YANG, Yi, WU, Changhong, SUN, Liang, WANG, Chuanqiushui and LUO, Jiong. Influence of Sports Intervention on the Mental Health of College Students in the Background of COVID-19 :A Systematic Review. Quality in Sport. 2024;33:56138 eISSN 2450-3118.
https://dx.doi.org/10.12775/QS.2024.33.56138
https://apcz.umk.pl/QS/article/view/56138

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique Identifier: 201398. Scientific disciplines assig589 ned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 12.10.2024. Revised: 14.11.2024. Accepted: 15.11.2024. Published: 18.11.2024.

Influence of Sports Intervention on the Mental Health of College Students in the Background of COVID-19 :A Systematic Review

Authors:
Yi Yang:
Research Centre for Exercise Detoxification, College of Physical Education, Southwest University, 400715,Chongqing, China,
https://orcid.org/0000-0001-9370-4303,
1390330627@qq.com

Changhong Wu:
Wuhan Sports University School of Sports Medicine, 430079,Wu Han, China
https://orcid.org/0009-0004-6016-1460,
wuchangmeng@126.com

Liang Sun:
Research Centre for Exercise Detoxification, College of Physical Education, Southwest University, 400715,Chongqing, China.
https://orcid.org/0009-0003-2660-6828,
1263088363@qq.com

Chuanqiushui Wang：
Research Centre for Exercise Detoxification, College of Physical Education, Southwest University, 400715,Chongqing, China.
https://orcid.org/0009-0005-7859-6443,
19982641028@163.com

Corresponding author:
Jiong Luo,
Research Centre for Exercise Detoxification, College of Physical Education, Southwest University, 400715,Chongqing, China.
https://orcid.org/0000-0003-0161-7320，
784682301@qq.com

Abstract: Objective: This review aims to understand the mental health status of college students during the popularity of covid-19, and explore the impact of sports intervention on College Students' mental health and its path mechanism through a literature review. **Methods:** According to PRISMA 2020 guidelines, this paper searched the literature on the Sports College Students' Mental Health from 2019 to 2022 in PubMed, web of science, CNKI, and dimensional spectrum database. **Results:** 64 research papers were included for comprehensive analysis. **Conclusions:** Sport interventions as an important means for the regulation of the development of the mental health of the college students. Sport intervention improves cognitive functioning, emotional state, interpersonal relationships, and self-efficacy in college students and is an important strategy for dealing with public health emergencies. Sport intervention therapy is recommended as one of the important means to prevent mental health problems among college students.

Keywords: COVID-19; Isolation; College student; Mental health; Exercise intervention; Depression; Anxiety; Subjective well-being

0 Introduction

After the outbreak of the 2019 novel coronavirus, COVID-19 spread rapidly around the world through droplet transmission, close contact, etc., and evolved into a major global public health event. The sudden outbreak of COVID-19 has not only caused a lot of property damage, but more importantly, COVID-19 has threatened people's life safety and mental health, and the virus infection has even deprived many people of their lives [1]. In the early days of the outbreak, to prevent the spread of the epidemic to the greatest extent possible, all sectors of society had to block communities and urban areas, and enforce the social distancing of people [2]. Facts have proved that the implementation of isolation measures in the early stage of the development of infectious diseases is an effective prevention and control strategy. However, the closure of the city and the implementation of strict isolation measures have seriously affected people's daily lives, and thousands of families have had family conflicts due to isolation [3].

The mental development of students cannot be guaranteed, and the longer the isolation time, the worse the psychological condition of the witnesses, and is accompanied by severe traumatic stress syndrome [2]. The complex social environment during the epidemic has had a serious negative impact on people's mental health, Relevant studies have reported that isolation measures and complex social environments cause people to have negative psychological states such as anxiety, stress, depression, abnormal behavior, panic attacks, delirium, decreased subjective well-being, hostility, and other [4-5]. And then affect people's normal life and work.

To maintain social distance under the epidemic, people's social, entertainment, work, and learning methods have undergone tremendous changes. Extensive Internet use among young people leads to sedentary behaviors, increased screen time, and severe physical inactivity [6-7]. Low physical activity is one of the important factors leading to depression [8], especially the student group, whose physical and mental development is not yet fully mature, and the self-control ability is not strong enough. In this special environment, they are deeply affected. As we all know, the college age is an important stage of life development, but at the same time, this group also faces many adverse mental health problems, such as anxiety, depression, and even suicidal ideation during college [9]. However, sports and exercise psychology studies have confirmed the positive effects of physical activity on mental health. Physical exercise can relieve stress [10], regulate depression [11], and enhance self-efficacy [12]. Accordingly, the healthy lifestyle of sports intervention can effectively solve the psychological problems of college students, make them quickly return to normal study and life, and play an important role in the process of young college students entering maturity.

During the epidemic period, most colleges and universities adopted online teaching and suspended offline courses in the mode of "suspending classes without stopping", but the academic burden did not change much. If the school failed to provide psychological counseling and health services promptly, it was bound to be harassed. The mental health of college students in a closed isolation environment has a negative impact. So far, the epidemic has not been fully contained. Although preventive measures such as vaccination, personal protection, and isolation of suspected patients have been taken, it will inevitably cause people's panic. In countries with better control of the epidemic in China, there will inevitably be an influx of infected people from abroad, which will lead to a counter-wave of the epidemic in some cities, which will undoubtedly have a serious negative impact on student's academic work and physical and mental health.

To sum up, under the background of the epidemic, it is urgent and meaningful to explore the effect of sports intervention on the mental health of college students. This review aims to analyze the impact of physical exercise and college students' mental health during the epidemic, explore the multi-model path of its impact, to provide empirical suggestions for college students to actively deal with similar public health problems in the post-epidemic era, as well as provide researchers with feasible suggestions theoretical guidance.

1 Data and methods

1.1 Data sources

Using PubMed, web of science, CNKI, dimension spectrum, and other databases, keywords:COVID-19; isolation; college students; mental health; exercise intervention; depression; anxiety; subjective well-being. The retrieval time is for research papers published in relevant journals at home and abroad from January 2019 to April 2024.

1.2 Finalist criteria

1) College students during the COVID-19 epidemic were the research objects; 2) Exercise intervention was used as the intervention method 3) Outcome indicators: mental health, healthy physical fitness, academic performance, subjective well-being, etc.

1.1 Literature Exclusion Criteria

1) Documents not in English or Chinese are excluded; 2) RCTs are not excluded; 3) Literature on sports intervention for college students under the non-COVID-19 epidemic.

1.2 Data intake quality assessment

1) The shortlisted papers are read in three stages. In the first stage, the researcher searches the database, browses the titles and abstracts, and preliminarily selects the found literature; in the second stage, another researcher organizes the literature and eliminates duplicates; in the third stage, two researchers read the full text together to determine the Whether the literature meets the inclusion criteria. If there is no consensus in the literature, the decision will be discussed.

2) Literature quality and empirical level. The PEDro scale is used to examine each document and evaluate the quality of its research. The higher the score, the better the research quality of this document. Each document was independently graded by two researchers. If the scoring items are different, reach a consensus after discussion. Because of the characteristics of the included papers, therapists need to provide therapeutic interventions during the study. The maximum total score for items that cannot be blinded by a therapist may be 9. Therefore, it is determined that those who score more than or equal to 5 on the PEDro scale are high-quality papers, and those who score less than or equal to 4 are low-quality papers.

According to the keyword search strategy, a total of 1482 relevant documents were found, 654 duplicate documents were excluded, and 532 remaining documents were excluded. After reviewing the titles and abstracts, 232 articles that did not meet the literature selection criteria were excluded. Finally, 64 research papers were included for comprehensive analysis. The process of literature retrieval and inclusion in this study is shown in Figure 1.

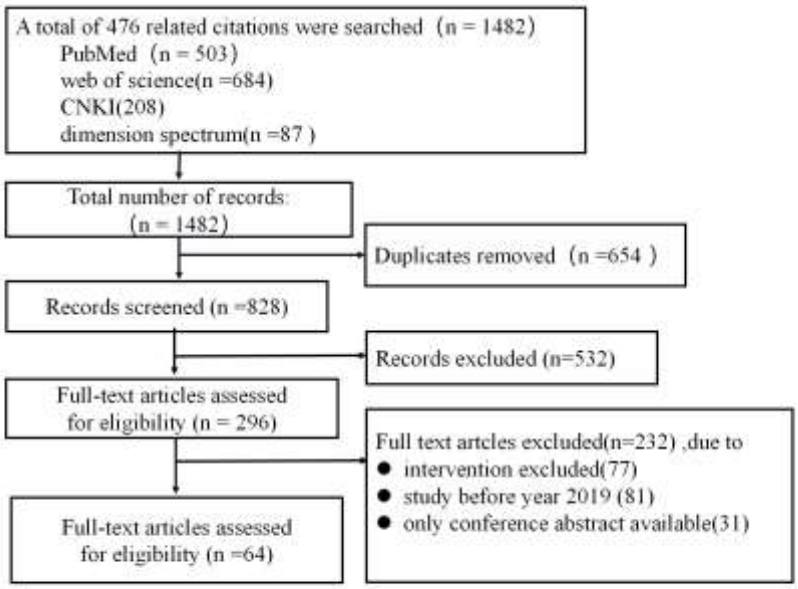

Figure 1 Search and exclusion process flow diagram

2 Results

2.1 The concept and evaluation criteria of mental health

2.1.1 The concept of mental health

What is mental health? Scholars at home and abroad have different opinions, and a unified concept has not yet been formed. The World Health Organization defines mental health as a state of well-being in which everyone can fulfill their potential, cope positively with life's stressors, work productively, and contribute to the community. Domestic scholars believe that mental health generally includes two aspects of positive and negative emotions, the reduction of negative emotions and emotions, and the increase of positive emotions and emotions. 13]; In addition, mental health refers to a continuous psychological state, which is mainly manifested as positive inner experience, full of vitality, strong social adaptability, full development of personal potential, and positive social function [14]. Foreign scholars define mental health as a self-attribute or a part of the self-according to three clinical criteria: know oneself clearly; get along well with others; The behavior is normal and beneficial and does not cause harm to self or others [15]. Scholars such as Galderisi S et al. [16] believe that mental health is a dynamic state of internal balance, which enables individual abilities to live in harmony with the universal values of society : Possess basic cognitive and social skills; Ability to identify, express and regulate one's own emotions and kindness; Ability to respond flexibly to adverse life events and play social roles; In addition, physical and mental harmony represents an important component of mental health and is, to varying degrees, ascribed to a state of internal balance. 心 The concept of mental health is relative, and its concept and practical application will depend on the epistemological and moral framework formed by people, and mental health has different differences in the psychological, social and physiological fields.

To sum up, the concept of mental health is comprehensive and complex, and mental health can reflect the harmony and unity of a person's inner state and the external world.

The healthy psychological state of college students can adapt to changes in the social environment, individuals can give full play to their potential, and maintain a good psychological state to continuously grow and achieve self-realization.

2.2 The negative impact of COVID-19 on the mental health of college students

Mental health problems of college students include health conditions including changes in mood, behavior, or thinking. Mental health problems are related to factors such as low physical activity, bad behavior patterns, and complex social environments. Students face complex and panic-stricken social situations and great changes in their learning and lifestyles, which lead to abnormal psychological states of students, and students may be more prone to impulsive behaviors such as depression, anxiety, and self-mutilation [17].

COVID-19 has affected many negative psychological changes in students. Under the environment of isolation, blockade, and social distancing, a large amount of leisure time makes students addicted to the Internet, and sedentary behavior increases, which in turn leads to the frequent occurrence of symptoms such as depression, anxiety, and post-traumatic stress disorder in students [18].Cao et al [7] found in their cross-sectional study that 30% of the interviewed college students suffered from severe anxiety. Scholars such as Zhao Y et al. [19] found that during the quarantine period in Wuhan, low physical activity and increased screen time for college students may cause them to suffer from ADHD, which seriously affects their physical and mental health. In addition, high screen time or low physical activity was significantly positively associated with depressive symptoms, and the two also had an interaction effect on depressive symptoms. A survey found that most students may suffer from psychological distress, and scholars believe that physical activity, sleep time, nighttime bedtime, screen time, and viral infection have a significant impact on students' depression levels [17].

The isolation state breaks the original regular life and rest, and the risky behaviors generated by this way of life will affect mental health. During the COVID-19 epidemic, going to bed late and waking up late has caused college students to suffer from sleep disorders and increased anxiety and depression. In addition, some students use alcohol or seek drugs to relieve negative emotions, resulting in college students' physical and mental health. poor [20].College students reduce the common communication and social participation of their peers, which can also lead to mental health problems. College students who are isolated at home get along the most with their families, such as family conflicts caused by intergenerational differences, communication barriers, and mutual incomprehension [3]. In addition, the lack of normal learning and social activities of college students in a closed state will affect their learning progress and aggravate their anxiety [21].

In the face of sudden and critical events, college students cannot actively adapt and respond, and thus are prone to negative psychological states, such as troubles in online courses, worries about when the epidemic will end, and worries about the side effects of vaccines, etc. [22]. Some studies have pointed out that traumatic or threatening information and content can affect fear conditioning by activating fear circuits in the brain, and may produce symptoms of post-traumatic stress disorder [23].

In the era of rapid news, a large number of epidemic-related news reports, and even the dissemination of false information, the more time college students are exposed to online media, the more prone to acute stress symptoms [24], which intensifies the panic and anxiety of college students [10].In addition, excessive media exposure may lead to post-traumatic stress disorder in patients with viral infection [25], and such patients need to strengthen mental health counseling. Therefore, enhancing the correct cognition of COVID-19 among college students is also an effective measure to actively respond to the epidemic crisis. The higher the cognition degree of college students on COVID-19, the better their psychological state may be [9,21].

In conclusion, COVID-19 has seriously affected the study life and physical and mental health of college students. In the face of major health emergencies, relevant measures should be taken quickly to mediate and resolve psychological problems.

2.3 The influence of sports intervention on the mental health of college students

Regular physical activity is a subset of planned, structured, repetitive physical activity with the ultimate or intermediate goal of improving or maintaining physical and mental health [26], It is one of the important means to improve physical and mental health, and maintain and improve people's quality of life [27]. Under the epidemic, physical activity is a protective factor for college students to maintain their mental health [10].

2.3.1 Improve cognitive function and promote academic performance

In the college years, it is a stage of rapidly acquiring knowledge and enriching ideas. It is beneficial for sports to intervene in the study and life of college students. Regular physical exercise for a long time has been widely confirmed in terms of improving cognitive function [28], especially improving memory ability. and executive function, thereby improving the learning efficiency and academic performance of college students [29]. Memory plays an important role in the learning process, and improving memory has positive benefits for college students' academics. Studies have shown that 10 minutes of walking training can significantly improve students' performance in mathematical algorithms, especially students with poor performance [29]. In 88 college students, to explore the effect of acute exercise on episodic memory, the results suggest that 15 minutes of moderate-intensity running before learning can effectively improve long-term episodic memory [30]. In addition, high-intensity exercise also has positive effects on long-term memory [31]. Therefore, different intensities of physical exercise strengthen memory function and then enhance the academic performance of college students. Executive function, as an important part of the higher cognitive domain, includes categories such as executive control, volitional control, and working memory, and plays an important role in daily life and learning. Slusher AL et al [32] found that executive function dependent on the prefrontal cortex was immediately enhanced after high-intensity intermittent exercise. Notably, executive function is primarily controlled and regulated by the prefrontal cortex, and brain-derived neurotrophic factor has been suggested as a biomarker of enhanced executive function at rest or after exercise. In the study of Martínez-Díaz IC [33], 25 college students showed significant improvement in BDNF levels after a 30-minute high-intensity exercise intervention, suggesting the effect of high-intensity interval training on neurophysiological responses and cognitive function.

Acute exercise may also help to promote specific aspects of executive function, not in general cognitive improvement but selectively in the motor response-inhibiting aspects of executive function [34], which can effectively elicit responses in smartphone-addicted college students Changes in inhibition [35]. Furthermore, not only does physical activity have a positive effect on executive functioning, but experiences in physical activity also enhance students' creativity [36]. The above evidence supports the plasticity of the brain, and the intervention of exercise improves the cognitive performance of college students.

Under the epidemic, the increase in sedentary behavior will lead to multiple harms, and increasing the amount of physical activity is a protective factor against the harm of sedentary behavior. Scholars such as Joubert L et al [37] believe that low-intensity cycling can maintain students' academic performance and may reduce weekly sedentary behavior. It should be emphasized that insisting on regular physical exercise during the isolation period requires strong self-discipline, and cognitive flexibility may increase self-regulation and control ability, thereby participating in more physical activities [38]. Aerobic exercise for five weeks enhanced the pain tolerance of college students after exercise and improved the self-control of female college students [39]. Accordingly, exercise intervention breaks the sedentary behaviors of college students, thereby improving academic performance by improving inhibitory control.

2.3.2 Suppress negative emotions and enhance willpower

Under the epidemic, the main negative emotions of college students are depression, anxiety, stress, etc., which are caused by the special environment. It is necessary to take positive behaviors to suppress the negative emotions of college students, overcome pressure and anxiety, and enhance the quality of will. The process of sports is a process of constantly surpassing oneself and improving one's self, and then tempering the will, improving the personality, and cultivating a healthy psychological orientation in engaging in sports.

Studies have shown that there is a significant correlation between the amount of physical activity of college students and the prevalence of depression [40], and engaging in physical exercise will reduce the negative emotions of college students. With the loss of a normal life structure, people begin to panic and become anxious, and college students begin to worry about academic progress, employment issues, etc., their mental state will deteriorate, and their willpower will become weaker and weaker. However, regular physical exercise is an important protective factor for college students to alleviate their negative emotions [41], enhance the will quality of college students, and cultivate a positive and healthy attitude. Exercise can improve the health belief level of college students and directly affect the psychological pressure of college students. It can also indirectly affect psychological pressure and improve mental health through the health beliefs of college students. Teachers used online dance to treat college students' mental health, and the virtual video platform was free and open. The results found that dance intervention effectively alleviated the anxiety and depression of college students during the epidemic [43], and this method has good feasibility.16-week Taijiquan exercise can reduce the levels of serum court, pro-inflammatory factors TNF-α and IL-6 in college students, enhance the level of anti-inflammatory factor IL-10, and effectively improve the depression state of college students [44].

Scholars such as Herbert C (2020) conducted a 6-week aerobic exercise intervention on 185 college students and found that regular physical activity improved college students' depression, anxiety, and psychosomatic stress, and had a positive impact on their quality of life [45]. Early in the outbreak, a longitudinal study suggested that COVID-19 indirectly affected college students' negative emotions by improving their sleep quality, however, physical activity could be an effective strategy for improving mental health and sleep [46]. Therefore, under the isolation state, sports intervention has a positive effect on the anxiety and depression of college students. On the contrary, people who regularly engage in physical exercise will have a higher defense capacity against emergencies than those who do not exercise. Jacob L et al [47] also found that during the COVID-19 epidemic, people who regularly engage in physical exercise have better overall mental health than others, In addition, during moderate-intensity physical activity, college students who exercised more frequently were at lower risk of depression, anxiety, and stress [48].

2.3.3 Improve interpersonal relationships and enhance social adaptation

There are many differences in the psychology of contemporary college students from different backgrounds and different environments. In the process of growing up, various pressures from family, society, and individuals cause students to be withdrawn, introverted, unwilling to communicate with others, etc., interpersonal relationships in life are tense, and social adaptability is weak, which will affect their future of college students. Development is very unfavorable. Studies have shown that sports intervention has a direct effect on the mental health of college students. Participating in physical exercise can relieve stress, regulate emotions, and improve interpersonal relationships [11]. Physical activity itself is a social activity of social adaptation, especially in group projects or ball games, people contact and communicate with each other, encourage and help each other, and effectively reduce the hostility and sensitivity of college students in interpersonal communication. mentality has a positive effect on improving interpersonal relationships [49].In their research, Jiao Xiaoxia et al. [50] found that after 16 weeks of Wuqinxi intervention, female college students' interpersonal sensitivity and depression factors changed significantly. The results suggest that Wuqinxi can regulate the body and mind of college students, stabilize their emotions, and eliminate their distracting thoughts. , thereby improving the mental health of college students.

College students are in an important stage of cognitive transformation and value formation. In addition to facing problems such as interpersonal communication, social adaptation is also an important aspect that cannot be ignored. Studies have shown that regular physical exercise can improve college students' mental health, psychological capital, and social adaptability, and obtain greater social support from exercise [51]. Faced with similar major health events, the psychological coping mechanism of college students has a greater impact on mental health. Physical activity may inhibit the overactive sympathetic nervous system response, thereby improving college students' ability to resist stress and reducing the stress of COVID-19. response intensity and face stressful events with a positive mindset [52]. For special college students, the problem of mental health is particularly prominent.

After 8 weeks of moderate-intensity Baduanjin exercise intervention, the self-assessment health level of special college students has been effectively improved, and the communication between special college students and teachers and classmates has been enhanced, thereby enhancing their performance. social adaptability [53]. The same is true in dance programs. Dance training can promote college students' coping style to be more positive in the face of stress, and then adjust their mental sub-health state [54]. From a cognitive point of view, as college students in the new era, not only should they have innovative knowledge concepts, a solid knowledge base, and healthy psychology, but also can adapt to changes in the environment, know how to get along with others, and deal with problems independently. And sports is a good means to improve the social adaptation of college students [55].

2.3.4 Improve self-efficacy and improve the level of subjective well-being.

Self-efficacy refers to an individual's confidence in one's ability or completing a certain behavior. Self-efficacy affects college students' behavioral choices, cognitive processes, and emotional processes [56]. In addition, the life satisfaction and subjective well-being of college students are the important basis for their mental health. Research shows that physical exercise is an important "magic weapon" for improving college students' self-efficacy and subjective well-being. Female college students often participate in aerobics exercise, and their mental health level and self-efficacy level. It is worth noting that self-efficacy level, as a mediating variable of mental health level, is significantly correlated with negative emotions such as depression, anxiety, and stress in mental health. Negative correlation [57]. Among 265 elective students, it was found that under the epidemic situation, participating in Tai Chi, physical training, and other sports can regulate the emotional self-regulation efficacy of college students, thereby improving the mental health level of college students [58]. In addition, self-efficacy can better enhance college students to overcome difficulties and persist in exercising and has good compliance. Wei Qiang et al. [12] found that physical exercise improved the mental health and self-efficacy of weak college students. Strong willingness to participate in sports activities, therefore, in a special period, is a good strategy to improve the self-efficacy of college students through sports intervention. Six-week aerobic exercise intervention significantly improved the subjective well-being of college students, and stress and depression played a mediating role between exercise and well-being [45]. Canadians with higher levels of physical activity will have higher levels of subjective well-being during the COVID-19 pandemic.

To sum up, the positive effect of sports intervention on the mental health of college students is beyond doubt. A large body of evidence shows that physical activity participation has a greater impact on cognitive performance, negative emotions, social adjustment, and subjective well-being, and it is found that there is a dose effect of the impact of an exercise intervention on mental health, The mental health level of college students who often engage in physical exercise is better than that of those who do not exercise. It can be seen that exercise can be used as an effective strategy to maintain or improve the mental health of college students.

2.4 Mechanisms of sports intervention to improve the mental health of college students

2.4.1 Physiological mechanism

1) Improve neurotransmitter expression. The increase in the secretion of neurotransmitter molecules will affect people's mental health. Exercise can increase the synthesis and release of neurotransmitters and neurotrophic factors, which may be beneficial to angiogenesis and neuroplasticity, and promote the increase of blood circulation in the brain [59]. Exercise intervention increased insulin-like growth factor 1 (IGF-1), phosphatidylinositol-3-hydroxylase (PI3K), brain-derived neurotrophic factor (BDNF), extracellular signal-regulated kinase levels; Furthermore, physical exercise enhances the activity of pathways such as irisin, leading to neuronal survival and maintenance of good mental health [60]. Results from clinical studies have also shown that stress and depression reduce neurotrophic factor expression and neuron proliferation in the brain, while exercise blocks stress and antidepressant effects by enhancing neurotransmitter expression [61]. Brain-derived neurotrophic factor is a potential mechanism by which acute exercise affects memory function, and long-term exercise has been shown to increase the concentration of BDNF in the hippocampus [62]. In addition, physical exercise changes the hypothalamic-pituitary-adrenal cortex system by controlling the level of serum cortisol, reducing the secretion of corticotropin-releasing hormone adrenocorticotropic hormone, thereby reducing the function of the HPA axis and improving people's mental health [63 - 65].

2) Promote the release of endorphins. During physical exercise, a morphine-like chemical is secreted in the brain, especially the secretion of beta-endorphin, which relieves depression, pain, and anxiety, and produces a feeling of joy [66]. Long-term runners describe the pleasure of running as a sudden uplifting, calming, and analgesic effect, and these sensory responses are mediated by beta-endorphins produced during running [67]. Elevated beta-endorphin concentrations are associated with a variety of psychological and physiological changes, including changes in an emotional state and exercise-induced euphoria, as well as altered pain perception, anxiety, etc. [68-69]. It is worth noting that the secretion of β-endorphin, which is closely related to nerve regeneration, increases significantly after exercise [70], and this physiological change will positively affect the change of mental state.

3) Regulate the nervous system. Exercise mediates nervous system development by regulating neurotrophic factors, specific cellular molecules in the brain. Exercise intervention can regulate the human sympathetic nervous system, thereby relieving depression and anxiety, and inhibiting negative emotions under adverse stress. In addition, the HPA axis and BDNF also have a positive effect on the nervous system under the induction of exercise [71]; Recent reviews suggest that exercise intervention promotes synaptic plasticity, nerve regeneration, angiogenesis, and autophagy, which in turn moderately activates the parasympathetic nervous system, autonomic nervous system, and central nervous system, thereby preventing and protecting sleep disorders and cognitive disorders. and the role of mood disorders [72]. In addition, it was found in animal experiments that exercise reversed the harmful effects of the central nervous system on the emotional and spatial performance of rats, and the behavioral changes caused by the central nervous system may be related to hippocampal BDNF levels [73].

2.4.2 Psychological mechanism

1) Improvement in cognitive behavior. Exercise not only improves physical fitness, but it also has a positive relationship with self-evaluation and self-esteem, Mastering a difficult task during exercise promotes the individual's perception of physical abilities and motivates the individual to continue to engage in healthy behaviors [74]. Thus, a positive cognitive-behavioral cycle promotes physical and mental health. Studies have shown that improving self-esteem and confidence in control during exercise, thereby enhancing a sense of control over stressful situations, can also shift individuals' unpleasant cognitive emotions and behaviors [75]. Under the epidemic, through the intervention of sports, it is very important to enhance the individual's correct cognition of external things, especially in the face of infection-related information processing, and actively respond to external stress changes, which is of great importance to the psychological state [76]. In addition, the positive emotions and experiences induced by exercise have positive significance for negative emotions such as depression and anxiety, such as physical self-esteem, self-efficacy, etc. Such experiences and positive emotions can effectively help individuals fight against depression, anxiety, and other negative emotions, and promote psychological health [70].

2) Distraction. Distraction is a way of responding when people are busy with an attractive activity (e.g. hobby, work), distracting themselves from stressors to enjoy moments of physical activity, thereby effectively reducing attention to negative emotions [77], reducing the psychological state of tension. Distraction is a key factor in increasing the intensity of positive emotions after exercise [78], fully enjoying the pleasant experience brought about by exercise. It is worth noting that during the epidemic, the degree of negative information acquisition about the COVID-19 pandemic is related to anxiety symptoms, and positive experiences and distractions during physical exercise can slow down negative emotions [79]. Exercise intervention at this time enhances the individual's sense of control, and a sense of self-reflection in emotional states leads to an increase in self-efficacy and a shift of attention to more positive points of control [74]. Therefore, exercise intervention improves the individual's mental health status by distracting attention.

3) Social support. Social support is help or care that comes from outside the individual. Social support can increase knowledge related to the pandemic to increase self-efficacy and maintain or promote mental health, and high-risk levels undermine the role of self-efficacy in promoting mental health. Therefore, in the fight against COVID-19, people need to support and cooperate to increase self-efficacy and reduce risk to maintain and promote mental health [80]. Different doses of exercise intervention can improve students' self-efficacy and reduce their risk of depression. In addition, increasing school and social support is an important measure to improve college students' mental health [81]. Social support improves college students' sense of security and positive psychological capital, thereby enhancing their life satisfaction [82]. Recent studies have shown that during the COVID-19 epidemic, social support can not only directly inhibit the negative emotions of college students, but also indirectly inhibit the negative emotions of college students through the chain mediating effect of resilience and self-esteem [83]. In addition, social support has a protective effect on the mental health of returning college students, helps to enhance the life adaptability of returning college students, and has positive significance in promoting their recovery after stress or trauma [84]. In summary, the influence path and mechanism of exercise to improve mental health are shown in Figure 2.

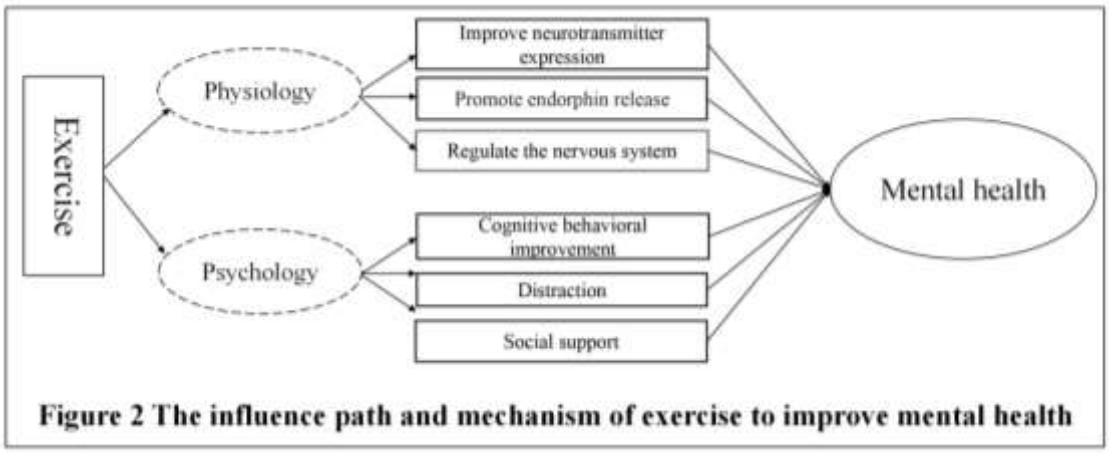

Figure 2 The influence path and mechanism of exercise to improve mental health

3 Conclusions and Recommendations

According to the review of this article, during the COVID-19 epidemic, factors such as home isolation, closed management, and social distancing led to negative emotions such as anxiety, stress, and depression among college students, which seriously affected their physical and mental health. Although there is currently no clear comprehensive mechanism to explain how to exercise intervention improves the mental health of college students, exercise intervention is an important means to regulate college students' mental health, which can improve college students' cognitive function, relieve their negative emotions, improve their interpersonal relationships, and enhance their Self-efficacy, which is crucial to the healthy development of college students. This article only discusses exercise intervention therapy and does not involve other adjustment methods such as psychological intervention. Future research can explore the positive benefits of multi-modal comprehensive intervention on college students' mental health.

In the post-epidemic era, the global epidemic crisis has not been resolved. To prevent it from happening, it is meaningful to actively take measures to deal with the negative crisis brought about by COVID-19. Therefore, this article calls on, first, college students to actively participate in personalized and comprehensive sports to improve their mental health and improve their adaptability to the epidemic. ; Second, college students should reduce screen time and sedentary behavior, increase physical activity, and promote the development of physical and mental health; Third, college students should develop positive health behaviors, such as healthy lifestyles such as reasonable diet, early going to bed and early rising, and diligent communication and relaxation. In conclusion, college students should pay attention to their physical and mental health under COVID-19, and take reasonable and effective ways to mitigate the negative impact of the epidemic.

References

[1] Lai CC, Shih TP, Ko WC, et al. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. Int J Antimicrob Agents. 2020 Mar;55(3):105924.

[2] Brooks SK, Webster RK, Smith LE, et al. The psychological impact of quarantine and how to reduce it: a rapid review of the evidence. Lancet. 2020 Mar 14;395(10227):912-920.

[3] Blackman JS. A psychoanalytic view of reactions to the coronavirus pandemic in China. Am J Psychoanal. 2020 Jun;80(2):119-132.

[4] Xiao P, Chen L, Dong X, et al. Anxiety, Depression, and Satisfaction With Life Among College Students in China: Nine Months After Initiation of the Outbreak of COVID-19. Front Psychiatry. 2022 Jan 18;12:777190.

[5] Li Y, Wang A, Wu Y, et al.Impact of the COVID-19 Pandemic on the Mental Health of College Students: A Systematic Review and Meta-Analysis. Front Psychol. 2021 Jul 14;12:669119.

[6] LaCaille L J, Hooker SA, Marshall E,et al. Change in Perceived Stress and Health Behaviors of Emerging Adults in the Midst of the COVID-19 Pandemic. Ann Behav Med. 2021 Oct 27;55(11):1080-1088.

[7] Cao W, Fang Z, Hou G, et al.The psychological impact of the COVID-19 epidemic on college students in China. Psychiatry Res. 2020 May;287:112934.

[8] Schuch FB, Bulzing RA, Meyer J, et al. Associations of moderate to vigorous physical activity and sedentary behavior with depressive and anxiety symptoms in self-isolating people during the COVID-19 pandemic: A cross-sectional survey in Brazil. Psychiatry Res. 2020 Oct;292:113339.

[9] Jinghui Chang, Yuxin Yuan, Dong Wang. Analysis of the mental health status and influencing factors of college students under the new coronavirus pneumonia epidemic [J]. Journal of Southern Medical University, 2020, 40(02): 171-176.

[10] Planchuelo-Gómez Á, Odriozola-González P, Irurtia MJ, et al. Longitudinal evaluation of the psychological impact of the COVID-19 crisis in Spain. J Affect Disord. 2020 Dec 1;277:842-849.

[11] Hengchan Yin, Min Lu, Xinli Wang, et al. Research on the influence of exercise on the mental health of college students [J]. Sports Science, 2007(05):41-46+56.DOI:10.16469/j.css.2007.05.006.

[12] Qiang Wei. Intervention effect of different exercise modes on mental health and self-efficacy of college students with weak constitution [J]. China School Health, 2018, 39(02): 281-284.

[13] Chongde Lin, Hong Li, Feng Ruiqin. Scientific understanding of mental health and mental health education [J]. Journal of Shaanxi Normal University (Philosophy and Social Sciences Edition), 2003(05):110-116.

[14] Huashan Liu. Re-understanding of the concept and standard of mental health [J]. Psychological Science, 2001(04): 481-480.Thirunavurakasu M, Thirunavukarasu P, Bhugra D. Concepts of mental health: definitions and challenges. Int J Soc Psychiatry. 2013 May;59(3):197-8.

[15] Galderisi S, Heinz A, Kastrup M,. Toward a new definition of mental health. World Psychiatry. 2015 Jun;14(2):231-3.
[16] Awais MA, Chaudhery MM, Khan MS, B et al. Factors contributing to distress among school and college-going adolescents during COVID-19 Lockdown: A cross-sectional study conducted in Sibi Balochistan, Pakistan. J Educ Health Promot. 2021 Aug 31;10:317.
[17] Liu CH, Zhang E, Wong GTF, Hyun S,et al. Factors associated with depression, anxiety, and PTSD symptomatology during the COVID-19 pandemic: Clinical implications for U.S. young adult mental health. Psychiatry Res. 2020 Aug;290:113172.
[18] Zhao Y, Jiang Z, Guo S, et alAssociation of Symptoms of Attention Deficit and Hyperactivity with Problematic Internet Use among University Students in Wuhan, China During the COVID-19 Pandemic. J Affect Disord. 2021 May 1;286:220-227.
[19] Tao X, Chen D, Fan Y,et al. A cross-sectional study for the mental health status and sleep quality among college students in Macao during the COVID-19 pandemic. PeerJ. 2021 Dec 7;9:e12520.
[20] Chang J, Yuan Y, Wang D. [Mental health status and its influencing factors among college students during the epidemic of COVID-19]. Nan Fang Yi Ke Da Xue Xue Bao. 2020 Feb 29;40(2):171-176. Chinese.
[21] Khan AH, Sultana MS, Hossain S, et al. The impact of COVID-19 pandemic on mental health & wellbeing among home-quarantined Bangladeshi students: A cross-sectional pilot study. J Affect Disord. 2020 Dec 1;277:121-128.
[22] Dubey S, Biswas P, Ghosh R, et al. Psychosocial impact of COVID-19. Diabetes Metab Syndr. 2020 Sep-Oct;14(5):779-788.
[23] Ma Z, Zhao J, Li Y, et al. Mental health problems and correlates among 746 217 college students during the coronavirus disease 2019 outbreak in China. Epidemiol Psychiatr Sci. 2020 Nov 13;29:e181.
[24] Yuqing Zhao, Yuanyuan An, Xing Tan ,et al. Mental Health and Its Influencing Factors among Self-Isolating Ordinary Citizens during the Beginning Epidemic of COVID-19, Journal of Loss and Trauma, 2020,25:6-7, 580-593,
[25] Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985 Mar-Apr;100(2):126-31.
[26] Ruegsegger GN, Booth FW. Health Benefits of Exercise. Cold Spring Harb Perspect Med. 2018 Jul 2;8(7):a029694.
[27] Chenglin Zhou, Xinhong Jin. Interpretation of the theory and practice of sports to improve learning efficiency from brain science [J]. Journal of Shanghai Institute of Physical Education, 2021, 45(01): 20-28.
[28] Mualem R, Leisman G, Zbedat Y, et al. The Effect of Movement on Cognitive Performance. Front Public Health. 2018 Apr 20;6:100.
[29] Sng E, Frith E, Loprinzi PD. Temporal Effects of Acute Walking Exercise on Learning and Memory Function. Am J Health Promot. 2018 Sep;32(7):1518-1525.
[30] Frith E, Sng E, Loprinzi PD. Randomized controlled trial evaluating the temporal effects of high-intensity exercise on learning, short-term and long-term memory, and prospective memory. Eur J Neurosci. 2017 Nov;46(10):2557-2564.

[31] Slusher AL, Patterson VT, Schwartz CS, et al. Impact of high intensity interval exercise on executive function and brain derived neurotrophic factor in healthy college aged males. Physiol Behav. 2018 Jul 1;191:116-122.
[32] Martínez-Díaz IC, Escobar-Muñoz MC, Carrasco L. Acute Effects of High-Intensity Interval Training on Brain-Derived Neurotrophic Factor, Cortisol and Working Memory in Physical Education College Students. Int J Environ Res Public Health. 2020 Nov 6;17(21):8216.
[33] Chien-Heng Chu,Brandon L.Alderman,et al. Effects of acute aerobic exercise on motor response inhibition: An ERP study using the stop-signal task [J].Journal of Sport and Health Science,2015,4(01):73-81+107+111.
[34] Fan H, Qi S, Huang G,et al. Effect of Acute Aerobic Exercise on Inhibitory Control of College Students with Smartphone Addiction. Evid Based Complement Alternat Med. 2021 Aug 5;2021:5530126.
[35] Christian Büning, Lara Jürgens & Hedda Lausberg . Divergent learning experiences in sports enhance cognitive executive functions and creativity in students, Physical Education and Sport Pedagogy, 2021, 26:4, 402-416,
[36] Joubert L, Kilgas M, Riley A, et al. In-Class Cycling to Augment College Student Academic Performance and Reduce Physical Inactivity: Results from an RCT. Int J Environ Res Public Health. 2017 Nov 4;14(11):1343.
[37] Kelly SM, Updegraff JA. Substituting activities mediates the effect of cognitive flexibility on physical activity: a daily diary study. J Behav Med. 2017 Aug;40(4):669-674.
[38] Zou Z, Liu Y, Xie J,et al. Aerobic Exercise As a Potential Way to Improve Self-Control after Ego-Depletion in Healthy Female College Students. Front Psychol. 2016 Apr 18;7:501.
[39] Zhang Y, Wu X, Tao S, et al. Associations between screen time, physical activity, and depressive symptoms during the 2019 coronavirus disease (COVID-19) outbreak among Chinese college students. Environ Health Prev Med. 2021 Nov 2;26(1):107.
[40] Bourion-Bédès S, Tarquinio C, Batt M, et al. Stress and associated factors among French university students under the COVID-19 lockdown: The results of the PIMS-CoV 19 study. J Affect Disord. 2021 Mar 15;283:108-114.
[41] Chunlei Zhang, Shouwei Zhang, Kunpeng Xiao. The effect of exercise intervention on college students' psychological stress: the mediating effect of health beliefs [J]. Journal of Chengdu Institute of Physical Education, 2016, 42(04): 103-108
[42] Bohn J, Hogue S. Changing the Game: College Dance Training for Well-Being and Resilience Amidst the COVID-19 Crisis. Health Promot Pract. 2021 Mar;22(2):163-166.
[43] Jinxia Chen, Yuanhao Li, Yingqing Wu, et al. Effects of Taijiquan exercise on depression and serum inflammatory factors in female college students [J]. Chinese School Health, 2019, 40(07): 1065-1068.
[44] Herbert C, Meixner F, Wiebking C, et al. Regular Physical Activity, Short-Term Exercise, Mental Health, and Well-Being Among University Students: The Results of an Online and a Laboratory Study. Front Psychol. 2020 May 26;11:509.
[45] Zhang Y, Zhang H, Ma X, et al. Mental Health Problems during the COVID-19 Pandemics and the Mitigation Effects of Exercise: A Longitudinal Study of College Students in China. Int J Environ Res Public Health. 2020 May 25;17(10):3722.

[46] Jacob L, Tully MA, Barnett Y, et al. The relationship between physical activity and mental health in a sample of the UK public: A cross-sectional study during the implementation of COVID-19 social distancing measures. Ment Health Phys Act. 2020 Oct;19:100345.
[47] Xiaomi Lin, Jianqing Xu. The impact of physical exercise on the mental health of college students under the new coronavirus pneumonia epidemic [J]. Chinese School Health, 2020, 41(11): 1682-1687. DOI: 10.16835/j.cnki.1000- 9817.2020.11.023
[48] Mingsheng Xiong, Xucheng Guo, Zongkui Zhou. The influence of exercise behavior, experience, and willingness on the mental health of college students [J]. Journal of Wuhan Institute of Physical Education, 2011, 45(03): 48-51.
[49] Xiaoxia Jiao, Hong Ji, Jing Chen. Effects of traditional Wuqinxi on physical fitness and mental health of female college students [J]. Chinese School Health, 2021, 42(09): 1323-1327.
[50] Xiaolong Lu, Kun Wang. Influence of extracurricular physical exercise on mental health and social adaptability of college students' psychological capital [J]. Chinese School Health, 2019, 40(03): 392-395.
[51] Liu Y, Wang Z, You S. The Mediating Effect of Coping Style on Physical Activity and Negative effect Caused by Public Health Emergencies: Evidence from Chinese College Students. Int J Environ Res Public Health. 2021 Nov 17;18(22):12086.
[52] Liang Gao, Lihua Wang, Liugen Xiao, et al. Effects of Baduanjin exercise on the self-assessed health status of some special college students in China [J]. Journal of Capital Institute of Physical Education, 2020, 32(04): 374-378.
[53] Hui Yang, Guangwei, Che, Yujuan Feng, et al. Effects of physical dance exercise on mental sub-health status of college students: the mediating effect of coping style [J]. Journal of Tianjin Institute of Physical Education, 2020,35(05):560-565.
[54] Ji H, Zheng C. The influence of physical exercise on college student's mental health and social adaptability from the cognitive perspective. Work. 2021;69(2):651-662.
[55] Wenxia Zhou, Guiping Guo. Self-efficacy: Concept, Theory, and Application[J]. Journal of the Renmin University of China, 2006(01):91-97.
[56] Haiyan Liu, Zhaogang Tong, Jun Yan. A study on the effects of aerobics at different times and intensities on female college students' self-efficacy and mental health [J]. Journal of Xi'an Institute of Physical Education, 2007(01):125-129.
[57] Yang Liu, Xuening Li, Xieshun Wang, et al. The mediating effect of an exercise intervention on negative emotion regulation self-efficacy of home students during the novel coronavirus pneumonia epidemic [J]. Journal of Beijing Sport University, 2020, 43(03): 76- 83.
[58] Matta Mello Portugal E, Nevada T, Sobral Monteiro-Junior R, et al. Neuroscience of exercise: from neurobiology mechanisms to mental health. Neuropsychobiology. 2013;68(1):1-14.
[59] De Sousa RAL, Improta-Caria AC, Aras-Júnior R, et al. Physical exercise effects on the brain during COVID-19 pandemic: links between mental and cardiovascular health. *Neurol Sci*. 2021;42(4):1325-1334.
[60] Duman RS. Neurotrophic factors and regulation of mood: role of exercise, diet and metabolism. Neurobiol Aging. 2005 Dec;26 Suppl 1:88-93. doi: 10.1016/j.neurobiolaging.2005.08.018. Epub 2005 Oct 13.

[61] Loprinzi PD. Does brain-derived neurotrophic factor mediate the effects of exercise on memory? Phys Sportsmed. 2019 Nov;47(4):395-405.
[62] Parker KJ, Schatzberg AF, Lyons DM. Neuroendocrine aspects of hypercortisolism in major depression. Horm Behav. 2003 Jan;43(1):60-6.
[63] Rimmele U, Zellweger BC, Marti B, et al. Trained men show lower cortisol, heart rate, and psychological responses to psychosocial stress compared with untrained men. *Psychoneuroendocrinology*. 2007;32(6):627-635.
[64] de Oliveira, L., Machado, F., Rocha-Dias, I., et al. (2022). An overview of the molecular and physiological antidepressant mechanisms of physical exercise in animal models of depression. *Molecular biology reports*,
[65] Xinhua Bi, Yanchun Peng. The effect of physical exercise on the mental health of college students [J]. China Sports Science and Technology, 2003(03):31-32.DOI:10.16470/j.csst.2003.03.012.
[66] Fuss J, Steinle J, Bindila L, et al. A runner's high depends on cannabinoid receptors in mice. *Proc Natl Acad Sci U S A*. 2015;112(42):13105-13108. doi:10.1073/pnas.1514996112
[67] Harber VJ, Sutton JR. Endorphins and exercise. *Sports Med*. 1984;1(2):154-171.
[68] Tendzegolskis Z, Viru A, Orlova E. Exercise-induced changes of endorphin contents in hypothalamus, hypophysis, adrenals and blood plasma. *Int J Sports Med*. 1991;12(5):495-497.
[69] Changjun Li, Henan Jia, Junnan Zuo. The effect, mechanism, and prospect of exercise on promoting mental health [J]. China Sports Science and Technology, 2015, 51(01): 132-139.
[70] Nana Han, Aiwen Wang, Lei Yu, et al. The potential biological mechanism of physical activity to help prevent and control the epidemic during the COVID-19 epidemic [J]. Journal of Capital Institute of Physical Education, 2021, 33(04): 384-395.
[71] Mahalakshmi B, Maurya N, Lee SD, et al. Possible Neuroprotective Mechanisms of Physical Exercise in Neurodegeneration. *Int J Mol Sci*. 2020;21(16):5895.
[72] Zheng H, Liu Y, Li W, et al. Beneficial effects of exercise and its molecular mechanisms on depression in rats. *Behav Brain Res*. 2006;168(1):47-55.
[73] Chow YW, Tsang HW. Biopsychosocial effects of qigong as a mindful exercise for people with anxiety disorders: a speculative review. *J Altern Complement Med*. 2007;13(8):831-839. doi:10.1089/acm.2007.7166
[74] Liu Ji, Lin Li, Xiaozan Wang. The effect of physical exercise on mental health [J]. Journal of Shandong Institute of Physical Education, 1998(01):38-43.
[75] Thoma V, Weiss-Cohen L, Filkuková P, et al.Cognitive Predictors of Precautionary Behavior During the COVID-19 Pandemic. *Front Psychol*. 2021;12:589800. Published 2021 Feb 25. doi:10.3389/fpsyg.2021.589800
[76] Ai X, Yang J, Lin Z, et al. Mental Health and the Role of Physical Activity During the COVID-19 Pandemic. *Front Psychol*. 2021;12:759987. Published 2021 Oct 20.
[77] Privitera GJ, Antonelli DE, Szal AL. An enjoyable distraction during exercise augments the positive effects of exercise on mood. *J Sports Sci Med*. 2014;13(2):266-270.

[78] Ebrahimi OV, Hoffart A, Johnson SU. Physical Distancing and Mental Health During the COVID-19 Pandemic: Factors Associated With Psychological Symptoms and Adherence to Pandemic Mitigation Strategies. Clinical Psychological Science. 2021;9(3):489-506.
[79] Wang S, Feng K, Zhang Y, et al. Antecedents of Public Mental Health During the COVID-19 Pandemic: Mediation of Pandemic-Related Knowledge and Self-Efficacy and Moderation of Risk Level. *Front Psychiatry*. 2020;11:567119. Published 2020 Nov 12.
[80] Xiang M, Gu X, Zhang X, et al. Psychosocial Mechanism of Adolescents' Depression: A Dose-Response Relation with Physical Activity. *Children (Basel)*. 2020;7(4):37.
[81] Yanfan Jia, Xuejun Bai, Zhijie Zhang, et al. The impact of social support on college student's life satisfaction: the chain mediating effect of security and positive psychological capital [J]. Chinese Journal of Health Psychology, 2021, 29(11): 1703 -1707.
[82] Yang Shu, Jia Yang, Shaoyun Yang, et al. The effect of social support on college students' anxiety during the COVID-19 control period: the chain mediating effect of self-esteem and resilience [J]. Chinese Journal of Clinical Psychology, 2021, 29(06): 1333-1336 +1342.
[83] Jing Liu, Ming Wang, Qiwu Sun. Influencing factors of college students' adaptation after returning to school in the post-epidemic era [J]. Chinese Journal of Clinical Psychology, 2021, 29(06): 1337-1342.