WACHOWSKA, Maria, RYCĄBEL, Paweł Maciej, ROMANIUK, Mateusz, MOLENDA, Marek Jarosław, PANIAK, Mateusz, SOWIŃSKI, Wojciech Jan, WOSZCZYŃSKA, Oliwia Brygida, SZYMURA, Marta, WOJCIECHOWSKA, Agnieszka Ewelina, and KRAWCZYK, Michał Brunon. Physical Activity in Mental Health Disorders – Therapeutic Potential and Mechanisms. Quality in Sport. 2025;41:60020. eISSN 2450-3118.
https://doi.org/10.12775/QS.2025.41.60020
https://apcz.umk.pl/QS/article/view/60020

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

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 02.04.2025. Revised: 15.04.2025. Accepted: 02.05.2025. Published: 05.05.2025

Physical Activity in Mental Health Disorders – Therapeutic Potential and Mechanisms

Maria Wachowska

Podhale Specialist Hospital named after St John Paul II in Nowy Targ

ul. Szpitalna 14, 34-400 Nowy Targ, Poland

maria.wac97@gmail.com

ORCID: 0009-0004-2069-9469

Paweł Maciej Rycąbel

Independent Public Health Care Center

of the Polish Ministry of Interior and Administration in Lublin

ul. Grenadierów 3, 20-331 Lublin, Poland

pawelrycabel@gmail.com

ORCID: 0009-0008-4039-8312

Mateusz Romaniuk
Independent Public Health Care Center
of the Polish Ministry of Interior and Administration in Lublin
ul. Grenadierów 3, 20-331 Lublin, Poland
mateusz.romaniuk.44@gmail.com
ORCID: 0009-0007-1486-5522

Marek Jarosław Molenda
4th Clinical University Hospital in Lublin
ul. Kazimierza Jaczewskiego 8, 20-954 Lublin, Poland
markollo1998@gmail.com
ORCID: 0009-0002-7900-4970

Mateusz Paniak
Cardinal Stefan Wyszyński Province Specialist Hospital in Lublin
ul. al. Kraśnicka 100, 20-718 Lublin, Poland
mateuszpaniak.mp@gmail.com
ORCID: 0009-0009-0110-9634

Wojciech Jan Sowiński
1st Military Clinical Hospital with the Outpatient Clinic, Lublin, Poland
wojciechjansowinski@gmail.com
ORCID: 0000-0002-2267-4773

Oliwia Brygida Woszczyńska
Independent Public Health Care
of the Ministry of the Internal Affairs
ul. Kartuska 4/6, 80-104 Gdańsk, Poland
ob.woszczynska@gmail.com
ORCID: 0009-0001-7724-544X

Marta Szymura
Independent Public Healtcare Center No.1 in Rzeszów
ul. Tadeusza Czackiego 2 35-051 Rzeszów, Poland
martaszymura3581@gmail.com
ORCID: 0009-0000-2776-8974

Agnieszka Ewelina Wojciechowska
Cardinal Stefan Wyszyński Province Specialist Hospital in Lublin
ul. al. Kraśnicka 100, 20-718 Lublin, Poland
ine.wojciechowska@gmail.com
ORCID: 0009-0009-3344-9115

Michał Brunon Krawczyk
Pediatric Cardiac Surgery Department of Mikołaj Kopernik Hospital in Gdańsk
Gdańsk, Poland
michalkrawczyk@gumed.edu.pl
ORCID: 0009-0008-9697-6548

ABSTRACT

Introduction and Purpose: Mental health disorders are a global public health challenge, with rising emergency visits, especially among youth. Physical activity has gained recognition as an effective intervention for some mental disorders. PA positively affects mental health by enhancing neuroplasticity, neurotransmitter regulation, and reducing inflammation. Aerobic and resistance exercises, as well as yoga, are effective in alleviating depressive symptoms, anxiety, and PTSD, improving ADHD-related cognitive functions, and decreasing substance cravings. This study aims to analyze the influence of physical activity on mental disorders.

Reasearch Objective: The primary aim of this literature is to evaluate the impact of physical activity (PA) on mental health, focusing on depression, anxiety, PTSD, ADHD, and substance use disorders.

Materials and Methods: A literature review of studies published from 2019–2024 in the PubMed database analyzed clinical trials, meta-analyses, and systematic reviews on the effects of PA, using the following keywords: “physical activity” ; “depression” ; “anxiety” ; “substance abuse” ; “adhd”.

Conclusions: PA is an effective, accessible adjunct therapy for mental health conditions, providing significant physical and psychological benefits. Future research should prioritize optimizing intervention protocols, investigating long-term effects, and adapting treatments to the specific needs of diverse populations.

Keywords: physical activity, depression, anxiety, substance abuse, adhd

1. Introduction

Mental health disorders pose a major public health concern, with extensive social and economic consequences. Individuals affected by these conditions encounter considerably higher mortality rates, leading to a significant reduction in life expectancy, which highlights the global burden and health system challenges posed by mental illnesses. [1] In recent years, emergency department visits related to mental health have significantly risen, particularly among young individuals, highlighting the growing severity of mental health crises within this population. [2] Concurrently, data from studies on U.S. college students reveal shifting patterns in help-seeking behavior, with notable disparities based on race and ethnicity, emphasizing the necessity for personalized prevention and intervention approaches to address the distinct needs of various populations. [3] These interrelated factors highlight the complexity of mental health issues, requiring a holistic approach that incorporates both global and local perspectives.

Physical activity has consistently been recognized as a fundamental element of a healthy lifestyle, providing a wide range of physiological benefits such as improved cardiovascular fitness, muscle strengthening, and enhanced immune system resilience. In recent years, however, there has been a growing interest in exploring its potentially equally impactful role in mental health. [4,5,6] Against the backdrop of a growing number of individuals affected by mental health conditions including depression, anxiety, post-traumatic stress disorder (PTSD), attention-deficit/hyperactivity disorder (ADHD), and substance use disorders, physical activity

is gaining recognition as a supportive intervention that is not only effective but also safe and widely accessible.

Scientific literature increasingly emphasizes the multifaceted mechanisms by which physical exercise influences mental health. These mechanisms involve biological alterations, including augmented neuroplasticity, regulation of neurotransmitter levels (dopamine, serotonin, and endorphins), and a reduction in systemic inflammation. Additionally, physical activity contributes to improved cognitive function, stress reduction, enhanced self-esteem, and increased social interaction, making it a comprehensive therapeutic tool. Several forms of exercise, such as aerobic and resistance training, as well as mind-body interventions (e.g., yoga), have proven effective in addressing a wide spectrum of mental health disorders across diverse populations, including adolescents, adults or populations particularly vulnerable to the risk of depressive disorders, such as oncology patients.

The objective of this article is to present the current state of knowledge on the impact of physical activity on mental health, with a particular focus on its role in the treatment of depression, anxiety, PTSD, ADHD, and substance use disorders. The discussion encompasses the efficacy of different forms of exercise as well as the limitations of existing studies, including small sample sizes or the lack of long-term analyses. Practical considerations are also addressed, including the importance of exercise regularity, the individualization of physical activity programs, and the role of social support in the therapeutic process.

Although the available scientific evidence strongly suggests the beneficial effects of physical activity on mental health, further research is needed to determine optimal exercise protocols, including type, intensity, and duration, tailored to the specific characteristics of different patient groups. The article also reflects on the potential for incorporating exercise interventions into healthcare systems, which could significantly enhance the quality of life for millions of people worldwide.

The analyses presented aim not only to provide an overview of current research findings but also to inspire further efforts to understand and harness the full potential of physical activity in the context of mental health. By doing so, physical activity may evolve into not only a component of therapy but also a fundamental element of prevention and the promotion of mental health on a global scale.

2. Biological mechanisms through which physical activity influences mental health

2.1 Brain-Derived Neurotrophic Factor (BDNF)

Brain-Derived Neurotrophic Factor (BDNF) is a neurotrophic protein essential for neuroplasticity, the brain's capacity to reorganize and adapt in response to experience. Research indicates that aerobic exercise particularly enhances BDNF secretion, which in turn supports neural health by stimulating neurogenesis and strengthening synaptic connections. These mechanisms contribute to improved cognitive performance, memory, and resilience against stress and depression. The increase in BDNF levels induced by physical activity may also have therapeutic implications for mental health, as it has been linked to mood enhancement and a reduction in depressive symptoms. Additionally, the increase in BDNF levels resulting from physical activity supports neuroplasticity, potentially strengthening the brain's ability to cope with new obstacles and stressors. [7,8]

2.2 Neurotransmitters evaluation

Chemical messengers in the brain, including serotonin, dopamine, norepinephrine, GABA, and glutamate, are vital for maintaining emotional balance, motivation, cognitive abilities, and overall mental well-being. Regular physical activity stimulates their release, which positively affects psychological health. Higher serotonin levels promote emotional stability, lower anxiety, and support healthy sleep cycles. Similarly, dopamine, essential for motivation and the brain's reward system, increases with exercise, leading to improved concentration and cognitive performance. Additionally, greater norepinephrine production enhances mental alertness, strengthens the ability to cope with stress, and optimizes cognitive function, ultimately improving focus and resilience. [9]

2.3 Neuroprotection

Consistent physical exercise also provides neuroprotective advantages, aiding in the prevention of neurodegenerative disorders like Alzheimer's and Parkinson's diseases. Aerobic activities stimulate the production of neurotrophic factors such as BDNF, which are vital for supporting the regeneration of neurons and inhibiting their degeneration. Additionally, physical activity enhances cerebral blood circulation, improving the exchange of nutrients and the removal of metabolic waste, thereby contributing to the long-term maintenance of brain health and function. [10]

2.4 Autonomic nervous system (ANS)

The autonomic nervous system (ANS) is responsible for controlling involuntary functions within the body, including respiration, heart rate, digestion, and the body's reaction to stress. [11] Engaging in physical activity positively influences the autonomic nervous system's balance, enhancing the functioning of both the sympathetic nervous system (which governs the "fight or flight" response) and the parasympathetic nervous system (which facilitates relaxation and recovery). Regular exercise fosters a more favorable equilibrium between these systems, leading to reduced stress, fewer anxiety symptoms, and improved sleep quality. Furthermore, physical activity helps regulate heart rate and blood pressure, lowering the risk of cardiovascular disease, which in turn supports mental and emotional well-being. [12]

3. The impact of physical activity on mental disorders

3.1 Depression

Depression is a global health issue affecting individuals regardless of age or social status. [13] Engaging in physical activity, acknowledged as a natural and accessible method for enhancing mental well-being, is increasingly being recognized as a valuable strategy for aiding in the treatment of depression. This is evidenced by the growing number of studies exploring various forms of exercise. Strength training, aerobic exercises, and running therapy have been shown to positively influence both the mental and physical health of patients with depression, although their effectiveness depends on the target group, type of activity, and duration of intervention. [14]

A study conducted by O'Sullivan et al. in 2023 evaluated the effects of resistance exercise training (RET) on individuals with Major Depressive Disorder (AMDD) and Major Depressive Disorder (AGAD). The participants were young adults with an average age of 26 years. The eight-week intervention resulted in a substantial decrease in depressive symptoms within the intervention group, with the observed effect surpassing one standard deviation on the measurement scales employed, highlighting its clinical significance. The most pronounced benefits were identified among individuals exhibiting subclinical depressive symptoms, suggesting that resistance training is particularly effective in cases of milder symptom severity. Moreover, participants with subclinical generalized anxiety disorder showed a significant decrease in anxiety symptoms after undergoing the exercise intervention. Improvements in muscle strength observed among the intervention group may have further contributed to enhanced psychological well-being. The effects were more significant among individuals who

consistently followed the training regimen, underscoring the critical role of regularity in maximizing the benefits of exercise. The study presented several limitations, including a small and relatively homogeneous sample with a predominance of women, which limits the generalizability of the findings. It focused primarily on young adults, and the results may not apply to other age groups. Reliance on self-reported measures introduced subjectivity, and the eight-week duration allowed only for the assessment of short-term effects. The absence of a control group engaging in an alternative form of physical activity restricted comparisons with other methods. [15]

Aerobic exercise demonstrates beneficial effects on depressive symptoms. A cohort study involving a relatively small sample of 42 patients with moderate to severe depression (HDRS-17 score >16) found that consistent aerobic exercise elicits substantial benefits for both mental and physical health. [16] In the short term, participants showed a significant reduction in depressive symptoms (as assessed by HDRS-17 and BDI), along with enhanced psychological resilience. Additionally, physical fitness, cognitive flexibility, and a decrease in body mass index (BMI) improved significantly. Aerobic exercise also positively impacted working memory, as indicated by statistically significant enhancements in this domain. Over a six-month follow-up period, these effects remained stable, particularly regarding the reduction in depressive symptoms, maintenance of psychological resilience, and weight control. One of the factors that complicates drawing definitive conclusions is that the control group was not "passive," as participants could engage in activities potentially yielding benefits, making it harder to isolate the specific effects of aerobic exercise. [16]

A meta-analysis evaluated aerobic exercise as an adjunctive treatment for major depressive disorder (MDD) in adults recruited from mental health services. [17] This study conducted a systematic review and meta-analysis of randomized controlled trials (RCTs) exploring the impact of aerobic exercise on depressive symptoms in adults. Eleven electronic databases and the bibliographies of 19 systematic reviews were searched (including PubMed, PsycINFO, Embase, and Cochrane Library) up to May 2018, focusing on interventions lasting at least four weeks. After a thorough screening process, 11 studies involving 455 participants were included based on the established criteria. The quality of these studies was assessed for potential bias, and the data were analyzed using random-effects models. Aerobic exercise (AE) showed a large, statistically significant effect on reducing depressive symptoms with low heterogeneity, pointing to a consistent pattern across the studies. Sub-analyses demonstrated that AE was effective regardless of setting (e.g., home-based vs. institutional), delivery mode (group vs. individual), or patient type (hospitalized vs. outpatient), and independent of

depression severity. The effects were more pronounced in studies with shorter intervention durations (up to four weeks), and when participants were allowed to choose exercises according to their personal preferences. Participant characteristics, such as age and baseline fitness levels, may have contributed to variations in the outcomes. By focusing exclusively on aerobic interventions, the study did not allow for comparisons with other forms of physical activity. Participant preferences may have amplified placebo effects or influenced adherence, posing additional challenges to the interpretation of the results. [17]

An analysis of running therapy, where participants engaged in running twice a week over a 16-week period, and the use of antidepressants, like escitalopram and sertraline, revealed that both methods are comparably effective in alleviating depressive symptoms in individuals with depression and anxiety disorders. (44.8% for medications and 43.3% for running). However, running therapy provided additional health benefits, including reductions in body weight, waist circumference, blood pressure, resting heart rate, and improved heart rate variability, which is particularly relevant for individuals with depression, as they face increased cardiovascular risks associated with a sedentary lifestyle. [18] The study's findings may be biased due to the allowance of group selection preferences, with only a portion of participants being randomly assigned. Consequently, the majority of participants opted for running therapy, leading to an uneven group distribution (45 individuals on antidepressants and 96 in the running therapy group), which could have influenced the results. The preference for running therapy may have stemmed from higher expectations regarding its effectiveness, potentially inducing a placebo effect. Furthermore, individuals actively involved in treatment selection might be more inclined to report health improvements. Additionally, participants choosing running therapy might differ from those opting for medications in terms of age, physical activity levels, or lifestyle preferences, which may also influence the results. In contrast, the preference for running therapy among most participants suggests that it is seen as more acceptable and appealing, which is significant for the practical application of the findings and for treatment choice in clinical contexts. [18,19]

Physical exercise has proven effective in reducing depressive symptoms in specific groups, such as adolescents hospitalized in specialized psychiatric facilities [20] or breast cancer survivors. [21] A study conducted among hospitalized adolescents demonstrated that physical exercises supervised by specialists proved to be more effective in reducing depressive symptoms compared to therapies based on social interactions, as reflected particularly in the HADS-D scale results. This improvement may be attributed not only to the physical activity itself but also to the positive effects of building therapeutic relationships and reducing social

isolation. Regarding anxiety levels, both groups experienced reductions, however, there were no significant differences between the therapy types, suggesting a limited impact of exercise on anxiety in adolescents. Physical fitness indicators, including VO2max, demonstrated notable improvement in the exercise group, despite both initial and final values remaining below normative standards. [20]

Depression is notably common among cancer patients, with studies indicating its prevalence ranges from 13% to 27% of those diagnosed, a rate two to three times higher than that observed in the general population. [22] This heightened risk is associated with the psychological burden of the diagnosis and the side effects of cancer treatments, including alterations in physical appearance, functional limitations, and fear of recurrence. [23] Among oncology patients, a study found that aerobic exercises had a significant effect on improving the quality of life. Participants in the program reported enhancements in physical, emotional, and social functioning, as well as in role performance. They also reported a decrease in the severity of symptoms, including fatigue, pain, sleep disturbances, and financial challenges related to the illness. Simultaneously, the WHOQOL-BREF (the Quality of Life assessment tool developed by the World Health Organization, used to assess four main domains of quality of life: physical health, mental health, social relationships, and environment) assessment demonstrated improvements in overall quality of life, physical and mental health, and social relationships. Regular physical activity emerged as a key factor in improving both psychological and physical well-being, highlighting its essential contribution to the recovery process after cancer treatment. [21] However, these studies focus on specific, narrow populations, and their findings may not be generalizable to broader groups.

The aforementioned studies encompass a broad spectrum of interventions, including strength training, aerobic exercises, and running therapy, evaluating their effects on diverse patient groups, ranging from individuals with subclinical symptoms to adolescents and oncology patients. The results are clinically significant, demonstrating the efficacy of physical activity in reducing depressive symptoms, improving physical health, and enhancing quality of life. Factors that may complicate the interpretation of the results include small-sample sizes, a focus on short-term effects, and a lack of demographic diversity. Many studies target specific groups, making it challenging to generalize the findings to the broader population. Long-term research with larger sample sizes is vital for determining the most effective types of physical activity and for uncovering the mechanisms that drive their therapeutic effects in the treatment of depression. Additionally, some studies employed active control groups, which may have underestimated the differences between groups. The variability in study populations (e.g.,

adolescents, oncology patients) underscores the necessity for additional research that includes more diverse and heterogeneous groups.

3.2 Anxiety

Anxiety is one of the most common mental disorders, affecting individuals across all age groups. At present, cognitive-behavioral therapy (CBT) and pharmacological treatments are commonly used approaches for managing anxiety disorders. [24,25] Despite the documented efficacy of both approaches, they are not without constraints. Patients with anxiety disorders frequently exhibit treatment resistance, experience adverse side effects, and demonstrate low adherence to pharmacological regimens. Moreover, CBT may induce concerns regarding unjust stigmatization for some individuals and may not always be readily accessible. [26]

Physical activity has the potential to serve as an excellent alternative or complement to traditional methods of treating anxiety. The mechanisms through which physical activity mitigates anxiety symptoms are multifaceted, involving biological aspects like enhanced neuroplasticity and lowered inflammation, as well as psychosocial influences, such as elevated self-esteem and improved social engagement.

Research on resistance exercise training (RET) has yielded promising results. A study conducted on young adults without clinically significant symptoms of generalized anxiety disorder (GAD) demonstrated that an 8-week RET program effectively reduced anxiety levels. The greatest reduction in anxiety symptoms was observed during the more intensive phases of the exercise regimen, suggesting a correlation between RET intensity and anxiety alleviation. [27] These results underscore the potential of RET as an effective preventive tool to mitigate the escalation of anxiety to clinical levels. Similar results were observed in a cohort of individuals with elevated subclinical symptoms of GAD who are at greater risk of developing full-blown GAD. In this group, an intervention based on RET, implemented according to WHO and ACSM guidelines, substantially decreased the intensity of anxiety symptoms. This is reflected in a notably low number needed to treat (NNT = 3), meaning that one in three individuals undergoing the intervention achieved remission. The value of this study is further enhanced by the absence of significant baseline differences between the RET and waitlist control (WL) groups in key variables such as age, BMI, anxiety levels, and physical activity. As a result, the outcomes can be directly linked to the effects of the intervention rather than to pre-existing disparities among participants, thereby enhancing the reliability and scientific credibility of the findings. [28]

Similar effects were observed in a study investigating the impact of aerobic exercise on individuals aged 18 to 65 with anxiety disorders under primary healthcare supervision. The

research showed that both low-intensity exercise and moderate-to-high-intensity exercise contributed to a reduction in anxiety symptoms when compared to the control group. Notably, greater benefits were observed in the group engaging in higher-intensity exercise and the observed improvement was determined to be independent of changes in aerobic capacity, suggesting that the observed effects may result from other mechanisms, such as enhanced neuroplasticity or improved emotional regulation associated with endorphin release and cortisol reduction. The reliability of the findings is supported by the large sample size (153 participants) and the high adherence rate to the study protocol (70%). These findings are consistent with prior research while offering additional insights. For example, no association was found between anxiety symptom reduction and changes in muscle strength or VO2max. [29]

The research conducted by Wu et al. in 2022 highlights the effectiveness of physical activity in reducing anxiety symptoms while emphasizing the importance of intervention quality. Studies on older adults have revealed that engaging in regular physical activity lowers anxiety levels while also promoting better physical health, such as improved respiratory function and balance. [30] Among adolescents and university students, physical activity has been shown to effectively reduce test-related anxiety, with the best outcomes achieved through longer, regular low-intensity exercise sessions in contrast to previous studies, which primarily emphasized the reduction of anxiety through intensive training. Research indicates that a minimum effective intervention involves at least 20-minute aerobic sessions conducted 2–3 times per week for a minimum duration of four weeks. Furthermore, combining exercise with psychotherapy yields superior results. However, the interpretation of these findings should be approached carefully, due to a small number of studies, limited sample sizes, and moderate quality of the included research, which often lacked clear details about randomization methods and allocation concealment. [31]

Despite these promising results, a number of studies do not include long-term follow-ups, making it difficult to assess the lasting impact of the observed effects. Additionally, the diversity of study samples is often insufficient, limiting the generalizability of findings to other population groups. Moreover, research on RET has highlighted that the absence of appropriately designed control groups, accounting for social interactions and researcher attention, may lead to an overestimation of effects. [28,32]

3.3 Substance use disorders

Substance addiction constitutes one of the major challenges to contemporary public health, affecting individuals, families, and communities worldwide. A critical issue lies in the

multifaceted nature of this phenomenon, which integrates genetic, biological, psychological, social, and cultural factors, necessitating integrated and multidimensional intervention strategies. [33] Systematic studies emphasize the importance of risk factors, such as peer pressure and lack of family support, while also highlighting the role of protective factors, including positive family relationships and education. [34] The practice of family medicine is essential in identifying and treating addictions, facilitating early interventions and providing ongoing support for patients. [35] Simultaneously, a holistic approach is essential, encompassing the collaboration of medical, educational, and social institutions to prevent and effectively address addiction-related issues. [33]

Physical activity (PA) is gaining increasing attention as a potential component in the treatment of substance use disorders (SUD), offering multidimensional benefits that are both physical and psychological. Recent research suggests that incorporating exercise into therapeutic interventions can contribute to a reduction in substance use, improvement in mental health, and support in preventing relapse.

A systematic review conducted by J. Li et al. (2024) assessed the effectiveness of different types of physical activity, including aerobic exercise, yoga, and resistance training, in treating individuals with alcohol use disorder (AUD). The results revealed a notable decrease in daily alcohol consumption and lower scores on the Alcohol Use Disorders Identification Test (AUDIT), highlighting the potential of exercise in alleviating alcohol dependence. Additionally, improvements in mental health were observed, including a decrease in anxiety and depression symptoms. However, the study was limited by high heterogeneity of results, which may affect their interpretation. [36]

In another study conducted in an addiction treatment clinic, a Contingency Management (CM) program (a behavioral intervention based on operant conditioning, using rewards or consequences to reinforce desired behaviors) focused on physical activity, significantly improved participants' physical activity levels and quality of life. Increased motivation to exercise and self-efficacy were observed, despite an overall decline in social support. However, the program did not demonstrate a unique effect on substance use reduction compared to the CM-General group, which focused on other behavioral aspects. Both groups utilized financial incentives, which resulted in increased study completion rates. The study emphasized difficulties in ensuring participants' adherence to the program, highlighting the necessity for further research on strategies to improve engagement. Carrying out the study in a practical clinical environment, along with its limitations such as high participant dropout rates and focus on a single facility, limits the broader applicability of the findings. [37]

Research indicate that exercise can operate on multiple levels. Firstly, it has a direct impact on reducing substance cravings. A study conducted on patients with Alcohol Use Disorder (AUD) demonstrated that even short, intensive sessions of aerobic exercise significantly decreased subjective feelings of alcohol craving. This effect was most noticeable in individuals with lower physical fitness and higher initial levels of craving. [38] Secondly, on a biochemical level, aerobic exercise has been shown to increase levels of endocannabinoids, such as anandamide, which contribute to mood enhancement and stress reduction. In a study with patients receiving intensive outpatient treatment, findings indicate that participants who engaged exercise, reported higher levels of vitality and better outcomes in reducing substance cravings, suggesting that aerobic exercise may support abstinence through its influence on the endocannabinoid system. [39]

Short- and medium-term physical interventions also provide further psychological advantages. Research indicates improvements in positive affect, increased self-esteem, and reductions in anxiety and negative emotions following physical activity sessions. These effects were especially notable in patients with multiple addictions, highlighting the potential of physical activity (PA) as a tool for enhancing mental health in high-risk populations. The exercise protocol consisted of moderate to intense physical activity aimed at improving mood by stimulating endorphin release. [40]

Considering the studies mentioned above, the following conclusions can be drawn. Physical activity (PA) shows promise in treating substance use disorders (SUD), offering both physical and psychological benefits, including reducing substance cravings and improving mental health by increasing endocannabinoid levels and enhancing mood. The high heterogeneity of results and methodological diversity among studies limit the generalizability of conclusions. Insufficient participant adherence and the lack of standardized exercise protocols present additional challenges. Moreover, many studies report difficulties in isolating the effects of PA itself from the influence of other therapeutic components, such as motivational therapeutic approaches or social support.

3.4 PTSD

Post-Traumatic Stress Disorder (PTSD) is a mental health condition that can develop following exposure to traumatic events, such as war, violence, or natural disasters. It is characterized by symptoms including recurrent intrusive memories, avoidance of trauma-related stimuli, and heightened arousal, each of which notably disrupts the daily functioning of patients. [41] Despite progress in diagnostic and therapeutic approaches, the treatment of PTSD continues to

be a challenge, requiring a comprehensive strategy that also targets comorbid conditions like depression and anxiety disorders. [42] Cultural studies on PTSD underscore the importance of incorporating local social and cultural factors into treatment, as these can significantly influence the trajectory and management of the disorder. [43] PTSD therefore poses not only a medical challenge but also a societal one, requiring interdisciplinary collaboration and the customization of therapeutic strategies to reduce patient suffering and improve their quality of life.

An increasing number of studies in recent years have confirmed the positive impact of physical activity on both the mental and physical health of individuals suffering from post-traumatic stress disorder (PTSD). Physical activity is being considered both as a therapeutic intervention and as a supportive method to complement other forms of PTSD treatment. Research conducted across various population groups, including war veterans, trauma-exposed individuals and patients with chronic pain coexisting with PTSD, delivers important perspectives on the potential mechanisms of this intervention.

Studies have demonstrated that physical activity, including aerobic and strength exercises as well as mind-body exercise (MBE) interventions, such as yoga, provide moderate benefits in reducing PTSD symptoms. A systematic review and meta-analysis conducted by Björkman & Ekblom (2022), which searched the PubMed, APA PsycInfo, and SportDiscus databases from their inception until February 1, 2021, indicate that intensive engagement in physical activity (exceeding 20 hours) may be associated with greater reductions in PTSD symptoms, as well as improvements in sleep quality, cognitive function, and overall well-being. Physical exercise has also been shown to enhance participants' self-esteem and motivation during therapy. [44]

In a study conducted on older war veterans, the "Warrior Wellness" program demonstrated positive effects on both the physical and psychological functions of participants. Regular physical activity not only alleviated PTSD symptoms but also boosted motivation and the ability to undertake new challenges, utilizing elements of social cognitive theory. [45,46] On the other hand, the role of mind-body exercises (MBE) in preventing PTSD and acute stress disorder (ASD) in trauma-exposed individuals was analyzed in systematic review by Tan et al. (2023). The research included six studies encompassing a total of 399 participants and found that MBE has a small effect in reducing the risk of developing PTSD, primarily in the short term following trauma exposure. According to the studies, MBE may partially prevent PTSD symptoms, however, these effects are limited and short-lived. [47]

While the study demonstrates that physical activity can be an effective intervention for enhancing the functioning of patients with post-traumatic stress disorder (PTSD) and chronic

pain, which often coexists with PTSD, sustaining regular exercise over a long period continues to be one of the main challenges. Within this framework, factors such as self-efficacy and intrinsic motivation play a pivotal role in helping patients establish sustainable exercise habits. These aspects are fundamental for achieving the long-term benefits of physical activity, such as pain reduction and improved psychological well-being. An interesting aspect of this process is the neurobiological mechanisms that contribute to the positive effects of exercise. Research highlights the role of neuropeptide Y (NPY), which elevated levels during physical activity are associated with enhanced motivation and higher self-esteem. Additionally, physical exercise can improve stress coping abilities and restore balance within the neurotransmitter system. [48]

Despite some pieces of evidence supporting the effectiveness of physical activity in the treatment of PTSD, a number of notable limitations remain. Systematic reviews indicate significant differences in research methodologies, making it difficult to reach firm conclusions on the ideal types, doses, and intensities of exercise. In some cases, the therapeutic effect is limited to a short period following the intervention, suggesting the need for long-term support to help patients maintain physical activity. Another challenge is the insufficient number of high-quality studies, particularly those examining the impact of specific types of exercise on different patient populations.

Physical activity holds significant potential as an adjunctive intervention in the treatment of PTSD. Future research should focus on identifying the most effective exercise protocols, including the type, intensity, and duration, as well as on understanding how biological and psychological factors influence the efficacy of these interventions. Equally important is the development of strategies to support the long-term maintenance of physical activity within this population.

3.5 ADHD

Attention Deficit Hyperactivity Disorder (ADHD) is a prevalent neuropsychiatric disorder among children and adolescents. Current estimates suggest that approximately 5-7% of children worldwide are impacted by ADHD, with its prevalence varying according to geographical location and the specific diagnostic criteria applied. [49] Persistent issues with focus, increased impulsiveness, and overactivity, which can significantly impact social, educational, and emotional functioning, are key characteristics of the disorder. [50] ADHD poses a significant challenge to public health and educational systems due to diagnostic difficulties and controversies surrounding potential overdiagnosis in certain cases. [51] Current therapeutic approaches emphasize individualized treatment, combining pharmacotherapy with behavioral

interventions and psychosocial support. European guidelines highlight the need to tailor interventions to the patient's age and symptom profile, thereby increasing treatment efficacy and improving the quality of life for patients. [52]

Physical activity is increasingly recognized as a valuable component in the treatment of ADHD, particularly as an adjunct to pharmacotherapy and behavioral therapy. Research has shown that physical exercise offers moderate improvements in executive functions, attention, and motor skills, though its impact on hyperactivity and impulsivity remains less definitive. Enhanced neuroplasticity, regulation of essential neurotransmitters such as dopamine and norepinephrine, and a rise in blood flow to the brain, particularly in the frontal lobe, are mechanisms that contribute to these benefits. [53, 54, 55]

Research indicate that moderate to vigorous physical activity (MVPA) alleviates core symptoms of ADHD, such as attention deficits, and provides moderate benefits for social functioning. Although the effects of MVPA are less pronounced compared to pharmacotherapy, they are comparable to those of psychosocial therapies. Notably, aerobic and coordination-demanding exercises (e.g., yoga, swimming, trampoline activities) have shown a beneficial impact on working memory, cognitive flexibility, and impulse control. Studies also suggest that group interventions conducted by professionals are more effective than exercises performed independently, likely due to the additional social and motivational support provided. Despite promising results, the diversity of exercise protocols and the lack of standardization in terms of intensity and duration make direct comparisons challenging. Also most analyses have focused exclusively on children, limiting the generalizability of findings to adolescents and adults with ADHD. While some studies have demonstrated high efficacy in improving attention, evidence for significant effects on other symptoms, such as impulsivity or aggression, remains lacking. [56,57,58]

In the context of the brain-derived neurotrophic factor (BDNF), which supports neuronal growth and survival and is associated with cognitive functions [59], studies have not identified differences in its levels between students with and without ADHD. Furthermore, physical exercise did not affect BDNF levels in either group, contradicting earlier studies suggesting that physical activity may increase BDNF levels. It is possible that the moderate intensity and short duration of exercise in this study (30 minutes) were insufficient to induce significant changes in BDNF levels. The scientific literature indicates that an increase in BDNF often requires higher-intensity exercises or longer durations. [55]

Existing evidence suggests that physical activity should be incorporated as a component of comprehensive therapy for ADHD. Effective interventions seem to involve consistent,

moderately intense physical activity lasting a minimum of 20–40 minutes, conducted multiple times a week. Engaging in group activities could also be beneficial, as they help foster the social and motor development of children with ADHD. Further investigations are needed to explore the most effective types of physical activity and their effects on different domains of functioning in individuals with ADHD. [53]

While physical activity does not replace pharmacological treatment, it can function as an important form of therapeutic assistance for individuals with ADHD, offering benefits in both cognitive and social domains with minimal risk of side effects.

Summary

Physical activity is increasingly recognized as a multifaceted and effective approach to addressing various mental health conditions, including depression, anxiety, PTSD, ADHD, and substance use disorders. Research consistently demonstrates its ability to reduce symptoms, with some studies suggesting that even the results are comparable to traditional treatments, while offering additional physical health benefits such as improved cardiovascular fitness, body composition, and metabolic health. Aerobic exercises, resistance training, and running therapy have shown to be especially effective in reducing symptoms of depression, particularly in cases of mild to moderate severity. Similarly, anxiety symptoms are significantly reduced by both low- and high-intensity exercises, while PTSD patients benefit from improved sleep, cognitive function, and overall quality of life through structured exercise programs like yoga, aerobic training, and strength exercises.

In ADHD, tailored exercise programs enhance executive functions, attention, and motor skills, complementing pharmacological and behavioral therapies. Although the effects on hyperactivity and impulsivity are less well-defined, physical activity enhances cognitive flexibility, social engagement, and the establishment of structured routines. For substance use disorders, aerobic exercises and strength training reduce cravings, bolster resilience, and provide a healthy outlet for stress. The biological mechanisms underlying these effects include neuroplasticity, neurotransmitter regulation, and reduced inflammation, alongside psychosocial benefits such as enhanced self-esteem, emotional resilience, and social integration.

Although these benefits exist, challenges still prevail. Many studies rely on small, heterogeneous samples and short-term interventions, raising questions about the sustainability of effects over time. The lack of standardized exercise protocols adds to the difficulty of clinical implementation. Nonetheless, the evidence highlights the significant potential of physical activity as a safe, accessible, and holistic intervention for mental health.

Upcoming studies should aim at standardizing protocols, identifying optimal exercise types and intensities, and exploring long-term outcomes. Greater attention to demographic and cultural factors will help tailor interventions to diverse populations. By addressing these gaps, physical activity can be refined as a cornerstone of mental health therapy, improving well-being across physical and psychological dimensions.

Disclosures

Authors' Contributions Statement

Conceptualization: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Methodology: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Software: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Check: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Formal analysis: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Investigation: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Resources: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Data curation: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Writing - rough preparation: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Writing - review and editing: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Visualization: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Supervision: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

Project administration: Maria Wachowska, Mateusz Romaniuk, Marta Szymura, Wojciech Sowiński, Michał Krawczyk, Paweł Rycąbel, Oliwia Woszczyńska, Marek Molenda, Mateusz Paniak, Agnieszka Wojciechowska

All authors have reviewed and consented to the publication of the final version of the manuscript.

Funding Statement:
This study did not receive funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Acknowledgments

Not applicable.

Conflict of Interest Statement

The authors declare no conflict of interests.

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