-0.0023	0.0023	-0.0069	0.0022
Indirect effects 1	-0.0005	0.0002	-0.0009	-0.0001
Indirect effects 2	-0.0047	0.0010	-0.0067	-0.0027
Indirect effects 3	-0.0007	0.0003	-0.0013	-0.0001
Total indirect effects	-0.0058	0.0011	-0.0081	-0.0037

Notes: Direct effect refers to physical exercise → deviant behavior; indirect effect 1 represents physical exercise → sleep quality → deviant behavior; indirect effect 2 represents physical exercise → mental health → deviant behavior; indirect effect 3 represents physical exercise → sleep quality → mental health → deviant behavior.

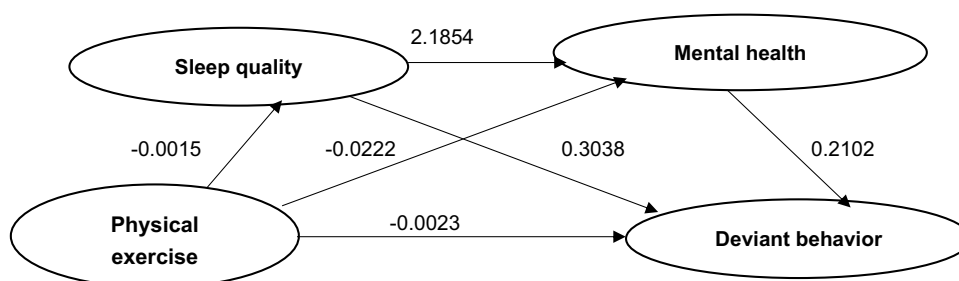
of $[-0.0067, -0.0027]$, which excluded the 0 value, thus indicating that the mediation effect is significant. The chain mediation effect of sleep quality and mental health between physical exercise and deviant behavior was -0.0007 , with a 95% confidence interval of $[-0.0013, -0.0001]$, which did not contain a 0 value, indicating that the chain mediation effect was significant. Therefore, physical exercise affects deviant behavior through a complete mediating effect. The chain mediation model shown in Figure 2 was obtained based on the above data analysis.

Discussion

At present, intervention studies on deviant behaviors pay more attention to the improvement of the external environment, especially the supportive social environment, such as peer relationships, parenting styles and family atmosphere, which have a positive effect on individual prosocial behavior.^{42,43} However, reciprocal determinism theory holds that the influence of the external environment on individuals must be produced through an evaluation of internal perceptions.⁴⁴ As a positive method of self-repair and self-regulation, sleep quality promotes well-being in a supportive external environment and contributes to the effectiveness of interventions.⁴⁵ In addition, the external environment often interacts with good sleep quality and mental health, and it is difficult to find an effective path and mechanism for deviant behavior intervention if the problem is solved from the single perspective of physical exercise. This study explored the psychological resources (sleep quality and mental health) that play key roles in the relationship between physical activity and deviant behaviors from a positive psychology perspective. Physical exercise can inhibit deviant behaviors by optimizing sleep quality and mental health. Therefore, strengthening the construction of these two positive psychological resources will help reduce the probability of deviant behaviors.

Effects of Physical Exercise on Deviant Behavior

The results of this study show that physical activity does not directly predict biased behavior, which is inconsistent with previous research.^{46,47} The possible reason for this may be due to the influence of the frequency and intensity of physical exercise. While this study counted the weekly physical exercise volume of the study subjects, it did not compare its frequency and intensity. Some studies suggest that exercise intensity and frequency have no significant impact on deviant behaviors such as suicide in 13-year-old individuals,⁴⁸ however, studies have found that high-intensity physical exercise can help reduce deviant behaviors such as suicide.⁴⁹ Studies have also found that adolescents who do not participate in

**Figure 2** Mediation model diagram of physical exercise and deviant behavior.

physical exercise have a 1.42 times higher risk of developing deviant behaviors compared to those who participate in high-intensity physical exercise three times a week. Further studies have shown that general physical exercise is not associated with deviant behavior, but systematic and professional physical exercise has a positive impact on reducing it.⁵⁰ It can be seen that the frequency and intensity of physical exercise affect the effect of experiential exercise on deviant behavior. Another reason why physical activity does not directly impact biased behavior is the existence of other mediating pathways and mechanisms.⁵¹ Related studies have shown that physical exercise can increase family satisfaction, and improving family satisfaction can reduce adolescent deviant behavior.^{6,52} Moreover, physical exercise has proven beneficial for optimizing the mental health of children and adolescents,⁵³ while a poor mental health status increases the risk of adolescent deviant behavior.⁵⁴ Physical exercise plays an important role in promoting friendship between peers and increasing their sense of belonging; simultaneously, a good sense of belonging among adolescent peers can reduce the occurrence of deviant behaviors.⁵⁵ As shown, variables such as family satisfaction, mental health, and peer relationships are all mediators of the influence of physical exercise on deviant behavior in children and adolescents. This instructs that the path and mechanism of reducing the occurrence of deviant behavior should be discussed from a multi-angle and all-round perspective, and the occurrence of deviant behavior should be reduced as much as possible to reduce social problems, such as crimes caused by deviant behaviors in adolescence in adulthood.

Sleep Quality Mediates Between Physical Activity and Deviant Behavior

Results show that sleep quality played a partial role in mediating the relationship between physical activity and deviant behavior. This study and related studies confirmed that physical exercise can positively predict sleep quality, improve the dilemma of adolescent sleep quality is not optimistic, which is consistent with previous related research.^{56,57} A seven-year longitudinal study of a sample of 45,757 adolescent students showed that sleep quality was strongly associated with deviant behavior and that the lower the sleep quality or shorter the sleep duration, the higher the frequency of students' deviant behavior.⁵⁸ In addition, the interaction model of physical exercise and sleep quality provides a theoretical basis for the results of this study. The theory states that physical activity and sleep quality are influenced by complex bilateral interactions involving multiple physiological and psychological pathways.⁵⁹ On the one hand, while physical activity is beneficial for improving sleep, it may be regulated by factors such as age, physical activity level, and gender; on the other hand, sleep disorders can also impair an individual's willingness to exercise, exercise ability, and cognitive ability.⁵⁹ However, the results of a 15-year survey showed that the sleep quality situation of Chinese adolescents is not optimistic, and the causes of sleep problems are insufficient sleep time, high study pressure, daytime dysfunction, poor awareness of sleep hygiene, obesity, negative psychological emotions, smoking and drinking behavior, unhealthy diet, excessive screen use, poor family economic situation, and lax parental discipline.⁶⁰ Another big data study of China's National Mental Health Survey also showed that the problem of sleep deprivation among Chinese adolescents is prominent, with 95.5% of primary school students, 90.8% of junior high school students, and 84.1% of high school students not meeting the sleep duration target.⁶¹ This suggests that educators can promote appropriate physical activity in adolescents to optimize sleep quality and prevent adolescent deviance.

Mental Health Mediates Between Physical Activity and Deviant Behaviors

This study found that mental health played a mediating role between physical exercise and deviant behavior. This suggests that physical activity promotes mental health in adolescents, further reducing deviant behaviors. Poor mental health is a major cause of poor quality of life and disability in children and adolescents,⁶² however, globally, one in seven adolescents aged 10–19 years has mental health problems.⁶³ Conversely, positive mental health can reduce teenage inclusion in ADHD, school refusal, autism spectrum disorder (ASD), learning disorders, bullying and other deviant behaviors.⁶⁴ Studies have shown that higher motivation to participate in physical activity is associated with higher scores on positive mental health indicators and lower scores on indicators of mental health problems,⁶⁵ and that eight weeks of physical activity can significantly improve adolescent mental health.⁶⁶ According to the World Health Organization, adolescents need 1 h of moderate-to-vigorous physical activity per day to promote their physical and mental health. A study on the relationship between physical activity and mental health showed that adolescents exercised 2.5–7.5 h per week to achieve the best mental health promotion benefits.⁶⁷ However, this study found that the daily participation time

of Chinese adolescents in physical exercise was 20.4652 ± 9.311 min/day, which did not meet the minimum requirements and should urgently attract the attention of relevant Chinese departments and educators.

Role of Sleep Quality and Mental Health in the Chain Mediation Between Physical Exercise and Deviant Behavior

Results showed that sleep quality and mental health played a chain-mediating role in the relationship between physical activity and deviant behavior (Table 4). This implies that, in addition to the mediating role between physical exercise and deviant behavior, sleep quality can also indirectly affect deviant behavior by affecting mental health, thus reducing the frequency of deviant behavior in adolescents. This suggests that sleep quality and mental health are important intrinsic factors of physical exercise that inhibit deviant adolescent behavior and have the greatest benefit among the three pathways (Table 4).

This study found that physical activity had an indirect effect on adolescent mental health through sleep quality. A series of studies confirmed that physical exercise can improve the quality of sleep and promote the mental health of adolescents.^{68,69} Physical activity not only promotes quality sleep,⁷⁰ but also directly or indirectly reduces the risk of depression and anxiety.⁷¹ Moreover, sleep quality promotes adolescent mental health more than healthy behaviors such as physical exercise, sleep intake, and healthy diet; this phenomenon is prevalent in different geographical and cultural settings.⁷² High-quality sleep has been shown to maintain weight, boost metabolism, improve learning ability, enhance memory, improve the immune system, and optimize mental health; however, poor sleep quality is strongly associated with suicidal thoughts, depressive symptoms, and cardiovascular disease.⁷³ Therefore, good sleep quality is a major factor in promoting mental health in adolescents. This shows that the paths of “physical exercise, sleep quality, and mental health” were established.

Sleep quality was found to have an indirect effect on adolescent deviance through mental health, which could inhibit the occurrence of deviant adolescent behaviors. This shows that individuals with good sleep quality are more inclined to adopt positive self-control methods, often have a positive attitude towards themselves, have a higher evaluation of their abilities, and actively control and manage their thoughts and behaviors. Thus, they can better adapt to the outside world and the influence of the outside world on themselves, effectively preventing the breeding and performance of deviant behavior. If society, school, and family give adolescents higher social support to ensure good sleep time and quality, it will be beneficial in promoting their physical and mental health, affording them a higher self-control in the face of adverse temptations or stimuli, enabling them to keep a clear mind, think about the consequences of behavior, and helping them to control the occurrence of deviant behavior.⁷⁴ This suggests that to reduce the incidence of adolescent deviant behavior, in addition to finding ways to guide adolescents to actively participate in physical exercise, they need to be ensured adequate sleep time and quality, while promoting their physical and mental health from multiple perspectives and levels and exploring policy support, home-school cooperation, and sports interventions.

Significance, Limitations, and Study Prospects

Although existing studies have confirmed the predictive effect of physical exercise on adolescent deviance, research on the internal mechanism by which physical exercise affects Chinese adolescent deviance is limited. Using survey data from the China Education Tracker from 2014 to 2015, this study explored the internal mechanism of physical exercise affecting the deviant behavior of Chinese adolescents and analyzed it from the multidisciplinary perspectives of sociology and psychology. Compared with previous studies, the contributions of this study are as follows. First, it confirms that lack of physical exercise is an important public health problem for adolescents in China, and families, schools, and society should comprehensively explore ways and means to promote youth sports participation. Second, sleep quality and mental health play a chain-mediating role between physical exercise and deviant adolescent behaviors. It is suggested that Chinese adolescents need to focus on cultivating coping strategies to reduce deviant behaviors and promote sleep quality, physical, and mental health by promoting active lifestyles such as physical exercise, avoiding the occurrence and development of deviant behaviors, and promoting healthy growth.

This study had some limitations. First, only students in the second grade of junior high school were selected as the research subjects; hence, care must be exercised when generalizing to adolescents because the research is not based on data on adolescents of all ages. In the future, the sample range and size should be expanded to further verify the model used in this

study. Second, this study adopted a cross-sectional design relying on the self-reports of middle school students, which has the disadvantage of self-response bias. Although the relationship between the variables is explained in the cross-sectional section, causality between the participants' variables cannot be revealed. Follow-up research could use longitudinal studies, crossover study designs, as well as experimental and interview methods to provide richer empirical evidence to explain the long-term effects of physical exercise on adolescents' deviant behaviors and improve the credibility of this study. Third, this study only explored the average daily time of adolescents participating in physical exercise and did not specifically examine the comparative study of adolescents' exercise intensity level, gender, age group, and even different regional samples; subsequent studies can compare the above factors and examine their influence mechanisms on adolescent deviant behavior to provide a more comprehensive and specific empirical reference for targeted interventions.

Conclusion

Physical exercise cannot directly and positively predict deviant behavior, and future research should explore its mediating path and mechanism to reduce deviant behavior from multiple, all-round perspectives. Physical exercise affects the deviant behavior through the mediating effect of sleep quality and mental health as well as the chain mediating benefit of "sleep quality-mental health". This indicates that sleep quality and mental health are important internal factors of physical exercise that inhibit deviant adolescent behavior.

Disclosure

The authors report no financial sources or conflicts of interest regarding this work.

References

- Li Z. The effects of family environment on juvenile delinquency—A quantitative analysis based on CEPS 2014–2015. *Issues on Juvenile Crimes and Delinquency*. 2022;6(6):28–43. doi:10.3969/j.issn.1006-1509.2022.06.003
- Zhen Wei X. TPSR physical education model intervention in adolescents' deviant behavior. *Contemporary Sports Technol*. 2022;12(30):87–90. doi:10.16655/j.cnki.2095-2813.2203-1579-9396
- Yufei XU, Fan XU. Effect of post-traumatic stress disorder on deviant behaviors in adolescents. *Chin J Sch Health*. 2022;43(7):1108–1111. doi:10.16835/j.cnki.1000-9817.2022.07.035
- Xin X. Social work intervention in adolescent deviant behavior: a case study of primary school B in A city. *Guangxi Quality Supervision Herald*. 2021;(06):64–66. doi:10.3969/j.issn.1009-6310.2021.06.034
- Wu Dian W. Diagnosis and counseling of deviant behavior mental health. *Educ Pri Sec Sch*. 2001;(8):7–10. doi:10.3969/j.issn.1671-2684.2001.08.003
- Yang Y, Jiang J. Influence of family structure on adolescent deviant behavior and depression: the mediation roles of parental monitoring and school connectedness. *Public Health*. 2023;217:1–6. doi:10.1016/j.puhe.2023.01.013
- Merrin GJ, Davis JP, Berry D, Espelage DL. Developmental changes in deviant and violent behaviors from early to late adolescence: associations with parental monitoring and peer deviance. *Psychol Violence*. 2018;9(2):196–208. doi:10.1037/vio0000207
- Busching R, Krahé B. The contagious effect of deviant behavior in adolescence: a longitudinal multilevel study. *Soc Psychol Pers Sci*. 2018;9(7):815–824. doi:10.1177/1948550617725151
- Pals H, Love TP, Hannibal B, Waren W. The consequences of school environment and locus of control on adulthood deviant behavior. *Deviant Behav*. 2016;37(9):1003–1022. doi:10.1080/01639625.2016.1167430
- Seddig D. Individual attitudes toward deviant behavior and perceived attitudes of friends: self-stereotyping and social projection in adolescence and emerging adulthood. *J Youth Adolesc*. 2020;49(3):664–677. doi:10.1007/s10964-019-01123-x
- Hai R. Nanjing youth olympic games and remodeling Chinese youth sport values. *Sports Sci*. 2011;32(4):1–3,16. doi:10.3969/j.issn.1004-4590.2011.04.001
- Greco G, Andriani O, D'Arcangelo E, de Ronzi R. Sports activities as primary prevention of youth deviant behaviours: an educational intervention research. *J Physic Educ Sport*. 2022;22(2):479–488. doi:10.7752/jpes.2022.02060
- Peng S, Yan T, Jinyue S. Relationship between physical exercise and smoking behavior of adolescents aged. *Chin J Sch Health*. 2022;43(7):986–989. doi:10.16835/j.cnki.1000-9817.2022.07.007
- Sánchez-Alcaraz BJ, Gómez-Mármol A, Valero-Valenzuela A, Courel-Ibáñez J. Implementation of the teaching personal and social responsibility model to reduce violent and disruptive behaviors in adolescents through physical activity: a quantitative approach. *J Teach Phys Educ*. 2021;40(2):238. doi:10.1123/jtpe.2019-0126
- Felez-Nobrega M, Haro JM, Vancampfort D, Koyanagi A. Sex difference in the association between physical activity and suicide attempts among adolescents from 48 countries: a global perspective. *J Affect Disord*. 2020;266:311–318. doi:10.1016/j.jad.2020.01.147
- Yuan Y, Ming-ming S, Chang-hao J, et al. Review on the relationship between physical exercise and sleep quality. *Chin J Health Educ*. 2018;34(11):1016–1019. doi:10.16168/j.cnki.issn.1002-9982.2018.11.012
- Makela KSKL. Physical activity, screen time and sleep among youth participating and non-participating in organized sports: the Finnish Health Promoting Sports Club(FHPSC)Study. *Ad Phys Educ*. 2016;6(4):379–388. doi:10.4236/ape.2016.64038
- Lang C, Brand S, Feldmeth AK, et al. Increased self-reported and objectively assessed physical activity predict sleep quality among adolescents. *Physiol Behav*. 2013;120:46–53. doi:10.1016/j.physbeh.2013.07.001

19. Yi LJ, Qiang Z. The effect of extracurricular physical exercising on college students' sleep quality. *J Phys Educ.* 2009;16(9):74–77. doi:10.3969/j.issn.1006-7116.2009.09.018
20. Lallukka T, Sivertsen B, Kronholm E, et al. Association of sleep duration and sleep quality with the physical, social, and emotional functioning among Australian adults. *Sleep Health.* 2018;4(2):194–200. doi:10.1016/j.sleh.2017.11.006
21. Welty CW, Gerald LB, Nair US, Haynes PL. Vaping and sleep as predictors of adolescent suicidality. *Am J Health Promot.* 2023;37(1):39–46. doi:10.1177/08901171221112027
22. Yen C, King BH, Tang T. The association between short and long nocturnal sleep durations and risky behaviours and the moderating factors in Taiwanese adolescents. *Psychiatry Res.* 2010;179(1):69–74. doi:10.1016/j.psychres.2009.02.016
23. Testa A, Semenza DC, Jackson DB. Violent victimisation trajectories from adolescence through adulthood: consequences for sleep problems. *J Epidemiol Community Health.* 2022;76(2):140–145. doi:10.1136/jech-2021-217356
24. Guo Z, Zhang Y, Rajakani K. Study on the interactive factors between physical exercise and mental health promotion of teenagers. *J Healthc Eng.* 2022;4750133–4750134. doi:10.1155/2022/4750133
25. Bor W, Dean AJ, Najman J, Hayatbakhsh R. Are child and adolescent mental health problems increasing in the 21st century? A systematic review. *Aust N Z J Psychiatry.* 2014;48(7):606–616. doi:10.1177/0004867414533834
26. Molcho M, Gavin A, Goodwin D. Levels of physical activity and mental health in adolescents in Ireland. *Int J Environ Res Public Health.* 2021;18(4):1713. doi:10.3390/ijerph18041713
27. Zou J. An empirical analysis of the effects of physical exercise on adolescent mental health and its mediating mechanisms. *J Environ Public Health.* 2022;2482884. doi:10.1155/2022/2482884
28. Pascoe MC, Parker AG. Physical activity and exercise as a universal depression prevention in young people: a narrative review. *Early Interv Psychiatry.* 2019;13(4):733–739. doi:10.1111/eip.12737
29. Belcher BR, Zink J, Azad A, et al. The roles of physical activity, exercise, and fitness in promoting resilience during adolescence: effects on mental well-being and brain development. *Biol. Psychiatry.* 2021;6(2):225–237. doi:10.1016/j.bpsc.2020.08.005
30. Wang X, Xie R, Ding W, et al. You hurt me, so I hurt myself and others: how does childhood emotional maltreatment affect adolescent violent behavior and suicidal ideation? *J Interpers Violence.* 2022;37(23–24):NP22647–NP22672. doi:10.1177/08862605211072177
31. Zhinchin G, Shah A. The relationship between NHS performance indicators and suicide rates. *Med Sci Law.* 2013;53(4):223–226. doi:10.1177/0025802413487903
32. Tan L, Yang QH, Chen JL, et al. The potential role of attitudes towards suicide between mental health status and suicidal ideation among Chinese children and adolescents. *Child Care Health Dev.* 2017;43(5):725–732. doi:10.1111/cch.12471
33. Lawrence D, Johnson SE, Mitrou F, Lawn S, Sawyer M. Tobacco smoking and mental disorders in Australian adolescents. *Aust N Z J Psychiatry.* 2022;56(2):164–177. doi:10.1177/00048674211009617
34. Holtes M, Bannink R, Joosten-van ZE, et al. Associations of truancy, perceived school performance, and mental health with alcohol consumption among adolescents. *J Sch Health.* 2015;85(12):852–860. doi:10.1111/josh.12341
35. Cheah YK, Kee CC, Lim KH, Omar MA. Mental health and risk behaviors among secondary school students: a study on ethnic minorities. *Pediatr Neonatol.* 2021;62(6):628–637. doi:10.1016/j.pedneo.2021.05.025
36. Wallace DD, Boynton MH, Lytle LA. Multilevel analysis exploring the links between stress, depression, and sleep problems among two-year college students. *J Am Coll Health.* 2017;65(3):187–196. doi:10.1080/07448481.2016.1269111
37. Miller MB, DiBello AM, Carey KB, Borsari B, Pedersen ER. Insomnia severity as a mediator of the association between mental health symptoms and alcohol use in young adult veterans. *Drug Alcohol Depend.* 2017;177:221–227. doi:10.1016/j.drugalcdep.2017.03.031
38. Roberts RE, Duong HT. The prospective association between sleep deprivation and depression among adolescents. *Sleep.* 2014;37(2):239–244. doi:10.5665/sleep.3388
39. Becker SP, Jarrett MA, Luebbe AM, et al. Sleep in a large, multi-university sample of college students: sleep problem prevalence, sex differences, and mental health correlates. *Sleep Health.* 2018;4(2):174–181. doi:10.1016/j.sleh.2018.01.001
40. Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav Res Methods Instrum Comput.* 2004;36(4):717–731. doi:10.3758/bf03206553
41. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol.* 1986;51(6):1173–1182. doi:10.1037//0022-3514.51.6.1173
42. Yoon D, Yoon S, Pei F, Ploss A. The roles of child maltreatment types and peer relationships on behavior problems in early adolescence. *Child Abuse Negl.* 2021;112:104921. doi:10.1016/j.chiabu.2020.104921
43. DeLay D, Ha T, Van Ryzin M, Winter C, Dishion TJ. Changing friend selection in middle school: a social network analysis of a randomized intervention study designed to prevent adolescent problem behavior. *Prev Sci.* 2016;17(3):285–294. doi:10.1007/s11121-015-0605-4
44. Smith MA. Social learning and addiction. *Behav Brain Res.* 2021;398:112954. doi:10.1016/j.bbr.2020.112954
45. Saunders TJ, Gray CE, Poitras VJ, et al. Combinations of physical activity, sedentary behaviour and sleep: relationships with health indicators in school-aged children and youth. *Appl. Physiol. Nutr. Metab.* 2016;41(6 Suppl 3):S283–S293. doi:10.1139/apnm-2015-0626
46. Shah N, Rao S, Inam S, et al. Healthy lifestyle as a preventive measure against victimization among school-going adolescents. *East Mediterr Health J.* 2019;25(9):604–612. doi:10.26719/emhj.19.007
47. Grasten A, Yli Piipari S. The patterns of moderate to vigorous physical activity and physical education enjoyment through a 2-year school-based program. *J Sch Health.* 2019;89(2):88–98. doi:10.1111/josh.12717
48. Brosnahan J, Steffen LM, Lytle L, Patterson J, Boostrom A. The relation between physical activity and mental health among Hispanic and non-Hispanic white adolescents. *Arch Pediatr Adolesc Med.* 2004;158(8):818–823. doi:10.1001/archpedi.158.8.818
49. Lee SW, Shim JS, Song BM, et al. Comparison of self-reported and accelerometer-assessed measurements of physical activity according to socio-demographic characteristics in Korean adults. *Epidemiol Health.* 2018;40:e2018060. doi:10.4178/epih
50. Mann M, Silver EJ, Stein R. Active Commuting to School, Physical Activity, and Behavior Problems Among Third-Grade Children. *J Sch Health.* 2018;88(10):734–743. doi:10.1111/josh.12677
51. Taliaferro LA, Rienzo BA, Miller DM, Pigg MR, Dodd VJ. Potential mediating pathways through which sports participation relates to reduced risk of suicidal ideation. *Res Q Exerc Sport.* 2010;81(3):328–339. doi:10.1080/02701367.2010.10599681

52. Rhodes RE, Hollman H, Sui W. Family-based physical activity interventions and family functioning: a systematic review. *Fam Process*. 2023;00:1–22. doi:10.1111/famp.12864
53. Silva CS, Mendes R, Godinho C, et al. Predictors of physical activity promotion in clinical practice: a cross-sectional study among medical doctors. *BMC Med Educ*. 2022;22(1):624. doi:10.1186/s12909-022-03686-z
54. Wei C, Li J, Yu C, et al. Deviant peer affiliation and non-suicidal self-injury among Chinese adolescents: depression as a mediator and sensation seeking as a moderator. *Int J Environ Res Public Health*. 2021;18(16):8355. doi:10.3390/ijerph18168355
55. Carlo G, Mestre MV, McGinley MM, et al. The protective role of prosocial behaviors on antisocial behaviors: the mediating effects of deviant peer affiliation. *J Adolesc*. 2014;37(4):359–366. doi:10.1016/j.adolescence.2014.02.009
56. Xu F, Adams SK, Cohen SA, Earp JE, Greaney ML. Relationship between physical activity, screen time, and sleep quantity and quality in US adolescents aged 16(-)19. *Int J Environ Res Public Health*. 2019;16(9):1524. doi:10.3390/ijerph16091524
57. Sori M, Starc G, Borer KT, et al. Associations of objectively assessed sleep and physical activity in 11-year-old children. *Ann Hum Biol*. 2015;42(1):31–37. doi:10.3109/03014460.2014.928367
58. Jackson DB, Vaughn MG. Adolescent health lifestyles and educational risk: findings from the monitoring the future study, 2010–2016. *Am J Prev Med*. 2019;57(4):470–477. doi:10.1016/j.amepre.2019.05.008
59. Chennaoui M, Arnal PJ, Sauvet F, Léger D. Sleep and exercise: a reciprocal issue? *Sleep Med Rev*. 2015;20:59–72. doi:10.1016/j.smrv.2014.06.008
60. Rong-Mao L, You-Wei Y, Xiang-Dong T. A meta-analysis of sleep quality studies with Pittsburgh sleep quality index in young students over the past 15 years in China. *Chin Mental Health J*. 2010;24(11):839–844. doi:10.3969/j.issn.1000-6729.2010.11.010
61. Xiaojing L, Chang L. How do mobile phones hinder teens' sleep? – Empirical research based on national data. *Chin Youth Res*. 2023;(7):26–33. doi:10.19633/j.cnki.11-2579/d.2023.0096
62. Shoemaker EZ, Brenner AM. Making more child and adolescent psychiatrists: responding to the national emergency in mental health in children and adolescents. *Acad Psychiatry*. 2022;46(1):1–5. doi:10.1007/s40596-022-01597-1
63. Zhang J, Yang SX, Wang L, Han LH, Wu XY. The influence of sedentary behaviour on mental health among children and adolescents: a systematic review and meta-analysis of longitudinal studies. *J Affect Disord*. 2022;306:90–114. doi:10.1016/j.jad.2022.03.018
64. Kaku SM, Sibeoni J, Basheer S, et al. Global child and adolescent mental health perspectives: bringing change locally, while thinking globally. *Child Adolesc Psychiatr Ment Health*. 2022;16(1):82. doi:10.1186/s13034-022-00512-8
65. Hosker DK, Elkins RM, Potter MP. Promoting mental health and wellness in youth through physical activity, nutrition, and sleep. *Child Adolesc Psychiatr Clin N Am*. 2019;28(2):171–193. doi:10.1016/j.chc.2018.11.010
66. Gmmash A, Alonazi A, Almaddah M, et al. Influence of an 8-week exercise program on physical, emotional, and mental health in Saudi adolescents: a pilot study. *Medicina*. 2023;59(5):883. doi:10.3390/medicina59050883
67. Kim YS, Park YS, Allegrante JP, et al. Relationship between physical activity and general mental health. *Prev Med*. 2012;55(5):458–463. doi:10.1016/j.ypmed.2012.08.021
68. Chunguang L. The effect and mechanism of physical activity on adolescents' academic performance: an empirical analysis based on the China education longitudinal survey (2014–2015). *Educ Acad Monthly*. 2023;(06):67–74. doi:10.16477/j.cnki.issn1674-2311.2023.06.002
69. Wang P, Wang J, Zhao J, et al. The relationship between physical activity level and depressive symptoms in college students: based on the action path analysis of resting EEG. *J Shanghai Inst Sport*. 2023;47(04):51–60. doi:10.16099/j.sus.2022.07.30.0003
70. Chin MK, Anderson E, de Ridder JH, Uvinha RR, Durstine JL. BRICS to BRICSCESS-A perspective for practical action in the promotion of healthy lifestyles to improve public health in five countries. *J Sport Health Sci*. 2019;8(6):520–523. doi:10.1016/j.jshs.2019.07.008
71. Francis HM, Stevenson RJ, Chambers JR, et al. A brief diet intervention can reduce symptoms of depression in young adults - A randomised controlled trial. *PLoS One*. 2019;14(10):e0222768–e0222768. doi:10.1371/journal.pone.0222768
72. Wickham SR, Amarasekara NA, Bartonicek A, Conner TS. The big three health behaviors and mental health and well-being among young adults: a cross-sectional investigation of sleep, exercise, and diet. *Front Psychol*. 2020;11:579205. doi:10.3389/fpsyg.2020.579205
73. Toussaint L, Gall AJ, Cheadle A, Williams DR. Editor choice: let it rest: sleep and health as positive correlates of forgiveness of others and self-forgiveness. *Psychol Health*. 2020;35(3):302–317. doi:10.1080/08870446.2019.1644335
74. Li X, Li Z, Li Z. The relationship between adolescent social support and aggression: the chain mediating role of self-esteem and self-control. *Psychol Dev Educ*. 2017;33(02):240–248. doi:10.16187/j.cnki.issn1001-4918.2017.02.13

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