

Study on the Correlation between Physical Fitness and Anxiety Disorders among Adolescents during the COVID-19 Epidemic

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Abstract: ***Objective:** To study the relationship between adolescents' physical fitness and anxiety disorders during the COVID-19 epidemic, and to provide a reference for improving adolescents' mental health. **Methods:** From September 2021 to December 2021, a random sampling method was used to screen 1032 adolescents (620 boys and 412 girls) in Guangdong Province for anxiety related emotional disorders and test for physical fitness from September 2021 to December 2021, and regression analysis was used to test the relationship between these two aspects during the epidemic. **Results:** (1) During the COVID-19 epidemic, the overall obesity rate among adolescents in Guangdong Province was high (30% for boys and 20% for girls), and the physical fitness test indexes (BMI, standing long jump, one-minute rope skipping, five times two-meter turn back run) of adolescents were all at the lower-middle level (passing grade). (2) During this epidemic, the average anxiety disorder test score of 1,032 adolescents in Guangdong Province was at a medium level, with a total test score of 17.88 ± 13.87 , 320 cases (31%) scoring greater than 25 points, and 712 cases (69%) scoring less than 25 points. The data for the overall scores, scores greater than 25, and scores less than 25 for the five factors of somatization panic, generalized anxiety disorder, separation anxiety disorder, social phobia, and school phobia were compared and the differences were all statistically significant ($p < 0.05$). (3) There was no statistically significant correlation between generalized anxiety disorder and physical fitness index ($P > 0.05$), while there was a statistically significant correlation between somatization panic, separation anxiety disorder, social phobia, school phobia, and physical fitness index ($p < 0.05$), and was negatively correlated with physical fitness index (t values: -4.82, -2.65, -3.52, -6.21). This indicates that the higher the scores of somatization panic, separation anxiety disorder, social phobia, and school phobia, the lower the physical fitness index of the adolescents. **Conclusion:** During the epidemic of COVID-19, adolescents in Guangdong Province had a high rate of physical obesity and a significant decline in physical fitness, as well as psychological problems such as anxiety disorders. Schools and families should strengthen the physical exercise of adolescents in Guangdong Province during COVID-19, and improve their physical fitness in multiple ways to cure their anxiety disorders and other problems.*

Keywords: during the COVID-19 epidemic; physical fitness; anxiety disorders; adolescents ; Physical exercise

1. Research Purpose

Since the outbreak of COVID-19, to curb the continued spread of the epidemic, various schools at all levels in China have delayed the start of school and required adolescents to be homebound for online instruction. Studies have shown that the epidemic of COVID-19 has a certain impact on the emotions of home-isolated adolescents [1], and adolescents in a sensitive period of growth and development often suffer from emotional disorders with symptoms of negative emotions such as excessive anxiety, worry, and fear, accompanied by emotional instability, inattentiveness, low learning efficiency, affected personality development, and performance concealment due to various reasons including long-term home [2]. At the same time, with growing age and increasing academic pressure, home isolation has hindered and disrupted the normal pace of learning. So facing the upcoming high school entrance examination, college entrance examination, strict isolation measures, the continuous spread of the epidemic, and inconvenient living, adolescent students are more prone to psychological stress reactions such as panic, anxiety, loneliness, and loss [3]. According to WHO statistics, about 10%-20% of children and adolescents in the world have mental health problems [1], and the proportion of people with psychological problems in adolescence is increasing year by year, which is much higher than that of other age groups [4], and mental health has become a major public health problem worldwide [5-6].

During the prevention and control of the COVID-19 epidemic, people's lives were disrupted. The monotony of home life, online classes, conflicts with parents, and a large amount of epidemic information, etc., have had a profound impact on the psychology of adolescents. As a result, they had increased pressure to study and live and a certain bad mood, which can be alleviated by physical exercise [7]. However, with the repeat of the epidemic, the isolation of students at home and the inability to perform regular physical exercise, the physical health of adolescents has been declining year by year with a significant tendency of younger age and the detection rate of obesity in adolescents of all ages is continuously increasing in worldwide [8-10]. It can be seen that the changes in the physical fitness of adolescents have become a school health issue that scholars from all over the world pay close attention to [11-12]. To understand the physical fitness, and mental health status of adolescents in Guangdong Province during the COVID-19 epidemic and the relationship between them, this questionnaire and test were specially carried out to provide a reference for ensuring the physical and mental health of adolescents in Guangdong Province during the COVID-19 outbreak.

2. Source and Methods

2.1. Data sources

During the COVID-19 epidemic, teenagers in Guangdong Province conducted online classes at home, which caused

great difficulties for the face-to-face physical fitness test of Guangdong adolescents. Therefore, to understand the current situation of physical quality of adolescents during the epidemic more scientifically and accurately, the physical fitness index system of Guangdong adolescents during the COVID-19 epidemic at home was constructed and provide reference to accurately analyze the relationship between physical fitness and anxiety disorders among the Guangdong adolescents in the epidemic, the specific data sources as follows.

First, interviews and questionnaires were used to consult experts in relevant fields in Guangdong Province to determine the physical fitness index system for adolescents in Guangdong Province during the COVID-19 outbreak (2020); second, a random sampling of adolescents in Guangdong Province during the COVID-19 outbreak was surveyed and tested (2021), and their parents' consent was also sought to serve as testers of the physical fitness of adolescents in this study (The author provided professional guidance to their parents via remote video before the test). In addition, the author also needed to have the testers conduct video remote tests during the test to obtain two test data (parental on-site test and author's video test). Then, the author averaged the test data to obtain the final physical fitness test data of this study, and the original physical fitness test data were converted and calculated according to the established index system Perform conversion calculations; third, the adolescents in Guangdong Province who participated in the test were asked to fill out the Anxiety Disorders Scale for Adolescents in Guangdong Province during the COVID-19 Epidemic (2021) in the form of questionnaires, and then obtain the anxiety disorders test data of this study. The test data mainly covered 21 prefecture-level cities under the jurisdiction of Guangdong Province (divided into four regions: Pearl River Delta, East Guangdong, West Guangdong, and North Guangdong), including Pearl River Delta: Guangzhou, Shenzhen, Foshan, Dongguan, Zhongshan, Zhuhai, Jiangmen, Zhaoqing, and Huizhou; East Guangdong: Shantou, Chaozhou, Jieyang, and Shanwei; West Guangdong: Zhanjiang, Maoming, Yangjiang, and Yunfu; and North Guangdong: Shaoguan, Qingyuan, Meizhou, and Heyuan.

2.2. Methods

2.2.1. Delphi method

The Delphi method is an independent evaluation of the evaluation content by the surveyed experts according to their knowledge and experience accumulation under "blinding" and obtains a statistically significant expert cluster evaluation result [13]. Specific steps are as follows:

a) Preliminary construction of index system

Using the literature method, with the theme of "physical fitness and anxiety disorders" as the theme, the author searched for relevant information on CNKI. Combined with interviews with front-line teachers, the author initially formulated an index system, including 1 first-level indicator, 4 second-level indicators, and 4 third-level indicators.

b) Determine the list of experts

2 rounds of expert questionnaires asked 15 experts, who were from colleges and universities, primary school sports experts, and front-line teachers in Guangdong Province. In terms of age, 3 people were 30-39 years old, 5 were 40-49 years old, 4 were 50-59 years old, 2 were 50-59 years old, and 1 was ≥ 60 years old; in terms of years of work, 6 were 10-19 years old, 6 were 20-29 years 6, 3 were ≥ 30 years. In terms of academic qualifications, there are 2 undergraduates, 11 masters, and 2 doctors; in terms of professional titles, there are 3 intermediates, 7 associate seniors, and 5 seniors; in terms of unit nature, there are 6 college physical education teachers, 7 primary school front-line teachers, and 2 researchers from the Institute of Sports Science.

c) Formulate an expert consultation form and inquire by letter

According to the index system of the primary selection, the indexes were evaluated by using the Likert 5-point scale (Assignment 1 is "unimportant"; assignment 2 is "not very important"; assignment 3 is "more important"; assignment 4 is "important"; assignment 5 is "very important"). After the initial selection indexes were assigned by experts, the indexes with significantly different characteristics were selected ($X \geq 4$) [14]. Therefore, two rounds of expert questionnaires were conducted from March 2020 to June 2020 using mutually isolated forms of communication (email, WeChat, telephone, etc.) to solicit expert evaluations, so that the evaluation results of the expert member group tended to be concentrated, and finally, the prediction of the physical quality index system for adolescents in Guangdong Province during the epidemic was made. Among them, the contents of the first round are questionnaire description, expert feedback time and confidentiality of expert information, basic information of experts, and a physical fitness index system. Contents of the second round are the determination of the final physical fitness index system and revision opinions of Guangdong Province's adolescents during the epidemic. Based on the above, the members of this study group make decisions according to the results of expert feedback.

d) Expert activism, degree of authority, and coordination of opinions

Two rounds of expert questionnaires were conducted in this study and the effective recovery rates of the first and second rounds of questionnaires were 100.00% (15/15) and 93.33% (14/15), respectively. The expert authority coefficient is the arithmetic mean of the expert's familiarity with the research content and the expert judgment coefficient [15], that is, the expert authority coefficient = (judgment coefficient + familiarity coefficient) / 2. The expert judgment coefficient of the first round of questionnaires was 0.878, and Cs was 0.820; the expert judgment coefficient of the second round of questionnaires was 0.883, and Cs was 0.824; the expert authority coefficients were 0.849 and 0.854, respectively. The Kendall's coefficient of concordance of the two rounds of expert questionnaires were 0.146 and 0.178, respectively, and the above coefficients were statistically significant ($P < 0.001$), indicating that after expert evaluations from

universities and front-line physical education teachers in Guangdong Province, the opinions of experts tended to be consistent. After the assessment was completed, a physical

fitness index system for adolescents in Guangdong Province during the COVID-19 epidemic was finally constructed (see Table 1).

Table 1: The physical fitness index system of adolescents in Guangdong Province during the COVID-19 epidemic in this study

First – level indicator	Second-level indicator	Third-level indicator	Importance ($x \pm s$ minute)	Coefficient of variation
Physical Fitness	BMI	BMI	4.55±0.23	0.112
	Lower Limb Explosive Power	Standing Long Jump	4.35±0.43	0.093
	Muscular Endurance	One-minute Rope Skipping	4.25±0.85	0.188
	Speed	Five Times Two-meter Turn Back Run	4.69±0.67	0.12

2.2.2. Screening for anxiety related emotional disorders

The Anxiety Related Emotional Disorders Scale is used for self-assessment of anxiety disorders in adolescents aged 8-18. It consists of 41 items, with five factors extracted by factor analysis: somatization/panic, generalized anxiety disorder, separation anxiety disorder, social phobia, and school phobia. The scale is scored on a three-level scale from 0 to 2 (none, sometimes, often). All scores are added together to obtain a total score, and a high score indicates anxiety (anxiety related emotional disorders test score ≥ 25) [16]. The Anxiety Related Emotional Disorders Screening Scale is a practical and effective self-assessment tool for people with anxiety symptoms. The most important feature of the scale is that it can separate anxiety from depression, which avoids the confusion between anxiety and depression, and provides a reference for clinical diagnosis [17]. Based on this, this questionnaire was entered by the researcher into a small program called Questionnaire Star, published on WeChat and Circle of Friends, and then filled out by randomly selected adolescents who were in line with this study. All survey respondents completed the Anxiety Related Emotional Disorders Screening Scale under the supervision of their parents (the survey data in this study were obtained with the informed consent of the parents of adolescents).

3. Results

3.1. Current status of physical fitness indexes of adolescents in Guangdong Province during the COVID-19 epidemic

Benchmarked the national physical fitness and health standards for adolescents, the study shows that during the COVID-19 epidemic, the obesity rate of adolescents in Guangdong Province was relatively high (186 boys were obese, with the obesity rate accounted for 30% of the total number of boys; 83 girls were obese, with the obesity rate 20% of the total female population). At the same time, benchmarking the physical fitness and health standards of standing long jump, one-minute rope skipping, and five times two-meter turn back run, the author found that the above three indicators of Guangdong adolescents during the COVID-19 epidemic in this study were only at the lower-middle level (passing grade). The indicators including BMI, standing long jump, one-minute rope skipping, and five times two-meter turn back run had statistical significance between males and females (all P value < 0.05). See Table 2.

Table 2: Current status of physical fitness indicators of adolescents in Guangdong Province during the COVID-19 epidemic in this study

Gender	BMI /kg·m ⁻²	Standing Long Jump/cm	One-minute Rope Skipping/Number	Five Times Two-meter Turn Back Run/s
Male	22.7 ± 3.82	186 ± 4.53	167 ± 6.4	3.63 ± 0.39
Female	23.2 ± 3.27	155 ± 3.23	155 ± 5.6	3.77 ± 0.33
P value	0.05	0.05	0.001	0.05

3.2 Scores of the Anxiety Disorder Scale for Adolescents in Guangdong Province during the COVID-19 outbreak

During the COVID-19 epidemic, 1, 032 adolescents in Guangdong Province had an anxiety disorder test score ranging from 0 to 88, and the average anxiety disorder test score was at a medium level. Among them, there were 320

cases with scores greater than 25 (31% of the total number of anxiety disorder testers), and 712 cases with scores less than 25 points (69% of the total number of anxiety disorder testers). The difference between the scores of each group with an anxiety disorder test score greater than 25 and less than 25 with the total score showed that they were all statistically significant ($P < 0.05$), as shown in Table 3.

Table 3: The scores of anxiety disorder test for adolescents in Guangdong Province during the COVID-19 epidemic ($x \pm s$)

Items	Overall score	Anxiety Disorder ≥ 25	Anxiety Disorder < 25	T value	P value
Somatization/Panic	3.53 ± 3.92	8.65 ± 4.54	2.12 ± 2.09	13.234	< 0.001
Generalized Anxiety Disorder	3.39 ± 2.67	8.21 ± 3.51	2.72 ± 2.32	14.321	< 0.001
Separation Anxiety Disorder	4.23 ± 2.34	7.65 ± 2.56	2.32 ± 2.12	14.521	< 0.05
Social Phobia	4.42 ± 2.6	8.75 ± 4.65	3.62 ± 2.80	10.212	< 0.001
School Phobia	2.31 ± 2.34	2.65 ± 2.38	0.89 ± 0.35	6.325	< 0.05
Total anxiety disorder score	17.88 ± 13.87	35.91 ± 17.64	11.67 ± 9.68	22.23	< 0.001

3.3. Linear regression analysis of physical fitness index and anxiety disorder among adolescents in Guangdong Province during the COVID-19 epidemic

First of all, this study was based on the constructed physical fitness index system for adolescents in Guangdong Province during the COVID-19 epidemic, which was known to contain four dimensions: BMI, lower limb explosive power, muscular endurance, and speed. At the same time, the physical fitness test rules of the New Evaluation Standard for Physical Fitness of Chinese Adolescents were used for testing [18].

Then, the scores of the four physical fitness indexes of Guangdong adolescents during the COVID-19 epidemic were standardized according to gender, and the total physical fitness index score (Z score for short) of this study was calculated. The formula is $\text{physical fitness index} = Z_{\text{BMI}} + Z_{\text{Lower limb explosive power}} + Z_{\text{Muscular endurance}} + Z_{\text{Speed}}$ [18]. Finally, multivariate regression was used to analyze the relationship between the physical fitness index and anxiety disorders of adolescents in Guangdong Province during the COVID-19 epidemic, and Table 4 was obtained. It can be seen that the correlation between generalized anxiety and physical fitness index is not statistically significant ($P > 0.05$), but there is statistical significance between somatization/panic, social phobia, separation anxiety disorder, school phobia, and physical fitness index ($P < 0.05$), and was negatively correlated with BMI.

Table 4: Linear regression analysis of physical fitness index and anxiety disorder among adolescents in Guangdong Province during the COVID-19 epidemic

Variables	β value	Standard error	B value	T value	P value
Somatization/Panic	- 0.615	0.125	0.000	- 4.82	<0.01
Generalized Anxiety Disorder	0.000	0.000	- 0.031	- 1.39	0.19
Separation Anxiety Disorder	- 0.003	- 0.002	- 0.039	- 2.65	<0.01
Social Phobia	- 0.003	- 0.003	- 0.057	- 3.52	<0.01
School Phobia	- 0.003	0.003	0.163	- 6.21	<0.01

4. Discussion

Physical fitness generally refers to the functions of the body's organ systems in terms of strength, speed, endurance, agility, flexibility, and coordination exhibited in muscular activities [12]. Physical fitness is the physical ability required to improve health, prevent diseases, and improve the efficiency of daily work. It is an important element of students' constitutional health. The physical quality development level of adolescents is closely related to their learning and quality of life [19]. In recent years, the physical development level of Chinese students has improved significantly, but the physical fitness level has not increased simultaneously [20-21]. In particular, the outbreak of COVID-19 has posed a serious threat to human life and health due to its rapid, widespread, and highly infectious characteristics, which has also posed an unprecedented challenge to the global public health system and governmental governance capacity [22]. During the epidemic, school closures interrupted students' learning, and the non-academic support previously provided

by the school was also lacking, which not only led to the deterioration of students' academic abilities, but also their physical fitness [23-24]. However, due to China's one-sided pursuit of higher education rates, there is a tendency in society to focus on intellectual education and less on sports. As a result, Chinese students' physical fitness indexes such as endurance, strength and speed continued to decline, and the proportion of obese students continued to increase [25], most notably during the home quarantine period of the epidemic. The study pointed out that, increased sedentariness and reduced active physical activity among adolescents can lead to overweight and obesity [36]. Another study showed that the wasting rate of children and adolescents aged 6-18 in Ningxia was 6.9%, the overweight rate was 12.6%, and the obesity rate was 8.7% [26]. It can be seen that with the improvement of adolescents' living standards and nutrition, part of the physical fitness of adolescents continues to decline, and the detection rate of overweight and obesity also increases significantly [27]. The above research results are consistent with the test results of the adolescents' physical fitness index data (BMI, standing long jump, one-minute rope skipping, five times two-meter turn back run) constructed in this study during the COVID-19 epidemic in Guangdong Province: during the COVID-19 outbreak, the obesity rate among adolescents in Guangdong Province was high, and the athletic quality was at the lower-middle level, and students' physique was declining. The results showed that during the epidemic, due to home isolation and lack of physical exercise and scientific guidance, the obesity rate was high and the physical fitness of Guangdong adolescents did decline. This suggests that relevant government departments, schools and families should work together to strengthen the physical exercise of adolescents and maintain a normal weight to quickly reverse the trend of declining physical fitness of adolescents in Guangdong Province during COVID-19 [28]. Therefore, improving the physical fitness of adolescents in Guangdong Province during the COVID-19 epidemic should be a top priority.

Due to the highly contagious nature of COVID-19, people are required to avoid close contact during the epidemic, which can effectively avoid virus infection, but may lead to social isolation [29-30], which has an important negative impact on people's psychological responses after the epidemic [31-33], with some children and adolescents experiencing psychological problems such as fear, anxiety, depression, and somatization [22-23]. The psychological development of middle school students is still in a semi-mature and semi-naive state, characterized by emotional instability and high academic pressure, all of which lead to greater psychological stress for middle school students [34]. Since the epidemic, the incidence of emotional and behavioral problems in children and adolescents has been higher than before, and 85.7% of parents reported that their children's emotional state has changed during the school suspension period, with inattention being a common symptom [23]. Some studies have pointed out that the mental health of adolescents is generally normal, but nearly half of them have mild psychological problems in different aspects,

with a higher percentage of those with moderate or severe psychological problems in anxiety, feelings of academic stress, and emotional instability [35]. The above conclusions just coincide with the results of this study: during the COVID-19 epidemic, adolescents in Guangdong Province had higher scores on the anxiety disorder test (the average anxiety disorder test score was at a medium level, and the total anxiety disorder test score was 17.88 ± 13.87), and some adolescents in Guangdong Province have already had different degrees of anxiety disorders. Scholars pointed out that mental health is an important connotation of the modern health concept, a premise for adolescents to receive education and learn scientific and cultural knowledge, and it is also an effective way for schools to implement quality education [29]. The higher the level of individual psychological quality, the higher the level of their mental health and the less likely they are to have psychological problems, and good mental health literacy is helpful to adolescents' physical and mental development [36-37]. Therefore, schools, families, and departments at all levels should adopt multiple methods and means to strengthen the mental health education of adolescents during the epidemic.

Physical fitness and psychological quality promote and restrict each other. The development of physical fitness can indirectly improve psychological quality and is the basic guarantee of psychological quality. The cultivation of psychological quality helps to improve the level of physical fitness and only synergy between the two development can promote the comprehensive development of adolescents [38]. Studies have shown that the development of adolescents' physical fitness is affected by psychological factors, and adolescents with poor physical fitness levels have a higher risk of developing psychological sub-health [24], which indicates that there is a certain correlation between the decline of physical fitness and the occurrence of anxiety disorders in adolescents. This is consistent with the regression analysis results of physical fitness and anxiety disorders among adolescents in Guangdong Province during the COVID-19 epidemic: there was a statistical significance between somatization/panic, social phobia, separation anxiety disorder, school phobia and physical fitness index ($P < 0.05$), and was negatively correlated with physical fitness index. That is, the higher the scores of somatization/panic, social phobia, and school phobia, the lower the physical fitness index. Therefore, how to enhance and improve the physical fitness and anxiety disorders of adolescents during the epidemic has become a current challenge. The study also noted that exercise capacity is significantly associated with the components of healthy fitness (R-value range: 0.15-0.38) [40], suggesting that the cumulative effect of cardiovascular disease risk diminishes as physical activity increases. Therefore, this result has a facilitative effect on exercise interventions for adolescent obesity [39]. At the same time, scholars also pointed out that the anxiety, depression and loneliness scores of adolescents who participated in physical exercise during home isolation were lower than those who did not participate in physical exercise [22], which indicates that physical exercise can reduce depression and anxiety symptoms and alleviate cognitive decline [40-41], and that

long-term regular exercise has significant psychological effects [42], especially both one-time exercise and long-term physical exercise can effectively improve depression, reduce material and state depression [43]. The above studies are sufficient to show that effective physical exercise is beneficial to the development of students' mental health [44-46]. During the COVID-19 epidemic, teenagers stayed at home for a long time and lacked communication with the outside world, which greatly affected their physical fitness and mental health. Parents and schools should guide adolescents in time to avoid the negative emotions of teenagers during the epidemic. In the face of COVID-19, families and schools should correctly grasp the characteristics of adolescents' psychological activities, and attach importance to adolescents' mental health education and physical exercise to lay the foundation for their future physical and mental growth [3].

The results of this study show that during the COVID-19 epidemic, due to home isolation, the physical fitness of young people in Guangdong Province is not optimistic, and there are also psychological problems such as anxiety disorders. Specifically: there was a negative correlation between somatization/panic, social phobia, separation anxiety disorder, school phobia and physical fitness index. That is, the higher the scores of somatization/panic, social phobia, and school phobia scores, the lower the physical fitness index. It indicates that the lack of physical exercise among adolescents in Guangdong Province during the COVID-19 epidemic led to a decrease in physical fitness and affect their mental health development. It is suggested that relevant parents and schools should strengthen physical exercise and mental health education of adolescents in Guangdong Province after the resumption of school. It can be said that the results of this study provide a certain degree of reference for the sports work of youths in Guangdong Province: school physical education should focus on the dual development of students' physical fitness and mental health. However, this study also has the following shortcomings: First, the index system constructed in this study considers the data measurement problem during the COVID-19 epidemic to simplify the physical fitness index system of adolescents, which may lead to the suspicion that the index of this study is incomplete in generalizing the physical fitness of adolescents in Guangdong Province. Then, the anxiety disorder test and physical fitness test in this study were completed by adolescents and parents through self-remote during the home isolation of the epidemic, so the accuracy of the anxiety disorder test results and physical fitness test may be affected to a certain extent. Finally, because it was a random sampling of adolescents in Guangdong Province during the home isolation of the epidemic, the number of study samples was insufficient. So this study needs to further expand the sample size and continue to track to increase the reliability and timeliness of this study.

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Among them, the subject names are the research on the construction and influencing factors of the physical and mental health index of college students from the perspective of physical exercise, and the research on the innovative model of applied talents training for first-class physical education majors in Guangdong Province; the subject numbers are: 202028, 2020GXJK382.

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