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## **The impact of physical activity on depressive and anxiety disorders: A literature review**

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**Purpose of Research:**

Depression and anxiety affect over 500 million people globally and are leading causes of disability. While pharmacotherapy and psychotherapy are effective for many, a significant proportion of patients remain resistant. This study examines the role of physical activity as a complementary or alternative treatment for these conditions, focusing on its effects on neuroplasticity, inflammation, and metabolic health.

**Research Materials and Methods:**

A systematic review of clinical and experimental studies was conducted using PubMed with keywords like “physical activity,” “running,” “mental disorder,” and “depression.” Included studies were assessed for methodology, participant demographics, and therapeutic outcomes.

**Basic Results:**

Physical activity improves depressive symptoms, neuroplasticity, and metabolic health. Running therapy significantly reduces depressive symptoms and inflammation compared to antidepressants. Preclinical studies show exercise reverses depressive-like behaviors and restores hippocampal function in rodents. Meta-analyses confirm the effectiveness of aerobic and strength exercises as standalone or adjunctive treatments, with variations based on age and gender.

**Conclusions:**

Physical activity is a cost-effective intervention with significant benefits for mental health, particularly for treatment-resistant patients or those with metabolic comorbidities. Its integration into treatment guidelines could enhance outcomes, emphasizing the need for tailored exercise protocols in future research.

**INTRODUCTION**

Depression and anxiety are widespread mental health conditions impacting millions globally. Approximately 300 million people experience anxiety disorders, while 280 million are affected by depression. These issues are among the primary causes of disability worldwide and were highlighted by the Lancet Commission on Global Mental Health and Sustainable Development as fundamental human rights and essential for the progress of all nations (“Global, Regional,

and National Burden of 12 Mental Disorders in 204 Countries and Territories, 1990-2019: A Systematic Analysis for the Global Burden of Disease Study 2019,” 2022). Many individuals with major depressive disorder respond positively to pharmacological treatments and psychotherapy (Cuijpers et al., 2020), although a significant proportion of patients remain resistant to these interventions (Strawbridge et al., 2019). Neuroplasticity of the brain is significantly lower in individuals with depression compared to healthy individuals. This ability increases markedly and can even reach the same level as in healthy individuals in those who are physically active. These adaptive capacities of the brain show an inverse correlation with depressive symptoms (Mul, 2018). Physical activity may serve as a valuable complement or, in some cases, an alternative to pharmacotherapy and psychotherapy in the treatment of various mental health conditions (Noetel et al., 2024).

## **MATERIALS AND METHODS**

The study conducted an extensive review of the literature and analyzed data to explore the impact of physical activity on mental disorders. Searches were performed in databases PubMed, utilizing keywords such as “physical activity,” “running,” “mental disorder,” “anxiety disorder,” and “depression.” Empirical data were drawn from both clinical and experimental studies, which were critically assessed with regard to their methodologies, participant demographics, and therapeutic results.

## **DEPRESSION – CURRENT GUIDELINES**

Depression is a common mental disorder that significantly reduces quality of life and the ability to perform daily social and professional roles. It manifests through various symptoms, including low mood, loss of interest, reduced energy, concentration problems, and in more severe cases, suicidal thoughts or psychomotor retardation. For a diagnosis, symptoms must persist for at least two weeks and significantly impact the patient’s psychosocial functioning. The primary treatment for depression includes pharmacotherapy and psychotherapy. Pharmacotherapy often involves selective serotonin reuptake inhibitors (SSRIs) as the first-line drugs due to their favorable safety and tolerance profiles. Psychotherapy, especially cognitive-behavioral therapy (CBT) and interpersonal therapy (IPT), can be used independently in mild cases or as an adjunct to pharmacotherapy in more severe cases. In particular situations, such as treatment-resistant depression, electroconvulsive therapy (ECT) or other modern methods like repetitive transcranial magnetic stimulation (rTMS) may be employed (Gautam et al., 2017).

## **ANIMAL MODEL**

Voluntary wheel running (VWR) is a commonly used rodent model that simulates some aspects of human exercise training. Preclinical studies have begun to provide insight into the brain nuclei, signaling pathways, and molecular adaptations that underlie the positive effects of exercise training on stress-related behavior. Nonetheless, the chemical mechanisms and brain circuitry that underlie the positive effects of exercise are poorly understood (Mul, 2018). Four weeks of running exercise significantly lowered the depressive-like behaviors of mice exposed to chronic unpredictable stress (CUS). Furthermore, running exercise reduced the microglial numbers and altered microglial morphology in three subregions of the hippocampus, restoring the M1/M2 balance, which is critical in the etiology of depression (Liu et al., 2024). Fluoride, an environmental toxin, may cause endoplasmic reticulum stress (ERS) in brain cells, ultimately leading to apoptosis and emotional dysfunction. Exposure to 100 mg/L sodium fluoride (NaF) for 6 months can induce anxiety- and depression-like behavior in mice. Voluntary wheel running reduces the symptoms of despair and anxiety in fluorosis mice (Qi et al., 2024). In one study mice underwent four weeks of running exercise after four weeks of CUS. The results indicated that running exercise can enhance the physical connections between astrocytes and synapses, which may be a key structural component for the antidepressant advantages of this type of exercise (Li et al., 2024). In adult male Sprague-Dawley rats, training on a treadmill or anaerobic resistance for 42-56 days showed no effect on adult hippocampal neurogenesis, but VWR unquestionably did (Nokia et al., 2016).

## **STATE OF KNOWLEDGE**

Metabolic and inflammatory problems are present in about one-third of individuals with depressive disorders; these are typically more noticeable in those who have atypical depressive symptoms, such as exhaustion, hypersomnia, increased hunger, and weight during depressive episodes (Milaneschi et al., 2020). In the MOod Treatment with Antidepressants or Running (MOTAR) trial, individuals (141 participants aged between 18–70) with depressive disorders and/or anxiety disorder had their mental and physical health evaluated after 16 weeks of running treatment and antidepressant use. Initially, patients who did not exhibit a strong preference for treatment were assigned at random to either running therapy or antidepressant medication. Those who agreed to participate in the study but refused to be randomly assigned were then assigned to their preferred intervention. Escitalopram, a selective serotonin reuptake inhibitor, was administered to patients at a dose of 10 mg per day. For 16 weeks, running therapy involved three group sessions per week. The purpose of this study was to assess the effects of running treatment and antidepressant use on the biology (indices of poor inflammatory and metabolic

health) and clinical (atypical, energy-related symptoms (AES)) aspects of immunometabolic depression (IMD). Within-group changes in the running therapy group showed a decrease in IMD parameters, such as AES severity, the inflammation index, metabolite PC1, and the metabolic syndrome index, whereas the antidepressant group showed a deterioration in these indicators. Running therapy was found to have a higher positive effect on the metabolic syndrome index than antidepressant use, which is consistent with earlier MOTAR findings showing reductions in blood pressure and weight following running therapy (Verhoeven et al., 2023; Vreijling et al., 2024).

A study was conducted to examine whether amateur marathon runners exhibit fewer depressive symptoms and negative emotions compared to individuals with a sedentary lifestyle. The research included 100 amateur marathon runners and 46 sedentary individuals, with both groups matched for age and gender. The comparison revealed that marathon runners reported fewer depressive symptoms, higher levels of positive emotions, and better overall functioning than the control group. These findings highlight that regular physical activity significantly improves mood, reduces depressive symptoms, and can be effectively incorporated into strategies for preventing and treating depressive symptoms (Roeh et al., 2020).

A study examining the impact of a 12-week low-to-moderate intensity aerobic exercise program on depression, anxiety, and sleep quality in high school students with depressive symptoms during the COVID-19 pandemic demonstrated that aerobic exercise significantly reduces depression levels. This highlights the critical role of physical activity in both the treatment and prevention of mental health disorders (Luo et al., 2021).

An interesting case may be the study conducted on elite athletes. According to data from studies with larger samples, in comparison to the general population, professional athletes appear to have a comparable risk of high-prevalence mental disorders, such as anxiety and depression. Elite athletes who are injured, nearing or in retirement, or having performance issues may be at higher risk for developing a disorder. Running in particular can help athletes self-treat their depression symptoms, but in some cases, the severity of the depressive episode or risk factors outweigh the benefits of aerobic exercise (Rice et al., 2016). In 2021, a study was published that investigated the effect of a 3-week physical activity (PA) program applied on clinical symptoms, motor excitability and plasticity, and cognition in patients with depression disorder (group of 23 participants), in comparison to a control intervention (group of 18 participants). The PA was performed 3 days a week and was guided by an instructor. Each session lasted 60 min and focused on one out of three exercise types once a week, either coordination, endurance, or strength training. Self-reported and investigator-

assessed evaluations were utilized to measure the intensity of clinical symptoms. At the same time, transcranial magnetic stimulation protocols were employed to analyze motor excitability, and paired associative stimulation was used to examine long-term potentiation-like plasticity (LTP). The study also evaluated cognitive functions, including working memory and attention. Findings from this research indicated that a physical activity intervention helps restore impaired LTP-related neuroplasticity in individuals with depression and contributes to alleviating clinical symptoms, showing a strong link between these two outcomes. Thus, by revealing that this intervention specifically addresses disrupted neuroplasticity as a fundamental pathophysiological factor, the study underscores the importance of neuroplasticity in understanding both the pathology of depression and the efficacy of physical activity treatment (Brüchle et al., 2021).

A recent meta-analysis was performed to evaluate the effect of exercise on depression. The meta-analysis included 218 studies, totaling 14,170 participants. Studies had to be randomized controlled trials that included exercise as a treatment for depression and included participants who met the criteria for major depressive disorder. Compared to active controls (e.g., normal care), dance resulted in significant depression reductions, whereas walking or jogging, strength training, mixed aerobic exercises, and tai chi or qigong resulted in moderate reductions. Exercise in combination with selective serotonin reuptake inhibitors or aerobic exercise in combination with psychotherapy also had moderate, clinically significant effects. When compared to active control, all of these therapies were noticeably more effective than the established minimum clinically significant difference. Some activities were more effective for women (strength training and cycling) and some for men (yoga, tai chi, and aerobic exercise were prescribed in addition to psychotherapy). Differences also concerned the age of participants. Psychotherapy combined with yoga and aerobic exercise seems to work better for older individuals than for younger ones. In comparison with older individuals, younger participants seemed to benefit more from strength training. Despite low confidence in many of the studies, treatment guidelines may be too conservative by conditionally suggesting exercise as a supplemental or alternative treatment for patients in whom psychotherapy or medication is either ineffective or inappropriate (Noetel et al., 2024).

## **CONCLUSIONS**

Physical activity exerts a significant influence on mental health, offering multiple benefits. Moderate-intensity exercise is widely recognized as beneficial for improving mood, reducing depressive and anxiety symptoms, and enhancing overall quality of life. Regular engagement in physical activity may also protect against the development of depression (Peluso & Guerra

de Andrade, 2005). Research suggests a strong connection between physical activity and chronic illnesses, indicating that a decline in aerobic fitness among children and adolescents adversely affects their growth and development. Regular physical exercise should be advocated since it is beneficial to both physical and mental health (Juan M. Tecco et al., 2022). WHO recommends regular physical activity for everyone, as it significantly enhances mental and physical health. For adults, at least 150–300 minutes of moderate-intensity activity or 75–150 minutes of vigorous-intensity activity per week is advised. Engaging in physical activity, even in small amounts, is beneficial, highlighting its importance in reducing sedentary behaviors and improving overall well-being (*WHO Guidelines on Physical Activity and Sedentary Behaviour*, n.d.).

## **DISCLOSURE**

### **Author's contribution:**

#### **Conceptualization:**

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#### **Methodology:**

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#### **Software:**

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The authors have read and agreed with the published version of the manuscript.

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