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APPLICATION OF RESISTANCE TRAINING IN MENTAL HEALTH DISORDERS, LATEST DISCOVERIES

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ABSTRACT

Mental disorders such as depression and anxiety are leading causes of disability. This review evaluates the potential of resistance training as an adjunctive therapy and its effect on symptoms. A synthesis of meta-analyses, systematic reviews, and randomized controlled trials indicates neurobiological benefits (enhanced brain plasticity and increased BDNF), hormonal effects (reduced cortisol), and anti-inflammatory effects (decreased TNF- α and IL-6). Resistance training also improves self-esteem, sleep quality, and social connectedness, increasing its applicability across patient populations. As a complement to pharmacotherapy and psychotherapy, it offers additional benefits and fewer barriers to implementation. Its program flexibility allows easy integration into personalized care and public-health strategies. Future research should standardize protocols, optimize intensity and duration, and assess long-term effects. Technologies — wearables and mobile apps — may improve adherence and accessibility. Resistance training has the potential to substantially enrich mental healthcare and improve quality of life for people with depression, anxiety, and other mental disorders.

KEYWORDS

Resistance Training, Mental Health, Depression, Anxiety

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Introduction

Mental health disorders, including depression and anxiety, are among the leading causes of disability worldwide, affecting more than 320 million people globally. Depression alone contributes significantly, often lowering life satisfaction more than chronic physical conditions like diabetes or heart disease [1]. These disorders impose substantial social and economic encumbrance, including lost productivity and increased healthcare costs. Traditional treatments, such as pharmacotherapy and psychotherapy, while effective for many, remain inaccessible to a significant proportion of individuals due to resource limitations, stigma, and logistical barriers [2–5].

In recent years, exercise has emerged as a promising adjunct or alternative intervention for managing mental health disorders. Guidelines from major health organizations increasingly advocate incorporating physical activity into therapeutic frameworks for depression and anxiety [6–10]. While aerobic exercise has traditionally dominated these recommendations, resistance training is gaining recognition for its unique physiological and psychological benefits. [11,12]. Resistance training, encompassing exercises like weightlifting and elastic band training, has been associated with improvements in neuroplasticity, hormonal balance, and inflammation, all of which play critical roles in mental health.

From a physiological perspective, resistance training is believed to regulate pathways that are dysregulated in mental health disorders. Depression and anxiety are characterized by disruptions in signaling pathways involving neurotransmitters such as serotonin, dopamine, and gamma-aminobutyric acid (GABA) [13]. Hormonal imbalances, particularly elevated cortisol levels, and pro-inflammatory markers like tumor necrosis factor-alpha (TNF- α) and interleukin-6 (IL-6), further exacerbate symptoms [14,15]. Resistance training has been shown to normalize these pathways by enhancing brain-derived neurotrophic factor (BDNF) levels, promoting hippocampal neurogenesis, and modulating the hypothalamic-pituitary-adrenal (HPA) axis [16].

Additionally, resistance training reduces systemic inflammation through several mechanisms. It downregulates pro-inflammatory cytokines, such as TNF- α and IL-6, by decreasing visceral fat and altering immune system activity [17]. Resistance training also induces the release of anti-inflammatory myokines, such as interleukin-10 (IL-10) and irisin, from skeletal muscles [18]. Improved insulin sensitivity, a result of regular training, mitigates metabolic dysfunctions that exacerbate inflammatory responses [19]. Furthermore,

enhanced mitochondrial function reduces oxidative stress, a key driver of chronic inflammation, thereby lowering systemic inflammation [20].

Resistance training, encompassing exercises like weightlifting and elastic band training, has been associated with improvements in muscle strength and physical fitness [21]). While this study focuses on physical outcomes, enhanced physical fitness is often linked to better mental health, suggesting potential indirect benefits of resistance training on mental well-being.

Studies measuring the impact of resistance training on mental health often utilize validated scales to assess symptom severity. Tools such as the Hamilton Depression Rating Scale (HAM-D), Beck Depression Inventory (BDI), and Generalized Anxiety Disorder Scale (GAD-7) are commonly employed [2,22]. Meta-analyses and systematic reviews ensure methodological consistency by including studies with comparable outcome measures, enhancing the reliability of findings [8,23].

Resistance training interventions vary widely in methodology, including program duration, intensity, frequency, and exercise modalities. For instance, some studies implemented moderate-intensity resistance training programs lasting 8–12 weeks, while others explored higher-intensity regimens over 24 weeks or more [24,25]. Elastic band exercises, traditional free weights, and machine-based resistance exercises are frequently utilized, offering adaptable options for diverse populations.

The purpose of this review is to synthesize evidence from meta-analyses, systematic reviews, and randomized controlled trials to explore the mechanisms, efficacy, and practical applications of resistance training in managing mental health disorders. By consolidating current evidence, we aim to highlight its unique contributions, address existing gaps in the literature and standardizing protocols, this study aims to optimize the therapeutic potential of resistance training for mental health care.

Materials and methods

The primary focus of this review was to identify and synthesize the latest research on the potential benefits of resistance training for mental health disorders. A comprehensive search was conducted using PubMed and Google Scholar, targeting studies published between 2010 and 2024. The search strategy emphasized the inclusion of meta-analyses, systematic reviews, and randomized controlled trials (RCTs), as these study types provide robust evidence regarding the efficacy of interventions.

To ensure precision, keywords were selected from the MeSH (Medical Subject Headings) database and included terms such as "resistance training," "mental health," "depression," "anxiety," "meta-analysis," "systematic review," and "randomized controlled trial." Boolean operators were used to combine these terms and refine search results.

Studies were selected based on their relevance to the research topic, methodological quality, and their focus on the physiological and psychological outcomes of resistance training in populations with mental health conditions. Papers that were not peer-reviewed, lacked sufficient methodological rigor, or did not align with the research objectives were excluded.

This methodology ensured a comprehensive and systematic approach to identifying relevant literature, providing a strong foundation for the synthesis and analysis presented in this review.

Results

Over the past decade, research into exercise-based mental health interventions has expanded significantly, with resistance training emerging as a distinct and promising modality.[5,13] Unlike aerobic exercise, which has long been the focus of studies on mental health, resistance training offers different physiological and psychological benefits that have garnered increasing attention [11,19]. This shift reflects the growing body of evidence supporting its efficacy in addressing both depressive and anxiety symptoms across diverse populations.

Recent meta-analyses and systematic reviews have consistently demonstrated the effectiveness of resistance training in reducing symptoms of depression and anxiety. Gordon et al. (2017) synthesized data from 54 studies and reported substantial reductions in depressive and anxiety symptoms among young adults aged 26 years or younger, with effect sizes (Hedges' g) exceeding -1.00. Li et al. (2024), in their systematic review of 18 studies on elderly individuals, highlighted improvements in both psychological and physiological markers. Mixed-effects models used in the meta-analysis showed significant stabilization of cortisol levels and increases in serotonin concentrations, both critical for mental well-being. [25] analyzing data from 12 trials, emphasized the role of elastic band resistance training in institutionalized older adults, demonstrating

reductions in anxiety and depressive symptoms alongside decreases in inflammatory markers such as TNF- α and IL-6.

In adolescents, resistance training has shown remarkable promise in reducing psychosocial disorders, including depression and stress [4,13,22]. Abou Sawan et al., (2023) and Barahona-Fuentes et al., (2021) noted that conventional strength training yielded the most significant outcomes when compared to modalities like plyometric or vibration-based exercises. These studies emphasized the importance of program structure, with interventions spanning 8–12 weeks showing the greatest efficacy in this population. [26] provides evidence on how leisure-time physical activity positively affects quality of life, encompassing mental health dimensions.

Kim et al., (2022) demonstrated that a 24-week resistance training program for obese older women improved functional fitness, reduced depressive symptoms, and enhanced bone mineral density. In a related trial, Sanchez-Lastra et al., (2022) found that targeted upper and lower body resistance exercises yielded differential effects, with upper body exercises more strongly correlated with cognitive improvements. Syed-Abdul, (2021) highlighted the broader benefits of resistance training in older adults, particularly its impact on self-esteem and daily functionality, which further support mental health outcomes.

Mechanistic studies have gained momentum, focusing on how resistance training influences neurobiological and hormonal pathways. For example, Donyaei et al., (2024) found significant increases in brain-derived neurotrophic factor (BDNF) levels in women with type 2 diabetes mellitus following a combined aerobic-resistance training program. This neurobiological marker is associated with hippocampal growth and improved neuroplasticity, which play a significant role in managing depressive symptoms. Meng et al., (2020) observed reductions in cortisol levels and systemic inflammation, as measured by decreases in TNF- α and IL-6, further supporting the physiological benefits of resistance training.

A notable trend in current research is the exploration of combined modalities, where resistance training is paired with aerobic exercise. These integrated interventions show potential for amplifying mental health benefits by targeting multiple physiological pathways simultaneously [13,19]. Efforts to make resistance training more accessible, particularly for populations of lower socio-economic status, have also gained traction. For instance, Takeshima et al., (2013) demonstrated that resistance band training could be effectively implemented as a low-cost, scalable intervention with significant mental health benefits.

Strength training has gone from being an activity associated with figures of muscular bodybuilders to a promising intervention that can effectively complement pharmacological and psychotherapeutic methods. Its use in diverse populations, combined with physiological and psychological benefits, could be a cornerstone in a mental health disorders treatment strategy.

Discussion

Strength training, by stimulating the secretion of brain-derived neurotrophic growth factor (BDNF), stimulates and supports neurogenesis and synaptic plasticity, which counteracts structural changes characteristic for depression and anxiety disorders [13,16,23,24,29]. It also positively influence hormonal system by down-regulating cortisol levels and increasing the secretion of endorphins, therefore leading to improved well-being and reduced stress levels [10,11,27,30]. Resistance training reduces the amount of secreted pro-inflammatory factors such as Interleukin-6 or TNF- α , which as a factor of chronic inflammation, are associated with the severity of depression [14,15,17].

A positive effect of resistance training is also a reduction in the severity of co-existing chronic diseases such as diabetes or cardiovascular diseases, which can indirectly support the mental health of people affected by them [10,20,24,31]. Silva et al., (2021) emphasizes improvements in endothelial function through resistance training as assessed via flow-mediated dilation (FMD). Enhanced cardiovascular health indirectly supports mental health by reducing chronic disease risk and systemic inflammation.

Moreover, resistance training fosters improvements in physical appearance, self-esteem, discipline, and daily functioning [11,18]. Moreover, resistance training fosters improvements in physical appearance, self-esteem, discipline, and daily functioning ([6,20]. Improved sleep quality, often disturbed in mental illnesses, is another frequently cited benefit [14,24].

Despite these promising findings, several gaps in the literature remain. Inconsistencies in Methodology represent a recurring issue across studies, particularly regarding the design of resistance training interventions. Differences are observed in:

1. Program Parameters: Variability in the intensity, frequency, duration, and types of exercises employed [13,18]. For instance, while some studies focus on high-intensity resistance training over 12 weeks, others explore low-to-moderate intensity over longer durations, complicating comparisons.

2. Population Characteristics: Studies often focus on specific demographics, such as adolescents or elderly populations, making it difficult to generalize findings to the broader population [14,24].

3. Outcome Measures: Tools used to assess mental health improvements, such as the Beck Depression Inventory (BDI) or Hamilton Depression Rating Scale (HAM-D), vary across studies, leading to inconsistencies in reported outcomes [2,6].

To improve consistency and comparability, future research should:

1. Standardize Training Protocols: Establish guidelines detailing optimal training intensity, duration, and frequency for specific mental health outcomes.

2. Expand Population Diversity: Include underrepresented groups such as racial and ethnic minorities, individuals with physical disabilities, and those from low socio-economic backgrounds [10,11].

3. Refine Outcome Measures: Utilize consistent and validated scales to measure symptom changes, such as depression and anxiety scores, across studies.

Most current studies are short-term, typically lasting 8 to 12 weeks, leaving long-term benefits and sustainability of resistance training interventions largely unexplored [15,16]. Longitudinal studies examining the effects of prolonged training on mental health outcomes and disease relapse rates are needed. Additionally, while theories on the role of BDNF, TNF- α , and IL-6 in resistance training's benefits are well-founded, few studies have directly measured these biomarkers in relation to mental health improvements ([23,27]. Advances in serum biomarker analysis and imaging techniques, such as comparative magnetic resonance imaging (MRI) of the hippocampus, could provide deeper insights into these mechanisms.

Practical Implications and Future Directions

Future research should also explore the integration of resistance training into clinical practice. Cost-effectiveness analyses could assess its viability as a standard complementary treatment. The use of wearable devices and mobile applications to improve adherence and personalize training programs is another promising avenue [10,13,20]. Ensuring accessibility through low-cost options, such as resistance bands, could further broaden its adoption [28].

Creating detailed, evidence-based guidelines tailored to specific populations and mental illnesses would be a milestone in advancing the use of resistance training as a therapeutic intervention [4,13].

Conclusions

Resistance training has proven to be a versatile and effective method for improving mental health through multidirectional influence on psychology and physiology. Reduction of depressive and anxiety symptoms has been proven for various populations and age groups. Regulation of BDNF, cortisol, pro-inflammatory cytokines, highlights the role of strength training in reducing the intensity of perceived stress, improving immunity and promoting neuroplasticity [14,17,23].

Besides biochemical aspects, resistance training has a positive effect on well-being, social bonds and facilitates everyday functioning. Thanks to the possibility of using various forms of training (resistance bands, free weights, training with your own body weight), it can be used by people with different abilities and needs [9,18,25].

Much work still needs to be done in future analysis, like considering socioeconomic inequalities, non-adherence, and most importantly lack of standardized training protocols to support mental health. To fully understand the potential of strength training as a therapeutic modality, future research must prioritize development of long-term studies, refined dose-response guidelines, and expanded accessibility through technology-driven solutions such as mobile platforms [1,10,32].

The results of the conducted studies indicate that resistance training cannot be considered as meaningless additional activity, but should be permanently incorporated into public health and clinical practice. If future research goes in the right direction, resistance training has potential to significantly improve mental health care, offering individuals support against mental illnesses at a low cost.

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