

How Does Physical Exercise Affect Academic Performance? The Mediating Role of Non-Cognitive Abilities

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Abstract. Previous studies have found that good physical exercise can promote academic performance, but the underlying mechanism behind this lacks large-scale empirical data. Based on this, we used the 2020 Jiangsu Province academic quality monitoring data to construct an OLS regression. Then, the non-cognitive abilities variable was built with the NEO-FFI Theory, and the mediation effect diagram was drawn through the Amos22.0 software. The study found that: (i) Physical exercise brought academic improvement to elementary and middle school students. (ii) The influence mechanism of physical exercise was different between elementary school and middle school. Students at the elementary school were directly and indirectly affected. (iii) In non-cognitive specific dimensions, openness played a significant and great mediating role.

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Literature Review and Questions

ENHANCING the physique of the national citizen has always been a livelihood issue of the country's focus. As an essential means, physical exercise has been highly valued at different times. Since the launch of "Sunshine Sports" in 2007, the value of physical exercise has been universally recognized. However, the question parents and teachers are more concerned about is if physical exercise can promote the improvement of academic performance and that is still unclear. Physical exercise can strengthen the body, but spend time on physical exercise instead of extracurricular learning, parents will inevitably worry that the physical exercise "occupies" the study time and causes children's academic performance to decline. Especially in the critical stage of entering higher education, many schools will even suspend physical exercise courses and increase academic courses. In recent years, the "quiet large class breaks" have also become a microcosm of the embarrassing position of physical exercise. Physical exercise seems to be "unrelated" to improving academic performance, and there is a general situation of "emphasizing academics and neglecting sports" throughout China. In the embarrassing public opinion, what is the relationship between physical exercise and students' academic performance? High-quality empirical research is urgently needed to find the answer to it. Especially in the context of reducing student's burdens and increasing students' efficiency, what physical exercise can bring to education is related to every student, parent, and educator.

The discussion on the relationship between physical exercise and students' academic performance can be traced back to the 1950s. Based on the sample data of students in third and fifth grades, Gleason et al. (1958) found a weak correlation between physical exercise and students' academic performance. Subsequent studies have mostly adopted experimental research methods and found that physical exercise can promote academic performance to a certain extent. Such studies were often based on physiology or psychology for theoretical construction. From the perspective of Arousal Theory, it was believed that the physical exercise that students engage in could effectively improve their brain's execution level and make them have better task performance. How-

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ever, the control of confounding variables in this kind of study was not comprehensive, and the attributes of a single discipline were evident. Thus, it had failed to achieve the intersection and breakthrough of theories between disciplines.

With the development of measurement technology and the continuous progress of cognitive psychology and neurobiology, the studies on the relationship between physical exercise and the academic performance had become more systematic and mature. On the basis of controlling some of the confounding variables, many researchers have found that students engaging in specific physical exercises can effectively improve their cognitive abilities or academic performance. The value of physical exercise in education quality and fairness has been effectively demonstrated. For example, Fang Liming, based on adolescent samples in the CEPS database, used the PSM method to control the endogeneity of the samples and found that physical exercise can not only improve the academic performance of adolescents but also effectively improve the academic performance of students from economically disadvantaged families and achieve educational equity. Such findings have also been verified in the study of Fang Chao et al. (2021). Quantile regression results found that physical exercise can reduce the difference between high and low quantile students and has a fair value that cannot be ignored. In addition, many researchers based on the sampling of regional samples also found that the frequency or duration of physical exercises of students was highly correlated with academic performance. The meta-analysis results also showed that allowing students to engage in physical exercise is conducive to improved academic performance.

The studies, as mentioned above, have formed two sets of mechanisms of physiology and psychology in terms of the influence mechanism of physical exercise. The former emphasized the “strengthening” of physical exercise and believed that students improve their health through physical exercise and thus improve their academic performance. For example, Zhang et al. (2016) found that physical exercise can improve the quality of sleep of students and improve the academic performance of high school students. The latter focuses on the “mental health” effect of physical exercise. It was believed that physical exercise effectively relieves students’ inner pressure and improves self-efficacy, which in turn enhances classroom performance and promotes academic performance. For example, the study of Zhang et al. (2021) selected peer relationship and self-confidence as the mediating variables and found that physical exercise promoted the improvement of both and thereby improved academic performance. Zhou (2018) used self-esteem as an intermediary variable and found that it played an essential role between physical exercise and academic achievement of college students.

Taken together, the existing research has provided sufficient evidence for the positive effects of physical exercise. However, there are still apparent shortcomings behind these pieces of evidence. On the one hand, the sample size was not enough, and high-quality, large-scale data analysis was still needed to verify this positive effect. On the other hand, many studies were not adequate in controlling confounding variables. They failed to control variables such as family background, which may cause bias in the regression results. In terms of influence mechanism, there may be multiple influence paths between physical exercise and academic performance. Many studies often select a

single intermediary variable. Most of them were psychological or physical variables related to cognitive ability but ignored the non-cognitive abilities highly correlated with students' academic performance. As a concept corresponding to cognitive abilities that emerged during the development of human capital theory, non-cognitive abilities were often regarded as critical abilities in the 21st century (Huang et al., 2017; Xu, 2017). In empirical research, many empirical studies had also selected non-cognitive abilities as the core explanatory variable. However, the theoretical frameworks they were based on are relatively vague. They often defined self-efficacy, peer relationships, and other existences unrelated to cognition in a broad sense as non-cognitive abilities. These concepts did not have the attribute of "ability." Therefore, in terms of mechanism research, the number of existing studies on the mediating variables is insufficient. The theory is not yet systematic, and the exploration of non-cognitive abilities is not comprehensive. Based on this, this study will adopt the more popular NEO-FFI Theory (Neuroticism Extraversion Openness Five Factor Inventory). We subdivided non-cognitive abilities into openness, conscientiousness, extraversion, agreeableness and neuroticism (Costa et al., 1985; Meng, 2003; Wang, 1994). The following questions are verified and discussed by constructing the non-cognitive abilities variable and assuming it as a mediating variable between physical exercise and academic performance.

1. *Can physical exercise improve students' academic performance?*
2. *Can physical exercise promote students' academic performance through non-cognitive abilities?*
3. *Which non-cognitive abilities does physical exercise mainly use to promote students' academic performance?*

Methodology

Research Ideas

This study first verified the relationship between physical exercise and academic performance by constructing a regression model and calculating regression coefficients. Subsequently, intermediary variables are included to explore possible influence mechanisms and demonstrate the vital role of non-cognitive abilities in students' academic performance. Finally, the mediation effect is calculated, and the path coefficient diagram is drawn. The effect size of each path is compared to explore the role of each dimension in the non-cognitive dimension in more detail.

Variable Selection

Core Explanatory Variables

- **Physical Exercise**

Students need to answer the daily physical exercise frequency in this test. They choose from five options: "No", "Less than 1 hour", "1-2 hours", "2-3 hours" and "3-5 hours".

In the elementary school sample, 26.9 percent of students failed to meet the one-hour exercise standard while in the middle school sample this accounted for 41.1 percent.

• **Non-Cognitive Abilities**

This study used the NEO-FFI Theory to subdivide sub-cognitive ability into five dimensions: openness, conscientiousness, extraversion, agreeableness, and neuroticism. Among them, neuroticism is a negative personality, which has been transformed into an upbeat personality. Openness mainly refers to students' ability to accept new things and use methods to solve problems. Conscientiousness primarily refers to the degree of effort that students have to accomplish their goals and whether they persist in the end. Extraversion refers to the enthusiasm and vitality of students, higher extraversion indicates that students have better peer relationships. Agreeableness refers to the ability of students to show altruistic behavior. Finally, neuroticism refers to the power of students to control emotions. Since the above five dimensions are all latent variables, it isn't easy to measure intuitively. Therefore, the five dimensions were all set with 3-4 questions for measurement, and the principal component method was used to fit the score. The elementary school and middle school samples were tested separately. The α indicators of the five dimensions were all in the interval of [0.6, 0.8], indicating that the data has good reliability. In terms of validity, the RMSEA indicators of the five dimensions were all less than 0.07, meaning a good fit, and the CFI and TLI are both greater than 0.9, and the validity is good. More statistics can be found in **Table 1**.

• **Explained Variable**

The academic performance middle school students participating in were divided into Chinese, mathematics, English, biology, geography, and physics; and the elementary school was divided into Chinese, mathematics and English. Considering the academic burden and other reasons, each student in the middle school only tested two subjects and the elementary school only tried one subject. Considering that there are apparent differences between subjects, it is impossible to simply take the subject scores of the students as the total score. Moreover, regression by the subject may cause the lack of a large area of samples. Therefore, after collecting the data, we decided to fit a regression model based on other items in the questionnaire that may be related to the results; and then performed multiple imputations on the results of the test subjects that the sample did not take to generate the general scores. Such methods are often used to deal with large areas of missing values in the sample. After getting the results of each subject, considering that the policies for the high school entrance examination in various regions of Jiangsu Province are different, and the examination methods of biology and geography are also different, the middle school's general scores only used the total scores of Chinese, mathematics, English and physics. In contrast, the elementary school used the total scores of Chinese, mathematics and English. As a result, the average score of all subjects in middle school was 555.22, and the average score of all topics in elementary school was 515.19.

• **Control Variable**

To avoid missing variables cause biased estimation of regression coefficients, this study incorporated students' family background variables, demographic variables, and school background variables into the regression model to control bias. In sociological research, students' stock of family capital can influence students' academic performance through intergenerational inheritance. These capitals cover three forms: economy, culture, and society. In this study, we averaged the number of students' reports about the items owned by student families and used it as proxy variables of economic capital. Students needed to answer the number of particular items (such as televisions, computers, cars, etc.) owned by the family. A total of nine questions were set. In terms of society capital, using the "Chinese Occupation Classification Dictionary (2015)" as a reference, the parents' occupations were assigned, sorted (scores of 1-8) and standardized, and the highest score of the parents was taken as the social capital in the family background. Finally, the parents' academic qualifications represented the cultural capital. First, the parents' academic qualifications were converted into years of education and assigned values of 9, 12, 16, and 19. After standardization, the highest scores of both parents were taken as the cultural capital of the student's family. In addition, the gender of students was 1 for girls and 0 for boys; the only child status was 0 for only children and 1 for non-only children. The school type was 1 for public and 0 for private. The school area was 1 for urban and 0 for rural areas. The specific sample descriptive statistics were shown in **Table 1**.

• **Model Setting**

This research will first conduct descriptive statistics on samples of the fifth and eighth grades in Jiangsu Province, locate the physical exercise situation, and construct an OLS regression model, including core explanatory variables, control variables, and mediation variables to analyze the positive effects of physical exercise and the role of non-cognitive abilities in the impact mechanism. The specific model expression is as follows:

$$Score_i = \beta_0 + \beta_1 Exercise_i + \beta_2 non - cognitive_i + \beta_3 Control_i + \varepsilon_i$$

Among them, $Score_i$ is the average grade of the subject of the i -th student. β_1 is the regression coefficient of the student's physical exercise situation. β_2 is the regression coefficient of students' non-cognitive abilities. β_3 is the regression coefficient of the control variable. Finally, ε_i is the residual of the regression equation.

• **Data Source and Processing**

This study used the 2020 monitoring data of students' academic quality in compulsory education in Jiangsu Province. The project is carried out once every two years. Two-

Table 1. Descriptive Statistics.

Elementary School	Mean	Standard Deviation	Minimum	Maximum
Only Child	0.63	0.48	1.00	2.00
PE Time	2.88	0.80	1.00	5.00
Public School	0.64	0.48	0.00	1.00
Urban	0.87	0.34	0.00	1.00
Female	0.48	0.50	0.00	1.00
Economic Capital	0.03	0.99	-3.04	4.21
Social Capital	0.69	0.29	0.00	1.00
Cultural Capital	0.49	0.33	0.00	1.00
Openness	0.03	1.00	-4.19	0.80
Responsibility	0.04	0.98	-3.88	0.89
Extraversion	0.01	1.00	-4.26	0.79
Pleasant	0.05	0.97	-4.55	0.71
Neuroticism	0.03	0.98	-3.41	0.84
Middle School	Mean	Standard Deviation	Minimum	Maximum
Only Child	0.55	0.50	1.00	2.00
PE Time	2.62	0.66	1.00	5.00
Public School	0.86	0.35	0.00	1.00
Urban	0.66	0.47	0.00	1.00
Female	0.47	0.50	0.00	1.00
Economic Capital	0.57	0.10	0.25	1.00
Social Capital	0.60	0.29	0.00	1.00
Cultural Capital	0.31	0.30	0.00	1.00
Openness	0.00	1.00	-3.39	1.16
Responsibility	0.01	1.00	-2.87	1.49
Extraversion	-0.01	1.00	-3.33	1.38
Pleasant	0.04	0.94	-4.00	0.98
Neuroticism	-0.01	0.99	-2.41	1.38

stage stratified sampling was used to conduct a sample survey of students, teachers, and school leaders in 13 cities in Jiangsu Province. Among them, a sample of students was randomly selected from the sampled schools, and a total of 213,334 questionnaires for fifth-grade students and 147,432 questionnaires for ninth-grade students were collected. After deleting the samples that failed the polygraph test and missing important information, a total of 156,657 valid elementary school questionnaires and 127,738 useful student questionnaires from middle school were obtained.

Results

Regression Analysis Result of Physical Exercise

In this study, students' average scores were selected as dependent variables, and model 1, model 2, model 3, and model 4 were constructed respectively. Model 1 only incorpo-

Table 2. OLS Regression Results.

	Model 1	Model 2	Model 3	Model 4		
Elementary School	(Constant)	484.50*** (0.548)	509.99*** (0.786)	501.13*** (0.867)	520.70*** (0.893)	
	Physical Exercise	10.78*** (0.184)	10.14*** (0.176)	8.69*** (0.176)	3.47*** (0.185)	
	Non-Only Child		-23.48*** (0.302)	-20.74*** (0.303)	-19.81*** (0.305)	
	Public School		-2.07*** (0.307)	1.29*** (0.314)	0.75 (0.318)	
	Urban		19.32*** (0.534)	13.87*** (0.529)	12.33*** (0.535)	
	Female		8.24*** (0.287)	6.71*** (0.285)	4.19*** (0.289)	
	Economic Capital			11.49*** (0.154)	10.29*** (0.156)	
	Social Capital			8.06*** (0.545)	6.79*** (0.553)	
	Cultural Capital			11.06*** (0.498)	9.51*** (0.505)	
	Openness				10.34*** (0.242)	
	Responsibility				4.17*** (0.229)	
	Extraversion				-0.21 (0.245)	
	Pleasant				5.76*** (0.213)	
	Neuroticism				0.22 (0.188)	
	R ²	0.03	0.11	0.17	0.27	
	F	3431.12	3236.64	3149.63	2832.05	
	Middle School	(Constant)	503.42*** (0.833)	545.11*** (1.032)	466.53*** (1.534)	497.41*** (1.533)
		Physical Exercise	4.51*** (0.309)	3.70*** (0.296)	3.50*** (0.292)	-3.58*** (0.296)
		Non-Only Child		-20.90*** (0.396)	-13.41*** (0.398)	-12.42*** (0.39)
		Public School		-33.70*** (0.56)	-24.22*** (0.556)	-19.99*** (0.544)
		City		20.07*** (0.418)	10.62*** (0.423)	10.14*** (0.416)
		Female		16.87*** (0.391)	14.81*** (0.384)	10.97*** (0.385)
		Economic Capital			81.31*** (2.168)	59.93*** (2.129)
		Social Capital			12.26***	11.28***

			(0.816)	(0.801)
Cultural Capital			44.22***	36.71***
			(0.807)	(0.793)
Openness				27.95***
				(0.303)
Responsibility				9.27***
				(0.284)
Extraversion				-10.49***
				(0.325)
Pleasant				4.44***
				(0.319)
Neuroticism				-7.23***
				(0.23)
R ²	0.002	0.09	0.16	0.29
F	213.088	2288.96	2653.349	3159.02

Note: () is the standard error of the coefficient; * represents the significance level, where * is $P < 0.1$, ** is $P < 0.05$, *** is $P < 0.01$.

rated physical exercise variables; models 2 and 3 incorporated background control variables to estimate the positive effects of physical exercise; model 4 incorporated non-cognitive abilities variables to build a full model, analyzed the positive impact, and initially discuss the impact mechanism of physical exercise. Before regression, the white collinearity test was performed on the sample data. There was no collinearity problem between the variables, and there was no obvious heteroscedasticity. The regression coefficients and standard errors of the samples are shown in **Table 2**.

From the results in **Table 2**, physical exercise had different effects in elementary schools and middle schools. In models 1-3, physical exercises all positively predicted the academic performance of elementary and middle school students. As the model variables increased, the regression coefficients decreased. The regression coefficient in the elementary school sample was always positive; in the middle school sample, after adding non-cognitive variables, the student's academic performance was significantly negatively predicted by the physical exercise, the regression coefficient was -3.60, and the significance level reached 0.01. On the whole, regardless of whether there was a mediating effect, the positive impact of physical exercise existed in the elementary school stage. However, after controlling the influence of background variables and non-cognitive abilities in the middle school stage, the positive effect of physical exercise turned into an "inhibition" effect. Each time a student's physical exercise time was increased by one unit, their academic performance dropped by 3.60 points instead.

Regression Analysis Results of Non-Cognitive Abilities

In addition to the high correlation between physical exercise and students' academic performance, this research also demonstrated the high correlation between non-cognitive abilities and academic performance. First of all, from model 4 of the elementary school and middle school samples, we found that the three dimensions of openness,

conscientiousness and agreeableness all positively and significantly predicted students' academic performance, which was consistent with the results of foreign empirical research. The effect sizes of the three dimensions were further calculated. In the elementary school sample, the effect sizes of the three dimensions were 0.195, 0.076 and 0.104, respectively, while the middle school sample were 0.379, 0.129 and 0.056, respectively. The above results showed that non-cognitive abilities could help students improve their academic performance. In its interior, the effects of each personality trait were different in different stages, but the openness was always in a higher position. That means students who is enthusiastic about new things and willing to challenge often promotes academic performance the most.

Regression Analysis Results of Other Variables

In terms of background variables, while controlling for the influence of other variables, the results of all models showed that students with non-only-child status had lower academic performance than students with only-child status. This may be because only-child families often have more investment space for students' academic or non-academic tutoring. In addition, the academic performance of urban students was higher than that of rural students, and the regression coefficient interval was located in [9.53, 19.99], indicating that the issue of regional education equity needs to be improved. Previous studies had agreed that a good family background would improve students' academic performance. In this study, the higher the stock of economic, social, and cultural capital of a student's family, the higher their academic performance would be, consistent with previous research results.

Analysis of the Impact Mechanism of Physical Exercise

From the regression coefficients of model 1 to model 4, the coefficient of physical exercise gradually decreased, especially after adding the five dimensions of non-cognitive abilities; the coefficients of elementary school and middle school decreased significantly, which preliminarily explained mediating effect statistically. In order to visually present the role of each non-cognitive dimension in the influence mechanism, amos22.0 software was used to construct an intermediary model to draw a path diagram. The regression path diagram is shown in **Figure 1**.

From the path diagram of the elementary school sample, the five non-cognitive dimensions would be significantly positively predicted by the physical exercise, and the regression coefficients were similar. All were significant at the level of 0.01, indicating that physical exercise can effectively shape all aspects of personality traits. The second half of the path was significant at the 0.01 level. The mediation effect calculation showed that the mediation effect of openness, conscientiousness, and agreeableness was more prominent, which were 28.43%, 10.95%, and 14.00%, respectively.

But unlike elementary schools, there were certain differences in the effects of physical exercise on the five non-cognitive dimensions in the middle school samples. **Figure 2** showed that in terms of regression coefficients, the entire five dimensions

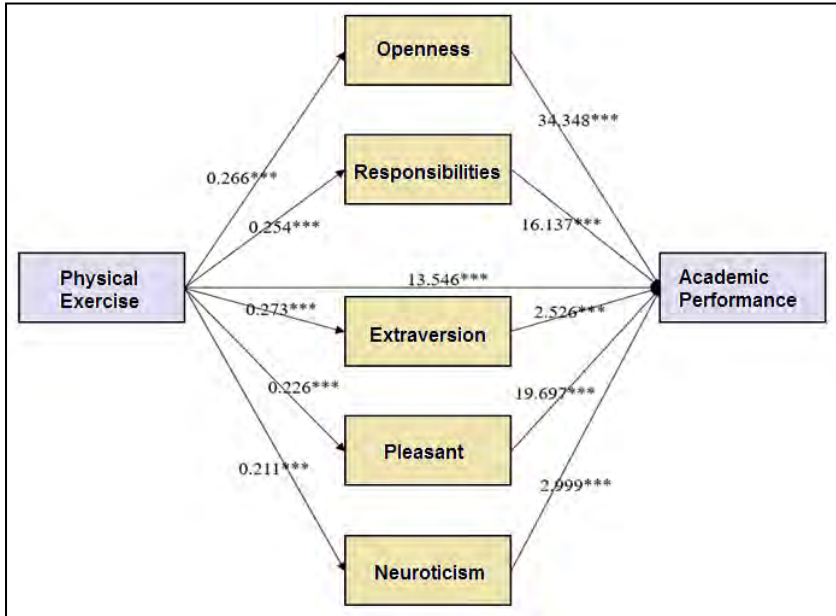


Figure 1. Elementary School Stage Road Map.

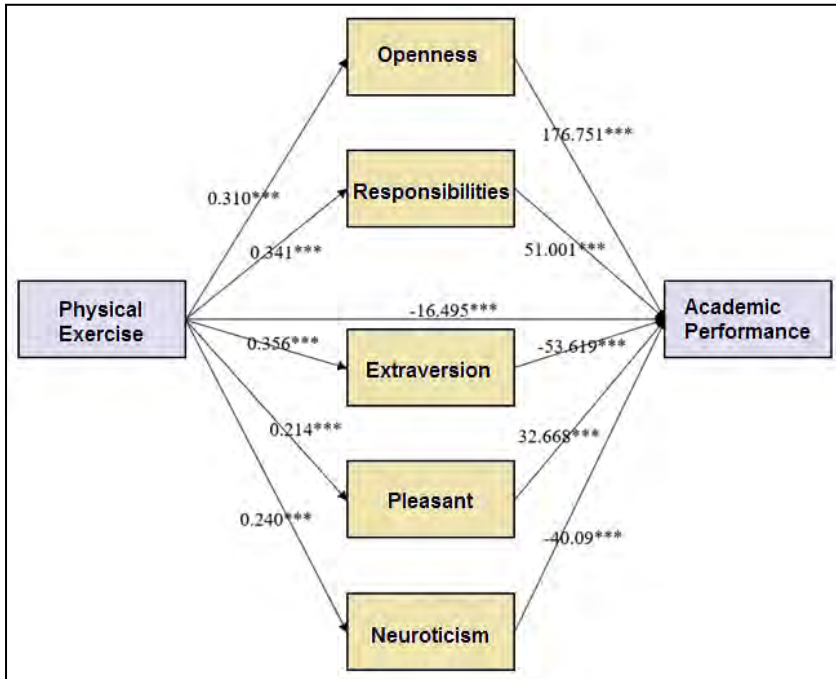


Figure 2. Middle School Stage Road Map.

could be affected by physical exercises, which were all significant at the level of 0.01. In the second half of the path, the entire dimension could predict academic performance while the extraversion and the neuroticism predict negatively. Among them the openness could predict academic performance much more strongly than other dimensions. After calculating the mediation effect, the mediation effect of the openness was the largest, reaching 41.17%, second of which is extroversion, only reach 13.52%. Conscientiousness, agreeableness and neuroticism were 12.45, 6.44% and 8.61%, respectively. Moreover, the direct effect is negative. The above results showed that students at the elementary school could directly improve academic performance through physical exercise and could also indirectly improve academic performance to a greater extent by shaping the personality traits of openness, conscientiousness, and agreeableness. Through shaping extraversion and neuroticism personality, physical exercise could indirectly promote academic performance to a lesser degree. However, middle school students are under the burden of academic burden, the relationship between academic performance and physical exercise was very delicate. On the one hand, physical exercise did not directly promote the improvement of academic performance. On the other hand, physical exercise could greatly indirectly promote academic performance by shaping openness personality whose mediating effect was more significant than the direct effect of physical exercise.

Discussion

Physical Exercise Can Directly or Indirectly Promote the Improvement of Academic Performance

“Sports have the power to change the world.” However, physical fitness is just the tip of the iceberg of the value of physical exercise. In the regression and mediating effect analysis of this study, physical exercise, whether in the elementary school sample or the middle school sample, was found to directly or indirectly improve academic performance. In the elementary school sample, physical exercise could reduce the burden and increase adolescents’ academic work efficiency and alleviate the educational equity brought about by the differences in students’ family backgrounds. This was consistent with the early research results of Yin et al. (2014), focusing on the positive effects of long-term physical exercise. However, we have again demonstrated this view under the influence of other variables under better control. In addition, this study also found that the direct effect of physical exercise in middle school samples is negative, which is contrary to the conclusions of many studies (Fang, 2020; Fang et al., 2021; Lu et al., 2014). The reason is that, on the one hand, we believe that this research has selected more intermediate variables and brought the variable of non-cognitive abilities into the regression model. This effectively stripped off the effect of physical exercise statistically and obtained more accurate coefficients (Wen et al., 2004; Wen et al., 2014).

On the other hand, in theory, middle school students and elementary school students have differences in psychology, physiology, and cognition, or there may be

two different influence mechanisms. This ultimately led to the fact that physical exercise cannot directly promote students' academic performance among middle school students. However, the mediating effect of non-cognitive abilities allows physical exercise to improve students' academic performance indirectly. Therefore, physical exercise seems to "squeeze" students' academic time but the relationship between academic time and performance is not linear (Shen, 2014; Zou & Tan, 2013). Therefore, finding the best advantages of academic time and proper planning of time investment can maximize the marginal effect of academic time and effectively exert the positive impact of physical exercise. Therefore, the concept of family education should shift from the original "focusing on academics and neglecting sports" to "grasp both academics and sports"; to achieve mutual complement, reduce burdens and increase efficiency.

Differences Exist in the Impact Mechanism of Physical Exercise between Elementary School and Middle School.

As mentioned above, middle school and elementary school may have two different influence mechanisms. The academic performance of elementary school students is directly and positively promoted by physical exercise and can be positively promoted by physical exercise through the five non-cognitive dimensions. On the other hand, the improvement of the academic performance of middle school students depends on physical exercise through the indirect effects of openness and agreeableness. Research on the role of non-cognitive abilities in the influence mechanism of physical exercise is scarce in China. The only study that failed to consider the multidimensional and complex concept of non-cognitive abilities, instead of using a single variable, the results obtained are not robust (Dong et al., 2020). This study built the dimension of non-cognitive abilities based on the NEO-FFT Theory and deeply analyzed the role of each sub-dimension in the influence mechanism. Middle school students rely on indirect effects, and we believed it might be that middle school students have higher non-cognitive abilities than elementary school students. Previous studies found that students of different ages have significant differences in the scores of the five dimensions (Nie et al., 2011), which made the marginal effect of physical exercise on non-cognitive abilities decline. Therefore, the promotion of academic performance will not be as apparent as the elementary school stage. But on the whole, there is a very high correlation between physical exercise and non-cognitive abilities. Physical exercise effectively shapes students' positive personality, helps students accept new things and better restraint ability, and finally, through these abilities, effectively promotes academic performance.

Open Personality Traits Play a Key Role

The immense theoretical contribution of this research is to compare the effects of the five dimensions of non-cognitive abilities rather than simply discussing whether non-cognitive skills play a role. At present, the academic circle is still inconclusive as to

which dimension of the five personality can effectively promote the improvement of academic performance. Under the premise of the independent variable of physical exercise, this study found that the mediating effect of openness personality is the greatest. This can show that physical exercise can help shape students' openness personalities and it also shows that students with more assertive openness personalities are more likely to exert the positive effects of physical exercise. Students with strong openness personalities can often use "wisdom" to summarize their behavior (Liu, 2001), and they are willing to actively seek solutions to problems and win external support (An, 2017). Specifically, in this study, students with open personality traits are less afraid of difficulties, have higher expectations of themselves, and can effectively use the learning methods learned in the classroom. These positive behaviors can effectively promote the improvement of academic performance. In physical exercises, especially in competitive sports activities, students have ample opportunities and possibilities to try new methods while striving to achieve competitive goals and develop a behavioral pattern that uses new methods rationally and is not afraid of difficulties. This experience will also be transferred to classroom learning to help them no longer be fearful of the challenges in the classroom learning so that they can communicate with teachers and parents, seek methodological support, and ultimately achieve the improvement of academic performance. In other words, physical exercise can improve academic performance because it has the effect of enhancing students' classroom performance, such as enhancing attention, which is consistent with the conclusions reached by some foreign studies (Grieco, 2009; Mahar et al., 2006).

Study Limitation and Perspective

This study demonstrated the positive effects of physical exercise and analyzed the mediating impact of non-cognitive abilities with the help of the NEO-FFI Theory. In response to the three problems established in the study, the following conclusions are drawn: physical exercise positively can improve students' academic performance. Furthermore, this positive effect is achieved by physical exercise through non-cognitive abilities. Among them, the openness personalities shaped by physical exercise are the most important. But this study still has limitations.

Firstly, the measurement of NEO-FFI Theory is incomplete compared with the measurement in psychological research and includes fewer questions. Secondly, the physical exercise variable is set as a level variable, not a continuous variable that can characterize the duration, which may make the research results miss some valuable findings, such as the optimal interval and nonlinear relationship of physical exercise. Thirdly, the direct effect in the middle school sample was negative, which is somewhat contradictory to previous studies. In addition to the mediating effect of non-cognition, we believe endogeneity is what makes this happen and some matching methods should be used in later studies.

Conclusion and Suggestion

Change Ideas, and Promote the Development of both Academics and Sports

Health and education are both essential components of human capital, and the two should be equally important. This study verified the positive effects of physical exercise. Educators need to realize that physical exercise has a role that other academic investments cannot replace as a health investment. Therefore, we should abandon the educational concept of “emphasizing academics over sports,” leaving enough time for students’ physical exercises and providing necessary support. Parents can regularly participate in physical conditioning with their children, enhancing the parent-child relationship and improving their academic performance. Teachers can use sports activities or competitions to cultivate children’s competitive spirit to develop positive behavior patterns and personality qualities and thus have better classroom performance.

Pay Attention to Non-Cognitive Abilities and Open the “Black Box” of Physical Exercise

This research has discovered the mediating role of non-cognitive abilities in the influence of physical exercise, which shows that in the black box of physical exercise and academic performance, previous studies have indeed overlooked some key variables. As a critical skill, non-cognitive abilities will be one of the core qualities of future students. Therefore, all educators and researchers should integrate students’ non-cognitive abilities into scientific research and classroom teaching and strive to find efficient and quick ways to improve non-cognitive abilities.

Pay Attention to the Cultivation of Openness Personality and Realize Efficient Classroom Learning

Open personality was found to play an essential role in the influence mechanism of physical exercise in this study, and it has a considerable effect on academic performance. Therefore, in daily family education, parents should attach importance to communication with their children and allow children to be open to competition and difficulties. Teachers should “teach students how to fish, not just give fish.” It is necessary to emphasize the importance of methods and let students develop the habit of using strategies to learn knowledge, which improves classroom efficiency and benefits students’ long-term development.

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