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Physical Activity and Depression: A Narrative Review

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ABSTRACT

Depression is a worldwide prevalent mental health condition with significant individual, societal, and economic impact. This narrative review examines the relationship between physical activity and depression. It explores the current evidence supporting the use of physical activity as a treatment for depression, summarizing key findings from relevant research studies. It adopts a systematic literature review to select appropriate and relevant empirical evidence. This method allows the researcher to locate credible studies that meet the review's inclusion criteria. The clinical description describes the prevalence of depression as a clinical issue in public health. The mechanisms and pathology of depression provide risk factors of depression ranging from genetic to metabolic. According to treatment methods, depression can be effectively managed through pharmacological, psychological, and physical activity. Approximately 19 studies were eligible for the narrative review. The findings confirmed that physical activity reduced depression symptoms. However, there was a need for combining physical activity with pharmacological treatment and psychological therapies to achieve desired outcomes in alleviating depression.

Keywords: depression, adults, physical activity, treatment

ABBREVIATIONS

WHO, World Health Organization
APA, American Psychiatric Association
GWAS, Genome-wide association studies
5-HT, 5-hydroxytryptamine
GABA, Gamma-aminobutyric acid
CRH, Corticotropin-releasing hormone
BDNF, Brain-derived neurotrophic factor
IL-12, Interleukin 12
CRP, C-reactive protein
SSRIs, Selective serotonin reuptake inhibitors
TCAs, Tricyclic antidepressants
NMDA, N-methyl-D-aspartate
MBCT, Mindfulness-based cognitive therapy
BDI, Beck depression inventory
6MWT, Six-minute walk test
STS, Sit-to-stand test
MADRS, Montgomery-Åsberg depression rating scale
QoL, quality of life
SMFQ, Short Moods and Feelings Questionnaire
MI, Motivational intervention
HPA, Hypothalamic-pituitary- adrenal
RCT, Randomized controlled trials
MDD, Major depressive disorder
DA, Dopamine
NMDAR, N-methyl-D-aspartate receptor
ACTH, Adrenocorticotropic hormone
IL-6, Interleukin 6
IL-4, Interleukin 4
TNFα, Tumor necrosis factor-α
SNRIs, Serotonin-norepinephrine reuptake inhibitors
MAOIs, Monoamine oxidase inhibitors
CBT, Cognitive behavioral therapy
SMD, Standardized mean difference
MVPA, Moderate to vigorous physical activity
LPA, Light physical activity
PA, Physical activity
Min/wk, minutes per week
AD, antidepressant
SB, sedentary behavior

INTRODUCTION

Depression or depressive disorder, a widely prevalent mental health disorder, affects many people each year regardless of age, gender, background, or status. Depression casts a shadow over a person's general well-being. It is characterized by persistent sadness, lack of interest or pleasure, feelings of hopelessness and worthlessness, and disruption in sleep, appetite, and energy levels. Depression takes a heavy toll on individuals and society, contributing to reduced quality of life, loss of productivity, and increased healthcare costs. According to the World Health Organization (WHO), depression is a leading cause of disability worldwide, affecting millions (1). Traditional treatments such as pharmacotherapy and psychotherapy may not be suitable for everyone. This has led to growing interest in alternative and complementary interventions. Physical activity has emerged as a promising option for improving mental health.

According to the World Health Organization (WHO), physical activity refers to any bodily movement produced by skeletal muscles that requires energy expenditure. This includes all forms of movement, whether carried out during leisure time, for transportation, or as part of work or household tasks (2). Therefore, physical activity is an accessible and cost-effective approach to improving mental health.

This narrative review explores the complex connection between physical activity and depression, analyzing the evidence supporting the use of physical activity as a treatment for depression. It also examines the potential mechanism behind its positive effects and considers practical aspects of integrating physical activity into depression management.

Hypothesis

Regular engagement in physical activity reduces depressive symptoms through neurobiological and psychosocial mechanisms.

Aim and Objectives

The research goal of this narrative review involves evaluating available studies exploring the relationship between physical activity and depression. The review seeks to fulfill the following objectives:

1. To synthesize the current literature about physical activity and depression.
2. To examine the effectiveness of treatment methods in addressing depression.
3. To offer evidence-based practices on managing depression.

METHOD

Literature selection strategy

The narrative review adopted a systematic review to select appropriate literature on the relationship between physical activity and depression. Credible databases such as Google Scholar, Trip Database, PubMed, and Cochrane were considered in the search. The review used various keywords to identify appropriate and relevant literature (66). Examples of these keywords included "physical activity and depression" and "exercise intervention for depression" and "exercise and mental health" and "mechanisms of exercise in depression." Boolean operators such as AND and OR were used to refine the search using filtering method. Table 1 illustrates the inclusion and exclusion criteria for the literature review.

Table 1. Inclusion and Exclusion Criteria

Inclusion	Exclusion
Peer-reviewed articles, randomized controlled trials (RCTs), longitudinal cohort studies, systematic reviews, and meta-analyses.	Non-peer-reviewed sources, opinion pieces, blog posts, and anecdotal studies.
Adults aged 18 years and older, including both males and females, diagnosed with clinical depression.	Studies involving children, adolescents, or individuals without a clinical depression diagnosis.
Physical activity as a treatment option for depression.	
Studies with clear research methodologies, including well-defined intervention protocols and outcome measures.	Studies lacking clear methodologies, case reports, or studies with ambiguous intervention details.
Studies published between 2010 and 2024.	Studies published before 2010.

Clinical description of Depression

Depression is a mood disorder that causes persistent feelings of sadness and loss of interest in previously enjoyed activities. While everyone experiences sadness or low mood sometimes, these feelings usually subside. Depression, also known as major depressive disorder or clinical depression, is different. It is a long-lasting condition that can affect anyone regardless of age, gender, race or ethnicity, income, culture, or education. According to statistics, women are diagnosed with depression at higher rates than men (11).

Since some papers use the Beck Depression Inventory, it is worth briefly describing it. The Beck Depression Inventory or BDI is a 21-item self-report questionnaire designed to assess the presence and severity of depressive symptoms (12). Another commonly used tool is the Montgomery-Åsberg depression rating scale or MADRS, developed in 1979. It was created to provide a more sensitive measure of changes in the severity of depression symptoms in response to treatment. The MADRS was designed to offer a more accurate evaluation compared to the previously commonly used Hamilton Depression Rating Scale (HDRS), which was introduced in 1960 and specifically used to investigate the treatment of anti-depressant medication (13).

According to the DSM-5 by the American Psychiatric Association (APA), depressive disorder exists in five categories. These include disruptive mood dysregulation disorder, major depressive disorder, persistent depressive disorder (dysthymia), and premenstrual dysphoric disorder, as well as depressive disorder due to other medical conditions. Depressive disorders present with either depressive feelings or general emptiness or irritability together with physical manifestations and mental alterations leading to substantial functional impairment for the individual (14). The same two-week period must include at least five depressive symptoms, of which one symptom must be either depressed mood or loss of interest or pleasure. Additionally, all symptoms must reflect a change in functioning compared to previous periods. The symptoms include:

- Persistent feelings of sadness, hopelessness, or emptiness
- Loss of interest or pleasure in activities once enjoyed
- Significant changes in appetite or weight (either increase or decrease)
- Sleep disturbances (insomnia or excessive sleeping)
- Fatigue or lack of energy nearly every day
- Difficulty concentrating, making decisions, or remembering details
- Thoughts of death, self-harm, or suicide

The symptoms mentioned above cause clinically significant distress or impairment in social, occupational, or other important areas of functioning. The episode should not be attributable to the direct physiological effect of a substance or other medical condition. The occurrence of major depressive disorder should not be explained by schizoaffective disorder, schizophrenia, schizophreniform disorder, delusional disorder, or other specified and unspecified schizophrenia spectrum and other psychotic disorders. There should never have been a manic or hypomanic episode (14).

Disease mechanism and pathology

Depression develops due to various biological, genetic, and environmental factors. (Figure 1). Knowledge about depression's pathological causes enables the development of better approaches to treating the condition (15). This discussion analyzes six pathological mechanisms of depression, including hereditary factors, neurotransmitter systems, hypothalamic-pituitary-adrenal (HPA) axis dysfunction, neurotrophins and neurogenesis, neuroinflammation, and metabolic disorders.

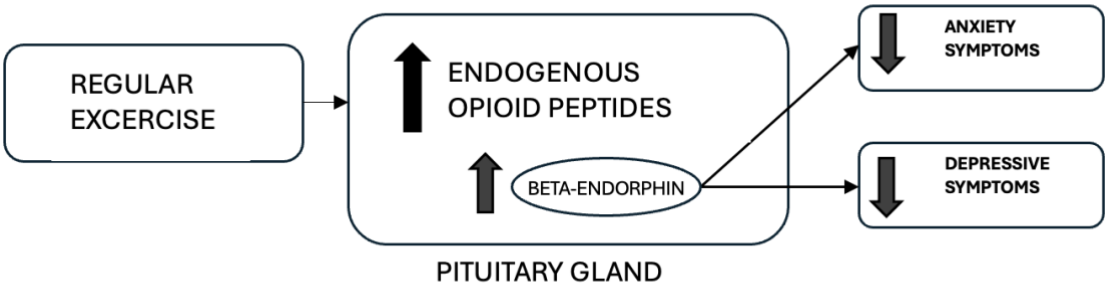

Figure 1. Flow chart demonstrating the link between beta-endorphins and depressive and anxiety symptoms. (5)

Hereditary Factors

Research on depression genetics demonstrates that heredity strongly influences the condition. Twins and adoption studies show genetic influence between 31% and. 2% (16). However, identifying specific genetic risk factors has proven challenging, as major depression exhibits complex genetic patterns and a broad range of clinical manifestations. The research field of genome-wide association studies (GWAS) continues to succeed by identifying multiple genetic locations that cause major depressive disorder (MDD) (17). Kendall et al. (18) discovered 15 genetic risk factors, whereas Cardno (19) presented 44 in their study, which is the biggest meta-analysis for various major depressive symptoms. These findings support the conclusion that hereditary factors contribute to depression development, but scientists still do not understand precisely how genes lead to the disorder.

Neurotransmitter Systems

Serotonin (5-HT), dopamine (DA) glutamate, and gamma-aminobutyric acid (GABA) neurotransmitter system dysregulation have been tied to depression (20). The empirical evidence has built their studies around the serotonin hypothesis because it demonstrates that reduced serotonin leads to depressive symptoms. The receptor function of serotonin in depressive patients seems to be altered based on scientific research that shows 5-HT2 receptor upregulation with concurrent 5-HT1A receptor downregulation (15). The neuromodulator dopamine plays a role in regulating motivation and the brain's reward system. The depressive state frequently results in ineffective dopamine signaling and heightened dopamine absorption thus lowering the amount of dopamine present in brain synapses.

Synaptic plasticity and emotional regulation functions through the excitatory neurotransmitter glutamate which serves as the primary neurotransmitter. Depressed patients have excess glutamate in their cerebrospinal fluid and brain tissues because their glutamatergic system remains overactive. Depressive symptoms appear when the N-methyl-D-aspartate receptor (NMDAR) faces interruptions (21). Ketamine as an NMDAR anti-depressant properties which establishes new therapeutic possibilities for mental health care. The primary inhibitory neurotransmitter GABA controls excitatory functions alongside deficient GABAergic processes leading to depressive states. Depression causes patients to have lower GABA levels coupled with reduced activity in GABAergic receptors making inhibitory neurotransmission crucial.

Hypothalamic-Pituitary-Adrenal (HPA) Axis Dysfunction

The Hypothalamic-Pituitary-Adrenal (HPA) axis acts as the primary body system for stress responses and scientists have thoroughly established the relationship between its dysfunction and depression (15). The hypothalamus activates due to stress to produce corticotropin-releasing hormone (CRH) that causes the pituitary gland to release adrenocorticotropic hormone (ACTH) until cortisol reaches the adrenal cortex. Straightforward signs of depression include failure in the feedback system along with hypercortisolemia and elevated cortisol levels accompanied by reduced feedback control. The HPA axis maintains elevated activity levels in depression patients leading to worse depressive symptomatology and treatment inefficiency (16). Limited success has emerged from treatments that focus on the HPA axis despite using glucocorticoid receptor antagonists because research into this area remains insufficient.

Neurotrophins and Neurogenesis

Depression pathogenesis has been linked to decreased concentrations of neurotrophic factors (22). This is where brain-derived neurotrophic factor (BDNF) stands as the primary factor involved. BDNF preserves synaptic plasticity as well as aiding growth and survival of neurons in the brain (23). Patients with depression show reduced BDNF levels in both their hippocampus region and peripheral blood supply. The primary stress element which causes depression can decrease BDNF expression along with decreasing neurogenesis and reducing hippocampal tissue size. The anti-depressant treatment appears to include both restoration of brain-derived neurotrophic factor levels and increased neurogenesis activity which leads to better depression symptom response (24). Depression appears to begin and continue because impaired neuroplasticity and reduced neurogenesis follow the neurotrophins hypothesis.

Neuroinflammation

Depression strongly correlates with inflammation in patients with MDD based on meta-analysis of cross-sectional studies of inflammatory markers of depression. According to these studies, inflammatory markers in depression presented elevated concentrations of interleukin 6 (IL-6), interleukin-12 (IL-12), C-reactive protein (CRP), tumor necrosis factor-α (TNFα), and decrease in interleukin-4 (IL-4) particularly acute depression (25). This is caused by chronic stress, dysregulated immune responses, and activation of HPA axis. Inflammation promotes changes to brain chemistry as well as decreases new neuronal cell development and impacts neural connections between cells which might cause depressive

symptoms. During neuroinflammation microglial immune cells activate to produce proinflammatory cytokines that worsen depressive symptoms. Acute inflammation acts as an underlying cause of depression based on the "cytokine hypothesis." Researchers have investigated inhibitory signals that could help reduce depressive symptoms (26). Additionally, muscle-related illness involve complex neural inflammatory responses which could complicate effective treatment selection.

Metabolic Disorders

Most depressed patients experience metabolic problems like obesity, diabetes, and dyslipidemia (27). Research using metabolomic approaches shows that depressive disorder leads to modifications within metabolic processes of amino acids and lipids and energy distribution (28). Two prominent metabolic changes linked to depression include lower isoleucine and glycerol concentrations and higher N-acetyl aspartate and β-alanine levels that have been found in animal depressions models. Glucose and lipid processing abnormalities in the body can lead to depressive condition formation (29). These findings indicate that metabolic abnormalities both develop from depression as well as actively play a role in creating the condition.

TREATMENT METHODS

The identification of depression pathologies enables specialists to create various treatment methods. They are broadly categorized into pharmacological treatment, psychological therapies, and physical activity-based interventions (15). These approaches seek to reduce depressive symptoms while helping patients regain normal ability and stopping depression from recurring. Their success rates differ according to how each person responds with the severity of the condition and other medical conditions present.

Pharmacological Treatments

Pharmacotherapy interventions represent a primary treatment method for depression when patients have moderate to severe symptoms. The preferred medications for treating depression are antidepressants which consist of selective serotonin reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs) (31). SSRIs such as serotonin reuptake blockers known as Fluoxetine, Sertraline, and Citalopram work by stopping serotonin destruction and boosting serotonin levels in nerve cell junctions. The class of drugs known as SNRIs includes Venlafaxine along with Duloxetine and both compounds work by increasing serotonin and norepinephrine levels in the brain (32). Doctors tend to

choose such medications because their safety advantages surpass those of tricyclic antidepressants (TCAs) along with monoamine oxidase inhibitors (MAOIs).

Antidepressant medications continue to remain in widespread use but achieve effectiveness in only a limited number of patients. A considerable number of patients ranging from 30-40% do not reach satisfactory symptom improvement with initial antidepressant medication treatments according to statistical studies that identify treatment-resistant depression (33). People using antidepressant medications need to deal with substantial side effects including weight increase, sexual problems, and digestive issues. In addition, anxiety symptoms tend to be elevated before the effect of the treatment becomes noticeable. The therapeutic withdrawal process can become complicated because Paroxetine and Venlafaxine tend to produce withdrawal symptoms after medication discontinuation. The effectiveness of antidepressant medications proves insufficient against both severe and long-lasting depression, making their future use as a medical option doubtful. Esketamine nasal spray has been found to be a novel pharmacological approach because standard antidepressants demonstrate several limitations. It acts as an N-methyl-D-aspartate (NMDA) receptor antagonist (34). Administration of Esketamine produces fast antidepressant effects especially for patients who do not respond to other treatments but its high cost and availability limit broader acceptance.

Psychological Treatments

Psychological therapies, particularly Cognitive Behavioral Therapy (CBT) and Mindfulness-Based Cognitive Therapy (MBCT) work effectively to treat depression (35). This can be achieved as either a standalone intervention or alongside current medication. CTB refers to a goal-focused therapy that identifies and modifies maladaptive thoughts, cognitive distortions, and behavioral patterns associated with depressive symptoms. CBT shows patients how to reshape their harmful thinking patterns which aids them in stopping recurring despair and circular thoughts. It achieves successful outcomes for managing mild to moderate depression among patients while producing better long-term results than using medications alone (36). The delivery of CBT occurs through multiple channels which include face-to-face therapy sessions, group participation and digital-based treatment to improve its availability.

The core elements of MBCT integrate CBT techniques with mindfulness sessions of meditation and deep breathing (37). This approach aims to establish present awareness beyond traditional therapies in order to control emotional responses. MBCT is especially

beneficial for individuals with chronic depression, as its approach helps disrupt negative thought patterns, reducing the likelihood of relapse. Goldberg et al. (38) found out that MBCT proved effective at lowering depression relapse among people with more than three chronic depressive episodes. The therapeutic value of MBCT enhances through its demonstrated ability to handle comorbid conditions with anxiety disorders. MBCT is especially beneficial for individuals with chronic depression, as its approach helps disrupt negative thought patterns, reducing the likelihood of relapse.

Psychological treatments face several specific disadvantages. Treatment avoidance happens because people must face barriers like therapist availabilities and therapy time limitations and social stigma connected to therapy-seeking (39). Treatment success from CBT and MBCT depends significantly on patients' engagement along with their homework dedication and their motivation levels. Lack of compliance will reduce the effectiveness (40).

Physical Activity as a Treatment

Medical experts now endorse physical activity as a proven combination of therapy for managing depression since it shows promise in fighting depressive signs while boosting general health status (18). Walking, alongside running and cycling strengthen the human body to release endorphins serotonin and dopamine and therefore enhance mood while reducing stress (41). A review study led by Schuch et al. confirmed that aerobic exercise matches the treatment results of pharmaceutical approaches for people with mild to moderate depression thus creating a meaningful supplementary or replacement method to medical drugs. The benefits of exercise include enhancing neuroplasticity as well as rising BDNF levels and fighting inflammation, thereby addressing multiple factors linked to depression.

Resistance training including strength exercises and weightlifting proves effective for improving mood while building self-esteem. People who engaged in resistance training exercises as per Hallgren et al. (42) showed lowered depressive symptoms regardless of their chosen workout intensity. When individuals achieve difficult exercises, they develop self-efficacy together with motivation which leads to improved therapy results. Additionally, yoga and Tai Chi involve both mindful body motions and breathing exercises which help people to relax while decreasing anxiety symptoms (43). These practices trigger the parasympathetic nervous system to lower cortisol amounts while improving emotional control abilities. Scientific evidence demonstrates that yoga and Tai Chi deliver positive effects on emotional well-being and decrease repetitive negative thoughts while boosting self-empathic capabilities making them strong alternative treatment options for depression.

However, the therapeutic outcome of physical activity for depression treatment proves different for each person because of their physical condition, drive, and available exercise locations (44-45). People with serious depression alongside physical health issues usually find it difficult to establish and keep up with their scheduled exercise schedule, making exercise treatment less effective.

RESULTS

Search Results

Initially, the search yielded 9,474 results which were reduced to 6,099 after removal of duplicates and considering exclusion criteria at the title and abstracts. These were subjected to thorough screening in terms of relevance, leaving 283 studies for consideration. Further screening tied to inclusion criteria led to the elimination of 266 articles. Only 17 articles were included in the narrative review.

Characteristics of Studies

This narrative review reviewed 17 studies with diverse designs. They consisted of 7 systematic reviews and meta-analyses, 2 literature reviews, 1 qualitative study, 2 randomized controlled trials (RCTs), 1 cross-sectional studies, 3, meta-analysis, 1 network meta-analysis.

Summary of Literature Review

Table 2: Systematic Reviews and Meta-Analyses Results

Author and Date	**Objective**	**Population**	**Interventions**	**Main Outcome Measures**	**Key Findings**
Pearce et al. (2022) (47)	Examine the dose-response relationship between physical activity and depression.	Systematic review and meta-analysis of 15 prospective cohort studies (N=191,130).	Various levels of physical activity exposure.	Incident depression, major depressive disorder or depressive symptoms.	PA is linked to a lower risk of depression, with even half the recommended level reducing risk by 18%.

					Meeting full guidelines lowers risk by 25%. Encouraging any increase in activity could help prevent depression.
Mammen and Faulkner (2013) (48)	Assesses whether physical activity prevents depression onset.	Systematic review of 30 prospective studies.	Baseline PA levels compared to later depression onset.	Depression diagnosis and symptoms over time.	This review found consistent evidence from high-quality studies that physical activity reduces the risk of developing depression. Even low levels of activity may offer protective benefits.
Wu et al. (2017) (57)	Examine PA effects on depression in Parkinson's disease patients.	Systematic review of 11 studies (N=342, mean age ≥60).	Aerobic exercise, Qigong, Tai Chi, balance training.	Beck Depression Inventory, Unified Parkinson's Disease Rating Scale.	Physical activity, particularly aerobic training, and Qigong was found to significantly reduce depression in patients with Parkinson’s disease. These findings support exercise as an effective strategy for managing

					depressive symptoms in this population.
Wolf et al. (2021) (56)	To investigate the association between physical activity (PA) and depression/ anxiety during COVID-19.	Systematic review of 21 observational studies (cross-sectional, longitudinal) with 42,293 participants.	Regular PA routines assessed through self-reports and surveys.	Depression and anxiety symptom levels during COVID-19.	Regular physical activity during COVID-19 is associated with lower symptoms of depression and anxiety, with higher volume and frequency linked to greater benefits. Individuals engaging in moderate to vigorous PA showed a 12-32% lower chance of depression and a 15-32% lower chance of anxiety.
Schuch et al. (2017) (51)	To investigate PA and sedentary behavior (SB) levels in people with major depressive	Systematic review and meta-analysis of 24 studies with 2,901 participants with MDD.	Assessment of PA levels and sedentary behavior through self-reports and objective measures.	PA levels, sedentary behavior, adherence to PA guidelines.	People with major depressive disorder (MDD) engage in less physical activity and more sedentary behavior than controls, with a significant proportion not meeting

	disorder (MDD).				recommended activity guidelines.
Lee et al. (2021) (54)	To assess the efficacy of exercise combined with standard treatment vs. standard treatment alone for depression.	Systematic review and meta-analysis of 22 RCTs.	Exercise + standard treatment vs. standard treatment alone.	SMD in depressive symptoms.	Exercise combined with standard treatments significantly reduces depressive symptoms more than standard treatment alone (SMD = -0.62). The greatest benefits were seen in more severe patients (SMD = -0.99). Sensitivity analyses showed similar positive effects for trials with lower risk of bias and patients with major depressive disorder.
Noetel et al. (2024) (64)	To determine the optimal type and dosage of exercise for treating MDD,	Systematic review and network meta-analysis of 218 RCTs with 14,170 participants	Various exercise interventions (walking/ jogging, yoga, strength training, mixed aerobic	Depression severity measured using standard scales; exercise modality	Walking/jogging, yoga, and strength training, effectively reduces depression symptoms. The intensity of exercise matters, with higher

	compared to other.	diagnosed with MDD.	exercises, Tai chi/qigong).	effective-ness.	intensity yielding better results. Yoga and strength training were well tolerated, making them suitable alongside other treatments like psychotherapy and antidepressants.

Table 3. Literature reviews results

Author and Date	**Objective**	**Study design and population**	**Interventions**	**Main Outcome Measures**	**Key Findings**
Dinas et al. 2011	Review the effects of physical activity on acute and chronic depression.	Literature review of approximately 90 published studies.	Several types of exercise and physical activity.	Depression symptoms and treatment efficacy.	Exercise and PA effectively reduce symptoms of both acute and chronic depression, with benefits comparable to antidepressant treatments.
Eyre et al 2017 (61)	To examine the neuro-immuno-modulatory effects of physical activity on depression	Review of 230 studies analyzing neuroimmune effects of physical activity on depression.	Analysis of immune responses and neuroplasticity linked to physical activity	Neuro-immune factors (IL-10, M2 microglia) and pro-inflammatory cytokines.	PA may help treat depression by modulating immune system function. PA has been shown to reduce inflammation and improve immune responses, which could

	and depression-like behavior.				play a role in alleviating depressive symptoms. Highlights the potential of PA as a complementary treatment for depression, focusing on its impact on immune pathways involved in mood regulation.

Table 4. Qualitative study results

Author and Date	**Objective**	**Study design and population**	**Interventions**	**Main Outcome Measures**	**Key Findings**
Searle et al. (2011) (60)	To explore patient perceptions of physical activity as a treatment for depression.	Qualitative study with in-depth interviews of 33 participants from an RCT on physical activity and depression in the UK.	Participants shared their experiences and beliefs regarding physical activity as a treatment.	Perceived benefits of physical activity, barriers to participation, impact on mood.	PA activity an acceptable treatment for depression, benefits including biochemical effects, distraction from negative thoughts, and a sense of purpose. Some reported low motivation and confidence as barriers, they suggested medication could help initiate and maintain activity. These findings highlight the importance of tailoring

					physical activity interventions to individual patients' views and needs.

Table 5. Randomized controlled trial results

Author and Date	**Objective**	**Study design and population**	**Interventions**	**Main Outcome Measures**	**Key Findings**
Chalder et al 2012 (41)	To assess the effectiveness of facilitated physical activity as an adjunctive treatment for adults with depression	Pragmatic, multicenter, two-arm parallel randomized controlled trial. 361 adults (18-69 years) with depression in primary care in the UK.	Intervention: up to 3 face-to-face sessions + 10 phone calls with PA facilitator over 8 months.	BDI scores at 4, 8, and 12 anti-depressant use; physical activity levels	The PA-intervention did not significantly improve mood or reduce antidepressant use compared to usual care, as measured by the Beck Depression Inventory at four, eight, and twelve months. However, participants in the intervention group reported more physical activity during the follow-up period than those in the usual care group.
Keller-Varady et al. (2023) (63)	Examine how personalized training combined with psychological interventions impacts	RCT with 31 outpatients diagnosed with moderate to severe	6 weekly sessions (60-90 min) with sports scientist, including MI & supervised	Moderate-to-vigorous physical activity (MVPA), Six-Minute Walk Test	The intervention group showed a significant increase in MVPA compared to the control group, with associated improvements in fitness markers.

	physical activity in people with depression.	depression in Germany.	exercise. Control: written activity guide only.	(6MWT), Sit-to-Stand test (STS), self-reported mental health.	Both groups had comparable improvements in depressive symptoms, but the intervention group had a decrease in antidepressant use, while the control group had an increase. The increased physical activity was maintained during the follow-up period.

Table 6. Cross-sectional studies results

Author and Date	**Objective**	**Study design and Population**	**Interventions**	**Main Outcome Measures**	**Key Findings**
Helgadóttir e al. (2015) (59)	To analyze the physical activity patterns of individuals with mild-to-moderate depression and/or anxiety	165 adults (18-65 years) with mild-to-moderate depressive/anxiety disorder symptoms in Sweden.	Participants wore accelero-meters for 1 week to objectively measure physical activity.	Light physical activity (LPA), moderate-to-vigorous physical activity (MVPA), sedentary time, (MADRS).	Each increase in depressive symptoms (as measured by MADRS) was associated with a reduction in light physical activity and an increase in sedentary bouts. Suggesting a potential treatment

					opportunity by encouraging patients to reduce sedentary time and increase light physical activity.

Table 7. Meta-analysis results

Author and Date	**Objective**	**Study design and Population**	**Interventions**	**Main Outcome Measures**	**Key Findings**
Schuch et al. 2016 (53)	To assess the effectiveness of exercise as a treatment for depression while adjusting for publication bias.	Meta-analysis of 25 RCTs, including 9 studies on Major Depressive Disorder (MDD).	Exercise interventions vs. control conditions	Adjusted SMD in depressive symptoms.	Exercise has a large and significant antidepressant effect, with a standardized mean difference (SMD) of 1.11, particularly in people with MDD. Larger effects were observed with moderate-intensity aerobic exercise, and supervised exercise interventions, suggesting exercise is an effective treatment for depression. Publication bias was found to have previously underestimated these benefits.

Schuch et al 2018 (46)	Investigate the prospective relationship between physical activity and depression	Meta-analysis of 49 cohort studies (N=266,939).	High vs. low physical activity levels.	The incidence of depression in relation to levels of physical activity, assessed through adjusted odds ratios, relative risks, and hazard ratios across prospective cohort studies.	Higher PA levels are linked to a lower risk of developing depression across all age groups and regions. This protective effect applies to both depressive symptoms and diagnosed depression.
Rebar et al. 2015 (49)	To quantify the effects of physical activity on depression and anxiety in non-clinical populations.	Meta-meta-analysis of 92 studies (4,310 participants for depression, 10,755 for anxiety).	Various physical activity interventions	standardized mean difference (SMD) in depression and anxiety levels following physical activity, as assessed in meta-analytic studies.	Physical activity has a medium effect on reducing depression (SMD = -0.50) and a small effect on reducing anxiety (SMD = -0.38) in non-clinical populations. These effects are consistent across high-quality meta-analytic studies.

Table 8. Network meta-analysis

Author and Date	Objective	Study design and Population	Interventions	Main Outcome Measures	Key Findings
Recchia et al. 2022 (52)	To compare the effectiveness of exercise, AD, and their combination in treating non-severe depression.	Network meta-analysis of 21 RCTs (2,551 participants).	Exercise, antidepressants, or their combination	SMDs in depressive symptoms the main outcome measures were the severity of depressive symptoms post-intervention and the drop-out rates as a measure of treatment acceptability.	Exercise, antidepressants, and their combination showed no significant difference in reducing depressive symptoms in adults with non-severe depression. All treatments were more effective than controls, but exercise had higher drop-out rates compared to antidepressants.

DISCUSSION

The burden of depression constitutes a major public health challenge, affecting over 280 million people worldwide, according to the WHO. However, nearly 60% of individuals with depression do not seek therapy due to false perceptions and stigma, which can hinder personal and professional life (3). Depression can manifest at any age, from childhood and adolescence to adulthood and the elderly, and affects more women than men, being about 50% more common among women (4). Each year, over 700,000 people die by suicide, making it the fourth leading cause of death among 15-29-year-olds. The impact of depression extends beyond the individual, affecting families, communities, and healthcare systems. The economic burden, including direct costs associated with treatment and healthcare resources, and indirect costs related to lost productivity and disability, is also substantial.

Physical activity (PA) has long been recognized for its benefits to physical health, contributing to the prevention and management of chronic diseases such as cardiovascular disease and type 2 diabetes. However, its positive effects extend beyond physical health to mental health, with PA potentially playing a crucial role in the treatment and management of depression and anxiety. Regular physical activity has been shown to improve depressive symptoms in a manner comparable to, or even more effective than, traditional antidepressants. Despite this, research linking exercise to a decreased risk of depression has not been analyzed in depth (5). The mechanisms behind antidepressant effects are still under investigation, with multiple hypotheses suggesting that changes in neurotransmitter systems, neurotrophic factors, and inflammatory markers, along with psychological benefits such as improved self-efficacy and social interaction, may all play a role. Further research is necessary to fully understand these mechanisms and to determine the optimal types, intensities, and durations of physical activity for treating depression.

Endorphins, the body's natural painkillers and mood elevators, play a role in the body's opioid system, influencing pain relief, social bonding, and mood regulation. These opioid polypeptides are produced by the hypothalamus-pituitary system in response to intense physical activity, emotional stimulation, or physical pain. Research has linked beta-endorphins to depressive symptoms, highlighting their potential role in mental health. According to "The Endorphin Hypothesis," physical activity increases the production of endogenous opioid peptides in the brain, which helps alleviate pain and improve mood, reducing feelings of anxiety and hopelessness. A recent study demonstrated that endorphins positively impacted mood during exercise, supporting this theory, but also emphasized the need for further investigation into the endorphin hypothesis (6).

Physical activity has consistently been shown to improve mood and alleviate depressive symptoms across all age groups, including children and adolescents (7). Global studies indicate that exercise is significantly effective and represents a promising intervention for depression. Various forms of yoga, particularly those incorporating breathing exercises, self-awareness, and relaxation techniques, have also been found to enhance mood and overall well-being (8). However, while the positive effects of exercise on mood are widely acknowledged, the ideal type or intensity of exercise to achieve these effects remains unclear, and it likely varies based on individual factors.

A meta-analysis of 23 randomized controlled trials involving 977 participants examined the impact of exercise on unipolar depression. While the immediate effects of exercise on

depression were moderate, the long-term impact was small and not statistically significant. Nevertheless, exercise showed a large and significant effect compared to no intervention and a moderate but meaningful effect compared to standard care (9). Similarly, a systematic review of randomized controlled trials investigating exercise as a treatment for anxiety disorders found that while exercise was beneficial as an adjunct therapy, it was less effective antidepressants medications (10).

Integrating physical activity into depression management requires considering individual preferences, physical limitations, and access to resources. Future research should focus on identifying the most effective strategies for promoting exercise, enhancing compliance, and maintaining physical activity routines among individuals with depression. Additionally, further research is needed to explore the potential of combining physical activity with medication and other therapies, and to investigate the long-term effects of physical activity on depression. Studies should also examine the optimal dose-response relationship between physical activity and symptom improvement and explore whether physical activity can reduce the risk of developing depression, though this would be challenging to measure.

Studies reviewed in this literature indicated that physical activity (PA) is an effective method for preventing depression. Several studies show that PA leads to meaningful reductions in depression symptoms and prevents depression across different population groups (46-49). Research by Schuch et al. (46) and Pearce et al. (47) suggests that even minimal levels of physical activity, below current guidelines, can prevent depression. Mammen and Faulkner (48) found that physical activity totaling less than 150 minutes per week could reduce the probability of depression. This evidence shows that people can gain mental health benefits from lower levels of physical activity, making exercise more accessible as a preventive method. This aligns with global studies that indicate physical activity reduces depression (18, 41-43).

Scientific research has demonstrated that exercise treatments are as effective as prescribed antidepressants in managing depression symptoms. Dinas et al. (50) and Schuch et al. (51) found that physical activity antidepressants effects comparable to pharmacological treatments. These findings are consistent with empirical evidence that antidepressants reduce depression symptoms in patients (31-34). However, Recchia et al. (52) found no significant difference between exercise-based therapy antidepressants. Medical data shows that physical activity is an acceptable non-drug treatment for patients seeking alternative health approaches. Research also indicates that dropout rates from physical activity interventions are

higher than those from medication-based interventions (53). The combination of physical activity with standard medical treatment has resulted in greater reductions in severe depression according to Lee et al. (54), highlighting the potential benefits of integrating physical activity into clinical care.

While physical activity consistently helps reduce depression, outcomes vary based on population group and exercise method. Brown et al. (55) found that structured physical activity interventions had greater effects on children and adolescents, and Wolf et al. (56) identified consistent exercise as a protective measure during the COVID-19 pandemic. Wu et al. (57) showed that Tai Chi and balance training were effective in treating depression in patients with Parkinson's disease. Exercise interventions tend to have stronger outcomes when healthcare professionals tailor programs to specific patient groups or health conditions. However, a study by Chalder et al. (58) found that simply providing instructions for physical activity did not significantly improve depression symptoms, suggesting that more structured guidance is necessary for therapeutic benefits. Barriers such as low self-confidence, minimal engagement in movement, and reduced motivation hinder individuals from performing physical activity. These barriers must be addressed to maximize antidepressant effects of physical activity. Helgadóttir et al. (59) found that individuals with mild to moderate depression engaged less in light physical activities and spent more time sedentary. Searle et al. (60) identified that some patients believed they needed medication before engaging in physical activity. Addressing these barriers is crucial, as they limit the potential antidepressant impact of physical activity. Overall, evidence demonstrates that physical activity reduces depression risk, but patient-specific preferences, treatment capabilities, and health conditions should guide the most effective approach (61-64).

LIMITATIONS

This narrative review depends mainly on secondary research from literature reviews from 2010 that present important limitations. The use of research from a previous decade might affect the current value of the study findings considering advancements in diagnosis methods and physical activity standards since 2010 (65-66). Several studies that were reviewed collected data regarding physical activity and depressive symptoms through self-reported methods which scientists think could contain reporting errors and bias. Additionally, multiple approaches to measure different levels of physical activity from scheduled athletic activities to spontaneous movements create difficulties when studying data across research studies thus affecting the universal application of study results (46-64).

This review mainly investigates how physical activity affects depression among patients with mild to moderate symptoms. This omits essential insights about severe depression. Most research covered in this review took place in Western high-income nations which restricts the potential application and basic data transfer of the reported conclusions worldwide (46-64). Physical activity treatment evaluation has been hampered by insufficient research assessments between its effects and standardized methods such as medication or psychotherapy. Better understanding of physical activity's abilities to control depression can be achieved by using recent research that includes different cultures and follows strong methodology.

CONCLUSION AND RECOMMENDATIONS

The narrative review demonstrates that physical exercise helps decrease symptoms of depression among patients with mild to moderate depressive symptoms. Regular exercise, even below recommended levels, is linked to a lower risk of developing depression and improvements in depressive symptoms. Various forms of exercise, including aerobic activities, strength training, yoga, and tai chi, have shown effectiveness, although individual responses may vary. The mechanisms behind these benefits are multifactorial, involving both biological and psychological pathways, such as increased endorphin production, improved self-efficacy, and enhanced social interaction.

Furthermore, although there are signs that physical activity may help prevent depression, more research is needed to confirm this effect and explore the long-term dose-response relationship.

Healthcare providers could implement physical activity programs along with psychotherapy and medication for patients with depression as an additional treatment method. Exercise programs developed with supervision for people experiencing different levels of depression would help both patients adhere to their treatment while optimizing positive mental health outcomes. Future research should investigate how physical activity affects severe depression, how it performs in comparison to traditional treatment choices, and how best to promote long-term engagement in physical activity tailored to individual needs and preferences.

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