ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202512_8(12).0034

Study on the Mechanism of Exercise Intervention on College Students' Mental Health

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Abstract

Objective:To systematically summarize the research progress of exercise intervention on college students' mental health, clarify the mechanisms by which exercise improves anxiety, depression, stress, sleep disorders and other issues, and provide evidence-based basis for promoting mental health in colleges and universities. Methods: Retrieve relevant literature from Chinese and English databases (CNKI, Wanfang, PubMed, Web of Science) in the past ten years, screen randomized controlled trials, longitudinal studies and systematic reviews involving college students, and summarize the effects and mechanisms of exercise intervention. Results: Studies have shown that regular exercise can significantly reduce college students' anxiety and depression levels, lower subjective stress, and improve attention, executive function and sleep quality. At the mechanism level, exercise exerts positive effects through multiple pathways: Physiologically, it promotes the secretion of brain-derived neurotrophic factor (BDNF), regulates the function of the hypothalamic-pituitary-adrenal axis, and reduces cortisol levels, thereby alleviating stress responses; Psychologically, exercise enhances self-efficacy, attention control and emotion regulation ability, and improves psychological resilience; Socially, group exercise activities improve social support and interpersonal connection, and reduce loneliness. There are differences in intervention effects among different exercise forms. Aerobic exercise and mind-body integrated exercise (such as yoga and tai chi) are more effective in reducing stress and improving mood. Conclusion: Exercise intervention is an effective way to improve college students' mental health, and its mechanism involves multiple physiological, psychological and social levels. Future research needs to strengthen large-sample, long-term longitudinal tracking and multimodal measurement to reveal the differentiated effects and sustainable mechanisms of exercise intervention, and provide practical paths for college mental health services.

Keywords

Exercise Intervention; College Students; Mental Health; Mechanism of Action.

1. Introduction

In recent years, college students' mental health problems have become increasingly prominent, with frequent occurrences of anxiety, depression, excessive stress and sleep disorders. The latest large-sample study confirms this trend. A national study published by Han et al. in BMC Public Health in 2025 surveyed 49,717 college students from 106 universities across the country through multi-stage sampling. The results showed that the detection rate of depressive symptoms was 9.8%, anxiety symptoms was 11.5%, and 6.5% of students had both problems. Anxiety and depression are prevalent among college students. Further analysis found that senior students (10.3% depression detection rate in the fourth grade) are at higher risk than

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junior students, and there is no statistically significant correlation between students' gender and the detection rate of depression and anxiety (P>0.05) [1]. A meta-analysis published by Lin et al. in BMC Psychology in 2025 summarized 32 cross-sectional studies (total sample of 93,679 people) and concluded that the comprehensive detection rate of depressive symptoms among Chinese college students was 34.70% (95% CI: 30.27%-39.26%); Subgroup analysis showed that the detection rate of depression during/after the pandemic (38.7%) was significantly higher than that before the pandemic (35.0%), the detection rate of medical students (38.3%) was higher than that of comprehensive major students (33.7%), and there were significant differences among different regions and measurement tools, showing an overall upward trend [2]. Traditional psychological interventions (such as counseling and medication) are effective but have limitations such as high cost and low compliance. As a natural, low-cost and sustainable non-pharmacological therapy, exercise intervention has gradually become an important means to promote mental health in colleges and universities.

A large number of empirical studies have shown that regular physical exercise can effectively alleviate negative emotions, improve self-efficacy and cognitive function, and have positive effects on college students' emotion regulation, social adaptation and quality of life [3-4]. However, there is still a lack of systematic integration of the mechanisms by which exercise intervention improves mental health. By systematically sorting out domestic and foreign literature in the past ten years, this paper explores the multi-layered mechanisms of exercise intervention affecting college students' mental health, and provides a theoretical basis for promoting college mental health and formulating exercise prescriptions.

2. Research Methods

2.1. Literature Retrieval and Screening Criteria

Retrieve databases such as CNKI, Wanfang, PubMed, and Web of Science, with a time limit of 2015-2025. Keywords include "college students", "exercise intervention", "mental health", "depression", "anxiety", etc. The inclusion criteria are: ① The research objects are college students; ② Adopt randomized controlled trials, longitudinal studies or systematic reviews; ③ Report mental health indicators (such as anxiety, depression, stress, sleep quality, etc.); ④ Published in peer-reviewed journals.

2.2. Research Types and Analysis Methods

Literature research method and logical analysis method are used to summarize the effects of exercise intervention and its physiological, psychological and social mechanisms, and conduct comprehensive demonstration combined with the latest meta-analysis results.

3. Research Results and Analysis

3.1. Overall Improvement Effect of Exercise Intervention on College Students' Mental Health

A large number of empirical studies and meta-analyses have consistently shown that physical exercise has a significant improvement effect on college students' mental health, especially in alleviating anxiety, depression and psychological stress. Chen et al. (2025) conducted a systematic review and meta-analysis with 514 college students as samples. Exercise intervention has a significant large effect on reducing college students' anxiety levels (effect size d=-0.83, 95% confidence interval [-1.18, -0.48], P<0.001), suggesting that regular exercise can significantly alleviate college students' anxiety and improve emotional stability [3].

A network meta-analysis published by Xiao et al. (2025) in BMC Public Health included 42 randomized controlled trials (total sample of 1,169 people) to systematically compare the

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improvement effects of six types of exercise interventions on college students' depressive symptoms. The results showed that the combined Special Training Units (STU) and Dance and Rhythmic Movement Groups (DRMG) had the most significant effects, with comprehensive SUCRA values of 65.1% and 64.8% respectively, which were significantly better than the traditional Aerobic Exercise Group (AEG, 61.3%) and Strength Training Group (SRTG, 60.9%). STU intervention combines physical activity with psychological behavioral activation techniques, which can improve both physiological and psychological states; DRMG enhances positive emotional experience through rhythmic movement, music stimulation, body perception and mindfulness. In contrast, High-Intensity Training (HITG) and Moderate-Intensity Exercise (MIG) had weaker effects (SUCRA = 26.2%, 21.7%) [5], which may be related to excessive physiological stress or insufficient stimulation. The study believes that exercise forms with strong rhythm, emotional involvement and physical-mental integration are more conducive to promoting positive emotional recovery and depression relief, providing evidence-based basis for colleges and universities to formulate differentiated exercise prescriptions.

A systematic review published by Singh et al. (2023) in the British Journal of Sports Medicine integrated 97 reviews and a total of 1,039 randomized controlled studies (sample size exceeding 128,000 people), pointing out that the moderate effects of physical activity on depression, anxiety and psychological distress are common in different populations, with average effect sizes of SMD = -0.43 (depression) and SMD = -0.42 (anxiety) respectively, and moderate to high intensity exercise has the most significant improvement effect (Singh et al., 2023) [6].

Overall, the promoting effect of exercise intervention on college students' mental health has been fully verified. Whether it is short-term aerobic exercise, team sports, or mind-body integrated exercise, it can effectively alleviate negative emotions and reduce psychological stress, providing a solid foundation for subsequent exploration of the physiological, psychological and social mechanisms of exercise.

3.2. Comparison of Different Exercise Forms

3.2.1. Aerobic Exercise: Optimizing Brain Structure and Function and Emotional Regulation Center

As one of the most common forms of physical activity, aerobic exercise has significant positive effects on college students' executive function and mental health. Aerobic exercise not only enhances cardiopulmonary endurance at the physiological level, but also is closely related to the optimization of brain structure and function. A large number of neuroscientific evidence shows that aerobic exercise can promote the secretion of brain-derived neurotrophic factor (BDNF) [7], which can promote neuron survival and synaptic plasticity. Aerobic exercise can enhance the plasticity of brain structure, promote the development of gray matter volume, and maintain the integrity of white matter in networks related to executive function, attention, learning and memory, thus showing higher behavioral efficiency and decision-making ability in learning and life tasks [8]. Aerobic exercise is also significantly correlated with the increase in gray matter volume of the prefrontal cortex. As a high-level center for emotional regulation, the optimization of its structure and function is believed to enhance the top-down regulation of emotional centers such as the amygdala, thereby helping to improve emotional stability and psychological resilience.

3.2.2. Mind-Body Integrated Exercise (Yoga, Tai Chi): Dual Regulation of Physiological and Psychological States

Mind-body integrated exercise (such as yoga and tai chi) combines the characteristics of breathing regulation, mindfulness meditation and body awareness, and can achieve dual regulation of psychology and physiology during relaxation training. The psychological improvement effect of traditional mind-body integrated exercises such as yoga and tai chi is

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202512_8(12).0034

closely related to their regulation of neuroendocrine system function. Such exercises can inhibit the excessive activation of the hypothalamic-pituitary-adrenal axis (HPA axis), balance the activities of the sympathetic and parasympathetic nerves, thereby reducing cortisol levels and alleviating anxiety and depression symptoms [9]. Such exercises frequently exercise individuals' ability to inhibit irrelevant information and resolve conflicts. The continuously improved awareness, concentration and emotional acceptance ability enable them to focus on the present, maintain attention and accept without judgment when facing negative emotional stimuli. Cognitive resources are not occupied by irrelevant information, so they can continue to focus on current inhibition function tasks [10]. Compared with simple aerobic exercise, mind-body integrated exercise shows more comprehensive advantages in alleviating negative emotions, improving psychological resilience and promoting overall physical and mental balance.

3.2.3. Group Exercise: Strengthening Social Support and Emotional Belonging

Group exercise (such as basketball, volleyball, dance aerobics, etc.) has outstanding advantages in promoting college students' sense of social support and emotional belonging, and has a significant effect on relieving depression and anxiety. A systematic review by Eather et al. (2023) showed that team and group sports can bring higher levels of mental health and social well-being through the strengthening of social interaction, sense of belonging and support networks [11]. Among college students, those who participate in team sports such as basketball and volleyball have significantly lower depression levels than non-participants, the negative impact of stress on psychology is significantly reduced, and emotional stability and sleep quality are improved [11-13]. Collective dance and rhythmic exercise can enhance group cohesion through synchronized movements and emotional communication, thereby improving participants' social connection and sense of well-being [14].

Overall, exercise forms with strong rhythm, sociality and physical-mental integration often promote college students' positive emotional recovery and mental health development through the path of "emotional resonance - social support - psychological safety".

4. Mechanism Analysis

4.1. Physiological Level: Neuroendocrine and Neurotrophic Factor Regulation

The physiological effects of exercise may include increased endorphin levels, body temperature, mitochondrial function and biogenesis, mammalian target of rapamycin (mTor) signaling, neurotransmitter production, and reduced hypothalamic-pituitary-adrenal (HPA) axis response to stress. Regular exercise can effectively promote the expression and release of key neurotrophic factors such as brain-derived neurotrophic factor (BDNF), which is crucial for neuron survival, differentiation and synaptic plasticity, and is the physiological basis for exercise to improve mood and cognitive function. At the same time, moderate- and low-intensity exercise can reduce resting cortisol levels and alleviate the body's chronic stress load by regulating the function of the hypothalamic-pituitary-adrenal (HPA) axis, thereby relieving anxiety and depression symptoms [15].

4.2. Psychological Level: Reshaping Psychological Capabilities and Cognitive Patterns

At the psychological level, exercise intervention is a key way to enhance college students' psychological resources and buffer psychological risks. Specifically, regular participation in physical exercise can effectively improve individuals' self-efficacy. By continuously setting and achieving exercise goals, individuals can accumulate a lot of "mastery experience", thereby strengthening their belief in their own abilities. At the same time, the optimization of brain prefrontal lobe function by exercise helps to enhance attention control ability and executive

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202512_8(12).0034

function [8], enabling college students to better concentrate on attention, inhibit interference in cognitive tasks, and complete tasks more efficiently. Exercise provides a healthy channel for emotional catharsis and can induce positive physiological states, thereby strengthening emotional regulation ability [9-10]. The coordinated development of these psychological abilities together builds a solid psychological resilience, enabling college students to maintain adaptability and resilience when facing stress and adversity. In the long run, this positive interaction mode can reshape positive self-cognitive schemas, and gradually eliminate helplessness and cognitive biases (such as "overgeneralization" and "personalization") caused by negative experiences, which is the core psychological mechanism for reducing depression vulnerability.

4.3. Social Level: Construction of Social Support and Collective Identity

Group exercise can have a unique protective impact on college students' mental health by building a positive social psychological environment. Such exercise is not only a physical activity, but also a powerful social intervention. Providing substantive social support: In the team, tactical cooperation, mutual encouragement and shared challenges among members can significantly enhance individuals' sense of belonging and acceptance, which provides important emotional and instrumental support for coping with academic pressure and life setbacks, and directly buffers loneliness and stress. Strengthening positive social connection: To achieve common goals, team members must communicate effectively, build trust and work together. This process itself can reduce social anxiety and give birth to strong social connections. This kind of connection based on common interests and collective honor is a stable source of positive emotions and well-being. Shaping positive social identity: As a member of the team, college students gain a positive collective identity. This sense of "we" helps to improve self-esteem and self-worth, resist self-doubt caused by negative evaluations or failure experiences, thereby maintaining emotional safety.

5. Discussion

5.1. Research Consistency and Differences

This study systematically summarizes the mechanism of exercise intervention on college students' mental health. The results show that its positive benefits are jointly achieved through multiple physiological-psychological-social pathways, and this core conclusion shows a high degree of consistency in different studies. Physiologically, exercise lays a material foundation for emotional improvement by regulating key neurotransmitters and trophic factors such as BDNF and 5-HT, and inhibiting the excessive activation of the HPA axis; Psychologically, it builds positive psychological resilience by improving self-efficacy, attention control and emotion regulation ability; Socially, group exercise provides unique external protective factors by strengthening social support, sense of belonging and collective identity.

However, there are significant differences in intervention effects among different exercise forms. This study found that mind-body integrated exercise (such as yoga and tai chi) is particularly prominent in alleviating anxiety and improving emotional stability, which is closely related to its dual characteristics of physical exercise and mindfulness meditation, and can simultaneously regulate neuroendocrine and psychological states. Team sports have unique advantages in enhancing social connection and reducing loneliness, which is highly consistent with the conceptual model of "Mental Health through Sport" proposed by Eather et al., that is, the team environment promotes mental health through mechanisms such as social comparison, role identity and sense of belonging. In contrast, strength training plays a significant role in enhancing self-efficacy and stress resistance, which may stem from the "sense of control" and physical confidence gained by individuals in the process of overcoming weight loads. These

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differences suggest that in the future, when formulating exercise prescriptions, targeted exercise forms should be recommended according to college students' specific psychological needs (such as relieving anxiety, improving social interaction or enhancing self-confidence) to achieve precise intervention.

5.2. Research Limitations and Future Directions

Although existing evidence fully supports the positive effect of exercise on mental health, current research still has several limitations. In terms of research design, most are cross-sectional studies or short-term intervention trials, lacking long-term longitudinal tracking, making it difficult to reveal the sustainability and dynamic development process of exercise benefits, nor to clarify the direction of causality. In terms of mechanism exploration, research on physiological mechanisms mostly relies on animal experiments or indirect biomarkers, and there are still insufficient studies directly using multimodal measurement techniques (such as functional brain imaging fMRI, dynamic cortisol monitoring) in college students. In terms of measurement tools, most studies rely on subjective self-report scales. In the future, objective indicators (such as heart rate variability, sleep monitoring equipment) should be combined to improve data accuracy.

Based on the above limitations, future research should: Strengthen long-term tracking and mechanism exploration: Conduct multi-time point longitudinal studies, and integrate multi-level data such as genetics, neuroendocrinology, and brain imaging to deeply clarify the mediating and moderating mechanisms of exercise on mental health. Construct a personalized exercise prescription system: Future research needs to systematically compare the differentiated effects of different exercise parameters (type, intensity, frequency, duration) on different psychological problems (such as generalized anxiety, social anxiety, depression) and college students with different personality traits, providing a solid basis for personalized recommendations. Promote intelligent and ecological monitoring: Make full use of digital health technologies (such as wearable devices, exercise APPs, ecological momentary assessment EMA) to achieve real-time and dynamic monitoring of college students' daily physical activity and psychological state, and conduct interventions in natural environments to improve the ecological validity and practical value of research.

Through efforts in the above directions, it is expected to build a data-driven, precise and efficient mental health exercise intervention system for colleges and universities, thereby more effectively serving the comprehensive health development of college students.

6. Conclusion and Outlook

Based on the comprehensive research at home and abroad in recent years, exercise intervention has been proven to be an effective means to improve college students' mental health. Its positive effects are reflected in alleviating anxiety, depression and stress, improving sleep quality and enhancing psychological resilience. Its mechanism is multi-dimensional: Physiologically, exercise reduces physiological stress by promoting BDNF secretion, regulating HPA axis function and lowering cortisol levels; Psychologically, exercise enhances self-efficacy and emotion regulation ability, and promotes positive self-cognition and psychological resilience; Socially, group exercise improves social support and sense of belonging, and relieves loneliness and psychological isolation. There are differences in the psychological benefits of different exercise forms. Aerobic exercise and mind-body integrated exercise (such as yoga and tai chi) are particularly effective in emotional improvement and relaxation regulation, while group exercise has more advantages in promoting social connection and emotional belonging. Future research should strengthen longitudinal tracking and multimodal mechanism exploration, combine neuroimaging, biochemical and behavioral indicators to reveal the long-term and differentiated effects of exercise intervention; At the same time, promote colleges and

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202512_8(12).0034

universities to build an integrated "exercise-mental health" model, carry out personalized exercise prescriptions and digital monitoring, achieve precise and sustainable mental health promotion, and provide scientific support for the comprehensive development of college students.

References

[1] Han, SS., Zhang, YS., Zhu, W. et al. Status and epidemiological characteristics of depression and anxiety among Chinese university students in 2023. BMC Public Health 25, 1189 (2025). https://doi.org/10.1186/s12889-025-22443-7

[2] Lin ZZ, Cai HW, Huang YF, Zhou LL, Yuan ZY, He LP, Li J. Prevalence of depression among university students in China: a systematic review and meta-analysis. BMC Psychol. 2025 Apr 11; 13(1):373. doi: 10.1186/s40359-025-02688-y. PMID: 40217329; PMCID: PMC11992738.

[3] Chen, P., Mazalan, N. S., Koh, D., & Gu, Y. (2025). Effect of exercise intervention on anxiety among college students: a meta-analysis. Frontiers in Psychology, 16, 1536295. https://doi.org/10.3389/fpsyg.2025.1536295

[4] Wang W, Yu L, Huang L, Gao X. Mechanisms of the impact of exercise intervention on college students' mental health: a longitudinal experimental study using swimming as an example [J]. Frontiers in Psychology, 2025, 16:1535214. https://doi.org/10.3389/fpsyg.2025.1535214

[5] Xiao Y, Shi C, Zhang X, Liu H. Effectiveness of different exercise interventions on depressive symptoms among college students: a network meta-analysis [J]. BMC Public Health, 2025, 25(1): 1845. https://doi.org/10.1186/s12889-025-22904-z

[6] Singh B, Olds T, Curtis R, et al. Effectiveness of physical activity interventions for improving depression, anxiety and distress: an overview of systematic reviews [J]. British Journal of Sports Medicine, 2023, 57(18): 1203-1209. https://doi.org/10.1136/bjsports-2022-106195

[7] BDNF and synaptic plasticity, cognitive function, and dysfunction in neuropsychiatric disorders. Handbook of Experimental Pharmacology

[8] Talukdar, T., Nikolaidis, A., Zwilling, C. E., Paul, E. J., Hillman, C. H., Cohen, N. J., Kramer, A. F., & Barbey, A. K. (2017). Aerobic Fitness Explains Individual Differences in the Functional Brain Connectome of Healthy Young Adults. Cerebral Cortex, 1–10. https://doi.org/10.1093/cercor/bhx232

[9] Aggarwal A. Hypothalamo-Pituitary-Adrenal axis and Brain during Stress, Yoga and Meditation: A Review [J]. International Journal of Health and Clinical Research, 2020, 3(9): 96-103. https://doi.org/10.31873/ijhcr.2020.03.09.013

[10] Li, X. J., Cui, L., Wang, Y., Zhu, L. N., Li, Y. F., Li, J., Shen, Q. Q., Zhang, J. Y., & Yin, H. C. (2020). Effects of short-term Tai Chi (Ba Fa Wu Bu) on inhibitory function under negative emotional stimuli in college students: An ERP study. Journal of Beijing Normal University (Natural Science Edition), 56(1), 141-147. https://doi.org/10.16360/j.cnki.jbnuns.2020.01.019

[11] Eather, N., Wade, L., Pankowiak, A., & Eime, R. (2023). The impact of sports participation on mental health and social outcomes in adults: a systematic review and the 'Mental Health through Sport' conceptual model. Systematic Reviews, 12(1), 102. https://doi.org/10.1186/s13643-023-02264-8

[12] Ji, C., Yang, J., Lin, L., & Chen, S. (2022). Anxiety and Sleep Quality Amelioration in College Students: A Comparative Study between Team Sports and Individual Sports. Behavioral Sciences, 12(5), 149. https://doi.org/10.3390/bs12050149

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202512_8(12).0034

[13] Johnston, S. A., Roskowski, C., He, Z., Kong, L., & Chen, W. (2020). Effects of team sports on anxiety, depression, perceived stress, and sleep quality in college students. Journal of American College Health, https://doi.org/10.1080/07448481.2019.1707836

[14] Delattre, B., Applewhite, B., Buckman, J. E. J., Harmer, C. J., & Murphy, S. E. (2024). Social dance and movement for mental health: A narrative review. Mental Health Science, 2, e62. https://doi.org/10.1002/mhs2.62

[15] Lin, T. W., & Kuo, Y. M. (2013). Exercise Benefits Brain Function: The Monoamine Connection. Brain Sciences, 3(1), 39–53. https://doi.org/10.3390/brainsci3010039