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ORIGINAL

AN EMPIRICAL ANALYSIS OF THE EFFECT OF PHYSICAL EXERCISE ON THE MENTAL HEALTH OF ADOLESCENTS AND ITS MEDIATING MECHANISM.

Lu Ying Jie*, Ma Hong Tao, Leng Chao Li

Beijing Sport University, Haidian, Beijing, 100084, China.
E-mail: luyingjie@bsu.edu.cn

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ABSTRACT

As we all know, the rich and splendid world culture contains a series of cultures of "life lies in sports". The thinker Voltaire once put forward the world-famous sports philosophy of "life in sports". Without a healthy body, nothing will go smoothly and successfully. Adolescents are the hope and future of the country, so it is necessary to cultivate the correct belief in physical health and develop good habits of physical exercise. Physical exercise has a positive intervention effect on improving the mental health of adolescents, but there has been debate on the effect of physical exercise time on mental health. This paper specifically uses the multi-layer linear model analysis method to analyze the impact of physical exercise on the mental health of adolescents, and uses the KHB mediation effect model to test the existing mediation mechanism with the construction of the structural equation. The experimental results show that the direct efficiency of adolescents' mental health level is 0.009, the indirect effect is 0.034, and the contribution rate of the indirect effect is 89%. Compared with other models, it shows that the model has a certain theoretical level and use value.

KEYWORDS: Physical Exercise; Adolescent Mental Health; Mediating Mechanism

1. INTRODUCTION

Without a healthy body, nothing will go smoothly and successfully. Adolescents are the hope and future of the country, so it is necessary to cultivate the correct belief in physical health and develop good habits of

physical exercise. Physical exercise has a positive intervention effect on improving the mental health of adolescents, but there has been debate on the effect of physical exercise time on mental health (Giménez-Meseguer & Tortosa-Martínez, 2021). Education and health are important components of individual human capital, and adolescence is a key stage of human capital accumulation. In the long-term development of exam-oriented education, school teaching mostly revolves around the "baton" of further education. Academic performance and physical activity are in an unbalanced and contradictory relationship (Silaban, Saepudin, & Adiwijaya, 2013).

Cultural courses have always played a dominant role in school teaching content. The school, parents and students are worried that the investment in non-cultural courses will affect their academic performance, thus compressing students' physical exercise time and causing problems such as a decline in students' physical quality. The cause of mental health started relatively late, but mental health issues have always received widespread attention from the society (Lee et al., 2014). Surveys show that young people are at high risk of mental health problems, both at home and abroad, with the incidence of psychological problems ranging from 10% to 30%. The current mental health problems of Chinese teenagers are not optimistic. "Research on adolescent mental health in recent years shows that 22.3% of school adolescents have obvious psychological problems, and the trend continues to rise" (TL, 2017). Nowadays, sports have played an increasingly important role in our daily life, and many scholars have begun to study the effect of physical exercise on mental health. Previously, many experts and scholars at home and abroad have begun to study the relationship between physical exercise and mental health. The research results show that physical exercise can not only promote the development of people's physical fitness, make people happy, but also improve participants' self-efficacy and mental health (Ford et al., 2018). Whether students participate in physical exercise or not, the time of participating in physical exercise, the frequency of physical exercise, and the load of exercise are closely related to the mental health of students (Cherfan, Avgerinos, & Chaer, 2020; Rodero-Cosano et al., 2016).

As we all know, the rich and splendid world culture contains a series of cultures of "life lies in sports". Aristotle, the sage of ancient Greek philosophy, believed that long-term absence of exercise activities is the most likely to cause human body function failure, thereby damaging health. Hua Tuo, a famous ancient Chinese doctor, created the "Five Animals Opera" from the daily activities of animals, and it has been passed down to this day. The creation of "Wu Qin Xi" has provided great help for the exercise activities of middle-aged and elderly people (Tariq, Reid, & Chan, 2021). In the long history of culture, scholars like Hua Tuo who believe that exercise is good for health abound. The famous sayings of ancient and modern Chinese and foreign celebrities, "A body is strong when one moves," and "the concept of proper exercise" jointly explain

the truth that "life lies in exercise, exercise is good for health", which is a valuable experience summed up by human beings in the process of continuous development and evolution of human beings (Nicholls, Taylor, & Sean, 2016). The 21st century is an era of great health. People pay more attention to physical health and constantly pursue comprehensive physical, psychological, social and environmental health. For adolescents, reasonable physical exercise can promote the material and energy metabolism of nerve cells, and enhance the command and regulation ability of the nervous system, thereby promoting the improvement of mental health (Nkansah-Amankra & Walker, 2012).

In addition, a certain amount of aerobic physical exercise can also promote the secretion of a chemical substance with the effect of morphine in the brain - endomorphine. It relieves pain and gives a feeling of euphoria. This euphoria caused by endomorphine can effectively reduce anxiety and other negative emotions, it can improve people's spirits and help to form a good psychological quality (Hutton, Nyholm, Nygren, & Svedberg, 2013). Therefore, targeted physical exercise is an effective training method to correct psychological defects and cultivate healthy personality of young people. This paper specifically uses the multi-layer linear model analysis method to analyze the impact of physical exercise on the mental health of adolescents, and builds a structural equation model to test the existence of the mediating mechanism. Compared with other models, it reflects that the model has certain theoretical level and use value (Thuy-My, Saissan, Kilian, Prakash, & Raffi, 2020).

This paper makes an empirical analysis on the influence of physical exercise on teenagers' mental health level and its intermediary mechanism. The innovations of this paper are as follows:

(1) Innovation in topic selection, combining physical exercise with the mental health of "adolescent" students, enriching the traditional theoretical system of mental health; Through the empirical analysis of the influence of mental health level and its intermediary mechanism, it shows the importance of physical exercise to adolescents' mental health and promotes their healthy growth.

(2) Most scholars usually use periodic rhythm index, psychological activity intensity, oaxaca decomposition method and regression model to study the factors that affect adolescent health. In this paper, the multi-level linear model is used for analysis, and the influence of variables among different levels on the whole can also be analyzed.

Starting from physical exercise, this paper makes an in-depth analysis on the influence of adolescents' mental health level and its intermediary mechanism by means of multi-layer model analysis. The structure is as follows: The first chapter is the introduction. This part mainly expounds the research

background and significance of the influence of physical exercise on teenagers' mental health level, and puts forward the research purpose, methods and innovation of this paper. The second chapter is a summary of relevant literature, summarizing its advantages and disadvantages, and putting forward the research ideas of this paper. The third chapter is the method part, focusing on the research on the influence of physical exercise on teenagers' mental health level and its intermediary mechanism based on multilayer linear model analysis. The fourth chapter is the experimental analysis. In this part, experiments are carried out on data sets to analyze the performance of the model.

2. Related Work

As teenagers' mental health level is paid more and more attention by social groups, many scholars have carried out a lot of research on how physical exercise affects teenagers' mental health level and what kind of intermediary mechanism exists in it, and a number of related research literatures have emerged for this research.

Bulley B refers to mental health as mental health, which includes two meanings: one is the state of mental health. When an individual is in this state, he is not only in good condition, but also in harmony with the society. 2 refers to the principles and measures to maintain mental health and reduce behavioral problems and mental illness (Bulley, Ram, & Nelson, 2021). Mai Huawen believes that mental health emphasizes the internal coordination of individuals and their adaptation to the external environment(Mai Huawen, Jin Jie, & Wang Si, 2018). It refers to good individual psychological traits and stable emotional performance formed on the basis of normal intelligence and is a good state that can effectively handle internal and external relations. Kim Y S, Park Y S and others measured the subjects after exercise, and found that their state anxiety, depression, nervousness and psychological disorder were significantly reduced, and their energy and happiness were significantly improved (Kim et al., 2012).

Regular teenagers engaged in moderate intensity and maximum heart rate, and exercising for a period of time at a time was helpful to improve their mood. Teenagers are in a golden age, so they should not be held back by their physical health. Therefore, they should take active physical exercise and develop good physical exercise habits. Teenagers should not only do some necessary physical exercises in the physical classroom, but also start from daily life, arrange physical exercises reasonably according to their own physical conditions, and remind themselves with the belief of physical health that they should not give up physical exercises easily and have a healthy physique (Jackson Foster et al., 2015). After reviewing the previous published research papers, Foulds H pointed out that people who regularly engage in physical exercise have less physiological stress than those who are used to sitting.

People who regularly take part in sports are more likely to form good interpersonal relationships with others (Foulds H, Bredin S, & Charlesworth S A, 2014). Paul, Moran and others pointed out that high-intensity physical exercise. Increasing the maximum oxygen uptake can reduce stress (Paul, 2016). And games have psychological health care values such as inspiring creativity, relieving tension, maintaining friendship and making people optimistic. By analyzing the influence of different mental health conditions on their physical quality, this paper demonstrates the relationship between mental health and physical quality, and on this basis, puts forward some teaching reform ideas and measures to strengthen students' mental health education and improve their physical quality, such as adopting recreational teaching methods, treating them differently, and persisting in collective activities.

Walls E research found that college students are under increasing pressure, their physical and mental health problems are becoming more and more prominent, and the incidence of mental disorders and mental diseases is rapidly increasing (Walls, Richmond, & Blood, 2012). Therefore, how to improve and cultivate students' mental health has become the main content of current research. Sports is not only a process of physical activity, but also a process of psychological activity. Adopting the method of after-school physical exercise can effectively promote the mental health of college students, and the effect is better than that of general physical exercise. The form of after-school physical exercise has a good regulating effect on many mental health factors. Kang K D, Sujin B and others show that teenagers should not only pay attention to the changes of their physical functions, but also their own psychological characteristics, such as the supervision and evaluation of general self-efficacy, young people's attitude, and the feedback of related evaluation results, so that they can adjust their exercise amount in time, and then achieve the purpose of improving exercisers' executive function and strengthening their physical and mental health growth (Kang et al., 2017).

Judging from the representative research literature listed above, the current research literature is concise and concise, and often puts forward the core viewpoints and main conclusions and measures from the outset on the basis of proper analysis. Although there is no lack of insight in this view, and its conclusions and measures are often quite operable, the above-mentioned literature also has the characteristics of being too theoretical. However, there are few empirical studies on the influence of physical exercise on adolescents' mental health level and its intermediary mechanism. Therefore, it is necessary to construct a multi-level analysis model to analyze and study this content, which will further explore and develop such studies in the future. Aiming at how physical exercise affects teenagers' mental health, this paper constructs a multilayer linear analysis model, and demonstrates the relationship between teenagers' mental health level and its intermediary mechanism from the

perspective of the model, and makes a scientific and rigorous statement, which will more clearly demonstrate the effectiveness of this kind of research.

3. Methodology

3.1 Overview of Adolescent Mental Health

Health is the foundation of human life, it is not only related to human development and social progress, but also to everyone's own happiness and success. People's understanding of health is a continuously deepening process, and people's understanding of health is not the same in different periods. The concept of health has different connotations and extensions in different countries and different historical periods, and so far there is no consistent concept. definition.

Mental health is a very complex concept, which involves medical phenomena, psychological phenomena and social imagination. Scholars from different disciplines have different perspectives and views on mental health. Mental health can be divided into three states according to its health. One is the normal state, called the normal state. The second is the imbalanced state, which means that the individual's psychology is in a state of anxiety, fear, depression, worry, contradiction, and stress. The third is unhealthy state, which includes neurosis, personality disorder, psychosexual disorder, schizophrenia and so on.

The characteristics of mental health have four aspects: 1. Normal intelligence; 2. Good social adaptability; 3. Sound personality; 4. Stable emotions (Song, 2016). Intelligence is the synthesis of people's attention, observation, memory, imagination, thinking and practical ability, and it is the performance of the overall function of brain activity, rather than a single psychological component. Have the ability to adapt to various natural environments, and achieve a harmonious state of harmony with the objective environment by constantly adjusting their psychological behavior and physical and mental functions. A healthy personality refers to the balanced and healthy development of various elements that constitute a personality, such as temperament, ability, and character.

Maintaining a stable state of mind is an important criterion for measuring whether a person is psychologically mature and healthy. How to educate adolescents with psychological imbalance, physical exercise through school sports is the main way for adolescents to exercise. The mental health quality of adolescents is some internal and relatively stable psychological qualities formed by adolescents under the combined action of heredity and environment, and these psychological qualities affect the mental health of adolescents. The classification and performance characteristics of common psychological

problems in adolescents are shown in Figure 1.

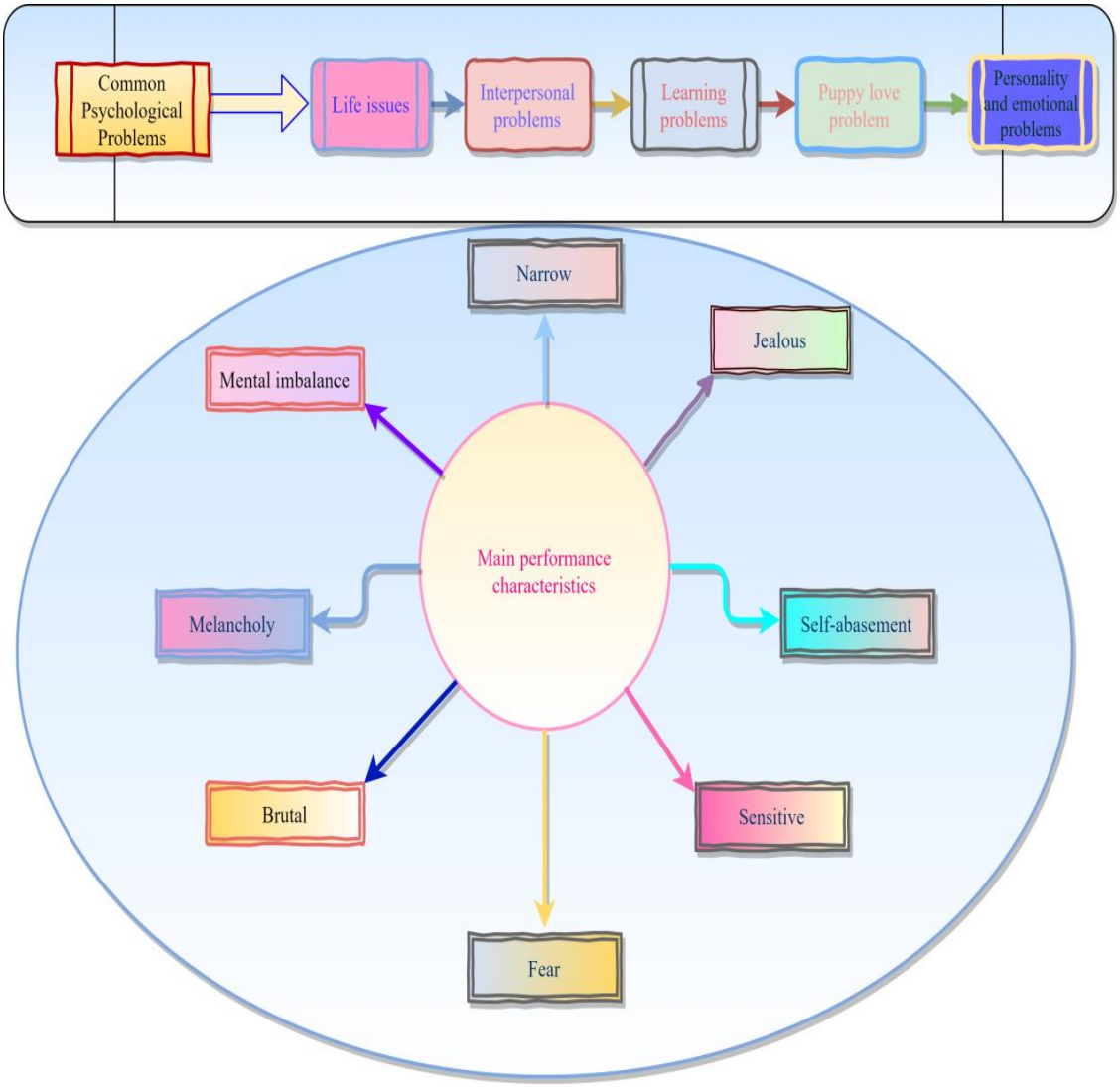

Figure 1: Classification and performance characteristics of common psychological problems in adolescents

Interpersonal quality and psychological adaptation, as two important factors of youth's mental health quality, are of great significance to the healthy development of youth. A person who realizes himself and gives full play to his own nature is a mentally healthy person, that is, the full realization of all human potential and the continuous growth and change of the human being. The so-called mental health not only refers to physical health, no disease and defect, but more importantly, it emphasizes an inner positive and healthy state of mind, effectively regulates one's emotions, and better adapts to the social environment.

In daily life, people's psychology is in a healthy state, not affected by negative emotions, maintain a positive and optimistic attitude, and conduct research and study on people's psychology (Graff & Ralph, 2014). The mental

health of adolescents is affected by a combination of factors. According to most researches, it is found that among the many factors affecting the mental health of adolescents, there are not only internal factors such as personal physiology and psychology, but also external factors such as adverse factors in the social environment. Internal factors, that is, psychological factors, are the main factors leading to student suicide. External factors, namely social factors, are complex and multifaceted. It is a sustained and healthy psychological state with positive inner experience and good social adaptation. Stable emotions are individuals who still maintain a stable state of mind after encountering a certain stimulus response. Good social adaptability can help people improve anxiety, anxiety and other negative emotions, and promote people's comprehensive and harmonious development (Azar, Reuveny, Yalon, Koren, & Constantini, 2013).

Adolescents are in adolescence and emotionally unstable. The quality of psychological adaptability directly affects young people's emotions about study, life and interpersonal communication. With the increasingly fierce competition in learning, academic pressure has seriously affected the mental health of adolescents. Depending on the type and duration of stressors, the effects of academic stress on adolescents' mental health may be mild disturbances, or may induce psychological disorders and lead to sub-health.

3.2 The effect of physical exercise on the mental health of adolescents and its mediating mechanism

As a new way of life and attitude towards life, physical exercise is gradually accepted by everyone. Physical exercise not only enhances people's physical and mental health, but also plays a vital role in strengthening the construction of socialist spiritual civilization. If you want to have a healthy physique, you must have the behavioral intention of physical exercise, persist in it for a long time, and develop the behavioral habit of physical exercise, all of which are inseparable from the support of the belief of physical health. Only with the belief of physical health can we have the motivation to persist in physical exercise behavior and behavior habits, so that teenagers can overcome all kinds of difficulties and become all-round development talents.

Physical exercise generally refers to physical exercise and the use of air, sunlight, water and other natural factors to improve health and improve people's adaptability to the external environment. If the purpose of physical exercise is divided into: (1) to strengthen physical fitness; (2) for the purpose of recreation and psychological adjustment; (3) To improve physical function and quality; (4) for the purpose of fitness and entertainment; (5) Pursue physical beauty; (6) for the purpose of enriching cultural life and emotional communication; (7) for the purpose of antagonism and non-resistance; (8) For the purpose of rehabilitation and auxiliary medical care. The relationship between physical exercise and mental health adaptability is shown in Figure 2.

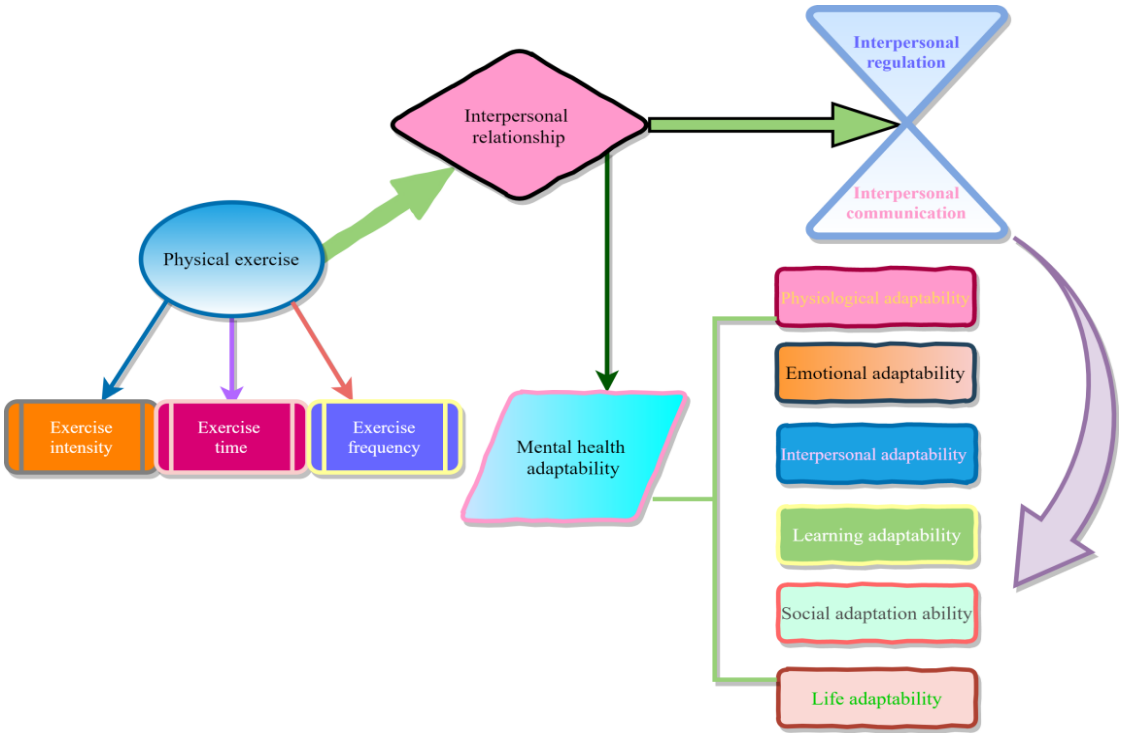

Figure 2: The relationship between physical exercise and mental health resilience

The mental health quality of adolescents is some internal and relatively stable psychological qualities formed by adolescents under the combined action of heredity and environment, and these psychological qualities affect the mental health of adolescents. Interpersonal quality and psychological adaptation, as two important factors of youth's mental health quality, are of great significance to the healthy development of youth. In order to better improve the interpersonal quality and psychological adaptability of adolescents, based on the psychological benefits of physical exercise on people, physical exercise can be used as a means to affect the interpersonal quality and psychological adaptation of adolescents. Physical exercise is a good means to improve people's interpersonal communication ability, enhance cooperation ability, and regulate bad emotions. Famous scholars Slav and Mai Yini believe that physical exercise can have the following effects on mental health: (1) generate a sense of security and spontaneity; (2) improve independence; (3) eliminate tension; (4) improve values; (5)) can help form friendships and increase prestige. Physical exercise refers to various forms of activities related to cardiorespiratory function, muscle strength and endurance, flexibility and body composition, etc. It usually refers to those planned, regular, and repetitive activities to develop the body, improve health, and enhance physical fitness. Purposeful physical activity, such as jogging, lifting weights, kicking a ball, etc.

3.3 Constructing an empirical analysis model based on the effect of physical exercise on the health level of adolescents

In relaxed and independent sports activities, students can enjoy the fun

of physical exercise. At the same time, it has a positive effect on the control and regulation of students' negative emotions such as anxiety and depression. The belief in physical health has a deep impact on Teenagers' behavioral intentions and habits of physical exercise, and has a positive role in promoting teenagers' physical exercise, this is the belief and motivation that teenagers can exercise and stick to it for a long time. Therefore, we should pay attention to the cultivation of the correct belief in physical health exercise, so that teenagers can adhere to physical exercise for a long time and develop the behavior habits of physical exercise, so as to promote the healthy development of physique. The path relationship between teenagers' daily exercise time and mental health level is shown in Figure 3.

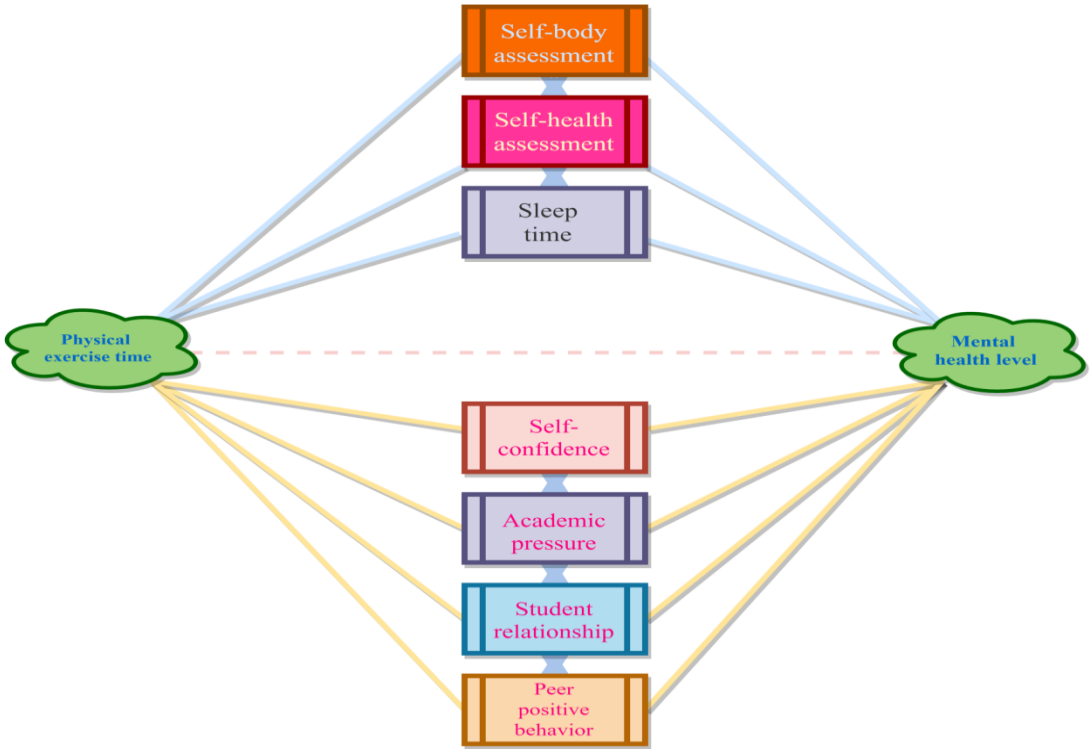

Figure 3: the path relationship between teenagers' exercise time and mental health level

It can be seen from Figure 3 that the first level of the relationship between physical exercise time and mental health level is the evaluation of self-figure, self-health and sleep time. The second level includes four parts: self-confidence, academic pressure, classmate relationship and peer positive behavior. These intermediary mechanisms play an important role in the impact of physical exercise on Teenagers' mental health.

The so-called "stratification" is to show the height, size and internal and external relationship of data through multiple linear models. The influencing factors on students' mental health include both the variable information of students' individual characteristics and the variable information of school characteristics. The basic principle of multi-level linear regression model is to decompose the variation of dependent variables into individual differences in

the same group and differences between different groups. For the influence of physical exercise on Teenagers' mental health level and its intermediary mechanism, a multi-level linear model is used for empirical analysis. The basic form of ordinary least squares regression is as follows:

$$Y_i = \beta_0 + \beta_i x_i + r_i \quad (1)$$

β_0 is the intercept of the regression equation, β_1 is the slope of the regression equation, which determines the slope and direction of the regression equation, and r_i is the residual, which satisfies the characteristics of normality, independence, and constant variance. When there are multiple levels of variables in a population predictor, the residuals cannot satisfy the pre-determined assumptions and need to use:

$$Y_{ij} = \beta_{oj} + \beta_{1j} x_{xj} + r_{ij} \quad (2)$$

For the second unit in the regression equation, that is, the school in the classic student, school model. The fixed effects for the first and second layers are:

$$\beta_{oj} = Y_{oo} + \mu_{oj} \quad (3)$$

$$\beta_{1j} = Y_{1o} + \mu_{1j} \quad (4)$$

Since each unit in the second layer has its own random part, that is, it has the same part of the characteristics, the residual error of each unit in the second layer will be smaller than that of different units in the second layer, so this is also the second layer. The source of the residuals for the layer. The variation part can be expressed as:

$$Y_{xj} = Y_{oo} + y_{1o} x_{ij} + \mu_{oj} + \mu_{1j} x_{ij} + r_{ij} \quad (5)$$

The null model is a model that does not consider independent variables but only dependent variables in the model, that is, variance analysis is usually used to determine whether there are significant differences between different levels. If there are significant differences, it means that a multi-layer linear model can be used for analysis. The difference indicates that it cannot be analyzed with a multi-layer linear model. The first layer can be expressed as:

$$Pr\ o\ b(Y = 1|\beta) = \phi \quad (6)$$

$$Log[\phi/(1-\phi)] = B_0 + E_0 \quad (7)$$

The second layer can be expressed as:

$$P_0 = B_{00} + R_0 \quad (8)$$

Cross-level correlation is a measure of how much of the overall variation

in the overall model Y is caused by differences in the second or third layer, so ICC is often used to measure whether a multi-layer linear model can be constructed:

$$ICC = \pi_{00}/(\pi_{00} + \sigma^2) \quad (9)$$

The health condition of the dependent variable is:

$$B_{00} = G_{000} + U_{00} \quad (10)$$

$$Health_{ijk} = \pi_{ojk} + e_{ijk} \quad (11)$$

Multilayer linear model (it is proposed in view of the limitations of classical statistical technology in dealing with data with multi-layer structure and the possible misinterpretation of the analysis results. It is suitable for in-depth and reasonable analysis and interpretation of the widely existing multi-layer data structure, and discusses the influence of independent variables at different levels on dependent variables. Compared with traditional statistical methods, multi-layer linear model has the following advantages, parameter estimation of multi-layer linear model method And hypothesis test results are more accurate, because it comprehensively analyzes random errors and variables at different levels, and solves the problem of random error independence; Multilayer linear model method can more accurately measure the change law between independent variables and dependent variables, because this method can grasp the correlation between intercept and slope; The advantage of multilayer linear model is not only that it can analyze hierarchical data, but also that it has good feasibility when analyzing repeatedly acquired data.

The influence mechanism of physical exercise on Teenagers' mental health is very complex. The existing relevant literature points out that physiological, psychological, interpersonal and other factors may affect teenagers' mental health. In view of this, this paper uses KHB intermediary mechanism test method to make an exploratory analysis, and uses KHB intermediary effect test method to test its intermediary effect, While testing the effects of multiple intermediary variables at the same time, calculate the explanation proportion of each intermediary variable in the indirect effect. The independent variable physical exercise time, dependent variable mental health level, intermediary variables (self-assessment of body shape, self-assessment of physical health, sleep time, confidence, academic pressure, classmate relationship, peer positive behavior) and control variables were included in the test model.

4. Result Analysis and discussion

The data selected in this study is the representative multi-layer data designated by the survey and data center. The dependent variable is the mental health level of teenagers. CEPS data uses the measurement content of

negative emotion for reference, and asks the degree of negative emotion of the respondents in the past seven days. In order to ensure the accuracy and stability of the research results, this study constructs two comprehensive indicators. The first comprehensive indicator assigns a new value to the variable. The larger the value of the variable, the better the mental health level of teenagers. The larger the value of the adjustment ability variable, the stronger the adjustment ability of teenagers to negative psychology. The independent variable is physical exercise time. This study calculates the average value of physical exercise of the respondents every day. After excluding the abnormal value, the average physical exercise time of teenagers in China is obtained. In order to verify whether there is a nonlinear relationship between physical exercise time and teenagers' mental health, the physical exercise time is squared. The control variables are divided into two levels: individual (family) and school. The mediation mechanism is one of the focuses of this study. The physiological level is sleep time, self-assessment of body shape, and self-health level. The psychological characteristics are confidence and academic pressure. Academic pressure is a continuous variable. Add the academic pressure values of English, mathematics and Chinese. The larger the value, the greater the academic pressure. The interpersonal level is classmate relationship and peer positive behavior. The measurement of peer relationship variables selects the friendliness of class students to the survey object, and assigns a value to it. The descriptive statistical results of variables are shown in Table 1.

Table 1: (a) descriptive statistical results of adolescent physical exercise time and mental health variables

VARIABLE	NAME	MINIMUM VALUE	MAXIMUM	AVERAGE VALUE	STANDARD DEVIATION
INDEPENDENT VARIABLE	Square of physical exercise time	0	12960	0	4264.04
DEPENDENT VARIABLE	Mental health level	0	100	70.68	20.28
	Psychological adjustment ability	0	3	2.03	0.75
CONTROL VARIABLE	Family	1	5	2.94	0.58
	School	1	24	1.37	0.483
MEDIATOR VARIABLE	Sleep time	0	1	3.18	2.09
	Self-body assessment	1	4	3.89	0.915

Table 1: (b) descriptive statistical results of adolescent physical exercise time and mental health variables

VARIABLE	NAME	MINIMUM VALUE	MAXIMUM	AVERAGE VALUE	STANDARD DEVIATION
MEDIATOR VARIABLE	Self-health level	1	5	0.59	0.825
	Confidence	1	5	3.15	0.701
	Academic pressure	0	9	4.25	1.91
	Student relationship	0	4	2.35	0.74
	Peer positive behavior	0	15	17.25	2.97

HLM estimation results of data. Mental health factors decompose the total variance of students' variation into two levels: family and school, and observe the characteristic changes of the first and second level variables. The HLM estimation results are shown in Table 2.

Table 2: HLM estimation results of impact effects

VARIABLE TYPE	VARIABLE NAME	MENTAL HEALTH LEVEL	PSYCHOLOGICAL ADJUSTMENT ABILITY
INDEPENDENT VARIABLE	Square of physical exercise time	0.140	0.006
	Mental health level	-0.152	-0.001
	Psychological adjustment ability	-0.115	0.001
FAMILY	Family emotional connection	3.19	0.084
SCHOOL	Whether to offer health education courses	-1.785	-0.689

In order to further analyze the correlation between physical exercise and adolescent mental health, six samples were taken to discuss the level of mental health and psychological adjustment ability with the time of physical exercise as the variable, and to test whether they can pass the significance test, as shown in Figure 4 and figure 5 respectively.

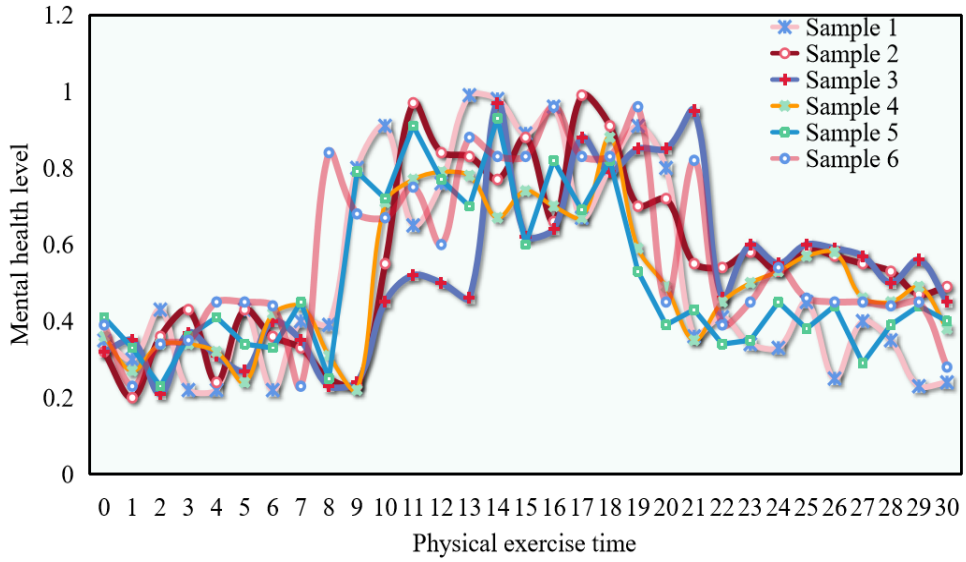

Figure 4: Relationship between physical exercise time and mental health level

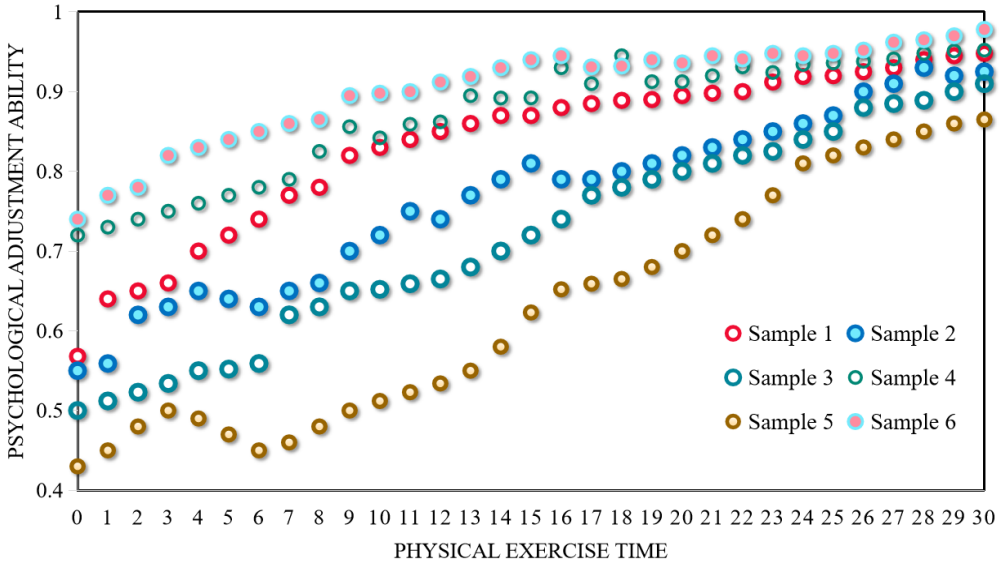

Figure 5: Relationship between physical exercise time and psychological adjustment ability

From Figure 4 and Figure 5, we can get that the time of physical exercise is positively correlated with the level of mental health, and its P value < 0.01 is significant, indicating that participating in physical exercise can help reduce the negative emotions of teenagers and improve the level of mental health. The square of physical exercise time has a nonlinear relationship with the mental health level of adolescents, which is negatively correlated, and there is an inverted U-shaped curve effect. Physical exercise time is also positively correlated with psychological adjustment ability. With the increase of physical exercise time, the acceptable degree of psychological adjustment is also higher, and the psychological adjustment ability is gradually enhanced. According to these six samples, we can know that with the increase of physical exercise time, it can help teenagers to adjust their adaptability, reduce negative emotions, and

improve their mental health management level. However, in view of its inverted U-curve effect, it can be seen that although physical exercise can enhance the level of mental health, its positive effect is not wireless. In order to verify the threshold points that exist between variables, the square of the physical exercise time is used as the dependent variable, and the threshold value of the mental health level is observed, and a linear fitting analysis is performed on it, as shown in Figure 6.

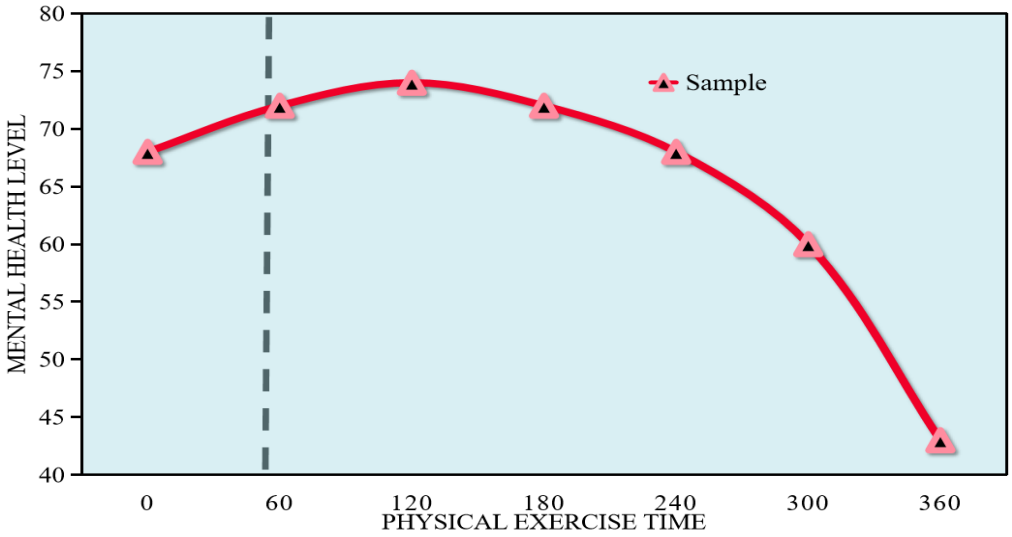

Figure 6: Mental Health Level Thresholds

Using the inverted U-shaped top algorithm in Woodridge's Introduction to Econometrics, it can be analyzed that the threshold is 105, that is, the time for the maximum positive effect of physical exercise time and adolescent mental health is 105min. It can have a positive effect within 105 minutes, and once it exceeds 105 minutes, there will be a downward trend. In order to verify the efficiency of this model, it is compared with different models, and the comparison results are shown in Figure 7.

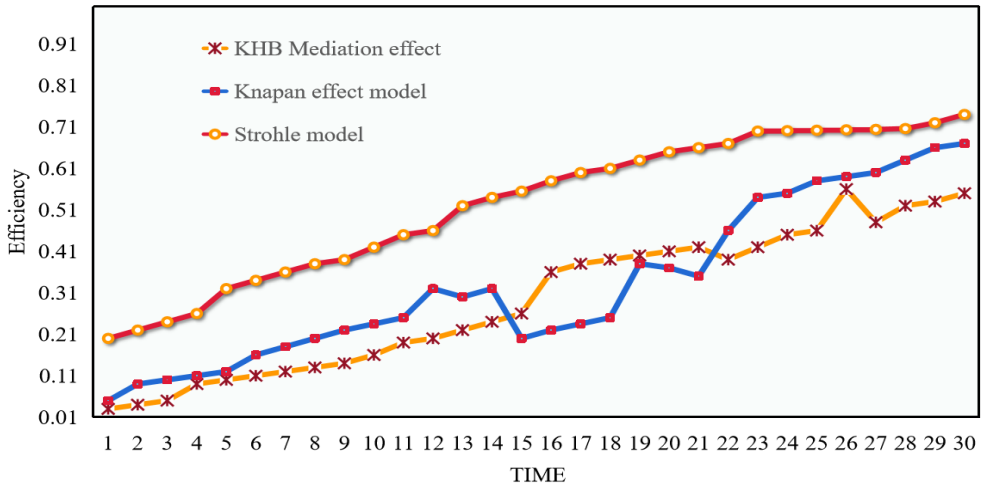

Figure 7: Direct efficiency comparison of different models

Intermediary mechanisms such as self-assessment, self-health assessment, and sleep time play an important role in the relationship between physical exercise and adolescents' mental health. The level is the independent variable and each mediating factor is used as a function, and the contribution rate comparison of indirect effects is shown in Figure 8.

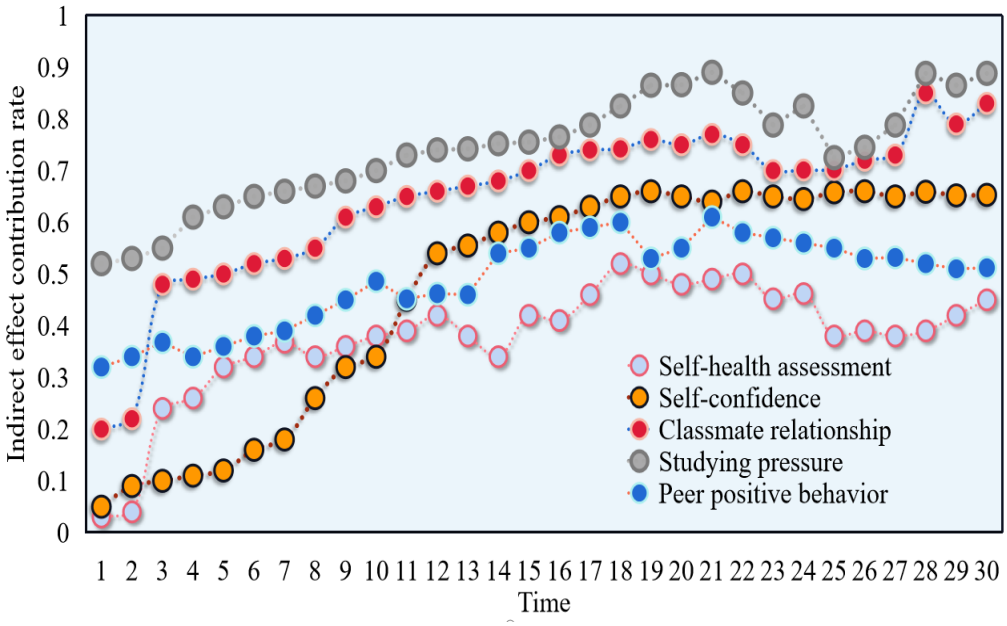

Figure 8: Comparison of contribution rates of indirect effects under different factors

According to Figure 8, it can be seen that there is no mediating relationship between self-assessment and sleep time between physical exercise and mental health, while the rest of the factors have important mediating mechanisms between physical exercise and mental health. In this case, the experimental results show that the direct efficiency of adolescents' mental health level is 0.009, the indirect effect is 0.034, and the contribution rate of indirect effect is 89%. The multi-layer linear model analysis method used in this paper verifies the correlation between physical exercise and adolescents' mental health and its mediating mechanism, and its mediating effect, indicating the nonlinear relationship between physical exercise time and adolescents' mental health. The inverted U-shaped relationship of , its threshold is 105.

5. Conclusions

With the advent of the 21st century, in this era of great health, people pay more and more attention to physical and mental health, and continue to pursue comprehensive physical, psychological, social and environmental health. For teenagers, reasonable physical exercise can promote the material and energy metabolism of nerve cells, enhance the command and regulation ability of the nervous system, and thus promote the improvement of mental health. Based on this, based on the general situation of mental health

development and the advantages of physical exercise, this paper adopts the multi-layer linear model analysis method to verify the correlation between physical exercise and the impact of adolescent mental health and its mediating mechanism, and to verify its mediating effect. It shows that there is a nonlinear inverted U-shaped relationship between physical exercise time and adolescents' mental health, and that there is an important mediating mechanism between self-health assessment, academic stress and other influencing factors and physical exercise and mental health level. The experimental results show that the direct efficiency of adolescents' mental health level is 0.009, the indirect effect is 0.034, and the contribution rate of the indirect effect is 89%. Therefore, we should use physical exercise as a means to prevent and improve the mental health of adolescents, but we must remember the principle of "full overflow", and only the appropriate amount of exercise will have the best effect on the mental health of adolescents.

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