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# Physical Activity and Mental Health in Children and Adolescents with Overweight and Obesity: Mechanisms and Effects on Depressive and Anxiety Symptoms- Narrative Review

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**Abstract**

**Background:** Childhood obesity is associated with an increased risk of anxiety and depressive symptoms, representing a growing global mental health concern.

**Aim:** The aim of this review was to examine the impact of physical activity on anxiety and depressive symptoms in children and adolescents with overweight or obesity, with particular emphasis on underlying neurobiological, psychosocial, and behavioral mechanisms.

**Material and methods:** This narrative review synthesizes current evidence on the effects of physical activity on mental health outcomes in children and adolescents with overweight or

obesity. A literature search was conducted using PubMed, Scopus, and Web of Science, including studies published between January 2015 and January 2026. Both observational and interventional studies, including randomized controlled trials, systematic reviews, and meta-analyses, were considered. Findings were synthesized narratively.

**Results:** Available evidence indicates that physical activity is associated with small-to-moderate reductions in depressive and anxiety symptoms in youth, with more consistent effects observed for depression. These benefits are mediated through multiple neurobiological, psychosocial, and behavioral pathways. Intervention effectiveness appears to depend on factors such as duration, intensity, supervision, and the inclusion of psychosocial components. However, substantial heterogeneity across studies and limited long-term data remain important limitations.

**Conclusions:** Physical activity represents a promising, accessible, and cost-effective strategy for improving mental health outcomes in children and adolescents with overweight or obesity. To maximize benefits, interventions should be structured, inclusive, and supported by behavioral and motivational strategies. Further research is needed to optimize intervention design and clarify causal mechanisms.

**Key words:** physical activity; obesity; overweight; children; adolescents; depression; anxiety; mental health.

## 1. Introduction

Childhood obesity has emerged as a major global public health challenge, affecting both physical and mental health. According to the latest data from the World Health Organization (WHO), the global prevalence of overweight and obesity among children and adolescents aged 5-19 has reached approximately 20%, corresponding to over 390 million individuals [1]. This growing epidemic extends beyond physical health consequences and represents a significant concern for mental well-being.

The UNICEF Child Nutrition Report (2025) highlights that obesity is closely associated with a substantial mental health burden [2]. Children and adolescents with elevated BMI demonstrate higher rates of mental health symptoms compared to their normal-weight peers. Meta-analytic evidence indicates that youth with overweight and obesity exhibit elevated rates of both

depressive and anxiety symptoms, although prevalence estimates vary depending on study population and assessment methods [4]. These findings are supported by large-scale population-based studies, which consistently demonstrate an increased risk of mental health problems in this group [3].

## 2. Materials and Methods

This narrative review synthesizes current evidence on the effects of physical activity on anxiety and depressive symptoms in children and adolescents with overweight or obesity. A literature search was conducted using PubMed, Scopus, and Web of Science.

To ensure both up-to-date evidence and theoretical context, two timeframes were applied:

- Recent empirical studies (primary evidence): publications from January 2015 to January 2026, including systematic reviews, meta-analyses, and clinical or observational studies
- Foundational and mechanistic studies: earlier publications (pre-2015) were included where necessary to explain biological and psychological mechanisms (e.g., inflammation, neurotransmission, behavioral models)

The search strategy combined keywords related to physical activity ("physical activity" OR "exercise"), weight status ("obesity" OR "overweight"), population ("children" OR "adolescents" OR "youth"), and mental health outcomes ("depression" OR "anxiety" OR "mental health"), using Boolean operators (AND/OR).

Both observational and interventional studies were considered, including randomized controlled trials, systematic reviews, and meta-analyses. Studies were selected based on their relevance to the research question and their contribution to understanding the relationship between physical activity and mental health outcomes in pediatric populations with overweight or obesity.

Data were synthesized narratively, with particular emphasis on:

- neurobiological mechanisms (e.g., inflammation, cytokines, BDNF, neuroendocrine responses)

- psychosocial factors (e.g., weight stigma, self-esteem, emotional regulation)

- behavioral and environmental influences (e.g., screen time, lifestyle factors)

Additionally, epidemiological context and environmental determinants were supported by reports from international organizations, including the World Health Organization and the United Nations Children's Fund.

Given the narrative nature of the review, a systematic approach following PRISMA guidelines was not applied. However, efforts were made to ensure a comprehensive and balanced inclusion of both recent high-quality evidence and key foundational studies.

## 3. Obesity as a Risk Factor for Anxiety and Depression

Obesity in childhood and adolescence is associated with an increased risk of mental health disorders, including anxiety and depression. Epidemiological and meta-analytic studies consistently demonstrate higher rates of these conditions among youth with elevated BMI compared to their normal-weight peers [3,4].

Children and adolescents with overweight and obesity exhibit elevated rates of depressive and anxiety symptoms, although prevalence estimates vary depending on study population and assessment methods [4]. These findings are supported by large-scale population-based studies, which consistently demonstrate an increased risk of mental health problems in this group [3].

In addition, clinical evidence suggests that higher BMI may be associated with specific depressive symptom profiles, including atypical features such as hyperphagia and hypersomnia, which may further contribute to the complexity of mental health outcomes in this population [5].

## 4. Pathways Linking Obesity and Mental Health

### 4.1 Inflammation-Driven Neurobiological Pathways

A key link between obesity and mental disorders is chronic low-grade inflammation [6-8]. In individuals with obesity, adipose tissue functions as an active endocrine organ, characterized by hypertrophy of adipocytes and infiltration of immune cells, particularly macrophages. This promotes a shift toward a pro-inflammatory state, with increased secretion of cytokines such as tumor necrosis factor alpha (TNF-α) and interleukin-6 (IL-6) [7-9].

These cytokines are thought to play a central role in modulating brain function through activation of indoleamine 2,3-dioxygenase (IDO), an enzyme expressed in microglia and astrocytes. IDO catalyzes the degradation of tryptophan, an essential amino acid and precursor of serotonin, along the kynurenine pathway. As a result, tryptophan availability for serotonin synthesis may be reduced, potentially contributing to depressed mood and anhedonia.

Furthermore, kynurenine is metabolized into several neuroactive compounds. Under inflammatory conditions, the pathway may shift toward the production of neurotoxic metabolites, including quinolinic acid. Quinolinic acid acts as an agonist at N-methyl-D-aspartate (NMDA) receptors, which may lead to increased glutamatergic neurotransmission, excitotoxicity, and neuronal dysfunction.

In parallel, inflammatory cytokines may interfere with dopamine synthesis by reducing the availability of tetrahydrobiopterin (BH4), a critical cofactor for tyrosine hydroxylase. This may result in impaired dopaminergic signaling within reward-related brain regions, further contributing to reduced motivation, anhedonia, and depressive symptoms [7-9].

### 4.2 Psychosocial Pathways

Children with obesity frequently experience weight stigma, bullying, and social exclusion across multiple environments, including school, family, and healthcare settings. It is estimated that approximately 30-60% of children with obesity report experiences of weight-based teasing or stigmatization [9,10]. These experiences contribute not only to reduced self-esteem and negative body image, but also to the internalization of weight bias, which is associated with increased symptoms of anxiety and depression [9].

Importantly, weight stigma can act as a chronic psychosocial stressor. Repeated exposure to teasing and negative evaluation may reinforce maladaptive cognitive patterns, such as fear of judgment and social withdrawal. As a result, children may disengage from peer interactions and structured activities, further exacerbating psychological distress [10].

Emotional eating often emerges as a maladaptive coping strategy in response to stigma-related stress. This behavior is more prevalent among adolescents with overweight and obesity and is associated with higher levels of depressive symptoms and perceived stress [11,12]. The consumption of palatable foods may provide temporary emotional relief, reinforcing a cycle of distress and overeating.

These psychosocial stressors are further compounded by lifestyle-related factors. Children who experience weight-related teasing are more likely to avoid exercise settings, particularly those involving public performance or peer comparison, which may further limit exposure to the protective mental health benefits of physical activity [9,10].

Excessive use of digital devices, particularly smartphones, has become increasingly prevalent among children and adolescents. Higher levels of screen time have been consistently associated with poorer mental health outcomes; however, causality remains unclear due to the predominance of cross-sectional evidence. The relationship is likely bidirectional, as increased screen use may contribute to psychological distress, while individuals with existing mental health difficulties may be more prone to excessive engagement with digital media. Further longitudinal studies are required to clarify these pathways [24,25].

## 5. Mechanisms of the Effects of Physical Activity on Mental Health

### 5.1 Neurobiological Mechanisms of Physical Activity

Physical activity influences mental health through multiple neurobiological pathways, including modulation of neurotransmitter systems, enhancement of neuroplasticity, and regulation of stress-response systems [13-15]. Both acute and chronic exercise have been shown to increase central levels of key neurotransmitters, particularly serotonin and dopamine, which play a central role in mood regulation, motivation, and reward processing [14,15].

Exercise is associated with enhanced serotonergic signaling, partly through increased availability and transport of tryptophan across the blood-brain barrier, thereby promoting serotonin synthesis. Simultaneously, physical activity influences dopaminergic pathways, particularly within mesolimbic reward circuits, contributing to improved motivation and reduced anhedonia [14,15].

A critical mechanism underlying the antidepressant effects of exercise is the upregulation of brain-derived neurotrophic factor (BDNF). Meta-analytic evidence indicates that both acute and long-term exercise are associated with increased circulating BDNF levels, which support synaptic plasticity, neurogenesis, and neuronal survival, particularly in the hippocampus-a region strongly implicated in depression [16]. These neuroplastic changes are thought to counteract stress-related neuronal atrophy and improve cognitive and emotional functioning.

In addition, physical activity exerts a regulatory effect on the hypothalamic-pituitary-adrenal (HPA) axis. Regular exercise has been associated with reduced basal cortisol levels and improved stress reactivity, indicating enhanced resilience to psychosocial stressors [17]. This is particularly relevant in children with obesity, in whom chronic stress and HPA axis dysregulation are commonly observed.

Emerging evidence also highlights the anti-inflammatory effects of exercise as a key neurobiological mechanism. Physical activity is associated with reductions in systemic levels of pro-inflammatory cytokines, such as IL-6 and TNF-α, alongside increases in anti-inflammatory mediators [18,31]. This shift in inflammatory balance may counteract neuroinflammatory processes implicated in the pathophysiology of depression and anxiety, including those mediated through the kynurenine pathway.

Furthermore, exercise-induced release of myokines and neuromodulators, including endorphins and endocannabinoids, contributes to acute improvements in affective state and reductions in anxiety symptoms [15,31]. These substances enhance reward signaling and promote a sense of well-being.

Taken together, these mechanisms indicate that physical activity exerts its effects through a complex and integrated network of neurobiological processes, influencing both brain structure and function and contributing to improved mental health outcomes in children and adolescents.

### 5.2 Psychosocial and Behavioral Mechanisms

Physical activity exerts significant effects on mental health through interconnected psychosocial and behavioral pathways. Regular engagement in physical activity is associated with improved self-esteem, body image, and perceived competence [19-21]. Participation in sports enhances social integration, peer support, and emotional well-being, which act as protective factors against anxiety and depression [20,35]. These psychosocial benefits may counteract weight stigma and reduce anxiety related to social evaluation, particularly in adolescents with obesity. However, participation in physical activity may also be hindered by body image concerns, self-consciousness, and feelings of embarrassment, which are common in this population. Therefore, structured and supportive environments that emphasize inclusion, enjoyment, and psychological safety are especially important to facilitate engagement and maximize mental health benefits [19-21].

In addition to psychosocial effects, physical activity is associated with improved emotional regulation and the development of adaptive coping strategies [22]. It also has a well-established impact on sleep, with evidence indicating improvements in sleep quality and duration, both of which are strongly associated with reduced symptoms of anxiety and depression [23].

A key behavioral mechanism is the reduction of sedentary behaviors, particularly excessive screen time. This effect is likely mediated by improved organization of leisure time and increased engagement in structured, goal-directed activities, which limit opportunities for passive screen use [19,22].

Furthermore, physical activity supports behavioral activation, routine formation, and goal-directed behavior, which are core mechanisms in the treatment of depression [26].

## 6. Empirical Evidence: Effects of Physical Activity Interventions

### 6.1 Overview of Intervention Studies

Evidence from recent umbrella reviews and meta-analyses of randomized controlled trials (RCTs) indicates that physical activity is associated with statistically significant, although generally small-to-moderate, reductions in symptoms of depression and anxiety in children and adolescents [28,29]. In a comprehensive umbrella review, Singh et al. reported effect sizes ranging from small to moderate across studies, with stronger effects observed for depressive symptoms compared to anxiety [28].

The effectiveness of physical activity interventions appears to be influenced by several key factors, including intervention duration, frequency, and level of supervision. Programs lasting at least 8-12 weeks and involving moderate-to-vigorous intensity exercise performed 3-5 times per week tend to demonstrate more consistent benefits [29,30].

Importantly, interventions delivered in structured and supervised settings tend to be associated with greater improvements in mental health outcomes compared to unsupervised or home-based programs [28,29]. This may reflect the additional contribution of social interaction, adherence support, and external motivation, which are often integral components of supervised interventions.

Furthermore, multimodal programs that combine physical activity with behavioral or psychosocial components-such as cognitive-behavioral strategies or motivational support-

appear to be associated with more robust and sustained effects, highlighting the importance of addressing both physiological and psychological determinants of mental health [28,29]. However, substantial heterogeneity across studies limits direct comparison of results and underscores the need for more standardized intervention protocols.

### 6.2 Effects on Depression Symptoms

Evidence from systematic reviews and meta-analyses indicates that structured physical activity is associated with significant reductions in depressive symptoms in children and adolescents [29]. These effects are generally of small-to-moderate magnitude but remain clinically meaningful, highlighting the potential role of physical activity as a complementary intervention in mental health care.

The antidepressant effects of exercise are mediated through multiple interacting mechanisms. At the neurobiological level, physical activity is associated with increased expression of brain-derived neurotrophic factor (BDNF), enhanced synaptic plasticity, and improved regulation of the hypothalamic-pituitary-adrenal (HPA) axis [30,31]. In addition, exercise is associated with modulation of serotonergic and dopaminergic neurotransmission, contributing to improvements in mood and motivation.

From a behavioral perspective, physical activity facilitates behavioral activation, a key therapeutic mechanism in the treatment of depression. Engagement in regular, goal-directed activities counteracts core depressive symptoms such as withdrawal, inactivity, and reduced motivation. The establishment of structured routines and the achievement of incremental goals may enhance self-efficacy and perceived competence, thereby supporting recovery [26].

Intervention context also appears to influence effectiveness. Structured and supervised programs, particularly those involving social interaction, may be associated with greater improvements in depressive symptoms, potentially due to increased adherence, motivation, and peer support [28,29].

### 6.3 Effects on Anxiety Symptoms

Although fewer studies have specifically focused on anxiety outcomes, current evidence indicates that physical activity is associated with reductions in anxiety symptoms in children and adolescents [32,33]. The observed effects tend to be smaller and more variable than those reported for depressive symptoms, likely reflecting heterogeneity in study design, intervention characteristics, and outcome measures.

Evidence specific to youth with overweight or obesity further supports this association. A recent meta-analysis of randomized controlled trials demonstrated a statistically significant reduction in anxiety symptoms in this population; however, the certainty of evidence was rated as low, and the results were characterized by substantial heterogeneity [35].

The anxiolytic effects of exercise are thought to be mediated, in part, by reductions in physiological arousal and improvements in emotional regulation. Physical activity may also enhance the ability to cope with stress, contributing to increased psychological resilience [33,36]. Nevertheless, the precise mechanisms underlying these effects remain incompletely understood and require further investigation.

### 6.4 Limitations of Current Evidence

Despite the overall positive findings, several limitations should be considered. There is substantial heterogeneity across studies in terms of intervention type, duration, intensity, and outcome measures, which complicates direct comparisons. Many studies rely on self-reported measures of physical activity and mental health, which may introduce bias. Additionally, long-term follow-up data are limited, making it difficult to determine the sustainability of observed effects. Future research should focus on well-designed, large-scale RCTs with standardized protocols, objective biomarkers (e.g., BDNF, cortisol), and long-term follow-up to better understand causal relationships and optimize intervention strategies.

## 7. Discussion

The findings of this review indicate that physical activity is associated with improvements in mental health outcomes in children and adolescents with obesity. These effects can be understood within a multidimensional framework involving interacting neurobiological, psychosocial, and behavioral mechanisms.

However, the magnitude of these effects is generally small to moderate, suggesting that physical activity should be considered a complementary component of a broader, multimodal approach rather than a standalone treatment. Intervention effectiveness appears to be strongly influenced by contextual factors, including social support, perceived competence, and enjoyment.

Weight stigma and body image concerns remain significant barriers to participation, particularly among those who may benefit most from physical activity. This creates a mismatch between need and engagement, potentially limiting the overall effectiveness of interventions.

These findings support the inclusion of physical activity as part of interdisciplinary strategies for improving mental health in youth with overweight and obesity. Interventions should prioritize inclusive, supportive, and non-competitive environments, with an emphasis on enjoyment and gradual skill development. The integration of behavioral and motivational strategies may further enhance adherence and outcomes.

Future research should focus on optimizing intervention characteristics and better understanding individual variability in response to physical activity.

## 8. Conclusions

Physical activity represents a promising, accessible, and cost-effective intervention for improving mental health among children and adolescents with overweight or obesity. Its benefits extend beyond physical health, influencing emotional regulation, self-esteem, sleep quality, and social functioning. The evidence suggests that the greatest benefits are achieved through structured, supervised, and socially engaging interventions that address both psychological and behavioral aspects of participation. Future strategies should adopt an integrative approach, combining biological, psychological, and social components to ensure sustainable and long-term improvements in mental health outcomes.

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